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The general public and community pharmacists' perceptions of using robotic dispensing methods: 'hub and spoke dispensing' and 'pharmacy automation' for dispensing in community pharmacies in England

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The general public and community pharmacists' perceptions of using robotic dispensing methods: 'hub and spoke dispensing' and 'pharmacy automation' for dispensing in community pharmacies in England

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Abstract

In 2015, the Department of Health sent out a letter to community pharmacies suggesting efficiencies to be made due to budget cuts, including lower operating costs by using large scaled dispensing methods such as 'hub and spoke dispensing'. Pharmacy automation is a method that is currently adopted in hospital pharmacy. Robotic dispensing has been a proposed method of dispensing in creating more time for pharmacists to engage in other activities such as the provision of services and an out of hours support, as highlighted in various healthcare policies such as the NHS Five-Year Forward View. It is believed by policymakers that community pharmacies need to adopt robotic dispensing methods in order to achieve this. Given the lack of research into the general public perception on the topic of hub and spoke, the aim of this thesis was to explore community pharmacists and the general public perceptions of the use of robotic dispensing methods 'hub and spoke dispensing' and 'pharmacy automation'. Community pharmacists being users of the dispensing technology and the general public being recipients of the use of the technology led to the investigation of the perception of both groups. A literature review was conducted, and an insight into the overview of healthcare policies helped to formulate questionnaires for the two empirical studies. Two large scaled studies were conducted using cross-sectional methodology; postal surveys were sent to community pharmacists (study one) and the general public (study two). The questionnaires identified differences of opinions between community pharmacists and general public respondents, relating towards perceptions towards the use of hub and spoke dispensing and pharmacy automation. Perceptions of community pharmacists were also found to be affected by factors such as age, type of community pharmacy (multiple, independent etc.) worked in and their employment status (employed, locum etc.). Whereas, the perceptions of the general public varied between the age and last type of community pharmacy visited by the respondent. Recommendations regarding the public and community pharmacists' perceptions towards hub and spoke and pharmacy automation have been proposed to help policymakers for the future implementation of robotic dispensing.

Keywords (6):

Community pharmacy
England
General public
Hub and spoke
Pharmacy automation
Robotic dispensing

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Preface

Towards the end of my second year of study my Director of Studies left suddenly, giving me last minute notice of his departure. This caused a major disruption to my studies and called for a new subject expert and a change in PhD topic. My undergraduate tutor at Aston University, Dr Joseph Bush kindly agreed to voluntarily act as subject expert on my supervisory team. During my undergraduate study he encouraged me to complete my training as a pharmacist and then to undertake a PhD so I could pursue a career in academia. I would like to finally thank Dr Joseph Bush for his support over the years which has been invaluable, and I am extremely grateful that he was able to take out his time to supervise my PhD study. Without the voluntary support of Dr Joseph Bush this PhD would not have been possible and I cannot thank him enough. I hope to provide the same level of support to future students and guide them on their journeys during their pharmacy degrees and beyond.

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List of abbreviations

AIMp	**The Association of Independent Multiple Pharmacies**
APPG	All Party Pharmacy Group
CCA	Company Chemists' Association
CCG	Clinical commissioning group
CPD	Continuing Professional Development
DH	Department of Health
EPS	Electronic Prescription Service
GMC	General Medical Council
GP	General Practitioner
GPhC	General Pharmaceutical Council
IMD	Indices of deprivation
IPF	Independent Pharmacy Federation
LA	Local Authority
LPC	Local Pharmaceutical Committee
LPS	Local Pharmaceutical Services
MHRA	Medicines and Healthcare products Regulatory Agency
MPharm	Master of Sciences of Pharmacy
MUR	Medicines Use Review
NHS	National Health Service
NMS	New Medicine Service
NPA	The National Pharmacy Association
OTC	Over the counter
P	Pharmacy only medication
PCT	Primary care trust
PDA	The Pharmacists' Defence Association
POM	Prescription only medicine
Pre-reg	Pre-registration
PSGB	Pharmaceutical Society of Great Britain
PSNC	Pharmaceutical Services Negotiating Committee
RPS	Royal Pharmaceutical Society
RPSGB	Royal Pharmaceutical Society of Great Britain
SPSS	Statistical Package for the Social Science
TV	Television
UK	United Kingdom
USA	United States of America

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Chapter One: Introduction, pharmacy history, policies and regulations

1.1 Overview of thesis

This thesis explored the general public and community pharmacists' perceptions of using robotic dispensing methods 'hub and spoke' and 'pharmacy automation' for dispensing in community pharmacies in England. This thesis provides insights into:

- The background of automation and the literature surrounding dispensing technologies
- The changes in the role of community pharmacy due to the NHS Five Year Forward View (5YFV), suggestions set out by the Department of Health (DH) as well as various healthcare policies relating to pharmacy
- General public and community pharmacists' perception of using robotic dispensing methods 'hub and spoke dispensing' and 'pharmacy automation' in community pharmacies in England
- Perceived benefits, drawbacks and trust with robotic dispensing methods
- The preferred method and location of dispensing by pharmacists and the general public
- Recommendations for the implementation of 'hub and spoke dispensing' and 'pharmacy automation' according to pharmacists and the general public perception

This research was undertaken due to the changes in the NHS involving community pharmacy, outlined by the NHS 5YFV 2014 (NHS England 2014). In 2015, the DH sent out a letter to community pharmacies detailing reductions being made in community pharmacy budget from £2.8 billion to no more than £2.6 billion (Department of Health and NHS England 2015). Therefore, the DH suggested making efficiencies such as the development of large-scale automated dispensing methods such as 'hub and spoke'' (Department of Health and NHS England 2015).

Community pharmacists would be the users of the dispensing technologies and general public as the recipients of the use of the technology in dispensing their medication. Therefore, exploring perceptions of both groups were deemed important to the proposed implementation of technologies by policymakers, as they are affected by the technologies.

1.2 Aims and objectives

The overall aim of this PhD was to investigate the perceptions of the general public and community pharmacists on the use of robotics dispensing methods: hub and spoke dispensing and pharmacy automation for dispensing in community pharmacies in England.

This was achieved by using the following research objectives:

- To understand the background and literature surrounding dispensing technologies
- To understand the various healthcare policies that impact on the role of a pharmacist
- To explore community pharmacists' perceptions of the introduction of robotic dispensing methods 'hub and spoke' and 'pharmacy automation'
- To explore the general public perception of the introduction of robotic dispensing methods 'hub and spoke' and 'pharmacy automation'
- To examine if community pharmacists' perception of robotic dispensing differs between the type of community pharmacies worked in, employment status and demographic factors
- To examine if general public perceptions of robotic dispensing differs between demographic factors and type of community pharmacy last visited
- To analyse any differences or similarities occurring within each study group towards the implementation of 'hub and spoke' and 'pharmacy automation'
- To explore the dispensing preferences by community pharmacists and the general public
- To examine the general public and community pharmacies perceptions of the claims made about robotic dispensing from healthcare policies and relevant professional bodies

1.3 Purpose of PhD

The purpose of this PhD was to evaluate the general public and community pharmacists' perceptions of using robotic dispensing methods, as no study has been conducted regarding this research. This thesis provided a steppingstone for evidence-based literature of the exploration of the public and community pharmacists perceptions of dispensing technologies. This thesis is set to assist policymakers with the proposed implementation of dispensing technologies.

1.4 Introduction and overview of this chapter

This chapter has given an overview into the history behind the development of automation, and the relation to its role in pharmacy practice. The changing role of the pharmacist was also discussed. Polices such as the NHS 5YFV and the role community pharmacy has to play in the future of healthcare were described. Views of large pharmacy organisations such as Pharmaceutical Societies Negotiating Committee (PSNC) and the National Pharmaceutical Association (NPA) were explored. Various policies have also been described such as the Community Pharmacy Contractual Framework 2019/20 to 2023/24. The letter sent out to community pharmacies by the Department of Health suggesting the proposed implementation of large-scale dispensing method such as, hub and spoke, have also been described. The legislation in relation to pharmacy practice have also been specified, including changes that will need to occur for the implementation of hub and spoke. The GPhC guidance in regard to hub and spoke dispensing, as well as models currently implemented within pharmacy companies and the viewpoints of policymakers have also been described. To begin this chapter key definitions throughout this thesis have been described.

1.5 Definitions

Firstly, this section has begun with the definition of pharmacy, a pharmacist and hub and spoke by the General Pharmaceutical Council. The term pharmacy automation and robotics are also described to provide a clear foundation to the start in describing this programme of work.

1.5.1 What is a pharmacy?

'Pharmacy' is a protected title in legislation and so it is an offence to use the term 'pharmacy' in respect of a retail business that is not a registered pharmacy (or the pharmacy department of a hospital or health centre). The purpose of this legislation is to protect public safety. The General Pharmaceutical Council states a pharmacy is

'a premises may only register as a pharmacy where the owner's service model from that pharmacy includes one of the following (General Pharmaceutical Council 2020c).

1) The sale of Pharmacy (P) medicines.
2) The supply of P medicines or Prescription Only Medicines (POMs) against prescriptions. The supply of medicines against prescriptions requires the product to be labelled for a specific patient as a dispensed medicinal product.
3) The supply of P medicines or Prescription Only Medicines (POMs) against prescriptions written by veterinary practitioners for the treatment of animals under the cascade'.

Changes to legal classifications of drugs must be made through the Medicines and Healthcare products Regulatory Agency (MHRA) and can also be made by the pharmaceutical industry. In reference to hub and spoke, the supply of P medicines or POMs against prescription is what would entitle a 'hub' as a pharmacy. Both the 'hub' and 'spoke' operations would require to be registered pharmacies. Operational failures such as large scale 'hub' would need to consider business continuity. Additionally, the 'hub' pharmacies would not require a wholesale dealing license.

1.5.2 What is a pharmacist?

The GPhC state pharmacists to be responsible for:

"the quality of medicines supplied to patients,' 'ensuring that the supply of medicines if within law', 'ensuring that the medicines prescribed to patients are suitable and 'advising patients about medicines, including how to take them, what reactions may occur and answering patients' questions" (General Pharmaceutical Council 2020f).

1.5.3 What is robotics?

Robotics is described as

"systems incorporating sensors and actuators that operate autonomously or semi-autonomously in cooperation with humans. Robotics research emphasizes intelligence and adaptability to cope with unstructured environments" (Goldberg 2011).

Whereas, automation research

"*emphasises efficiency, productivity, quality, and reliability, focusing on systems that operate autonomously, often in structured environments over extended periods, and on the explicit structuring of such environments*" (Goldberg 2011).

To put it simply,

"automation emphasises reliability versus adaptability, and efficiency versus exploratory operations" (Goldberg 2011).

Whereas, robotics emphasizes,

"*feasibility focuses on proof-of-concept, demonstrating how a new functionality can be achieved"* (Goldberg 2011).

1.5.4 What is hub and spoke dispensing?

In 2019, the GPhC described the hub and spoke pharmacy service to be where

"medicines are prepared, assembled, dispensing and labelled individuals against prescriptions at a central 'hub' registered pharmacy".

The GPhC also described the process of hub and spoke where

"the dispensed medicines are supplied by the 'hub' or delivered direct to patients in their homes or to care comes. The 'spokes' may be other registered pharmacies or; or non-registered premises, where patients drop off their prescriptions and from where they collect their dispensed medicines" (General Pharmaceutical Council 2019a).

1.5.5 What is pharmacy automation?

Pharmacy automation can be defined as involving

"*the mechanical process of handling and distributing medications; integrates the data, knowledge, and technology involved with the medication use process to improve outcomes"* (Market prognosis 2018).

Automation systems have been described to streamline workflow, reduce the risk of errors and improve patient-care activities (HeraldKeeper 2018). Systems involve mechanical processes, including medication dispensing, packaging, labelling storage and the retrieval of medications (Cuffari 2018). This was defined by TCGRx, a leading supplier of automation.

1.6 Pharmacy in Britain

This section has briefly focused on the history of pharmacy within Britain and has commenced with the establishment of the pharmacy profession and the changing role of the pharmacist throughout history.

1.6.1 History of pharmacy in Britain

During the thirteenth century, an 'apotheca*'* was described as a place where wine, spices and herbs were stored. The term 'apothecary' was derived from apotheca and was referred to as

"*a person who kept stock of these commodities, which he sold from his shop or street stall*" (Giam et al. 2011).

Traditionally, pharmacists have been known as compounders of medicines (Giam et al. 2011). Whereby, pharmacists have previously had a role in the apothecary (The Worshipful Society of Apothecaries 2020). Pharmacists are associated with overseeing the dispensing and clinical checking of prescription medications. Previously, pharmacists have been in the back of the pharmacy, hidden away in their white lab coats, not seen by the public (Mervyn Madge 1987). In fact, by the 1960s, the compounding and manufacturing roles traditionally held by the pharmacist had now transferred to the pharmaceutical industry (Robinson, 2016). The pre-packed 28 days calendar packs seen in pharmacies today, were being supplied to pharmacies (Bornat 2005). After the loss of this traditional task, the Nuffield Report was then published in 1986, as an inquiry to the future of pharmacy. This was commissioned by the trustees of the charitable trust responsible for funding research, also known as the Nuffield Foundation. Out of the twenty-six recommendations relating to community pharmacy, one involved extending the pharmacists roles (Committee of Inquiry 1986). Over time, the role of the pharmacist has significantly changed, with pharmacists being more associated with providing patients with pharmaceutical care to patients (Hepler and Strand 1990). Hepler and Strand (1990) were two pharmacists who defined pharmaceutical care as:

"the responsible provision of drug therapy for the purpose of achieving definite outcomes that improve a patient's quality of life".

After all "*drugs do not have doses, patients have doses"* (Cipolle 1986). The addition of pharmaceutical care provision to a pharmacist's job role has been a slow progression. Some pharmacists have chosen to take on pharmaceutical care as part of their job role. However, others still remain to stick their stereotype of being responsible for the provision of medicines. The pharmacy degree itself involves a wide range of knowledge of the pharmacokinetics and pharmacodynamics drugs, as well as active training on the clinical care required to be given to patients through case based patient scenarios. When a pharmacist firstly enters community pharmacy practice, after many years of working sometimes this clinical knowledge is lost along the way. As Hepler and Stand (1990) stated perhaps it could be pharmacy leader's responsibility to help search and establish a pharmacist's job role. However, pharmacists themselves need to accept their own pharmaceutical care responsibility before this is put into practice.

Following on, once recommendations from the Nuffield Report had been implemented the RPSGB updated the vision for pharmacy in a report called "*Pharmacy in a New Age (PIANA)*". The idea of this report was to involve as many members of the pharmacy profession as possible in developing a strategy for the future of pharmacy. 'The New Horizon' report in 1996 and 'Building the Future' report in 1997 also set out aims for pharmacy (Longley 2006). Such aims included: pharmacists being able to prescribe, provide advice and support to all patients on long-term medication and ensuring continually providing high-quality care. Having given a brief overview of the history of pharmacy and the ever so changing role. The next section describes the topic of robotics and automation in pharmacy.

1.7 Robotics and Automation

This section has discussed the history of automation in pharmacy and how it firstly came about. This section has ended with adoptions of automated dispensing in hospitals within the UK. The chapter has started with a briefing of the history of automation.

1.7.1 History of automation

Automation is involved in nearly every aspect of our everyday lives. The early stages of automation were found between 1790-1840 with the industrial revolution and industry machinery. The adoption of automation led to the fear of the effects it would have on jobs (ThinkAutomation n.d.).

In the 19th century, Charles Baggage designed the first automatic computing engine, considered to be the world's first computer (Computer History Museum 2020). Additionally, the term 'robot' was invented by Karel Čapek, a Czech novelist, which was derived from the word forced labour in a play Rossum's Universal Robots. In this play a scientist discovered the secret of creating human like machines that are more precise and reliable than human beings. This play presented the first instance of robots taking over the world (The Editors of Encylcopaedia Britannica 2002). The first physical robot 'Elektro' went on display at the 1939 New York World's fair built by electrical manufacturer Westinghouse (Sharkey 2008).This was a key point in the history of automation.

With any field of science, laws are often apparent, Isaac Asimov created the three laws of robotics, which dictated how a robot must act with regards to humans (Saige 2017):

- *One: A robot may not injure a human being or, through inaction, allow a human being to come to harm.*
- *Two: A robot must obey orders given it by human beings except where such orders would conflict with the First Law.*
- *Three: A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.*

In 1948, the first autonomous robot was created by William Gray Walter. The robots were able to find their way around obstacles, with use of sensory inputs light and touch. This enabled robots to follow light whilst making user of a bump sensor. A machines ability to think was measured with the introduction of the turning test in 1950 (ThinkAutomation n.d.) Furthermore, the term artificial intelligence was founded in 1956 at a conference based at Dartmouth University (ThinkAutomation n.d.). This led to the further development and research on robotics. For example, in the 1960s a mobile robot 'shakey' was created, which initially started off with a joke. The 1970s and 1980s, then lead to the 'AI winter'. However, within this period people became negative about the success on AI research and it was then halted.

Nevertheless, in 1979 began the development of the SCARA assembly line and in 1984 the RB5X a robot that learnt from experience. The 1990s began a major advancement in AI with the invention of 'deep blue' who defeated a chess champion and NASA deployed the first autonomous robotics system, 'sojourner', on the surface of Mars. The 1990s also led to the combination of automation with business process management. The early 2000s found the creation of 'ASIMO' the worlds most advanced humanoid robot. Although, after this was a stale period in the development of robotics (ThinkAutomation n.d.)

The next section detailed the involvement of automation in pharmacy, having discussed history of automation as a whole.

1.7.3 History of automation in pharmacy

The section prior to this had discussed how automation had come about, as well as the manufacturing industry, robotics also began to develop in healthcare. The 1970s began the introduction of electronic tablet counters, enabling pharmacy staff to dispense large quantities of frequently tablets in hospital pharmacy. Pharmacy found the introduction of computer systems in the 1980s, which were used for labelling medications and stock control, which impacted the operations within hospital pharmacy (Goundrey-Smith 2008).

1.7.3.1 Automated dispensing in hospital pharmacy

The USA and continental Europe had adopted automated dispensing systems for original pack dispensing in hospital and healthcare facilities (Goundrey-Smith 2008). The reasoning for the use of automated systems included: storage, stock management, picking and labelling medication. This implication of the system allowed stock to be controlled on a pack-to-pack or dose-to-dose basis. The bulk dispensing of loose tablets was also eliminated. However, this factor resulted in the UK not adopting automated dispensing systems as UK hospital pharmacy dispensing involved a mix of bulk dispensing, particularly with high use medications such as paracetamol.

In 1999 the European Community Directive 92/97 came into force. Ten years after the implementation of the directive saw a steady movement to the adoption of original pack dispensing. Original pack dispensing also led to the consideration of prescribing quantities as some drugs usually come in packs of 30 or 28 (Goundrey-Smith 2008). This has made automated dispensing systems in NHS hospitals to be more viable, and allowed more organisational benefits particularly for stock control (Goundrey-Smith 2008).

1.7.3.2 Spoonful of sugar report

The spoonful of sugar report for medicines management in NHS hospitals was produced in 2012, which reviewed the use of medicines in NHS hospitals (The Audit Commission 2001). This report described automation as "*robotics systems releasing staff for patient-centred services and reduce dispensing errors*" (The Audit Commission 2011). The report also detailed information on the implementation of robotic dispensing systems in hospital pharmacy in the UK. In 2001, a case study was conducted case study conducted at Wirral Hospitals NHS trust regarding robotic systems. The adoption of automated dispensing was found to cost approximately £300,000.

Benefits of installing this system included (The Audit Commission 2001):

- reducing dispensary turnaround time
- reducing staff down time
- Using staff more efficiently, where 3 equivalent pharmacy technicians were released to support patient care
- Reduced floor space by one-half
- Improved the reliability of service

- Simplifying ordering processes
- Reduction in dispensing errors from 19 per 100,000 to 7 per 100,000

This report outlined hospital trusts were likely to have the capital if they chose to invest in these systems (The Audit Commission 2001). However, hospital trusts specified different systems did not make sense, as there was no current national specification of automated dispensing. This report displayed the need for guidance to be created by the DH and National Assembly to enable economics of scale and the standardisation of systems and barcodes across hospital pharmacy. This was more likely to make the adoption of automated dispensing more feasible. (The Audit Commission 2001).

1.7.3.3 Pharmacy robots in the UK

Hospital pharmacies have adopted new technologies to streamline the dispensing process in the UK (Goundrey-Smith 2008). In 1999, the Wirral's Hospital NHS trust formulated a business case for an automated dispensing device at Arrowe Park Hospital. An ARX Rowa speedcase device was chosen, which held 8000 items being 80% of the hospital total dispensing volume (Goundrey-Smith 2008). Potential benefits of the system included a redistribution of pharmacy staff to wards and a possible reduction in dispensing errors (Goundrey-Smith, 2008).

The interest of pharmacy automation in the a Spoonful of Sugar audit, resulted in a number of pharmacies implementing automated dispensing services. In 2005, St Thomas hospital installed an ARX Rowa speedcase device. During this time only 150-200 products were stored in the robot; however, the robot was unable to dispense controlled drugs or refrigerator, unlicensed or bulk items. Benefits included, reducing the storage space required, freed up space for a counselling area and enabling the pharmacy team to be able to optimise care given to patients (Goundrey-Smith 2008).

In 2003, several automated dispensing systems were installed across the UK. New Cross hospital located in Wolverhampton, became the first UK site to install a Baxter Consis system (Goundrey-Smith 2008). Within this system, held two picking heads, one for single items and one for multiple items, storing 11,000 items in this device (Goundrey-Smith 2008). The Royal

Liverpool and Broadgreen University Hospitals NHS trust installed a swisslog pack-picker which had 5 heads and labelling stations (Goundrey-Smith 2008). This machine was able to handle 1200 high usage product lines. The dispensing process was redesigned supporting clinical services (Goundrey-Smith 2008). Furthermore, the ARX Rowa Speedcase machine was also installed in Whittingham Hospital and the Royal Free Hospital. A Swisslog Pack-Picker was installed at Charing Cross Hospital (Goundrey-Smith 2008).

West Wales hospital was the first to have an automated dispensing device installed with a tandem configuration Speedcase. The use of this device included dispensing and ward box filling. It also had the capacity to provide remote out-of-hours supplied by on-call pharmacists, which was important to such a rural area (Goundrey-Smith 2008).

This section has discussed the history of automation as a whole and in relation to pharmacy and current adoptions of dispensing methods used in the UK. The next section has given an overview of healthcare policies within the UK.

1.8 Hub and spoke dispensing and pharmacy automation

Matt Hancock became the Secretary of State for Health and Social Care in 2018 and made technology one of his three priorities for the NHS. His vision was for the better use of technology enabling better care and to save public money, in which he expected all healthcare providers to embrace this approach including community pharmacies. For pharmacy this could include the adoption of artificial intelligence, automated dispensing facilities and hub and spoke dispensing (Pharmaceutical Services Negotiating Committee 2018). This section begins with explaining the various models of hub and spoke.

1.8.1 Different types of 'hub and spoke' dispensing

Moreover, confusion has been reported over the terms 'hub-and-spoke' and 'centralised' dispensing. In the hub and spoke model 'prescriptions come into the spoke pharmacy and are sent electronically to the hub, where they are assembled and then returned to the spoke'. Pharmacists at the spoke are in patient contact, offering support and advice. This model deals with repeat prescriptions including monitored dosage systems with a 48-hour prescription turnaround (Elvidge 2016). Conversely, centralised dispensing involves relationships between patients and pharmacists at the hub. In this model dispensed drugs are up picked up from a collection point or delivered by courier or post. With this system, there are fewer opportunities for pharmacists to give patients individualised advice and support. Although this method has said to be more advantageous for housebound patients, or those struggling with interpersonal interactions. Claire Ward, chair of Pharmacy Voice, describes centralised dispensing as “the ‘Amazonisation’ of pharmacy, treating pharmacies as commodities” (Elvidge 2016).

An alternative model to the UK hub and spoke model, is the where the ‘hub’ pharmacy sends medicines directly to the patient or via a delivery company. The development of other models may exist in the future, however in any model patients should have access to the pharmacist. The UK spoke is required to have an NHS contract however, this is not an obligation for the hub. Although as both the hub and spoke are registered pharmacies, they must have a superintendent pharmacist. In multiple community pharmacies, the superintendent is the same at both the hub and spoke, however in independent companies this will be different (Elvidge, 2016). There are no proposals for any restrictions to be outlined in the Human Medicines Regulation 2012, as to what hub and spoke model can be operated. However, pharmacies providing NHS pharmaceutical services may have conditions for ‘hub and spoke’ outlining the above.

1.8.2 Automated dispensing

Dispensing technologies have been involved in the dispensing and distribution stages of the medicines use process. Automated dispensing has been used to describe ‘automated dispensing cabinets’ and ‘automated dispensing systems’. Automated dispensing cabinets are associated with the distribution of medications and not specifically dispensing.

Automated dispensing cabinets (ADCs) are commonly used as a medication distribution method in hospitals across the United States (US) (Rhodes & McCarthy 2019). Studies have shown automated dispensing cabinets to be evaluated by medication errors (Shah, Galt and

Fuji 2019; Fanning, Jones and Manias 2006). A mixed methods study using surveys on pharmacists was conducted by Shah, Galt and Fuji (2019) evaluating types of errors before and after the implementation of medication-related technologies, including ADCs. It was found that the use of ADCs eliminated four types of error associated with dispensing, labelling, narcotic safety and transcription. However, Shah, Galt and Fuji (2019) failed to specify that these errors were specifically due the implementation of using ADCs as other medication-related technologies were evaluated such as e-prescribing. Therefore, studying each medication-related technology separately would have allowed deeper understanding to what types of medication-related technology causes what types of error.

A prospective and direct observational before-and-after study conducted by Fanning, Jones and Manias (2016) evaluated the impact of ADCs on medication selection and preparation errors rates in an emergency department, involving 89 direct nurse observations. Medication errors were shown to reduce post-implementation where 864 errors occurred compared to 1139 errors pre-implementation of ADCs (Fanning, Jones & Manias 2006). This study was limited by the fact night-time observations were not conducted which may have resulted in an increase of errors (Fanning, Jones & Manias 2006). One major drawback of this study was the fact that pre-implementation, data were collected at the original emergency department and post-implementation data were collected at the new emergency department. Therefore, this study cannot state the implementation of ADCs alone reduced medication errors as the new environment could have been an impact factor.

Contrary to automated dispensing cabinets, automated dispensing systems are involved in the dispensing of medication as opposed to the distribution. Automated dispensing systems have been widely used in hospital pharmacy, for example for the administration of drugs with narrow-therapeutic indexes such as vancomycin (Ward et al. 2012). An automated dispensing system has been defined as

"a mechanical system that performs operations or activities, other than compounding or administration, relative to the storage, packaging, counting, labelling, and dispensing of medications, and which collects, controls and maintains all transaction information" (Department of Justice 2003).

1.8.3 Pharmacy automation

In contrast, to automated dispensing systems which refers to the mechanical system rather than a process. Pharmacy automation offers the potential to enable pharmacists to carry out patient related tasks, at optimal levels, research has shown time saved could amount to a potential hour throughout the day (Parks 2001).

1.9 Healthcare policies

The upcoming changes in the NHS have been associated with various policies, where regulators and membership bodies have evaluated the impact these will have on the future of pharmacy practice. This section covered the different policies and reports that have been undertaken within the NHS and pharmacy practice, around changing the role of the pharmacist and the proposed use of hub and spoke dispensing. The first part of the section has briefly described NHS policies in the 20th century.

1.9.1 Pharmacy in the 20th Century

In the year 2000, the NHS plan was published outlining various reforms for the NHS (NHS 2000). The labour party were elected in 1997 and Tony Blair was prime minister at time leading to implications for both the NHS and pharmacy. Following the publication of the NHS plan, 'Pharmacy in the Future – Implementing the NHS plan' outlined the future role pharmacy would play in the NHS (NHS 2000). The plan meant pharmacists would work more flexibly alongside other professionals. This would allow them to spend more time on individual patients' clinical needs and work in a system promoting life-longing learning and continuing their professional development. The establishment of Primary Care Trusts (PCTs) was also underlined in this plan, highlighting the fact that at the time more and more pharmacists were in fact prescribing advisers. PCTS had the role of controlling the spending on NHS services included those provided by pharmacists (NHS 2000).

In 2003, the NHS published a progress report on the NHS plan for pharmacy, 'Pharmacy in the Future, A Vision for Pharmacy in the new NHS', which highlighted 10 key roles of pharmacy (Department of Health 2003). The report also underlined how the role of the pharmacist needed to change to meet patient needs. However, still emphasising the great importance of the traditional role of the pharmacist (Department of Health 2003). Additionally, technological and scientific advances stated pharmacists needed to broaden their contribution. Pharmacists were pointed out to be an untapped resource for health improvement, where pharmacists should be the first point of contact with healthcare services. Pharmacists were also stated to playing a part in the improvement of the quality of services and tackling health inequalities (Department of Health 2003).

In April 2005, a community pharmacy contractual framework was introduced. The contract was made up of three different service levels: essential services, advanced services, locally commissioned services. Essential services are offered by all pharmacy contractors as part of the NHS Community Pharmacy Contractual Framework (Pharmaceutical Services Negotiating Committee, 2020b). There are six advanced services (Table 1.1) within the NHS Community Pharmacy Framework , where community pharmacies can provide any of these services as long as they meet requirements set out in the Secretary of State Directions (Pharmaceutical Services Negotiating Committee 2020a). Medicines Use Reviews (MURS) are an example of an advanced service and consisted of a structured review undertaken by a pharmacist to help patients manage their medication more effectively (Pharmaceutical Services Negotitating Committee, 2020g). These reviews take place in a private consultation room. The pharmacist must be accredited to undertake structured adherence-centred reviews with patients on multiple medicines, especially those with long term conditions. The service itself is a way for pharmacists to review patients use of their medication, ensuring they understand how to use their medicines and why they have been prescribed. In the review pharmacists are able to identify any problems and where necessary provide feedback to the prescriber. Although, an MUR is not considered as a full clinical review. Interestingly, two-thirds of pharmacists reported to feel under pressure to provide MURs at least once a day according to Chemist and Druggists readers, revealing both employed and locum pharmacists are under pressure (Collins 2016).

National target groups were previously agreed as a guide of selecting patients who will be offered the service (Pharmaceutical Service Negotiating Committee 2020e). As of 1st October 2019, at least 70% of MURs conducted in pharmacies required pharmacists to fall within two target groups: patients taking high-risk medicines or who were recently discharged from hospital who had changes made to their medication whilst in hospital (Pharmaceutical Services Negotiating Committees 2020e). Although, plans later this year (2020/21), state contractors can provide a total of 100 MURS, with the service being decommissioned at the end of 2020. Within the first quarter of 2020/21, 70% of MURS should fall within the two target groups stated above. An NHS Discharge Medicines Service was planned to be implemented in July 2020.

Following on, the New Medicine Service (NMS) is also another example of an advanced service, which commenced in 2011 (Pharmaceutical Services Negotiating Committee, 2020d). This was the fourth advanced service added to the Community Pharmacy Contractual Framework. The implementation of this service was followed by the government white paper, 'Pharmacy in England; Building on strengths- delivering the future', where the paper called for 'a new service for those who are starting to take regular medicines to treat their condition for the first time' (Department of Health 2008).

The NMS aimed to support people who have been prescribed a newly prescribed medicine with conditions, thereby aiding to improve medicines adherence and focussing on particular patient groups and conditions (Pharmaceutical Services Negotiating Committee, 2020d). More than 90% of community pharmacies have provided the service since its introduction in England. In an academic evaluation investigating clinical and economic outcomes of NMS by the University of Nottingham, findings were found to be overwhelmingly positive. Therefore, NHS England decided to the continue commissioning of the service (Pharmaceutical Services Negotiating Committee, 2020d). An increase in medication adherence, as much as 10% has been seen with the implementation of the NMS compared with normal practice (Elliot et al. 2017 and Elliot et al. 2016). Additionally, increased health gains have also been found at a reduced overall cost (Elliot et al. 2017).

Finally, locally commissioned services, formally known as 'enhanced services' are services which can be contracted through a number of different routes and different commissioners including, local authorities, Clinical Commissioning Groups (CCGs) and local NHS England teams (Pharmaceutical Services Negotiating Committee, 2020c). Examples of locally commissioned services including: alcohol screening and brief Intervention, emergency hormonal contraception and stop smoking services (Pharmaceutical Services Negotiating Committee, 2020c).

Essential Services	Advanced Services
Dispensing Medicines, appliances	Community Pharmacy Consultation Service (CPCS)
Clinical Governance	Hepatitis C Testing Service
Repeat Dispensing	Flu Vaccination Service
Discharge Medicines Service	New Medicine Service
Support for Self-Care	Stoma Appliance Customisation (SAC)
Public Health (Promotion to Healthy Live)	Medicines Use Reviews (MUR)
Disposal of Unwanted Medicines	Appliance Use Reviews (AUR)

Table 1.1 Essential and advanced services adapted from (Pharmaceutical Services Negotiating Committee 2020a; Pharmaceutical Services Negotiating Committee, 2020b and Pharmaceutical Services Negotiating Committee 2020c)

1.9.2 Pharmacy in the 21st century

In 2010, the government consisted of a Conservative-Liberal Democrat coalition. At the time, the '*White Paper, Equity and excellence: liberating the NHS'* was also published outlining Government reforms for the NHS in England (Department of Health 2010). In 2012, the Health and Social Care Act was established, signifying changes in the structure of the NHS. It was the first act introducing legal duties regarding health inequalities. The act set to put clinicians at the centre of commissioning, freeing up providers to innovate, empowering patients and giving a new focus to public health. NHS England passed on responsibilities that were previously dealt with by NHS England, a politically independent body.

Only, pharmacists dealing with the commissioning of services were subjected to the change. Currently, CCGs and LAs uphold responsibility for commissioning services replacing PCTs in 2013 (NHS Clincial Commissioners n.d.). CCGs are membership bodies with local GP practices as members. They are led by an elected governing body made up of GPs, other clinicians including a nurse and a secondary care consultant and lay members (NHS Clincial Commissioners, n.d.). CCGs are responsible for approximately 2/3 of the total NHS budget, being £79.9 billion in 2019/20 (NHS Clincial Commissioners n.d.).

NHS Commissioning Board local area teams are responsible for commissioning pharmacy services (Wilkinson 2013). However, pharmacies are required to work closely with CCGs for any type of pathway redesign, for example any locally enhanced service such as minor ailments, sexual health or medicines management (Wilkinson 2013). After the introduction of CCGs, pharmacy leaders called for more engagement between CCGs and pharmacists, instigated by disappointing results from a Chemist and Druggist investigation (Waldron 2013).

Local Pharmaceutical Committees (LPCs) exist as the local organisation for community pharmacies, recognised by NHS England under the NHS Act 2006 (Pharmaceutical Services Negotitating Committee 2020g). LPCs are an independent and representative group whose focus is for all community pharmacists and community pharmacy itself. They work locally with NHS England Area Teams, CCGs, Local Authorities and other healthcare professionals to plan healthcare services (Pharmaceutical Services Negotitating Committee 2020g). It is the job of the LPC to discuss and negotiate pharmacy services with commissioners, giving advice to pharmacy contractors and others wanting to know more about pharmacy services (Pharmaceutical Services Negotitating Committee 2020g). LPCs work closely with the Local Medical Committee as well as Local Dental Committees and Local Optical Committees (Pharmaceutical Services Negotitating Committee 2020g). Meaning that pharmacists are other healthcare professionals and work closely and deliver services to patients. However, in February 2020, pharmacy bodies have called for a reduction in the number of LPCs, reflecting the changing structure in the NHS (The Pharmaceutical Journal 2020a). Pharmacy bodies have agreed that reducing their numbers would free up funding for other local services (The Pharmaceutical Journal 2020a).

In 2013, the NHS (Pharmaceutical and Local Pharmaceutical Services) Regulation replaced the NHS (Pharmaceutical Services) Regulations 2012 and the NHS (Local Pharmaceutical Services etc) Regulations 2006. These regulations covered matter such as the production of pharmaceutical needs assessment, general matters relating to pharmaceutical lists and applications from chemists to join them. Part 7 and 8 of the regulations covered areas which are rural in which doctors may apply dispensing services, a restricted range of pharmaceutical services.

Overall, this section has given an overview of the history of pharmacy, how the role of the pharmacists has changed overtime. By understanding the history of pharmacy may help further understand the application of theories and further policies.

1.9.2.1 NHS Five Year Forward View

The NHS has experienced a dramatic amount of change from 1999-2014 (NHS England 2014). The NHS believe that the quality of care needs to be changeable, preventable (illness – widespread) and for a reduction in health inequalities (deep rooted). The changing needs of patients and emerging new treatments called for a change in the NHS. In October 2014, the NHS announced a five-year plan titled the '*NHS Five Forward View'*. This plan was developed by partner organisations that deliver and oversee health and care services, including Care Quality Commission, Public Health England and NHS Improvement (NHS England 2014). The changes implemented in this plan have also been suggested by patient groups, clinics and independent experts. The three main aims of the 5YFW were to narrow the widening health gap in the population, improve quality of care and for the funding of services (NHS England 2014).

NHS England and the national partners introduced 'new models of care', to change the way health care is delivered within the NHS. In order for the 5YFV to be delivered, vanguards were introduced. The five vanguards were: integrated primary and acute care systems, multispecialty community providers, enhanced health in care homes, urgent and emergency care and acute care collaborations. The vanguards were established to help design and develop these new models of care and help tackle upcoming challenges that may lay ahead. The emergency models of care are the care model most affect pharmacy (NHS England, n.d.).

1.9.2.1.1 NHS Five-Year Forward View and Pharmacy

The 5YFV also sets out ways in which groups of different healthcare professionals can act to help support the roll out of the new care models. The report outlined ways in which pharmacies can help support out of hours care, such as pharmacists being able to become non-medical prescribers and the referral of patients through NHS 111. NHS 111 was introduced to help people seek the right advice and treatment for their physical and mental health when urgently needed from clinicians, available online or on the phone twenty-four hours a day, seven days a week (NHS England 2017). Therefore, underlining the importance of building up the public understanding into how pharmacies can help them deal with minor ailments. Throughout history, pharmacists have had a traditional role in providing medicine, and often only having interactions with patients when handing out medications (PSNC, 2014). As time has gone on, pharmacists have had more of an active role in providing public health services such as smoking cessation (World Health Organization and International Pharmaceutical Federation 2006). However, still also maintaining elements of their role in being seen as compounders of medicine (Giam et al. 2011). Even though, pharmacists are able to give general health advice about medications and conditions, they are not always recognised for this. Previous reviews have showed the general public have not recognised community pharmacy as a source of general health information. Community pharmacies have been perceived as a place to collect prescription medication, for the purchase of over the counter medication and advice on minor health problems as opposed to long-term health conditions (Anderson et al. 2008, Anderson et al. 2004, Krska and Morecroft 2010 and Eades et al. 2011).

The plans set out in the 5YFV aimed to educate patients on the additional roles of pharmacist, on top of providing patients with prescriptions and over the counter medication. The new models of care regarding pharmacy in the review, involved pharmacies supporting out of hour's care (NHS England n.d.). The care models were also designed to help support the prevention or worsening of health conditions (PSNC 2014). The emergency models of care are one of the care models involving pharmacy. This care model was designed to push pharmacies to support an out of care system as well as being in providing more pharmaceutical care. The implementation of this care model could help the general public understanding that pharmacies and online resources can help deal with coughs, colds and other minor ailments. Building up patients understanding that they do not need to go to A&E and GPs for such ailments could potentially reduce waiting times in primary care (PSNC 2014). Pharmacy could help to improve the care for patients, support patients living independently and healthy and helping them to manage their own conditions. These opportunities could have a significant in changing the role of the pharmacist and enable them to be more adaptable in providing more pharmaceutical care to patients. The NHS views pharmacy to be an integral part of its future plans and pharmacy as a profession should utilise this to their advantage (NHS England 2014).

Complementary approaches linked to pharmacy that can be applied to help achieve the goals set out in the 5YFV include, 'accelerating innovation in new ways of delivering care'. The idea of this involves combining different technologies to change the delivery of health care, known as combinatorial innovation (PSNC 2014). Pharmacy as profession already uses technology to aid pharmaceutical care, such as blood pressure monitors and blood glucose meters. Further identifying possible scope for the expansion of such technologies in the future.

Later on, in December 2014, an update to the 5YFV was published titled, the report '*Next steps on the NHS Five Year Forward View'* (NHS England 2017). Significant development was shown in the progress report of the 5YFV, where better health was enforced by the action on prevention and public health. Examples of such actions include: the first national diabetes prevention programme and vaccination of over one million infants against flu (NHS England 2017). The follow up report outlined how technology would be used to support NHS priorities. NHS England was also stated to be involved in testing apps, web tools and interactive avatars in local areas using detailed evaluation to define the best approach.

This report highlighted how the steps will be taken to 'get the best value out of medicines and pharmacy.' As stated in the General Practice Forward View (NHS England 2016), NHS England co-funded pharmacists to work in GP practices to provide support to prescribing and medicines optimisation. Additionally, decisions regarding formularies were proposed to be made nationally as opposed to by each CCG. NHS Clinical Commissioners and CCGs reviewed the expenditure on medicines of low clinical value or available over the counter such as indigestion remedies, travel sickness and cough remedies. Costs of these medicines were found to account up to £128 million a year (PSNC 2017). The NHS spent around £16 billion a year on drugs and in 2016, the NHS drugs bill grew over 7%, shown as fastest growth in the overall NHS budget (NHS England 2017). Medicines Optimisation Committees now co-ordinate in medicines optimisation opportunities, including in care homes, multiple prescribing, use of generics and biosimilars, and reducing medicines wastage (NHS England 2017).

The NHS strived to increase the number of clinical pharmacists working in GP surgeries from 491 in 2017 that to over 900 by March 2018 and over 1300 by March 2019. Not only were patients projected to benefit from pharmacy services, but the introduction of clinical pharmacists was also proposed to help free up GP time to focus on those patients who need it most. For example, by supporting patients to manage high risk conditions such as high blood pressure earlier and more effectively, preventing cardiovascular disease (NHS England 2017).

1.9.2.2 Department of Health letter to PSNC

In 2015, a letter titled '*Community pharmacy in 2016/17 and beyond*' was sent to the PSNC, the voice of community pharmacies in England (Department of Health and NHS England, 2015). This letter marked the start of the consultation process on community pharmacy in 2016/17, as the government wished to better integrate community pharmacy into primary care (Department of Health 2015). The DH also highlighted the time for efficiencies to be made due to cuts in the pharmacy budget. One suggestion was the development of large-scale automated dispensing such as 'hub and spoke' arrangements which also was stated to provide opportunities for further efficiencies. The letter also stated the DH wished to work with pharmacy bodies and patient groups on best ways to maintain patient and public access whilst pursuing these efficiencies. The proposals set out in Community Pharmacy in 2016/17-and beyond proposal document stated hub and spoke to help pharmacies to become more efficient and innovative through the adoption modern dispensing methods. The efficiencies were proposed to help pharmacies lower their operating costs and enable pharmacists and their teams to provide more clinical services and to improve and support people's health (Department of Health 2016).

The Department of Health supported the 5YFV plans in a click and collect service for the ordering and delivery of patient prescriptions. They felt patients needed more online choices on how to order their medications online. Encouraging the optimisation of medicines duration and decreasing the wastage of medicines was also highlighted and save further costs amongst the NHS (Department of Health and NHS England 2015). Finally, the introduction of a Pharmacy Integration Fund was also introduced to change the use of community pharmacies in the NHS. Thereby, supporting the new models of care mentioned in the 5YFV (NHS England n.d.)

To summarise, the Department of Health believe finding more cost-effective ways of dispensing such as the 'hub and spoke model', could help to reduce operating costs and release pharmacists from their dispensing function to provide more pharmaceutical care (Department of Health & NHS England 2015). Community pharmacy is said to be at the heart of the NHS, utilising and optimising the use of pharmacists could be a driving force in improving care for patients with long-term conditions.

1.9.2.3 NHS Long Term Plan

In 2018, the NHS long term plan was published 'exploring further efficiencies through reform of reimbursement and wider supply arrangements' (NHS England 2019). The plan outlined the increasing digital options in supporting clinical care. For example, if a patient needed urgent treatment care, they could either use out of hours service or their GP. Medications could then be electronically prescribed and sent to pharmacy where they could be collected. Furthermore, future consideration of automated services and artificial intelligence (AI) would help make such systems smarter, with in-person services also being smarter for patients who need to want them (NHS England 2019).

This section highlighted NHS plans in relation to effects on community pharmacy and how its operations could change. The next section has described how the community pharmacy contractual framework will help support the delivery of the NHS long term plan.

1.9.2.4 The Community Pharmacy Contractual Framework for 2019/20 to 2023/24: supporting delivery for the NHS Long Term Plan

The Department of Health and Social Care published the *'Community Pharmacy Contractual Framework for 2019/2020 to 2023/24: supporting delivery for the NHS Long Term Plan*.' This framework highlighted pharmacists to have an essential role in the delivery of the long-term plan. Funding was used to expand primary care networks, where clinical pharmacists as with other healthcare professionals, have used their expertise to work alongside GPs for fully integrated community-based health care. Plans were also made for ongoing training and development of multidisciplinary teams in primary and community hubs. NHS 111 also started direct booking into GP practices across the country from 2019, as well as the referral of patients to community pharmacies who supported urgent care and promoted patient self-care and self-management. CCGs also developed pharmacy connection schemes for patients who don't need primary medical services (Department of Health & Social Care, NHS England, NHS Improvement and PSNC 2019). Furthermore, the NHS Community Pharmacist Consultation Service (CPCS) launched as an advanced service in October 2019 (Pharmaceutical Services Negotiating Committee 2020i). This service involves the CPCS to take referrals to community pharmacy from NHS 111, and NHS 111 online for requests for the emergency supplies of medicines (Pharmaceutical Services Negotiating Committee 2020i). This service as aimed to provide community pharmacy to play an even bigger role within urgent care.

The framework also stated 'technology will transform the supply of medicines and delivery of pharmacy services'. Wider discussions occurred on how community pharmacy could be clear with its IT suppliers, with the functionality required as the sector evolves. The new and expanding way of community pharmacy was said to require different ways of working. The need for dispensing to become more efficient was highlighted particularly in freeing up the pharmacists to provide new services, working at the top of their clinical license in a more professionally rewarding way to optimise benefits to patients (Department of Health & Social care, NHS England, NHS Improvement and PSNC 2019).

The government with the support of the PSNC was said to continue to pursue these changes. These changes include legislative changes allowing all pharmacies to benefit from hub and spoke dispensing and enable the increased use of automation and associated benefits. Additionally, the framework also stated the exploration and proposed implementing greater use of original pack dispensing in supporting efficient dispensing. Legislative changes were also highlighted in the framework proposing better use of the skill mix in pharmacies and enabling the clinical integrations of pharmacists. The impact of changes to funding and fee structures will also be explored in the future, including different types of prescriptions. Future changes may include supporting the community pharmacy market in moving towards more efficient dispensing practices, while increasing the clinical and public health content of any patient interactions (Department of Health & Social care, NHS England, NHS Improvement and PSNC 2019).

Funding through the framework has supported pharmacies in some places, ensuring good access to NHS pharmaceutical services. The consolidation of pharmacies with branches of the same company or even with competitor's pharmacy closely located may wish to consider this option. Protection will be offered to pharmacies wishing to consolidate under Regulation 26A of the NHS (Pharmaceutical and Local Pharmaceutical) Regulations 2013 (Regulation 26, NHS Pharmaceutical and Local Pharmaceutical Regulations, 2013). Thereby, maintaining fair and open competition and access to NHS pharmaceutical services.

Unnecessary administrative requirements was also mentioned to be reviewed to reduce regulatory burdens on service providers, such as looking to simplify current prescription endorsing requirements, as well as ceasing routine opening hours and complaints declarations. In 2020/21 introducing revised terms of service to reflecting the different way in which people use and access online services and the way services are provided were also reviewed. Continually protecting patients' free choice of community pharmacy, they wish the dispense their prescription also remains the same (Department of Health & Social care, NHS England, NHS Improvement and PSNC 2019).

This section described the community pharmacy contractual frameworks proposals. The next section highlights various parts of the GPhC strategic plan 2020-2025.

1.9.2.5 The GPhC Strategic Plan 2020-2025

In 2020, the GPhC released their five-year plan titled, 'strategic plan 2020-2025' (General Pharmaceutical Council 2020e). The aim of the plan was to deliver an adaptable standards framework that meets public and professional needs that are changing quickly. The idea of these standards and guidance were to help professionals deliver a broader range of clinical services, working in a variety of settings within different models of service delivery. Ideas included incorporating more and more advanced technology and significantly developing the new technologies on clinical care and advances in science and the way medicines are supplied.

1.9.3 Summary

Overall, this section has given an overview of the history of pharmacy, how the role of the pharmacists has changed overtime. By understanding the history of pharmacy should help further understand the application of theories and further policies. The next section has detailed information on legislation in the UK regarding pharmacy practice.

1.10 A summary of UK pharmacy practice legislation

This part of the chapter has detailed the current UK legislation, regarding pharmacy practice. The section begins with describing the Medicines Act 1968, Responsible Pharmacists Regulation 2008, Humans Medicines Regulation 2012, Health and Social Act 2012 and finally Pharmaceutical Services legislation 2008.

1.10.1 The Medicines Act 1968

The Medicines Act of 1968 was the first licensing system for medicines introduced to the UK. The Secretary of State responsible for Health in England and the Minister for Health in Northern Ireland are responsible for the administration of the Medicines Act 1968. This act provided a system for the manufacturing and dealing of medicines, including exemptions for certain persons and the facilitation of good healthcare in relation to medicines. Arrangements for pharmacy businesses, including the registration of pharmacy premises as covered in this Act. Furthermore, this Act classifies medicines into three different categories: Prescription Only Medicines (POMS), Pharmacy only medicines (which can only be sold to the public in a registered pharmacy by or under the supervision of the pharmacist) and General Sales list medicines.

1.10.1.1 Section 10 of the Medicines Act 1968

Certain exemptions are included in the Medicines Act 1968. Section 10 provides an exemption from the need of a manufacturing license for the assembly or preparation of medicinal products from a registered pharmacy, and from the need of a manufacturing license for the assembly or preparation of medicinal products in a registered pharmacy, as well for the medicinal product to have marketing authorisation. This is only applicable where activism is done with a view to sell or supply the product from the same pharmacy on one which forms part of the same business. Currently Section 10 of the Medicines Act 1968 (Section 10 of the Medicines Act, 1968), only allows hub and spoke dispensing if the hub and spoke pharmacy are both of the same retail pharmacy business, subsequently the same legal entity. Therefore, this means that pharmacies of different legal entities are in fact unable to adopt hub and spoke arrangements, meaning that changes need to be implemented.

1.10.2 Medicines (Pharmacies) (Responsible Pharmacist) Regulation 2008

The Medicines (Pharmacies) (Responsible Pharmacist) Regulations 2008 was introduced in 2009 where the regulation was changed (General Pharmaceutical Council 2020d). This regulation led to the introduction of 'the responsible pharmacist' with the lawful requirements when running a retail pharmacy business (General Pharmaceutical Council 2020d). A responsible pharmacist is required to be in charge of the registered pharmacy, appointed by the retail pharmacy business (General Pharmaceutical Council, 2020d). This was to ensure the safe and effective running of the registered pharmacy, when it's operational (General Pharmaceutical Council 2020d).

Legal requirements in the Medicines Act 1968, and the Medicines (Pharmacies) and (Responsible Pharmacist) Regulations 2008 associated with the responsible pharmacist include (General Pharmaceutical Council, 2020d):

- Displaying a notice detailing who the RP is
- Making and keeping records

- Pharmacy procedures
- Responsible pharmacist's absence from the pharmacy

1.10.3 Human Medicines Regulation 2012

The Human Medicines Regulation 2012 came into force in 2012, consolidating the law of the UK concerning medicinal products for human use. The regulations set out a regime for the authorisation of products in terms of manufacturing, importing, distributing, sale and supply of those products (Department of Health n.d.). The regulation also made provisions for the Responsible Pharmacist regulations made in 2008 (Department of Health n.d.).

1.10.4 Health and Social Care Act 2012

The Health and Social Care Act was introduced in 2012 and was in fact the first Act to introduce legal duties about health inequalities. The idea of the Health and Social Care Act 2012, was to put clinicians at the centre of commissioning, freeing up providers to innovate, empower patients, giving a new focus to public health.

1.10.5 The NHS (Pharmaceutical and Local Pharmaceutical Services) Regulations 2013

In 2013, the NHS (Pharmaceutical and Local Pharmaceutical Services) Regulation replaced the NHS (Pharmaceutical Services) Regulations 2012 and the NHS (Local Pharmaceutical Services etc) Regulations 2006. These regulations covered matter such as the production of pharmaceutical needs assessment, general matters relating to pharmaceutical lists and applications from chemists to join them.

The section has described UK legislation regarding pharmacy practice and proposed needed to implement hub and spoke. The next section has further detailed models of hub and spoke model.

1.11 Hub and spoke model in the UK

Currently, the hub and spoke dispensing model in the UK is only applicable to pharmacies in the same retail pharmacy business. This means that the model is not feasible for independent pharmacies to adopt this method. The model also has allowed for cost advantages to be exploited by expanding the scale of assembly and preparation making automation more viable. Whereby, automated dispensing alongside robust quality assurance systems are said to be linked to safer dispensing, with fewer dispensing errors (Department of Health 2016). Where large scale 'hub' pharmacies have the capacity to increase efficiency and lower operating costs.

In regard to UK legislation, Section 10 of the Medicines Act 1968, only allows 'hub and spoke' dispensing to take place if the 'hub' and 'spoke' pharmacy are both part of the same retail pharmacy business. Section 10 of the Act provides the exemption needing a manufacturing license for the assembly or preparation of medicinal products in a registered pharmacy and from the need for a medicinal product to have a marketing authorisation. However, this is only applicable where the activities are done with a view to sell or supply the product from the same pharmacy or one which forms part of the same business. Therefore, only pharmacies of the same chain can use the current UK 'hub and spoke' model.

1.11.1 Proposed changes to the current hub and spoke model

The current legislation means that the hub and spoke will not function for all types of community pharmacy, only with pharmacies within the same legal entity. Therefore, proposed changes consist of removing this impediment from the legislation allowing the operation of 'hub and spoke' dispensing models across legal entities, creating a level playing field in the pharmacy market. Legislation changes will be required to the Human Medicines Regulations 2012 and The Medicines Act, Section 10, 1968 to allow hub and spoke dispensing to take place for all legal entities. This is proposed to create a level playing field, making it more possible for independent pharmacies that are separate businesses or to even work together and invest in one 'hub' location. Giving independent pharmacies across the UK, a wider choice to which business model they chose to adopt. This could allow independent pharmacies to capture the efficiencies stemming from large-scale, automated dispensing, reduced stock holding and economies of scale in purchasing and delivery of stock to the hubs, freeing up time to concentrate in the spokes on delivering patient centred services designed to optimise the use of medicines by patients (Department of Health 2016).

The amendments to redesign the 'exemptions for pharmacists' in Section 10 of the Medicines Act 1968 (Section 10 of the Medicines Act, 1968) were in respect of the preparation and assembly of medicines brought into line with a recent judgement of the Court of Justice of the European Union (CJEU). In relation to 'hub and spoke dispensing,' it clarifies what activities the 'hub' can undertake under the pharmacists' exemption on behalf of the 'spoke' pharmacy. Where 'hub' pharmacies are hospital pharmacies supplying medicines to other hospitals, they will be unable supply pharmacopoeia preparations to other pharmacies and hospitals if these have been fully made up in advance of the prescription being received (Department of Health 2016).

1.11.2 Confidentiality, accountability and responsibility with hub and spoke

The new proposed changes of the hub and spoke model, may raise concerns around data protection, especially as data will be passed through two different pharmacies. The consultation document states the transmission of patient data between two pharmacies, for the purpose of fulfilling a prescription, whether they are in the same legal entity or not, is capable of falling within the law governing the disclosure of personal information as supported by the NHS confidentiality codes in each UK country.

Regulatory frameworks will be changed with respect to hub and spoke. Although, both the 'hub' and 'spoke' operations would both be required to be registered as pharmacies. Regulatory frameworks will be developed for the new types of pharmacy operations. However, the issues of accountability and liability would need to be addressed. Regulators and the pharmacy sector would need to work together to address these issues. Especially, giving the potential impact of operational failure in a large scale 'hub', where business continuity also needs to be considered.

Returning to the Responsible Pharmacist regulations made in 2008, a responsible pharmacist must be appointed by the owner of the retail pharmacy business, who is in charge of the registered pharmacy (General Pharmaceutical Council 2020d). Regarding the topic of hub and spoke, the GPhC describes the topic of accountability, where the pharmacy dispensing service is carried out at different locations such as the hub. The GPhC specified it to be clearly ascertained that the hub and spoke pharmacists know which parts of the dispensing process they are responsible for, as well as knowing which staff members are also involved in the dispensing service.

Issues of accountability and responsibility include where medicines are not collected by the person, instead by representation in the registered pharmacy or delivery to the person were also described. An example included the risk of the medicine being delivered to the wrong person. In this situation, clear guidance must be set out by pharmacy companies to who would accountable and responsible in this situation. Additionally, when contracting any part of the pharmacy service with a third party, the GPhC state it is the responsibility of the pharmacy service provider to provide the service safely and effectively, in this case 'due diligence' is to be carried out (General Pharmaceutical Council 2019a). Work is yet needed to be done with regulators and pharmacy companies with the development of a regulatory framework acknowledging issues such as responsibility, accountability and liability. For example, if a dispensing error occurred using the hub-and-spoke model, guidance on whether the pharmacist at the hub or spoke is accountable or responsible for the error must be made clarified. Further concerns were also raised with professional liability and hub and spoke dispensing PSNC planning report 2019.

The terms accuracy and validity were further explained in an NPA report. The hub was stated to be more accurate as it will give the product asked for, therefore if the wrong product is inputted at the spoke, the wrong product would be dispensed at the hub, which would not be valid (National Pharmacy Association 2016). The NPA believe there to be gaps in the accountability frameworks, particularly where the spoke and hub superintendent pharmacists differ within the inter-company model (National Pharmacy Association 2016). The new statutory defence for dispensing could be undermined. The NPA believe it would be the duty of care of the hub pharmacist for clinical errors, if they didn't spot an error, they cannot delegate the duty of care as the hub is a registered pharmacy (National Pharmacy Association 2016).

1.11.3 NHS England reconsiders ‘hub and spoke’ dispensing model

The Department of Health (2016) published a consultation document titled *‘Amendments to the Human Medicines Regulations 2012: ‘Hub and Spoke’ dispensing, prices of medicines on dispensing labels, labelling requirements and pharmacists’ exemption’.* In the consultation the Department of Health were seeking evidence to determine whether or not hub and spoke is more efficient, and provide cost saving and/or safer than traditional dispensing models. The consultation document also covered government proposals in permitting dispensing labels to include: the indicative cost of the medicine; clarifying dispensing label requirements, including those that relate to monitoring dosage system and products supplied under patient group directives (Department of Health 2016). However, the proposal produced by the Department of Health (2016) raised several questions such as the safety of the model and how pharmacies would comply with the Falsified Medicines Directive. Therefore, in June 2016 plans to implement the model did not proceed.

1.11.4 PSNC planning report 2019

The PSNC stated the alteration of hub and spoke models raised concerns and opportunities in their planning report. The report considered the benefits from automated dispensing and hub and spoke dispensing. The report highlighted the need for community pharmacy to lead the development of these proposed changed changes and that for the PSNC to be responsible for conversations with the government around hub and spoke dispensing and new technologies (Pharmaceutical Services Negotiating Committee, 2018).

Concerns, questions, needs and opportunities around hub and spoke dispensing were raised in this report. Questions included *(*Pharmaceutical Services Negotiating Committee 2018):

- How much dispensing of dispensed will be automated (i.e. acute vs repeat prescriptions)
- The dispensing volume of hub and spoke dispensing needed to remain optional
- The need for appropriate protection for those using competitors’ hubs
- Original pack dispensing to assist automation making it easier to control stock.
- Falsified Medicines Directive (FMD) whether its introduction would have safety benefits that could be gained through automated dispensing.

- Potential benefits from outsourcing Monitored Dosage Systems (MDS) dispensing or whether it is appropriate to encourage MDS dispensing in view of current RPS advice on the issue'

Additionally, concerns towards the costs spoke pharmacies would entail for using a hub such as margins and payments/fees were highlighted (Pharmaceutical Services Negotiating Committee 2018). Furthermore, Simon Dukes, the chief executive of the PSNC displayed concerns about the capacity of the community pharmacy sector and a general shortage of pharmacists (Wickware 2019). Dukes also stated no evidence had been seen that hub and spoke will save money, even though it may build capacity. Further conversations were to be held by the PSNC include information on wider automation, hub-and-spoke, skill mix, using pharmacy teams efficiently as well as providing pharmacy teams with the amount of time they need to perform services that are required of them (Wickware 2019).

Opportunities and the needs of hub and spoke dispensing were also discussed in this report. The opportunities of automation in pharmacy reported by the RPS as previously reiterated included freeing up pharmacists' time and questions were asked on how this extra capacity would be used. The needs to restrict hub and spoke dispensing to something that can take place between registered community pharmacies were raised. As well as the need to maintain the integrity of the market entry system. Additionally, also optimising medicines rather just focussing on supply and the need to have a clearer understanding from the government of what the future for community pharmacy looks like (Pharmaceutical Services Negotiating Committee 2018).

Legislative changes would also be proposed allowing the better use of the skill mix in pharmacies and enabling the clinical integrations of pharmacists. The impact of changes to funding and fee structures, including different types of prescriptions would also be further explored. Furthermore, exploration into whether or not these changes could support the market in moving towards more efficient dispensing practices, while increasing the clinical and public health content of any patient interactions (Department of Health & Social care, NHS England, NHS Improvement and PSNC 2019).

1.11.5 Medicines and Medical Devices Bill 2019/2020

The previous section described various hub and spoke models. This section has covered the Medicines and Medical Devices Bill 2019/20 which was first announced in 13th February 2020 (The Pharmaceutical Journal 2020b). This bill followed secondary legislation proposed to allow large multiple pharmacies with existing dispensing hubs to expand their capacity and offer chargeable prescription assembly services to independent and small multiple pharmacies (The Pharmaceutical Journal 2020b). Secondary legislations could also see the NHS, wholesalers and new companies to set up new large-scale facilities (The Pharmaceutical Journal 2020b). The bill promised to enable a wider range of healthcare professionals, which could include pharmacists, to prescribe 'low-risk' medicines. After the end of the Brexit transition period, it was expected that this would give the government continued power in amending the Human Medicines Regulation 2012. Also, any amends to secondary legislation would be with a full economic appraisal (The Pharmaceutical Journal 2020b).

The government noted that the 'the costs and benefits [of the model] remain uncertain, as do some details around the policy design', adding that it 'intends to continue to work with the sector in order to explore and set out the framework for how hub-and-spoke could be 'operationalised' in the NHS' (The Pharmaceutical Journal 2020b). They also stated the cost and benefits of the model will depend on the business of the pharmacy business, with high financial costs including financial costs, 'capital investment (hub) and changing business processes, IT and logistics (spoke)' (The Pharmaceutical Journal 2020b). Businesses were only deemed to adopt hub and spoke arrangements if it was beneficial for them to do so (The Pharmaceutical Journal 2020b). Other benefits including a potential for calmer working environment at the spoke pharmacy (The Pharmaceutical Journal 2020b).

To summarise this section discussed the various healthcare policies around pharmacy practice and how hub and spoke would require a change in some regulations. The next section has detailed the opinions of regulators and professional bodies towards hub and spoke.

1.12 Regulators and Professional bodies opinions on hub and spoke

The perceptions of healthcare professionals such as chief pharmaceutical officer, Keith Ridge and chief executive and registrar of the GPhC Duncan Ridkin and Michael Hewitson, former chair of National Pharmacy Association (NPA) were also explored.

1.12.1 Chief Pharmaceutical Officer - Dr Keith Ridge

Dr Keith Ridge viewed community pharmacists to have a

> "*professional obligation to adopt automated dispensing*" (Adcock 2016).

Ridge himself conducted a PhD on the automation of medicine supply and use in hospitals. Back in 2015, Ridge predicted centralised hubs to dispense two-thirds of England's prescriptions, from visiting two dispensing hubs in the North West England. Ridge believed the implementation of hubs has the potential to make dispensing more efficient and safer. Ridge also believed there to be potential to free up highly trained staff to work more closely with patients, and make the patient experience more convenient through click-and-collect home delivery services and digitalising a good chunk of traditional pharmacy practice (Waldron 2015).

During the All-Party Pharmacy Group's inquiry into the use of large-scale dispensing technologies at Westminster in 2016, according to Ridge and his literature references, believed errors rates in community pharmacy in England are higher than other countries who have adopted automated dispensing. However, Gareth Jones, public affairs manager of the National Pharmacy Association, questioned the evidence session given by Ridge (Adcock 2016). Ridge continued to focus his opinions on making use of 'large-scale' automated dispensing technologies and was concerned about the deployment of smaller scale automation in traditional community pharmacies (Adcock 2016).

Irrespective of the pharmacy setting Ridge believed pharmacists are trained as clinicians and their skills should be utilised. Health minister, Alistair Burt, also proposed to want pharmacists' time to be spent on those face-face consultations. Instead of a patient going to their GP to talk about medicines, Burt proposed they should go to their pharmacist instead, pharmacists know more about medicines (Adcock 2016).

1.12.2 Former chair of the NPA, Michael Hewitson

However, the former chair of the NPA, Michael Hewitson, stated hub and spoke models to be complex.

He stated there to be

"little published evidence information available about the potential outcomes, and I have seen no evidence so far to back up the claims that hub and spoke will reduce operating costs" (Elvidge 2016).

A working group was set up by the NPA following legislative changes around hub and spoke dispensing, chaired by Hewitson. The working group pulled in experts from academia and pharmacies, commissioned researchers to carry out an independent literature review looking at UK and international evidence. They also carried out a survey of NPA members, receiving responses from more than 400 people responsible for around 1,000 pharmacies.

Hewitson also stated

"the UK government has suggested that hub-and-spoke dispensing could potentially cover up to two-thirds of England's dispensing volume – our survey suggested figures of only around a quarter to a third" says Hewitson (Elvidge 2016).

The consultation document produced in 2016 (Department of Health 2016)

"predicts that if 60% of medicines are dispensed through 'hub and spoke' models, there would be a 10% reduction in pharmacist labour costs and a 25% reduction in pharmacy technician labour costs at spoke pharmacies. And there would be increases of between 2.5%

and 5% for pharmacist labour costs and between 6.25% and 12.5% for pharmacy technician labour costs at hub pharmacies".

With the assumption,

"*hub pharmacies are two to four times as efficient (excluding capital investment) as spoke pharmacies*".

However, Hewitson viewed *"the use of these statistics seems highly dubious".* He also added that data input was crucial as if the wrong item is inputted the wrong item will also be received (Elvidge 2016). Hewitson believed companies with their own automated assembly processes would potentially be able to demand high levels of training and accuracy before allowing staff to use their hub-and-spoke system. He perceived third party hubs to be unable to demand the staff at independent spokes to follow the same procedures, with potential risks. Cutting down staff has said to be a way of improving efficiencies, Hewitson viewed this to be associated with an increase in risk as

"pharmacists may be required to check their own work because of low staff levels. This could impact on patient safety, potentially offsetting any gains from automation".

The NPA view the hub and spoke model to consist of higher costs for independent community pharmacies. An independent pharmacy would need a third-party hub and there is a risk of independents being tied up to a single wholesaler in order to gain access to the hub. The use of a third-party hub would require a set up cost, which they believed would be reflected in an independent pharmacies margins and thereby adding a service fee. Although, independent pharmacies can individually source products from different wholesalers to try and keep costs as low as possible. Increasing costs will impact on short line wholesalers, reducing competition and further impacting on costs and supplies. The former chair of the NPA worried large scale automation would only be made available to major wholesales, creating an oligopoly.

Hewitson predicted financial benefits for independents from efficiencies and taking up additional services to average around £8,000-£10,000 per year (Elvidge 2016). This figure consisted of direct costs for using the hub service and indirect costs with potential procurement changes, process and transformation costs. Initially, Hewitson predicted changes to cost around £20,000 per pharmacy. Hewitson also viewed limited capacity for growth of services such as MURs, as pharmacies are only paid for a maximum of 400 per financial year.

1.12.2.1 NPA survey regarding hub and spoke

The NPA had serious concerns on the governments' proposal of hub and spoke dispensing and launched an inquiry into hub and spoke dispensing. A literature review, independent of the NPA was carried out by the University of Manchester where minimal published evidence was found. Although, international evidence was found however this was questioned for the relevance to UK systems or issues. An expert witness programme was made up of more than 20 experts in pharmacy practice including experts such as lawyers, small and large wholesalers and automation suppliers. A survey was distributed and promoted through NPA channels, trade press and buying groups. Members were given a briefing document and a video introduction from Group chair. The NPA undertook this survey to understand implications on NPA members particularly: strategic, economic, operational and financial interests. As well as an understanding of implications on inter-company assembly on professional practice including patients and the public (National Pharmacy Association 2016).

Results showed a statistical association ($p \leq 0.005$) between the type of pharmacy worked at (number of branches) and whether or not the respondent had negative or positive views around hub and spoke dispensing. Overall, 55.4% (191) reported negative attitudes towards hub and spoke dispensing and 44.6% (154) positive attitudes. However, it was not clear what positive and negative attitude actually detailed. The majority (63.7%, 135) of those working in single independent companies reported having negative attitudes towards hub and spoke dispensing. Pharmacists working for companies owning 11 or more branches were reported to have positive attitudes (82.8%, 24) towards hub and spoke dispensing (National Pharmacy Association 2016).

1.12.2.1.1 NPA Hub and spoke dispensing model

The NPA reported some evidence in releasing pharmacists from the dispensing process in providing more services. It also may be necessary for more capacity to be created in community pharmacy with the rise in prescription volumes. A business model was produced by the NPA, where moving a proportion of dispensing volume to the hub was measured against service income. It was viewed reaching a critical mass of 25% of dispensing volume, was not enough volume to deliver these services. Between 25-35% was said to be ideal for starting to deliver more services, with the hub and spoke model creating more capacity. Above 35%, was found to be a plateau whereby the capacity created by hub and spoke, was found not to be enough services to fulfil this capacity. The hub and spoke model was said to only remove prescription assembly, and processes such as receiving prescriptions, data input and giving out prescriptions are still carried out at the spoke (National Pharmacy Association 2016).

The survey reported results on what part of their workloads respondents were happy to shift with hub and spoke (National Pharmacy Association 2016). Nearly 60% reported unfavourable opinions to shifting hub and spoke dispensing to regular repeats. Over 50% also unfavoured moving nursing home workloads and MDS to hub and spoke. Moreover, over 50% of respondents also viewed hub and spoke to have a very negative impact on their patients, pharmacy company and the overall community pharmacy network (National Pharmacy Association 2016). The risks and benefits also were examined in this study. Key benefits including over 50% of respondents strongly disagreeing hub and spoke was in the long-term interests of independent community pharmacy or strongly disagreeing with the improvements in profit. Over 75% of respondents strongly agreed that hub and spoke would lead to delays in patients' access to their medicines and over 50% strongly agreeing pharmacy closures to occur (National Pharmacy Association 2016).

Additionally, the survey also reported more than 75% of providers of hub and spoke were strongly against a national wholesaler or an NHS hospital trust providing hub and spoke National Pharmacy Association 2016). Additionally, more than 50% of respondents were strongly against independent wholesalers providing hub and spoke. In practice the NPA suggested independent and national wholesalers were most likely to be providers for hub and spoke (National Pharmacy Association 2016).

The NPA mentioned a previous national wholesale where they were constrained by their branch capacity as the branch was too small and consequently did not enough space to add extra dispensary bench. Solutions included making branches bigger or to move, again incurring financial costs. The hub and spoke model here were ideal in meeting capacity demands (National Pharmacy Association 2016). A model on basic costings model was undertaken by the NPA, which modelled the average pharmacy. The costings where shown to outweighs the benefits. Benefits including service income, staff reduction and OTC which would was modelled to bring in a maximum of £20,000. Costings of the model included payment for hub services which may result in a reduction in purchase margin (National Pharmacy Association 2016). The rewriting of SOPs, due diligence on the hub provider and the training and educating of staff would also be additional costings. Explicit consent would also need to be obtained from patients allowing the transfer of patient data from their existing pharmacy to a pharmacy of a different legal entity. This also included validation costs and the IT infrastructure costings (National Pharmacy Association 2016).

1.12.2.1.2 Intra-company vs inter-company

Intra-companies fit into the current hub and spoke model where the hub is the same legal entity to the spoke, an inter-company is where the hub and spoke are different legal entities. The intra-company models have the same superintendent pharmacist at both the hub and spoke, meaning that the same standard operating procedures are apparent at both sites. However, with inter-company models the superintendent pharmacists would be different and pharmacists would only be required to follow the superintendent within their own legal entity. Inter-company models would involve outsourcing dispensing within the hub and spoke model. However, intra-companies would be centralising costs as dispensing is automated to bring down unit costs, which does not work for inter-companies (National Pharmacy Association 2016). The cost reductions that can be reduced would be staff costs. The NPA were cautioned against this whereby reducing the spoke staff, would lose the capacity benefit created. The NPA stated it was not possible to have a capacity benefits and no staff reduction with the current model. The only way this model would have cost benefits for NPA members would be by staff reduction, however this is reported to remain a concern for patient safety (National Pharmacy Association 2016).

The NPA was concerned about the reduction in competition and choice in the hub market. Independent pharmacies were said to benefit from having hubs to choose from as they could choose providers and drive down costs whilst keeping service levels high. However, the hub and spoke would require choosing a particular hub, which would limit their supply of restricted items in which they would have to obtain from elsewhere at an additional cost (National Pharmacy Association 2016). This model could be of a disadvantage to short-line wholesalers, which is against taxpayers' interests as it creates leverage through competition. The NPA stated investments needs to be recovered, by reducing margins, item of service payment or subscription. The GPhC regulate based upon outcome, they do not instruct on how to do things instead ensure the safe running of operations. Major concerns are shown by the NPA within procurement and supply, with a need for promoting coemption and choice between hub providers being apparent (National Pharmacy Association 2016).

Hub and spoke could lead to an impact in stockholding whereby an increase in supply chain could lead to supply shortages. If the hub were to fail, this is a factor that needs to be considered. Examples include a technical fault with the online pharmacy company, Pharmacy2U. A financial collapse occurred in pharmacy plus and in a large care home in Bristol and a fire that accorded at Boots D90. Concerns from this include the impact it could have on patients and the public and also risks to politicians after the failure of Pharmacy2U (National Pharmacy Association 2016).

1.12.2.1.3 NPA recommendations

For hub and spoke to work the NPA recommended a planned workload work be beneficial to control workflow and electronic repeat dispensing. Original pack dispensing was stated to be essential with hub and spoke dispensing, split packs only can be apparent in spokes and use would lead to an increase in cost. The NPA reported the GPhC needed to recognise the difference between inter and intra company models. According to the NPA, a development of a national set of standards for hub providers in complimenting and enhancing GPhC inspection regime would need to be implemented which could follow the British Standards Institute: Publicly Available Specification (PAS) model. In addition to legislative changes, the NPA stated it was also in the public interest for there to be competition and choice for hub services to keep costs low and raises service levels. Furthermore, the NPA were also viewed to be a in position to influence on the development of hub and spoke, through developing standards addressing professional concerns, taking a critical yet constructive approach (National Pharmacy Association 2016).

1.12.3 Hub and spoke model in practice – Celesio

This section has described hub and spoke dispensing in community pharmacy practice. Celesio, the owner of LloydsPharmacy used an automated assembly line combined with robotics for prescription assembly for a handful of community pharmacies in the north of England, Warrington. This was one of the world's first fully automated prescription assembly lines. The hub and spoke model used by Celesio was said to

"challenge the traditional role of community pharmacies but could increase efficiencies and reduce errors" and *"give pharmacists more time to deliver clinical services in the pharmacy setting".*

The dispensed process of automated assembly combined with robotics adopted by Celesio, was described to be (Elvidge 2016):

1. *Four-wheeled waist-high robot, a shiny and silent shuttered box, moves by itself to a hatch where a conveyer belt delivers freshly filled cartridges of drugs*
2. *Once full, the robot delivers its payload to a filling line, where robotic arms pick and drop individual tablets and capsules precisely into waiting trays.*
3. *Followed by technicians watching its initial voyage, the robot returns to wait for its next instructions or takes itself to its charging point.*
4. *At another line of white, metal clad stations, packets of drugs are identified, picked by robotic arms, individually labelled and placed into bags along with the completed trays.*

5. *Human operators, white-coated, move around the machines, watching the drugs move along the lines, checking computer screens filled with figures and images of drugs with a quiet tension as glitches are gradually ironed out.*

The system was taught to recognise drugs, by their physical characteristics and image recognition where an audit trail was created at each stage. Original packs 2D barcodes were scanned and images were captured at each step of the assembly of MDS trays (Elvidge 2016). Data validation was also carried out a large multiple for the implementation of hub and spoke. Each branch had to dispense 5000 items without making a mistake and if they did the validation process would restart, one branch was reported to reset this process 83 times.

Additionally, in the event of a label being medicine askew, or the system not recognising the label, these are validated and added manually in the patient's individual tote notes. The system also had the ability to track individual tablets to specific pockets as described by the former managing director of Celesio, Cormac Tobin, in 2016. He also stated the Warrington facility to be for

"prescription assembly, not offsite dispensing, since it's the pharmacists at the spoke that dispense the drugs".

Torbin perceived hub-and-spoke had potential to create more space to see patients and supply additional services as the assembly of prescriptions would be at the hub. Tobin envisaged the future of clinical pharmacy to combine

"face-to-face dispensing, click and collect in the pharmacy or in secure lockers opened with an iPhone, home delivery, and discussions on Skype. It's physical and digital coming together".

The new dispensing model was seen to have the potential to focus pharmacists in providing education and support to patients, resulting in an increased turnover by stocking products linking to services. LloydsPharmacy stores piloted the First Care walk-in clinics, where pharmacists treated minor ailments and injuries; helping pharmacies to sell self-care products for treatments. Corbin also believed this dispensing model to have the potential in training staff and carrying out MURs on site in care homes, administering flu and other vaccines, or working with private providers to provide screening (Elvidge, 2016). He also perceived the dispensing model may result in patients going to the pharmacist rather than the GP or A&E department.

Interestingly, the Celesio dispensing model was shown to exhibit change to community pharmacy practice however failed to demonstrate savings in costs. This could be explained by the fact that companies such as Celesio did not wish to make staff cuts. However instead changing staff shift patterns when transferring from existing processes to full automation, said by Danny NcNally, the companies head of off-site dispensing (Elvidge 2016). A case study by Mayberry Pharmacy also reported not to see any cost-savings or reductions in jobs. Instead, resulting in a shift in labour as fewer people were found to work at spoke pharmacies and more staff needed at the hub.

1.12.3.1 Accountability and responsibility with the Celesio dispensing model

Additionally, with the proposed changes to legislation regarding pharmacies able to use hubs of different legal entities. Corbin also alleged for an independent to invest in hub and spoke, a new service such as minor ailments, needs to be implemented to make use of the capacity (Elvidge 2016). Corbin viewed the business model Celesio have adapted would ensure independent pharmacists will be better off working for them. He stated,

"by becoming more efficient, the independents can retain more customers, and can focus on patient care and interaction, with selling opportunities for linked products" (Elvidge 2016).

With regards to the issues of accountability and responsibility, the Celesio model of dispensing stated the spoke pharmacist to be responsible for data entry, either manual or from a scanned barcode which is then transferred to the hub. The spoke pharmacist is responsible for performing clinical and accuracy checks carried out on screen, with step-by-step confirmation and cross checks with previous prescriptions, cautions and contraindications. Similarly prescriptions are filed at the spoke, with data remaining encrypted all the way to the assembly point (Elvidge 2016).

Moreover, the assembly of the prescription takes place at the hub, where original packs are: 'automatically picked, labelled, packed and sealed into bags. MDS trays are assembled by machine, with individual tablets packed and sealed, with dosage instructions printed on the back of the tray, and prescribing information printed and included'. Drugs are then transported from the hub and delivered to the spoke in sealed plastic bags with an opaque bottom for patient privacy and a clear top, allowing a final visual check before the bag is handed over to the patient (Elvidge 2016).

1.12.3.2 Celesio model – Assembly line

The Celesio assembly line has used the methodology of beta testing to validate the assembly line. At full tilt, the assembly line should be able to fill monitored dosage systems (MDS) trays, on average every five seconds, or 12 trays per minutes compared to seven or eight an hour with manual systems. The company Celesio owns the wholesaler and distributor AAH Pharmaceuticals and the community pharmacy chain LloydsPharmacy and in 2016 supplied 228 pharmacies (spokes) from four hubs for almost a decade. The automated hub is said to gradually replace the existing prescription assembly process at Warrington (Elvidge 2016).

1.12.4 Summary

Overall, this section outlined the viewpoints of different regulators in regard to hub and spoke. With opinions from organisations representing independent community pharmacies and from multiple companies themselves. The next section has outlined the different work levels in the pharmacy profession.

1.13 Pharmacy profession

Organisations and professions are split into different work levels:

- Macro (leadership and representation)
- Meso (organisations and institutions)
- Micro (individuals)

In regard to community pharmacy, at a macro level this would consist of the regulatory body being the GPhC and professional bodies such as the Royal Pharmaceutical Society with the unit being pharmacy. As meso level, 'the Pharmacy' would be the unit with pharmacy employers and organisations being examples. Lastly, at a micro level, 'the Pharmacist' are the unit, examples including employed and self-employed pharmacists.

1.13.1 The Pharmacy

This section has descripted further information on the various types of community pharmacy and the employment statuses of the community pharmacists.

1.13.1.1 The pharmacist's role in community pharmacy

Pharmacists are involved in the provision of medicines and delivery of services to patients. In the 2019 survey conducted by the GPhC on registered pharmacy professionals (General Pharmaceutical Survey 2019b), the main responsibilities of pharmacists included: providing advice and information to patients and carers (61%), supplying medicines and medical device (51%), providing advice and information to healthcare professionals (25%), management of staff (22%), patient consultations (21%), providing treatment to patients (16%), medicines reconciliation pre-/post- discharge (15%), repeat prescription management (15%), routine tasks to manage the pharmacy environment (14%) and providing treatment to patients (14%).

Davies, Barber and Taylor (2014) conducted a sampling study in London on different activities a community pharmacist undertakes throughout their day. In this sampling study 10 community pharmacies were purposely selected, and trained observers visited one pharmacy each, recording the activities of the responsible pharmacists using a fixed-interval work sampling technique. Table 1.2 displayed the mean percentages of the day in which the pharmacist spends on each activity, adapted by Turner (2016) based on an article by Davies, Barber and Taylor (2014). Pharmacists were reported to spend most of their time on dispensing/prescription activities, such as: prescription monitoring and appropriateness, assembly and labelling of products, endorsing prescriptions and clerical health-related work, counselling patients on prescribed medicines.

Daily activities of responsible pharmacist	Classification	Mean % of day spent on the activity
Prescription monitoring and appropriateness	Dispensing/Prescription	11.9%
Assembly and labelling of products	Dispensing/Prescription	25.2%
Endorsing prescriptions and clerical health-related work	Dispensing/Prescription	8.2%
Counselling patients on prescribed medicines	Dispensing/Prescription	4.2%
Non-prescription medicines counselling/responding to symptoms	Pharmacist communication	6.6%
Professional encounter with non-patients	Pharmacist communication	3.5%
Health-related communication	Pharmacist communication	3.2%
Provision of advanced services	Services	0.6%
Provision of enhanced or other National Health Service services	Services	2.6%
Provision of private enhanced services	Services	0.9%
Provision of services to homes	Services	0.9%
Inventory and stock control	Dispensing	3.6%
Staff training and education	Administrative	2.7%
Housekeeping	Administrative	2.7%
Sales transactions	Administrative	1.6%
Money and managerial administration	Administrative	2.9%
Rest, waiting and personal time	Pharmacist communication	11.2%
Non-professional encounters	Pharmacist communication	7.0%

Table 1.2 Daily activities spend by pharmacists adapted from Turner (2016) on Davies, Barber and Taylor (2014) classified into different types of activity

These services are included in the pharmacy contract, with some services being essential and others up to the pharmacy owner, as previously mentioned the most frequently provided services are MURs (Croft 2014). Additionally, pharmacists are now able to become independent prescribers. However as of 20th November 2019, only 15.7% (9,142/58,085) of pharmacists have become independent prescribers (General Pharmaceutical Council 2019c). The idea of the introduction of independent prescribers was to support the work of doctors. However, the implementation of pharmacist-led services have been undermined by the lack of public trust (Gidman et al. 2012). Previous research has suggested public opinion has been unfavourable towards pharmacists providing high risk services such as prescribing.

1.13.1.2 Type of community pharmacy

The previous section detailed the roles of the community pharmacist and this section has gone onto explain the different types of community pharmacy. Community pharmacy has been classified into different categories by various different groups. Following on, Table 1.3 displayed the classifications of community pharmacies where they were found to exist as different types being: large multiples, small multiples and independent pharmacies (The Pharmaceutical Journal 2016), as seen in Table 1.3.

Table 1.3 Classifications of different types of community pharmacy (The Pharmaceutical Journal 2016)

In the GPhC survey of registered pharmacy professionals 2013, the classifications of community pharmacies slightly differed where (General Pharmaceutical Council 2013):

- Large multiple pharmacy chain (one of ten companies: Asda, Boots, Co-operative, Day Lewis, Lloyds, Morrisons, Rowlands, Sainsbury's, Superdrug and Tesco)
- Other multiples- another community pharmacy not listed above with 5 or more stores
- Small community pharmacy – 4 stores or fewer

The classification of community pharmacies slightly different in the GPhC 2019 registrant (General Pharmaceutical Council 2019b): large multiple chain, small to medium chain, independent and online. The comparisons of response rates with regards to the type of community pharmacy between the 2013 and 2019 registrants survey are displayed in Table 1.4. However, the classifications systems were not defined in the 2019 registrant survey.

Type of community pharmacy	2013 survey (%)	2019 survey (%)
Large multiple chain	40	36
Small to medium chain	11	14
Independent	21	22
Online only	N/A	2

Table 1.4 Comparison of percentage of respondents in community pharmacy 2013 (General Pharmaceutical Council, 2013) vs 2019 (General Pharmaceutical Council 2019b)

1.13.1.3 Employment status of the pharmacist

Having explored the various types of community pharmacy, this section has explained the different employment statuses of the pharmacist. The employment status of pharmacists were defined in the 2013 (General Pharmaceutical Council 2013) and 2019 GPhC registrant survey (General Pharmaceutical Council 2019b).

The 2013 GPhC registrant survey defined the employment status of pharmacists as follows:

- Business owner (including pharmacy owner)
- Locum/self-employed/freelancer/contractor
- Employee

The classification system for the employment status of the pharmacists in the GPhC registrant 2019 (General Pharmaceutical Council 2019b) slightly differed where they were found to be:

- Business owner
- Locum
- Self-employed/freelancer/contractor (excluding locum)
- Employee

As seen Figure 1.1, the 2019 GPhC survey separated the employment statues: locum and self-employed/freelance/contractor. Both surveys revealed 65% of community pharmacists respondents were employed and the percentage of business owners increased from 9% in 2013 to 11% in 2019.

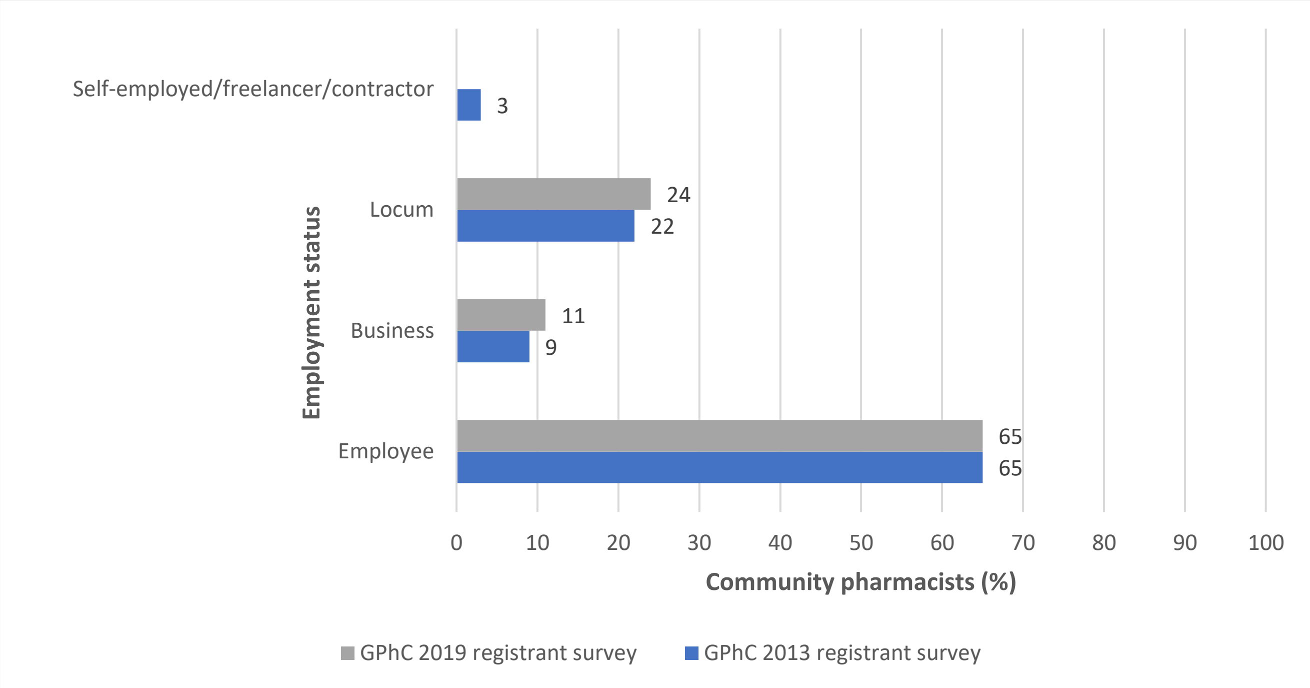

Figure 1.1 Employment status of pharmacists, GPhC 2019 registrant survey (General Pharmaceutical Council 2019b) and GPhC 2013 registrant survey (General Pharmaceutical Council 2013). NB the GPhC 2019 registrant survey

1.13.3 The Pharmacist

The previous section described the employment statuses of community pharmacists. This section has explored the satisfaction community pharmacists had towards their job, how they view themselves and are viewed by others. In the GPhC registrant survey conducted in 2019, 50% of community pharmacists were satisfied with working in community pharmacy as their main job, followed by 30% being dissatisfied, in England (General Pharmaceutical Council 2019b).

Pharmacists' satisfaction in main job	Type of Community Pharmacy Chain (%)		
	Large multiple	Small to medium multiple	Independent pharmacy or chain
Satisfied	48	50	51
Neither satisfied nor dissatisfied	20	22	21
Dissatisfied	32	29	28

Table 1.5 Pharmacists satisfaction of working in a community setting in their main job, adapted from GPhC registrant survey 2019 (General Pharmaceutical Council 2019b). (Pharmacists working in a community setting for their main job=7374)

Moreover, 70% of community pharmacists reported their role to me patient facing either all or most of the time. Before 1979, 64% of community pharmacists reported their role to be patient facing all or most of the time, between 1990-1999 this percentage declined to 59% gradually increasing between 2000-2009 to 67%, 75% from 2010 and 85% there 2016 or after (General Pharmaceutical Council 2019b). With 42% of community pharmacists satisfied with their work-life balance and 38% reported to be dissatisfied.

1.14 Summary

Overall, this chapter gives an overview of the history of pharmacy, the ever so changing role of the pharmacists and future plans for community pharmacies. Healthcare regulations and legislation regarding hub and spoke and viewpoints from professional bodies and regulators have been described. The different levels of the pharmacy profession have also been explained. The next chapter has presented a narrative review of the literature with respect to robotics and dispensing in pharmacy.

Chapter 2: A narrative review of the literature exploring dispensing technologies in pharmacy

2.1 Introduction and summary of literature review

This review has focused on the use of dispensing technologies in a pharmacy setting using a thematic approach. Research from the last ten years has been discussed in this review. The search strategy used has been detailed in this chapter including keywords and databases that were used. Different types of robotic dispensing methods, and terminology used for dispensing technologies were also discussed in this chapter. This review explored the various effects of the implementation of dispensing technologies that have been commonly used as outcomes in studies, such as medication errors, perceptions of robotics and financial implications. These outcomes identified in this literature review were used to construct the questionnaire in studies one and two. This chapter also explored various types participants that have been studied throughout literature, as well the different types of dispensing machines, comparators, settings and study participants were also explored in the literature.
No literature was found regarding hub and spoke dispensing and general public perceptions. This gap in literature, was identified and explained as to why the general public and pharmacists' perceptions of using robotic dispensing methods is important for future recommendations on policy regarding the implementation of robotic dispensing. The chapter has begun within a briefing of the medications use process and associated technologies involved in the process.

2.2 Medication use process

The medications use process described several stages in the medicine's delivery process, including prescribing and dispensing. Different interventions described in research related to various parts or combinations of the dispensing process. The medicines delivery process has found to include: transcribing, prescription filling and dispensing/patient counselling parts of the medicine's delivery process, as described in a systematic review by Sng, Ong and Lai (2019) Similarly, Anderson et al. (2002) stated the medications delivery process to be prescribing followed by transcribing, dispensing and administration. A computer simulation model was developed by Anderson et al. (2002) to replicate the medicines delivery process with associated technologies at each stage (Table 2.1).

Technology	Definition	Stage of the medication delivery process
Computer based system	Provides dosing information about drugs	Prescribing
Physician computer order entry	Physicians can enter their own orders directly onto the computer system	Transcribing
Unit dose system	In which medications are dispensed as a single unit or unit-dose pack that is ready to be administered to the patient	Dispensing and Administration
Automated medication dispensing system	Implementation of a barcode system	Dispensing
Comprehensive medication delivery system	System that would provide patient and medication information to the physician when medications are being prescribed.	Prescribing
Barcode medication administration systems (BCMAs)	Bar code medication administration (BCMA) systems are electronic scanning systems that intercept medication errors at the point of administration (Leapfroggroup hospital survey 2018)	Administering
Automated dispensing cabinets	A computerized point of use management system, for both medications and supplies designed to improve the accuracy of pharmacy inventory and billing and streamline the distribution process	Dispensing
Hub and spoke dispensing	The process where prescriptions are received from the 'spoke' (pharmacy/patient) and sent electronically to the 'hub' (an off-site dispensary) where they are assembled (by a robotic dispensing unit) and returned back to the 'spoke' (pharmacy). This could may also be referred to as centralised dispensing (Rechel 2019).	Dispensing
Multi-dose dispensing	Medications are re-packaged automatically into unit-dose bags for each time for administration (Rechel 2019)	Dispensing and administration

Table 2.1 Technologies used for each stage of the medication delivery process defined by Anderson et al. (2002), Murray (2001), Leapfroggroup hospital survey (2018) and Rechel (2019)

2.3 Methodology of literature review

This review has given an overview of the different dispensing technologies that have been evaluated within literature. The search strategy has been documented below with considerations of key terminology used to study the technologies associated with dispensing or dispensing and administration.

2.3.1 Literature search and screening process

A literature review using was conducted in: MEDLINE, Cumulative Index of Nursing and Allied Health Literature (CINAHL), Academic Search Complete, Scopus, Embase and Cochrane Library. The search strategy was limited to those written in English language and published over the past 11 years (2009-2020). Strict exclusion criteria were not used as the researcher did not want to miss potentially useful literature. Keywords were based on those in Sng, Ong and Lai (2019) surrounding the medication distribution process, functions and automation including hub and spoke dispensing.

The key terms used were divided as displayed in Table 2.2, as well as subject headings in retrospective databases Boolean operators were also used (e.g. AND; OR). Within each column, “OR” was used between the key words in the search process. A combination of search terms included: Column A AND Column B AND Column C AND Column D (Table 2.2).

A	B	C	D
AB medication* OR TI medication*	AB pick* OR TI pick*	AB pharmacy OR TI pharmacy	(MH "Technology, Pharmaceutical")
AB medicament* OR TI medicament*	AB pack* OR TI pack*	AB pharmacist* OR TI pharmacist*	AB automat* OR TI automat*
AB dose* OR TI dose*	AB dispens* OR TI dispens*	AB pharmaceutical* OR TI pharmaceutical*	AB robot* OR TI robot*
AB dosage* OR TI dosage*	AB stock OR TI stock	(MM "Pharmacy")	AB electronic* OR TI electronic*
AB drug* OR TI drug*	AB stocks OR TI stocks	(MH "Pharmacy Service, Hospital")	(MH "Robotics")
AB prescription* OR TI prescription*	AB label* OR TI label*		(MM "Medication Systems")
AB inventory OR TI inventory	AB prescrib* OR TI prescrib*		AB (hub and spoke) OR TI (hub and spoke) OR AB (spoke and hub) OR TI (spoke and hub)
AB inventories OR TI inventories	AB distribut* OR TI distribut*		

Table 2.2 Search terms used in literature review searching

Titles, abstracts and keywords of articles found were reviewed to asses relevance to research, to which relevant articles were read in full. The reference lists of appropriate articles were also surveyed in case they were not highlighted in the literature search.

2.4 Technologies in the dispensing process

2.4.1 Different types of dispensing technologies

Different names used for dispensing technologies were recorded in Table 2.3. Dispensing technologies terms were grouped classified as the following dispensing types: 'automated dispensing,' 'pharmacy automation,' 'robotic dispensing,' 'dispensing systems' and 'hub and spoke dispensing'.

Type of dispensing	Keywords
Automated dispensing	automated dispensing machine; automated dispensing system; automated drug dispensing system; centralized automated-dispensing system; automated dose dispensing; multi-dose drug dispensing
Pharmacy automation	pharmacy automation drug dispensing system; pharmacy automation system; pharmacy automation;
Robotic dispensing	centralized chronic dispensing model; robotic delivery system; robotic dispensing machine
Dispensing system	chronic dispensing unit (CDU); drug dispensing system; individual dispensing system; medication dispensing system

Table 2.3 The different keywords to describe robotic dispensing classified according to their type of dispensing classification

Automation has stated to be one of the primary factors contributing to a shift in pharmacy practice from predominately technical dispensing activities to patient care services (Andersen 1999). The idea of automation is to aid the dispensing process by replacing tedious labour-intensive tasks commonly used in pharmacy (Barker et al. 1998). Furthermore, the various dispensing technologies such as automated dispensing, pharmacy automation and methods similar to hub and spoke dispensing such as multidose drug dispensing have been explored in this review.

2.4.2 Multi-dose drug dispensing

Hub and spoke dispensing and automated dispensing were described in the previous chapter, This section has described dispensing models most similar to hub and spoke. Firstly, Rechel (2019) stated multi-dose dispensing a method to be similar to hub and spoke dispensing as medications are re-packaged automatically into unit-dose bags for each time for administration, a key feature in which both methods. Unit dose bags are similar to the dispensing of monitored dosage systems as referred to in the UK. The key difference highlighted between hub and spoke and multi dose drug dispensing is the end product produced. Multi-dose dispensing is dose specific for the patient, in which patient drugs are dispensed in one-unit dose for each occasion in disposable bags, for drugs which are available to use in 24 hours. Each dose unit is labelled with patient data, drug contents, date and time for intake. Multi-dose drug dispensing usually takes place for patients in defined groups, a minimum number of prescribed medications and usually reimbursed by the statutory health system (Rechel 2019). Whereas, hub and spoke dispensing uses original pack dispensing, which can supply patients for more than 24 hours, usually 28- or 56-days' supply, as this are the recommended guidance for dispensing amongst GPs. However, a prescription for controlled drugs in schedule 2,3 or 4 is only valid for 28 days, from the prescription date or start date specified, whereas schedule 5 drugs are valid for 6 months from the appropriate date. Therefore, this may restrict the supply for patients, schedule 2 and some schedule 3 drugs that require safe custody.

Following on, automated dose dispensing takes place in the method of multi-dose dispensing, also known as dose dispensing. Automated dose dispensing robots have been found to be implemented in community pharmacies, where most community pharmacies have purchased this service from a pharmacy specialising in automated dose dispensing. The Ministry of Social Affairs and Health recommended this service for older patients using health care services either at home or in nursing homes. (Rechel 2019). The service is only reimbursed by public insurance for patients over the age of 75, using six or more reimbursable prescription medicines that are suitable for ADD (Rechel 2019).

However, multidose drug dispensing has been identified as a less flexible approach when it came to changes in medication or dosage than manual dispensing. Pharmacists and GPs also reported a great influence for improving the quality in handling drugs after the implementation of multidose drug dispensing, even though GPs admitted they do not all work at the same level of accuracy (Wekre, Melby and Grimso 2011). This illustrates the important role of pharmacy in creating a trustworthy system for multidose drug dispensing and the importance of working within a multidisciplinary team (Wekre, Melby and Grimso 2011).

2.4.3 Chronic Dispensing Unit

Centralised dispensing is used in South Africa and was one of the first countries to have embarked large-scaled dispensing in the public sector (Magadzire et al. 2017). Processes involved include collecting prescriptions from over 200 health-care facilities, for approximately 300,000 patients, with chronic diseases each month. Individual patient parcels were then distributed from health care facilities or from community distribution points (Magadzire et al. 2017). This process being similar to that of the hub-and-spoke model in the UK (Rechel 2019).

Magadzire, Marchal and Ward (2017) conducted a case study on a Chronic Dispensing Unit in the Western Cape Province, on improving access to medicines through centralised dispensing in the public sector. Participants in the study included 15 senior and middle managers from the provincial Department of Health and the contractor, through focus group discussions and key informant interviews. The use of a CDU exhibited an increase in dispensing capacity facilitated by technological advancements. Parts of the dispensing process such as picking, packaging and labelling of medicines were largely automated (Magadazire, Marchal and Ward 2017). Between 2013 and 2014, the dispensing capacity steadily increased with over 350,000 patient medication packs (Magadazire, Marchal and Ward 2017). However, these results were limited by the fact during December/January, the supply of antiretroviral therapy accommodated the festive cold and flu period.

A qualitative study was conducted by Magadzire et al. (2017), where interviews were conducted on 40 intervention implementers consisting of clinicians, managers and service providers on the implementation of a Chronic Dispensing Unit (CDU) in South Africa. Benefits appreciated by healthcare practitioners also included the flexibility of the dispensing system in accommodating special requests from facilities and the dispensing of multiple medicines for multiple months for mobile populations (Magadzire et al. 2017).

Magadzire et al. (2017) also compared planned activities versus the actual activities performed with the implementation of CDU. Discrepancies were reported between planned activities vs actual activities, such as the pharmacist checking all parcels and fulfilling all the prescription requirements, using pharmacy stock in case of stock-out. However in reality pharmacists were not able to check all patient medication parcels as they felt it was time consuming (Magadzire et al. 2017). Pharmacists recommended using transparent instead of opaque packaging and inclusion of prescriptions in patient medicine parcels to facilitate easier checking (Magadzire et al. 2017). This study was limited by the small sample size. Another limitation of this study included being unable to quantify the intervention's such as reducing a pharmacists' workload and patient waiting times, as these were not measured before and after implementation, resulting in a comparison not being possible. Lessons to be learnt from this study included considerations about process improvements and considerations of hardware and software. This research highlighted how further research on centralised dispensing processes such as chronic dispensing units, with larger sample sizes, need to be conducted.

2.4.4 Hub and spoke dispensing

Previous sections have explored literature on models close to hub and spoke. The process of hub and spoke has also been referred to as a type of centralised dispensing (Rechel 2019). The Pharmaceutical Group of the European Union (EU) conducted a survey reporting the knowledge of the existence of the hub-and-spoke model within EU countries; seventeen responses were received and only four countries (Belgium, Denmark, Finland and Germany) within the EU had heard of the hub and spoke model (Pharmaceutical Group of the European Union 2016). No studies evaluating the hub-and-spoke dispensing model in the UK were found. Literature and reports regarding similar technologies to hub and spoke around the world have been explored.

2.4.4.1 Belgium

Firstly, a Royal Decree was published in 2012, stating conditions for ‘individual preparation of medication’ (IPM) in Belgium. This decree allowed pharmacies to deblister solid oral medicines and to then re-dispense them into weekly dispensers. Automated ‘individual preparation’ was allowed to be outsourced to another community pharmacy. The key problem with comparing this dispensing method to the hub and spoke model were that were no real off-site ‘hubs’ as Belgium community pharmacies were the hub providers (Rechel 2019).

2.4.4.2 Germany

However, Germany’s version of hub and spoke dispensing included multidose dispensing for patients receiving multiple medications (Rechel 2019). Pharmacy chains are not existent in Germany, however contrary to Belgium, ‘hubs’ (Blisterzentren) do exist, which operate industrially (Rechel 2019). Pharmacies are contracted to order prescription medication for patients. A similarity Germany has to the UK hub and spoke model are that German legal frameworks dictate only complete packages in officially authorised sizes may be dispensed. From 2015, a special exemption meant that individually prepared dispensing (*patientenindividuelle Verblisterung*) can only take place if prescribed by a doctor specifically (Rechel 2019). Therefore, this method resulted in supplying medicines to nursing homes for older patients being the main target group which is stated as a special exemption.

In Germany, a descriptive study was conducted by Cheung et al. (2014) on medication incidents related to automated dose dispensing in community pharmacies and hospitals. The study reported 24.4% (3685/15113) of medication incidents occurred in community pharmacies and 75.6% (11,428/15,113) in hospitals in Germany (Cheung et al. 2014). One of fifty medication incidents were related to automated dose dispensing, with more incidents occurring in community pharmacies (6.2%, 227/3,685) than hospital (0.4%, 41/11,428) (Cheung et al. 2014). The instant cause of an incident was often a change in the patient’s medicine regimen or relocation. Most incidents occurred in two phases either entering the prescription into the pharmacy information system or filling the automated dose dispensing bag (Cheung et al. 2014).

Descriptive analysis of incidents was conducted by two pharmacist researchers with hands on experiences in the analysis of CMR incidents (Cheung et al. 2014). The recording of additional incidents such as wrong name when filling ADD bag and the adjustment of the bags were also classed as an incident. An issue of underreporting may have been apparent with ADD with the absolute number of incidents being relatively low, as incidents were voluntarily reported thereby reflecting selective self-reporting (Cheung et al. 2014). The study was also limited as not all incidents were described in sufficient detail, as some incidents hardly requiring enough information for analysis. However, this could have been limited by prescribers only being able to report incidents once, therefore if they wanted to go back and add more information to the event, they were unable to. Different healthcare settings were also used in this study allowing comparison between different sites. Although, this could also be classed as a limitation as different healthcare settings have different environments, different staff members and different procedures (Cheung et al. 2014).

2.4.4.3 The Netherlands

In the Netherlands, centralised dispensing is used for repeat prescriptions and multi-dose dispensing for patients taking multiple medications. The Netherlands is the only global country which has operated a large scaled automated dispensing of original pack medicines to third party pharmacies, similar to the UK hub-and-spoke model (Rechel 2019). In 2014, Willach pharmacy solutions successfully launched a new hub and spoke dispensing model for community pharmacies, known as a 'local central filling'. This model involved a city teaming up and preparing repeat prescriptions in a central pharmacy using their own CONSIS robot. The robot dispensed medicines fulfilling prescription requirements with fully automated labelling. The model was reported to save considerable amounts of space and time for each pharmacy, improving efficiency and potential for greater profitability.

The process of the hub and spoke dispensing in the Netherlands consisted of stocking, dispensing and labelling as detailed in Figure 2.1. Walk-in prescriptions and prescriptions for collection were dispensed differently. Walk-in prescriptions were dispensed at the counter and always given priority to keep waiting times to a minimum. All packages for patient prescriptions were then ready to be dispensed within seconds and delivered to two dispensing points in the front office and directly behind the counters. Whereas, prescriptions that are for collection involved individual repeat prescription being dispensed into a single plastic container.

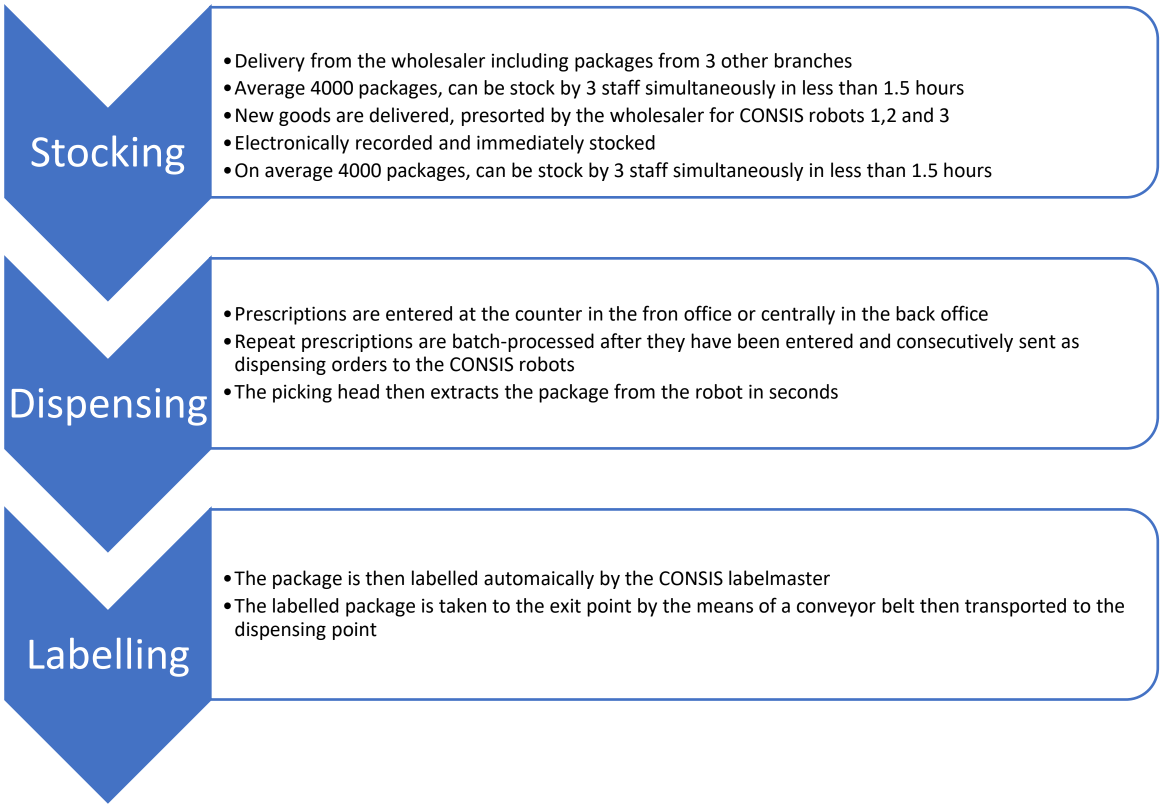

Figure 2.2. Hub and spoke model process in the Netherlands, using 'local central filling' (Willach Pharmacy Solutions 2013)

This system allows large numbers of prescriptions to be dispensed parallelly in a short space of time, three plastic containers were filled from the three CONSIS robots simultaneously (Willach Pharmacy Solutions 2013). Containers with fully prepared prescriptions were fed back to the back office on a roller conveyor belt with three parallel tracks. Packages were then checked and the whole prescription is placed into a special transparent bag, allowing easy identification of labelled medicines. Finally, prescriptions were then packaged into containers ready for the satellite pharmacy, previously requirement being for up to 4000 packages (approximately 1600 articles) (Willach Pharmacy Solutions 2013). Once the prescription had been processed, empty plastic containers were then returned on a separate roller conveyer. A signal was given using sensor and light signals, which automatically recognised when a new container is required. A separate feeder mechanism responded to the signal by delivering empty returned containers to the CONSIS dispensing point where they were needed.

Following on from the process of hub and spoke dispensing in the Netherlands, concerns were been raised with professional liability with hub and spoke pharmacists. Rechel (2019) stated the responsibility of accuracy and clinical checks to lie with the spoke pharmacy, as the hub is a supply unit as opposed to a registered pharmacy. However, the UK model dictates both the hub and spoke are registered pharmacies, leaving gaps with professionally accountability and the hub and spoke model. Some may argue that as clinical checks are conducted in the spoke pharmacy, the clinical check should be the duty of care of the spoke pharmacist and perhaps the accuracy checking falls with the hub pharmacist.

2.4.4.4 Sweden and Finland

In 1980, Sweden replaced the manual repacking of multi-dose medications from pharmacies with automated multi-dose drug dispensing. Sweden had the largest number of patients using automated dose dispensing worldwide, where in 2018, 200,000 patients were using this service (Rechel 2019). In 2002, automated dose dispensing was launched in Finland and implemented through legislation in 2011 (Rechel 2019). Bardage, Ekedahl and Ring (2014) conducted a questionnaire investigating Swedish health care professionals experience of using automated multi-dose drug dispensing. Responses were received from 1353 physicians, nurses and assistant nurses/nursing assistants. The majority of nurses (90%, 193/215) and assistant nurses/nursing assistants (74%, 678/915) reported patients to use multi-dose drug dispensing as it was found to increase patient safety. Over 80% (83%, 185/223) viewed automated multi-dose drug dispensing to be for patients who cannot manage their medication. Physicians (80%, 179/223) and nurses (70%, 637/915) reported poor memory to be a reason why automated multi-dose-drug dispensing was suitable for particular patients. The majority of nurses (83%, 179/215) perceived automated multi-dose dispensing was suitable for patients where their prescription does not change often. As this study did not include all types of healthcare professionals the results cannot be generalisable to all healthcare professionals.

2.4.4.5 Gaza

In a comparative study, a unit-dose drug dispensing system and a ward-stock drug dispensing system were assessed in two Gaza hospitals (Adham and Hamad 2011). The idea of this study was to assess which drug dispensing system was found to be most appropriate. Respondents in this study consisted of a mixture of 179 head nurses and pharmacists. A mixture of structured interviews, missing drug registration sheets and drug administration observation checklists were the assessment tools used. Multi-dose drug dispensing and ward-stock drug dispensing systems were affected by drug shortages with newly admitted hospitals cases, previously admitted or both (p=0.001) (Adham and Hamad 2011). The majority of pharmacists and head nurses often checked for prescriptions for drug-drug interactions in ward-based drug dispensing (59.1%,13/22) and 92.9% (13/14) in unit-dose drug dispensing, and statistical associations were reported (p=0.001) (Adham and Hamad 2011).

Pharmacists and head nurses were asked if they were satisfied with ward drug dispensing and wished to continue using it (p=0.001), 60.3% (35/58) said yes and 39.7% (23/58) said no in using ward drug dispensing and those using unit-dose dispensing 93.1 (27/29) said yes and 6.9% (2/29) were found to say no (Adham and Hamad 2011). This study contributed to evidence that unit-dose drug dispensing is a more rational, better for patient safety, allowing more clinical pharmacy-related interventions and better perceptions by nurses and pharmacists. Further research needs to be conducted, using comparative studies to verify these findings. Again, as this study was conducted in Palestine it is health care systems work differently to that of the UK, therefore some may argue they may not be valid in conclusive evidence-based decision making for the UK. Therefore, it is important to review a study setting when in relation to the country and type of pharmacy setting in question.

2.4.4.6 France

A study conducted by Cousein et al. (2014) was taken place in France evaluated the impact of an automated drug distribution system on medication errors, in a before and after observational study in a 40-short stay geriatric unit (Cousein et al. 2014). A comparison was made between a ward stock dispensing system and a combined unit dose dispensing robot with an automated medication dispensing cabinet (Cousein et al. 2014) The study found the combined system had reduced more than half discrepancies between medication ordered by physicians and medications administered by nurses. However, this study was limited by the fact medication errors are not limited to drug distribution systems and could be due to discrepancies between the medication the physician intended to prescribe, and the orders placed on the computerised physician order entry (CPOE).

2.5 Settings used in literature

The setting a study has been conducted in can be seen as the physical, social and cultural site to which the study is undertaken (Given 2008). Interestingly, in qualitative research the main focus is on 'meaning-making', for example the researcher studies the participants in their natural setting. Whereas, in quantitative research the aim is to establish general laws of behaviour and phenomenon across different settings and context (McLeod 2019).

Literature has shown studies regarding the evaluation of dispensing technologies to be set in community, hospital pharmacy and primary care. Although, the departments and type of hospitals differed within studies with a mixture of in-patient hospitals (Sakulbumrungsil 2016; Ward et al. 2012; Chapuis et al. 2005) and teaching hospitals (Berdot et al. 2019; Dussart et al. 2009; Rodriguez- Gonzalez et al. 2018). Silverstein (2010) conducted a study in a hospital, medical center and teaching hospital. Summerfield et al. (2011) conducted a study in a university medical center and Wekre et al. (2011) study was conducted in primary health care. Primary care is often the first point of contact for healthcare professionals such as GPs, dentists and pharmacists where the NHS is divided into primary, secondary and tertiary care. A community hospital is also another common setting in which studies have taken place (Sinnemaki et al. 2014; Sather, Forbes and Rovers 2007; Kwint et al 2011; Mertens et al 2018; Ruhle, Braun and Ostermann 2009). Cheung et al. (2014) conducted studies in a mixture of community pharmacies and hospitals. It is important for the setting of the study to be considered for future recommendations in healthcare, as well as the study design itself.

2.6 Countries used in literature

Having previously explored various settings evaluating dispensing technology, this section has explored different countries studies have been conducted. Many countries worldwide have provided government funded healthcare in addition the UK, including Switzerland, the Netherlands, Canada and Germany. The delivery and funding of healthcare differs within in country and this is a factor which needs to be taken into consideration when reviewing worldwide literature.

Studies on dispensing technologies were found to be conducted worldwide. A few studies have been found to be reported in the USA (Ward et al. 2012; Sather et al, 2007; Silverstein 2010; Summerfield 2010) and The Netherlands (Cheung et al. 2014; Kwint et al. 2011; Mertens et al. 2018). Other countries also included: Thailand (Sakulbumrungsil et al. 2016), Finland (Sinnemäki et al. 2014), France (Chapuis et al. 2015; Berdot et al 2019); Sweden (Hammer et al. 2015), Norway (Wekre et al. 2011), Singapore (Tan et al. 2009), Saudi Arabia (Al Muallem et al 2015), Madrid (Rodriguez-Gonzalez et al. 2018) and Germany (Ruhle, Braun and Ostermann et al. 2009). Literature was also found to have studies set in the United Kingdom by James et al. (2011,2013a, 2013b) and Beard & Smith (2013). The drive for more research in undertaken in the UK around the use of dispensing technologies may be key to future policy recommendations on the most relevant literature. Additionally, settings and countries are not the only factors that need to be considered, further exploration into the different types of participants used in literature have also been reviewed in the next section.

2.7 Participants used in literature

When designing a study, the type of participant being studied is decided before conducting a study. As studying a whole population is not feasible, a sample is chosen which is a subset of participant drawn from the target population, whose characteristics are of interest to the entire research team (Martínez-Mesa et al. 2016). Literature has shown participants in studies regarding dispensing technologies to be a mixture customers, patients and healthcare professionals. Patients have been a common participant group used throughout studies (Ward et al. 2012; Sinnemäki et al. 2014; Sather et al. 2007; Kwint et al. 2011; Adham & Hammad. 2011; Hammar et al. 2005; Kwint et al. 2013; Mertens et al. 2019; Rodriguez-

Gonzalez et al. 2018). Customers have been also reported as a participant type (Ruhle, Braun, Ostermann et al 2009). Pharmacy staff were another sample group studied in literature, classed as pharmacists, technicians and pharmacy managers were used as a sample population (James et al. 2011, 2013; Silverstein 2010; Muallem et al. 2015; Bepko, More & Coleman 2009; Tan et al 2009). Healthcare professionals consisting of clinicians, managers and service providers were also found as a type of participant studied within literature (Magadzire et al. 2017). Dussart et al (2009) study included nurses, junior and senior physicians as well as pharmacy staff. Wekre et al. (2011) study population included a mix care home nurses, pharmacists, GP medical secretaries and GPs.

No literature was identified in the literature review regarding the general public and dispensing technologies. Although, research has identified the general public to express a positive opinion towards health services research, where in the Harris poll, nearly 80 percent of respondents were interested in health research findings (Westin 2007). The idea of public health research is to benefit the community rather than a particular person and to contribute to or generate generalizable knowledge about the topic in question (Nass, Levit and Gostin 2009; Snider and Stroup 1997). The most common type of health services research have been identified as clinical trials and the use of secondary data has found to be common in fields such as epidemiology, health services research and public health research (Nass, Levit and Gostin 2009). Health services research including the evaluation of health care interventions and services were also identified (Lowrance 2002; Lowrance and Collins 2007).

Additionally, the differences between healthcare practice and healthcare research need to be considered when undertaking research. For instance, the benefits of public health research itself extend beyond the participants and the data collected has found to exceed the requirements for the care of the study participants. Whereas, in public health practice, the intended benefits of the project are primarily for the participants in the activity or for the participants' community. The data collected are only for those who need to assess or improve a public health program or service, or the health of the participants and their community (Nass, Levit and Gostin 2009). For example, collecting data on patients using a community pharmacy service, in order to improve the service. Therefore, general public research towards their perception of dispensing technologies, would go beyond the participants and used for the purpose of policymakers when implementing technologies in community pharmacy practice. Pharmacy services are designed to improve public health and conducting research on the general public around dispensing technologies is why this target group had been chosen to be studied in this thesis. Even though the general public may not necessarily use the pharmacy for dispensing services, they may use other services by pharmacists if offered through releasing pharmacists from their dispensing function.

2.7.1 General Public perception of robotics in health

The public reaction to science and technology has been explored in research and may help policy makers, who seek to involve the public in decision making issues relating the technological or scientific complexity (Hisschemöller and Midden 1999). Literature has identified different types of research exploring policy. Examples including opinion research, adoption research, literacy research and attitude research. In regard to opinion research, policy makers are interested in knowing if the general public keep up with innovations in science and technology. Opinion research has been a popular way of collating information on the publics judgments on all kinds of issues and is a viable option when policy makers want to legitimize policy actions. This type of research considers the general public to be classified as 'lay people' meaning that they are passive consumers of political conditions. Whereas, attitude research explains the relation between what people think, feel and do. Differently to opinion research, attitude research provides a more comprehensive theoretical basis; build upon a large amount of traditional empirical research from field and laboratory settings. This would be a viable choice for policy makers if the research purpose was to understand public perceptions and behaviours. This programme of work fit into the category of opinion and attitude research as the general public are classified as recipients of the use of dispensing technologies to dispense their medication. Additionally, the implementation of dispensing technologies are based upon empirical research.

Following on, underlying problem frames involving science and technology have been mapped out in two dimensions (Hisschemöller and Mideen 1989) . The first dimension contains to opposite approaches, the technical approach (experts) and the participation approach (lay people). The second dimension relates to the role of the government, alongside two opposing approaches, being the market approach (government role limited to safeguarding a free exchange of goods and values according to individual or group preference and the justice approach (argues in favour of the government intervention on behalf of vulnerable interests). The four policy approaches address members of the public in a different role. Different roles include passive-citizen consumers, those who would leave decision making to the experts (suited to opinion research) and active-citizen consumers who base their individual choices on a cost-benefit calculation including social values and innovative trends (suited to adoption research). Nonattentive citizens, those that need to be educated before they can participate in decision making regarding complex scientific and technological issues. This method is most suited to literacy research. Finally, the role mainly used is attitude research, for participative citizens who are capable of a reasoned judgement on issues of political choice. The choice is then whether or not policy makers and researchers want to pay attention for the public involvement in research. Therefore, improving the viability of research on public reactions will need to involve both researchers and policy makers. If there are uncertainties of how to approach the public, then it is recommended to seek an understanding of public attitudes in cognitions, values and emotional aspects rather than pinpointing to either scientific and technological literacy, consumer behaviour or public opinion support.

2.7.2 Patient perception of healthcare technology

Having reviewed the literature regarding the general public perception and healthcare technologies, this section helps further understand patient perceptions. Vast changes in the healthcare sector, have led to healthcare organisation paying more attention to their satisfaction of their patients. Patient satisfaction has been ranked amongst one of three of the most important performances measures considered by consumers of health care service (Roberts and Philp 1996). Typically, health professionals evaluate services from professional and organisational perspectives, as opposed to patient satisfaction. The health care reform movement reinforced the fact that patient satisfaction is a strategic variable in the health care market. If a decrease in patient satisfaction is shown, patients are more inclined to go back to their old provider (Marquis, et al. 1983).

In other words, if a patient was unhappy with their medication being dispensed by a robot they may choose to use a pharmacy that does not use this process. The exploration of patient acceptance of consumer health information technologies needs to be considered (Calvin and Karsh 2009). Previous literature has dictated significant rejection of these technologies resulting in benefits not being seen from their use leading to a loss of return on investment for healthcare organisations. Reasons for patients not accepting technologies included: poor device usability, insufficient training on how to use the technology, lack of computer skills and low self-efficacy (Kaufman et al. 2003).

2.7.3 Digital literacy

Further reasoning to why patents have rejected the use of technologies could be due to the digital literacy of the person. Following on, the digital literacy amongst the age of the respondent also needs to be considered. Digital literacy has been defined as *"primarily concerned with technical skills, and those who see it as focused on cognitive and socio-emotional aspects of working in a digital environment"* (Eshet-Alkalai 2004). The digital literacy of seniors is a topic that has been increasingly reviewed in literature. Particularly, acquiring data on the media competences of the elderly and its useful to practice and everyday life., where elderly people are classed as those aged over 60 years. Technologies are and will supplement and alter traditional habits of communication that are social, cultural and economic on society (Schäffer 2007). The increasing life expectancy of people means that there is an increase in the percentage of elderly people (Frevel 2004). This means that the use of new media technologies, will result in society having to deal with the more intense use of new media technologies for elderly people, alongside other factors in the field of continuing education (Schaefer et al. 2016). A study conducted in Germany reported 4% of the elderly to have occasionally used the internet in the year 2000, increasing to 18% in 2015 (Eimeren and Frees 2005). An increase was also found in all age groups whereby those aged 50-59 years saw an increase in 35%. (Eimeren and Frees 2005).

The older generation do not want to lose in touch with society, if the elderly does wish to play an active role in social development, they must learn in a 'self-controlled' manner with the new media (Schaefer et al. 2016). However, some older of the elder generation still are dealing less with the new media. The theory of media practices being specific to generations may be an explanation for the lack of interest in new things, relating to the inability to keep up as a result of the lack of competence, due to the real generation effect (Schaefer et al. 2016). For example, those aged over 60 have made a habit of media practice cultures that they acquired during their adolescence years, therefore approaching modern technologies with the same perspective which they had from their youth. Acquiring the knowledge to use media technologies, they find may find more difficult and time consuming compared to when they were in their younger years (Schaefer et al. 2016).

Additionally, those aged over 60 have reported anxiety being a barrier towards the use of computers, as well as feeling that computers are not relevant to older people (Universiteit 2005). These barriers have been found to be addressed through design guidelines for interfaces and through the principle of universal design and perhaps could be applied to the implementation of technologies in pharmacy practice. Considerations of these aspects by designers could have a positive impact for the elderly and society. Where, the ability to share and retrieve information as well as engaging in different social communities has shown an increase in life satisfaction, as a reward from using such technologies (Universiteit 2005).

We live in a society which is permitted by the use of digital tools such as computers, laptops and mobile phones. In 1995, Bill Gates claimed that *"the information revolution is just beginning"* (Gates 1995:21). However, using such phrases can be seen as misleading messages, suggesting social changes are characterised by revolutions (Martin 2008). Digital media is no longer believed to be regarded as 'information' or even 'technology' (Martin 2008).

The use of technology has been adapted from the very early years of life where leisure time activities for children, including the use of computers are often used to convey images allowing imaginative and expressive play; and not just limited to information retrieval (Martin 2008). As children get older, digital literacy has shown to need a minimal set of skills enabling users to operate software tools effectively or even perform basic information retrieval skills. A Skills for Life survey conducted by the British government in 2003 (Williams et al. 2003) found over half of respondents to have a common understanding of common ICT terminology.

Following on, the media could be a reasoning towards influencing public knowledge on popular healthcare topics. For example, German newspapers had positively portrayed healthcare technology which may have influenced the German public population. The media also portrayed health, societal and economic benefits (Laryionava 2012). Interestingly, topics in which the media had reported included common relationships with technologies such as robots, where they were seen as assistants, colleagues and friends (Laryionava, 2012). Furthermore, robotics has displayed major potential for future application in medicines and healthcare (Laryionava 2012).

Laryionava (2012) examined the risks and opportunities of new medical technologies presented, and whether or not newspapers portrayed technologies as a threat to humans (Laryionava 2012). Three relationships human-robot relationships were identified in the study being:

- Person and machine fuses with each other
- Either robots and humans co-operate, or robots become servants or slaves of humans
- Robots are superior to people or masterful and masterly and both admired and respected by humanity

In addition, to the potential threat humans may see by the implementation of robotics, the computer proficiency of the respondent may be a factor effecting the general public use of technologies including health technologies. Computer proficiency is *"ability to use digital technology, communication tools and/or networks appropriately to solve information problems in order to function in an information society*" (Wijaya and Surendro 2006). Research has shown those who consider themselves as 'beginners' in the use of computers do not necessarily reject e-health options, and those who have classed themselves as 'good' do not completely accept all e-health services (Laryionava 2012).

This section has explored the various types of participants studied in literature examining dispensing technologies. Also further exploring the importance of patient and public perception research in healthcare for policymakers.

2.8 Outcomes used in literature

This section explored the outcomes used in studies to evaluate dispensing technologies. Literature has identified both qualitative and quantitative methods to be used in studies. The outcomes used can be divided into the following categories: medication errors, medication adherence, users' perceptions and the cost implementations. Firstly, the topic of medication errors and dispensing technologies have been reviewed.

2.8.1 Medication and dispensing errors

Medication errors (Rodriguez-Gonzalez et al. 2018) and dispensing errors (Beard and Smith 2013; James et al 2013b) have been used evaluate dispensing technologies in literature (Beard and Smith 2013;). Medication errors have been defined as

"any error in the prescribing, dispensing or administration of a drug, irrespective of whether such errors lead to adverse consequences or not, are the single most preventable cause of patient harm" (Williams 2007).

Whereas, a dispensing error

"is a discrepancy between a prescription and the medicine that the pharmacy delivers to the patient or distributes to the ward on the basis of this prescription, including the dispensing of a medicine with inferior pharmaceutical or information quality" (Van den Bemt and Egberts 2007; Beso, Franklin and Barber 2005; Teagarden et al. 2005; Cina et al. 2006; Maviglia et al. 2007; Ashcroft, Quinlan and Blenkinsopp 2005).

Bates et al. (1995) have shown adverse drug events to occur 49% in the prescribing and administration phase in eleven medical and surgical units in two tertiary care hospitals.

Hospitals have been adopting different health information technologies (HIT) including computerised provider order entry (CPOE), automated dispensing systems and point-of-care bar code medication administration systems (BCMA) to help prevent medication errors during the medication delivery process (Oren, Shaffer and Guglielmo 2003). A future framework classifying errors according to specific causes such as technology design, operation and interface with the human and delivery system may be beneficial (Oren, Shaffer and Guglielmo 2003)

Rodriguez-Gonzalez et al. (2018) measured dispensing errors in a prospective before-and-after medication error study with the implementation of a robotic original pack dispensing system in an outpatient hospital pharmacy. Robotic dispensing reported 3 dispensing errors were made, identified as wrong quantity due to the lack of stock. Whereas, manual dispensing acknowledged 16 errors due to the wrong quantity when counting medication, or when a specific quantity was specified in the prescription, which could not be fulfilled when dispensing full packages (Rodriguez-Gonzalez et al. 2018). Interestingly, during manual dispensing the greatest number of errors occurred when dispensing was performed by technicians (16.9%). Overall, the implementation of a dispensing robot reported to reduce the percentage of incorrectly dispensed prescriptions from 1.31% (43/3284) of prescriptions to 0.63% (19/3004), with relative risk reduction (RRR), 51.7%; 95% CI, 17.3% to 71.8% (Rodriguez-Gonzalez et al. 2018).

Unlike, Beard and Smith (2013) who reported dispensing errors to not be adversely affected and products dispensed by an electronic prescribing- robot system. This study used quantitative case study analysis on one hospital with 1000 beds who had used integrated electronic prescribing for 10 years and combined this with two dispensing machines in 2009. The rate of dispensing errors (quality) and efficiency (costs) were outcomes used in this study. After 7 months of implementation, products dispensed by the electronic prescribing-robot system produced zero dispensing errors. An increase in dispensing speed was also found (Beard and Smith 2013). Although, two months after the implementation of the electronic prescribing dispensing robot there appeared to be a peak in errors per month (Beard and Smith 2013). Using outcomes such as dispensing errors are limited to determining whether or not they occur to chance or due to a flaw in the dispensing process (Beard and Smith 2013).

Due to the integration of electronic prescribing and the robot system, when the doctor electronically prescribed a medication they also had written the dispensing label for the medication. An advantage of this combined system was that no transcription errors may occur, as the label will always be accurate to the prescription. However, an issue of accountability may occur with medication errors as the doctor are the ones prescribing the medication thereby producing the dispensing label. Another safety aspect from the combined technology was found to be the direct electronic link between the medicine, barcode, the item selected on the electronic prescription and the label that the robot applies. This system was also designed to work from anywhere in the hospital, where 60% of dispensing activity was able to be triggered outside the pharmacy.

James et al. (2013b) also evaluated the impact of automation on dispensing errors as well as pharmacy workload in hospital pharmacy pre-and-post automation, in a longitudinal study. Outcomes reported in this study included data on dispensary workload and prevented dispensing incidents. These incidents were defined as detected dispensing errors reported before medication had left the pharmacy ,which were collected before and the installation of an automated dispensing system, over a 6-week period (James et al. 2013b). The rate of prevented dispensing incidents was significantly lower by 0.28% post automation (49%, n=86) compared to pre-automation (61%, n=143). The prevention of dispensing incidents included labelling errors, combined drug and labelling errors and drug label and issue errors (James et al. 2013b). Prevented dispensing incidents were found to occur most frequently in the morning and mid-afternoon either after a prolonged period of moderate workload or following a busy period (James et al 2013b).

Contrary, to Beard and Smith (2013), the most common type of dispensing error, was reported to be the wrong strength of medicine (pre-automation: 22 %, n= 8; post automation 10%,n= 5) (James et al. 2013b). Another type of dispensing error detected was the wrong quantity dispensed pre-automation 21% (8) and post-automation 16% (7) (James et al. 2013b). These results are similar to those reported by Beard and Smith (2013). The wrong quantity being dispensed could be explained by the fact that robotic dispensing is that it cannot dispense part-packs hence the term original pack dispensing (Beard and Smith 2013).

In reality, part-packs cannot be avoided such as for steroid courses, fridge items and controlled drugs which have safe custody requirements.

Using dispensing errors as an outcome, tests the safety of dispensing. However, it is an outcome in which just tests the safety and accuracy of the process, commonly pre- and post-implementation (Beard and Smith 2013; James et al. 2013b). These studies were both conducted in a hospital setting and few studies has evaluated the effects of dispensing technologies on dispensing errors in a community pharmacy setting. The cause of dispensing errors was not measured directly, however James et al. (2013) did assess the relationship between dispensary workload, staffing levels and preventing dispensary incidents as explained later on in this chapter. Staff themselves were reporting dispensary incidents, therefore incidents were only reported if staff members were aware (James et al. 2013b). This could have resulted in the true amount of dispensary incidents may not have been reported. Other factors need to be considered when discussing the prevention of dispensing errors that may not be directly to the implementation of a robotic dispensing machine, such as prolonged task performance and mental fatigue. A solution to this would be to rotate dispensary staff activities and schedule regular short breaks as seen in shown in studies by Rosa (1995) and Tucker et al. (2003).

2.8.1.1 Drug related problems

Having discussed dispensing errors as an outcome to evaluate dispensing technologies, this section explored drug related problems. Drug-related problems include prescribing errors, poor adherence and insufficient monitoring (Howard et al. 2007). Kwint et al. (2011) conducted a pragmatic randomized- controlled study evaluating automated drug-dispensing systems on pharmacist-led medication reviews, on drug related problems in older patients. Kwint et al. (2011) evaluated 63 patients in the intervention group and 55 patients in the waiting-list group, recruited from 6 Dutch community pharmacies. The study reported the mean number of drug related problems in those receiving a medication review at the start (intervention group) compared to those receiving a medication review after 6 months (waiting list group). The mean number of drug related problems across all patients was 8.5, with no difference found between the two groups (Kwint et al.2011). At baseline, the mean number of drug-related problems leading to recommendations for drug change was 4.5; this did not differ between the two groups (Kwint et al. 2011). A reduction of 29% in drug-related problems was found in the intervention group and a reduction of 5% ($p<0.01$) (Kwint et al. 2001). It needs to be considered that this Kwint et al. (2011) used two reviewers from a pool of 5 pharmacists, meaning there was no guarantee whether or not a less experienced reviewer would have picked up identical drug related problems (Kwint et al. 2011). The outcomes used in this study were classed as intermediate, such as change in the number of potential drug-related problems and drug changes. It cannot be assumed that reducing the number of drug-related problems will have a positive impact on all clinical outcomes (Holland et al. 2005; RESPECT Trial Team 2010; Zermansky et al. 2001). This study examined the quality of pharmacotherapy for patients which can be improved and suggested all patients with automatic drug dispensing undergoes a thorough medication review, therefore focussing on the clinical care of the patient.

2.8.1.2 Medication administration dosing

Additionally, automated dispensing was also shown to improve the dosing administration of vancomycin in the emergency department (Ward et al. 2012). Before automation, no patients received vancomycin within 60 minutes from bed placement to drug administration. However, post-automation, 14.7% (5/34) patients received vancomycin within 60 minutes from bed placement to drug administration (difference in proportions 14.7%, 95% CI 0.39%-30.0%, P=0.040) (Ward et al. 2012). The appropriateness of the dose did not change due to the intervention. Additionally, medication administrations were also found with the implementation drug dose dispensing in a quantitative, comparative cross-sectional study between two Gaza hospitals. One hospital using a ward stock drug dispensing system and the other a drug dose dispensing system. (Adham and Hammad 2011). The mean number of medication administration errors was found to be higher in the hospital using ward stock drug dispensing (1.8) in comparison to the hospital using unit dose drug dispensing (0.9). Types of medication administration errors, including wrong drug, wrong dose and wrong time ($p=0.038$).

2.8.1.3 Medication adherence and reconciliation

Medication adherence was also used to assess the implications of the installation of dispensing technologies such as a personal automated dose-dispensing system. Sather et al. (2007) conducted an open noncontrolled case series, where medication adherence was defined as doses taken at prescribed times, after the installation of a personal automated dose-dispensing system were measured on three patients. The system consisted of 60 preloaded dosage cups in a locked dispenser, placed in each patient's home and attached to the telephone line. Information regarding drug and dosing were programmed into the machine's memory, where at scheduled times a voice alert prompted the patient to take their medication, to which the patient would then press the button on the machine and receive their dosage. The personalised automated dose-dispensing system was found to improve patient's medication adherence. A 3-month study showed the prevalence of missed doses to decrease from 4-5 per week to 1-2 (Sather et al. 2007) The small sample size to this study resulted in generalisation becoming difficult; medication refills does not necessary mean that patients had consumed their medication.

Medicines reconciliation was also an outcome used to evaluate an automated dispensing service provided by community pharmacies in Finland (Sinnemäki et al. 2014). A national survey was undertaken on 325 patients in Finland to investigate how medication was reconciled using the service (Sinnemäki et al. 2014). Interestingly, the study identified more than one source of information for 63% of patients was needed for medications reconciliation. The most common sources included nursing staff for 72% of patients. The majority of patients (96%) had also undergone a prescription review. In this review, 93% of patients had undergone technical changes and 43% had experienced treatment-related changes. The study was limited by its response rate of 45% (147/325) as it was quite small, which may have caused non-response bias. Another limitation may have been pharmacists conducting the start-up process for automated dose dispensing may have responded more accurately than pharmacists.

2.8.2 Financial implications

The economic impact of dispensing technologies were also explored throughout literature, considering claims have been made by the Department of Health stating that the introduction of large scale dispensing methods would lower operating costs. A robotic dispensing machine was implemented in German pharmacies, data concerning the financial and economic implications were evaluated in a study by Ruhle, Braun and Ostermann (2009). After 12 months, post-installation of a robotic dispensing machine found the costs situation deteriorated in only 6% of cases, 50% of the pharmacies the cost situation improved and in 44% it was remained unchanged (Ruhle, Braun and Ostermann 2009). Cost situations included costings per year such as acquisition and installation costs, capital costs and operating costs (Ruhle, Braun and Ostermann 2009). Pharmacies whose sales were greater than 2 million, reported to benefit from cost savings more than those with a lower annual sales volume (Ruhle, Braun and Ostermann 2009). As this study focused on the impact of a robotic dispensing machine from a single supplier, results cannot be extrapolated for the use of other dispensing machines (Ruhle, Braun and Ostermann 2009).

The cost of drug storage was also found to be lower with the installation of an automated dispensing system. Whereby, Chapuis et al. (2015) evaluated the economic impact of automated dispensing systems in surgical intensive care units. The cost of drug storage before the installation of automated dispensing systems was €93,832 and post-implementation was €49, 525. The cost of expired drugs was found to be reduced by €14,772 each year. The regular monitoring of the expiration of drugs was found to be completely eliminated with automated drug dispensing (Chapuis et al. 2015). This study contributed to the few data on the economic impact of automated drug dispensing, particularly in European countries.

2.8.3 Prescription filling, dispensing speed and technical dispensing activities

Following on, in theory the implementation of robots in any industry would be thought to speed up the process. Pharmacy robotics have found to achieve faster dispensing, however the time saved by pharmacy robots is dependent upon the type of machine and task. For example, with monitored dosage systems, one human can take up to half an hour to make up a tray whereas a robot can achieve this within three minutes (P3 Pharmacy 2018). However, the implementation of a robotic original pack dispensing system in an outpatient hospital pharmacy was shown to be rated low amongst technicians (6.33/10). This was because the length of the conveyer belts, as the robot was installed in the building adjacent to the Pharmacy Department, and to the availability of 8 different dispensing points at the same time (Rodriguez-Gonzalez et al. 2018). Technicians did not need to move the storage to pick the medication can promote a sense of false slowness. Employees reported to want an increase in dispensing speed, although still prefer the use of a dispensing robot to manual dispensing.

Moreover, further literature was explored examining the effects robotic dispensing technologies would have on dispensing speed and prescription filling. Robotic dispensing has shown to increase technician prescription filling efficiency based on overall time; however previous literature showed a lack of statistical significance (Walsh et al. 2011). Automation and prescription filling have found an increase in complexity (Walsh et al. 2011). This could be explained by the change in pharmacy workflow.

Technical dispensing activities were examined in a study by Angelo, Christensen and Ferreri (2005) with the implementation of an automated dispensing machine at four community pharmacy sites. Fewer prescriptions were received from patients at automated sites (9%, 3/33) in comparison to nonautomated sites (37%, 21/57) ($p=0.004$) (Angelo, Christensen and Ferreri 2005). Entering prescription data onto computers was found occur at 79% (76/96) of nonautomated sites and 44% (32/73) of automated sites ($p=0.001$). The retrieval of stock bottles occurred at 56% (58/104) of nonautomated sites and 15% (5/33) at automated sites ($p=0.001$) (Angelo, Christensen and Ferreri 2005). Labelling prescription bottles occurred at 19% (20/105) of nonautomated sites and 3% (1/33) at automated sites ($p<0.05$). Additionally, 32% (10/31) filed completed prescriptions for pick up at nonautomated sites and none (0%, 0/14) at automated sites ($p<0.05$) (Angelo, Christensen and Ferreri 2005). Four percent (3/75) of non-automated sites delivered prescriptions for patients and 13% (7/54) at automated sites ($p<0.05$) (Angelo, Christensen and Ferreri 2005). Overall, automated dispensing has demonstrated to reduce the occurrence of technical dispensing activities in pharmacies, with the delivery of prescriptions happening more at automated sites. For the study conducted by

Angelo, Christensen and Ferreri (2015) it needs to be noted that only one automated site was studied compared to three nonautomated sites, due to geographic constraints. No control group was used in this study due to the fact, two different sites were compared, using a pre- and post- automation design.

2.8.4 Occupational stressors

Moreover, having explored the physical influences the robotic dispensing machine has on pharmacy practices such as dispensing speed. This section has focussed on the influence dispensing technologies has previously had on occupational stressors. Occupational stressors have been defined as working conditions, workload and experiences of work (James et al. 2013a). James et al (2013a) was the first to conduct a study where the effects of installing an original pack automated dispensing system, on staff experience of occupational stressors. An occupational stressor questionnaire was used to assess these outcomes, pre and post automation, in a study by James et al. (2011) set in a UK hospital (James et al. 2011). Examples of occupational stressors that were evaluated included: stress, working conditions, dispensary workload, staffing levels, staff satisfaction and job satisfaction (James et al. 2011).

2.8.4.1 Stress

Firstly, James et al. (2013a) reported fewer staff to report stress post-automation (12.5%, n=2) in comparison to pre-automation (34.3%, n=12). A focus group was also conducted where corresponding views to the occupational questionnaire were identified, as participants also experienced less stress post-automation. However a relatively low response rate was achieved in this study due to the fact swine-flu was apparent at the time of conducting this study. The findings in this study were conducted in one hospital therefore, they cannot be generalised to other hospitals and for other types of automated dispensing machines (James et al. 2013a).

2.8.4.2 Working conditions

Working conditions were classified as dynamics such as the working environment, the presence of automation, staffing and sickness (James et al. 2013a) Advantages of automation included an improvement in working conditions and an ease in prescription processing.

Although, technicians still felt that dispensing was physically and mentally demanding despite automation being in place (James et al. 2013a).

The implementation of an automated dispensing machine, results in the redesign of the dispensary, aimed to improve working conditions (James et al 2013a). The redesign of the hospital dispensary resulted in pharmacy staff being distracted by outpatients and other healthcare staff in the waiting room (James et al. 2013a). Poor lighting was also reported to be an issue with the redesign as well as a reduction in teamwork. Automation was perceived to have had a negative effect on staff within the pharmacy dispensary. Focus group participants further explained, there were fewer experienced staff in the dispensary, post-automation, therefore increasing pressure on them (James et al. 2013a). This highlighted a reduction in staff with the implementation of automation, as being a problem. In order for the dispensing model to be economically efficient, labour costs would need to be reduced for the implementation of dispensing technologies.

2.8.4.3 Workload and workflow

Other occupational stressors that have been studied throughout literature included dispensary workload and workflow. A 6-week study was undertaken by James et al. (2011) in two hospitals in Wales, one hospital used automated dispensing and the other hospital used a manual dispensing system both measuring dispensary workload. Dispensary workloads were compared using the Welsh-bench marking event record technique and the direct time technique, objectively measuring time spent by staff on different dispensary activities where data were collected over a period of 6 weeks (James et al. 2011).

The direct time techniques measured a mixture of all elemental tasks in the dispensing process such as prescription reception, validation of patient information, technical and clinical checks, medication assembly, product labelling and financial accuracy checks. This workload measurement technique involved breaking down these activities into a logical sequence of distinct elemental tasks. Each part of the task was measured by using physically observed starts and endpoints, where observers would time each section of the task as it was performed. Multiple timings were made for each part of the task. Whereas, the welsh benchmarking event record technique recorded the dispensing of inpatient, outpatient discharge prescriptions, patient's own drugs, monitored dosage systems, controlled drugs and drugs requiring such as clozapine, cytotoxic, emergency cupboard items.

Additionally, a non-participant observer was used to measure dispensary workload (James et al. 2011). The mean workload, using a direct time technique was found to be significantly greater at the automated hospital (11.93 items per person per hour) compared to the nonautomated hospital (7.27 items per person per hour; t=5.23, df=0.417, p<0.001). Additionally, the mean workload using the Welsh benchmarking event recording technique was also found to be significantly higher at the automated hospital (12.60 items per person per hour) compared to the non-automated hospital (9.57 items per person per hour, t=4.41, d.f.-0.704, p<0.001) (James et al. 2011).

Similarly, another study used standard daily accounting records to measure dispensing workloads as well as direct observation of workflow and patient interaction in a study conducted by Angelo, Christensen and Ferreri (2005) in community pharmacies. Automated sites (59 ± 7.26) had a higher prescription volume than nonautomated sites (24 ± 16.28) averaging prescriptions dispensed per hour. Weak associations with pharmacist workload at automated and nonautomated sites were identified (correlation coefficient= 0.379 nonautomated and 0.298 automated). Although, no relationship was identified between the mean percentage of patients counselled, and the pharmacist workload during each observed hour, which varied widely (Angelo, Christensen and Ferreri).

In a longitudinal case study conducted by James et al (2013b), the impact of automation before and after implementation was evaluated on dispensary workload and dispensary workload. James et al. (2013b) reported dispensary workload increased significantly by 43% post-automation (from 9.20 items/person/h/ pre-automation, 13.17 items/person/h post-automation). The rates of prevented dispensing incidents decreased significantly by 56% (from 0.64% pre-automation to 0.28% post automation). Both pre- (r_s = 0.13, p = 0.015) and post-automation there was a significant positive association between dispensary workload and the occurrence of prevented dispensing incidents (James et al. 2013b).

Information collected on dispensary workload was measured using the event recording technique. A positive linear association was reported between workload and preventing dispensing error both pre-automation (p=0.13, p=0.015) and post-automation (p=0.23, p <0.001) respectively (James et al. 2013b). Furthermore, post-automation also reported the day of the week to have a significant effect on dispensary workload (p=0.011); where dispensary workload was found to be at its lowest on a Saturday (James et al. 2013b).

Additionally, four focus groups were undertaken with pharmacy staff to establish any differences in the dispensing process pre- and post-automation. The focus group respondents report workload to increase post-automation, although automation had found to improve efficiency, which enabled them to cope with the workload (James et al. 2013b). Studies conducted by James et al. (2011; 2013b) were limited by the fact they used non-participant observation.

Having previously, explored the effects of dispensing technologies on pharmacy workloads, this section details previous experiences on the effects on pharmacy workflow, such as workflow interruptions. This is a factor which needs consideration, so pharmacies can be prepared for changes (Walsh et al. 2011). One study explored the impact of an automated prescription-filling device on community technician workflow, set in an independent community pharmacy, with 77 technicians observed pre-installation and 88 post-implantation of an automated prescription filling device (Walsh et al. 2011). The pharmacy dispensed an average of 350 prescriptions daily. Pharmacy technicians were observed before and 3 months after the installation of an automated robotic prescription filling device. Furthermore, workflow interruptions such as answering the phone, questions to the pharmacist, questions to or from technicians were all reported to increase post-automation (Walsh et al. 2011). Questions from pharmacists also were observed to decrease post-automation, as were wrong drugs and missing drugs Walsh et al. 2011).

Automation resulted in workarounds such as entry technicians entered new prescriptions without pulling shelf drugs, where this deviation was reported to occur 10% and 36% of the time pre- and post-installation respectively was observed (Walsh et al. 2011). Another turnaround discovered was that automation meant that prior pharmacy orders were able to be completed first. In terms of workaround observation, pre and post-automation entry technicians entered new prescriptions without pulling shelf drugs where was reported to occur 10% pre- automation and 36% post-automation (Walsh et al. 2011). Another turnaround found was that automation meant that prior pharmacy orders were able to be completed first. However, this study came with limitations such as potential behaviour changes due to the presence of an observer, and installation of a robot may have caused physical adjustments to the pharmacy workspace, as pharmacy workflow is reorganised.

2.8.4.4 Staffing levels

Automation has been shown to have effects on staff levels in pharmacies, where James et al. (2013b) reported the effects automation had on staffing levels in a hospital pharmacy. Before automation, staffing levels were reported to be 11-16 staff per day, with the highest levels of staff present between 4-5pm (James et al. 2013b). This is a time near when children finish school and adults are most likely to finish work, perhaps explaining the reasoning for more staff needed at this time. Additionally, dispensary workload has also been measured according to the individual staff member, where items were measured per person per hour. A previous study demonstrated dispensary workload consisted of 7 and 11 items/person/h and was at its highest between 11am-12pm pre-automation (James et al. 2013b). The highest level of prevented dispensing errors pre-automation occurred between 11am-2pm and 2-3pm, where dispensary workload and staffing levels were at their highest at 9-11 items/person/h and 16 staff respectively (James et al. 2013b). Post-automation staffing levels were constant between 10 and 15 people throughout the working day; maximum staffing levels were seen between 4-5pm, with minimum staffing between 1-2pm (James et al. 2013b). Maximum workload was shown to be 22 items/person/h was observed at 11am-12pm; the minimum workload occurred between 5-6pm post-automation (James et al. 2013b). The rate of prevented dispensing incidents was highest between 9-10am, when workload and staffing was high post-automation.

2.8.4.5 Staff and job satisfaction and employability

Amongst the exploration of staffing levels with the implementation of automation, pharmacy staff satisfaction with the adoption of dispensing technologies has been explored as they are considered users of the technology. Rodriguez-Gonzalez et al. (2018) observed pharmacy staff and patient satisfaction towards automation using an anonymous cross-sectional questionnaire. Further analysis of the measurement of staff satisfaction was towards stock management, the operation of the dispensing robot with computerized physician order entry's (CPOE) and pharmacy software. High staff satisfaction was observed amongst pharmacists compared to technicians towards an original pack dispensing machine (8.63±0.7 vs 7.78 ± 0.7) (Rodriguez-Gonzalez et al. 2018). Although, this study was limited by the fact an uncontrolled before-and-after observational study was conducted which could lead to bias as there was not a control group (Rodriguez-Gonzalez et al. 2018).

Firstly, similar levels of control pharmacy staff felt they had towards their job was exhibited pre- and post-automation. In terms of the effects on the job role of pharmacy staff with automation, technicians were reported to feel like production workers instead of skilled dispensers (Rodriguez-Gonzalez et al. 2018). Accuracy checking technicians have also found to perceive pharmacy staff could not progress beyond a certain skill with the automation of dispense. (James et al. 2013a). A previous study demonstrated mixed views in a focus group where pharmacists and technicians felt that automation enabled the expansion of technical staff roles to ward-based dispensing, resulting in fewer staff needed in the dispensary (James et al. 2013a). Pharmacists on the other hand reported automation had given staff control over their activities and opportunities to extend their own role (James et al. 2013a). Overall, automation has not shown to have a significant difference on enhancing the careers and professional development of staff members amongst survey respondents.

Moreover, as well as staff satisfaction with the use of dispensing technology, literature has also seen studies on job satisfaction. Interestingly, before and after automation, survey respondents have reported to be satisfied with their job role in an anonymous occupational stressor questionnaire (James et al. 2011). A significant difference between the median responses by survey respondents pre- and post- automation was found (James et al. 2011). Focus group participants reported to be satisfied with their job due to expansion of the roles, as they were released out of the dispensary due to automation (James et al. 2011).Automation was also found to improve the work-life balance of survey respondents, where no respondents reported a negative effect to occur. However 14% (n=5) of respondents reported pre- automation to affect their home-life (James et al. 2011) Although it cannot be assumed that this was due to the effects of automation (James et al. 2011).

Automation of any industry often leads to the worry that job roles would be replaced. However, James et al. (2013) presented no significant impact on staff perceptions of their employability with the effects of, where survey respondents agreed they could easily find another job. A reasoning for this could be that automation was seen to raise the profile of the pharmacy department, facilitating recruitment and retention of staff as displayed by focus group respondents (James et al. 2013). Although, it needs to be considered that respondents reported pre- and post- automation to be committed and embedded to the organisation.

2.8.6 Counselling activities

The previous section explored the literature evaluating the effects automation had on occupational stressors. The introduction of large scaled dispensing methods has been proposed to enable pharmacists spend more time on patient related activities such as counselling patients on their medication, however a lack of literature has supported this claim. Alfadl, Alrasheedy and Alhassun (2018) evaluated medication counselling practice at community pharmacies in Saudi Arabia. On average, pharmacists counselling duration was less than one minute with the manual method of dispensing (51.54+-15.839 seconds) (Alfadl, Alrasheedy and Alhassun 2018).

With the implementation of automation, oral counselling (direct observation) was shown to occur more at automated sites (78%, 38/49) in comparison to non-automated sites (28%, 24/86), a statistical association was found ($p<0.001$) (Angelo, Christensen and Ferreri 2015). Nearly 40% (38%, 3/8) of counselling events occurred at nonautomated sites and 42% (7/17) at automated sites (Angelo, Christensen and Ferreri 2015). The majority of pharmacist believed they had adequate time to counsel (pharmacist survey) at automated sites (67%, 2/3) compared to 38% (3/8) at nonautomated sites (Angelo, Christensen and Ferreri 2015). In a patient survey, 46% (6/13) of patients were counselled about new prescriptions at nonautomated sites and 27% (3/11) at automated sites (Angelo, Christensen and Ferreri 2015).Patients were shown to agree with consideration of patient needs (2.09 ± 0.300, p=0.060); explanation of information patients received with dispensed prescription (2.01 ± 0.310, p=0.236) and technical competence of pharmacy staff (2.10 ± 0.023, p=0.007) (Angelo, Christensen and Ferreri 2015).

Another study examined the interaction length between pharmacy staff and patients and job satisfaction of 68 practitioners in 10 community pharmacies with and without automation in Portugal using a cross-sectional quasi-experimental design (Cavaco and Krookas 2014). Interestingly, automation was observed to have no significant influence on interaction durations of pharmacy staff with patients. Although, gender and professional categories were found significantly longer with older patients with interaction durations (p=0.017) (Cavaco and Krookas 2014). Automation also enabled pharmacy counter staff to have 45% more free time from direct patient contact. The mean overall satisfaction score was 5.52 (SD=0.98) out of 7. Again, no significant differences were identified with automation as well as between professional categories of the pharmacists (Cavaco and Krookas 2014). However, a significant lower job satisfaction was exhibited for younger pharmacists (Cavaco and Krookas 2014).

Barriers towards counselling included, patients unable to identify the pharmacist reported as a difficulty, due to the similar uniform and lack of name badge, therefore patient answers may not about pharmacists themselves. The four sites were within the same pharmacy chain allowing the observation of general practice patterns of pharmacists. (Angelo, Christensen and Ferreri 2015).

2.8.7 Trust and robotics

In addition to the considerations of patient and pharmacists' perceptions towards robotic dispensing literature has shown, trust with automation was a topic that has also been examined. Trust is a psychological concept, seeming specifically important when understanding human-automation partnerships. It can be defined as

"the attitude that an agent will help achieve an individual's goals in a situation characterised by uncertainty and vulnerability".

A lack of literature was identified towards trust and the use of dispensing technologies. A qualitative study was conducted based on focus group interviews with early experiences with multidose drug dispensing system with GPs, home-care nurses, pharmacists and medical secretaries (Wekre, Melby and Grimso 2011). Most participates expressed positive attitudes towards multidose drug dispensing, and quite frequently either directly or indirectly related their attitude towards trust (Wekre, Melby and Grimso 2011). Although, one nurse explained they kept checking the multidose drug packages as they arrived from the pharmacy, indicating there wasn't complete trust with multi-dose drug dispensing (Wekre, Melby and Grimso 2011). However, the small sample size limits this finding.

As people are reliant on automation, people then respond to technology, consequently showing trust is a factor that influences reliance in automation. When people trust automation, they tend to rely on it, where no trust is present, automation is then rejected. Trust is further important when as it guides reliance when complex and unanticipated situations occur, particular when understanding of automation becomes impractical (Lee and Moray 1992). An example being if a robotic dispensing machine were to unexplainably break down, and there wasn't an understanding as to why this happen, trust would help guide reliance in trying find a solution for this problem.

By guiding reliance, trust helps to overcome the cognitive complexity people face in managing increasingly sophisticated automation (Lee and See 2004). Especially, when the complexity of the automation makes a complete understanding impractical and when the situation demands adaptive behaviour that procedures cannot guide (Lee and See 2004). For example, if uncertainty is the case, then trust plays a critical role in moving away from highly structured organizations and simple technology.

Additionally, understanding the issue of trust is important in the implementation of any system (Saleem et al. 2009). It most often details factors surrounding system implementation and the work put into it. Therefore, in order for a better understanding of the system being implemented, further analysis may be better by an expert system (Giddens 1990). When implementing new systems, it raises the issue of trust, as workflow is often reorganised. This makes it imperative to understand the interplay between systems and personal trust towards the system. This helps further understanding on an intra-organisational level of implementation of any system. (Bachmann 2001).

A meta-analysis conducted by Schaefar et al. (2016) assessed research concerning human trust in automation and demonstrated how understanding the foundation of autonomous systems can help future autonomous systems to be built. A theoretical model of human-automation trust states there to be three factors of trust (Schaefer et al. 2016):

- Human related (traits, states, cognitive factors and emotive factors)
- Automated partner-related (features and capability)
- Environment-related (team collaboration, task/content)

2.8.9 Social issues and automation

The understanding of social issues and the use of automation need to be considered with robotics. A balance must be achieved between a design that is human centred as an alternative of being more socially acceptable. These designs have to be evaluated as trade-off spaces, assessing potential efficacy versus the agreement in which they the technology was designed. The advantage of using machines over humans, are humans often favour decisions that benefit themselves or those close to them, however robots do not have and remove this bias. Furthermore, on the other hand the replacement of human labour, may result in a disservice to society. Further impacts for humans also unemployment, which may cause them to suffer from a loss of identity and a reduction in self-esteem.

When examining trust with technologies, there are different levels of trust to consider such as interpersonal trust, system trust and trust in technologies. Trust and distrust are considered opposites and two separate measures need to be developed. One study disclosed patients to rate the concepts of generalized trust, interpersonal trust and trust in technology to be similar (Enid et al. 2009). However, results in the study did not show whether or not trust in medical technology was the same as general technology (Enid et al. 2009). Although, the development of a framework of trust regarding medical technology, provided evidence determining trust in medical technology was empirically different from trust in technology (Enid et al. 2009). Understanding users trust in medical technologies helps to provide understanding for misuse, disuse and abuse by patients, health care providers and health system issues including error, malpractice, adoption and satisfaction (Parasuraman and Riley 1997). Misuse refers to failures occurring when people unintentionally violate critical assumptions consequently relying on automation inappropriately (Lee and See 2004). Whereas, disuse signifies failures occurring when people reject the capabilities of automation (Lee and See 2004).

Trust in complicated automated systems have been explored throughout literature (Dzindolet et al. 2003; Madhavan et al. 2006; Lee and See 2004). Interestingly, one study reported how pre-automation considered automated decision aid trustworthy and reliable. However after observation of the automated aid making errors, study participants then distrusted this post-automation (Dzindolet et al. 2003). The replacement of manual labour with automation is an interesting topic, for example Madhavan et al. (2006) found automation errors on tasks that could easily be performed by humans to severely degrade trust. Therefore, automation can be viewed as a problematic approach as people fail to rely on it appropriately (Lee and See 2004).

Following on having explored the social issues with automation, the different perspectives of trust have also been discussed in the literature. Different perspectives of trust have included organisational, sociological, interpersonal, psychological and neurological perspectives (Lee and See 2004). Cognitive processes concerning trust are dependent on the interplay amongst analytic, analogical and affective processes (Lee and See 2004). Neurological evidence suggested trust may play an important role in decision making when cognitive resources are available to support a calculated choice.

The way in which automation is used, influences automation performance providing goal-oriented perspectives assessing automation characteristics. Deeper analysis of the process of trust in relation to automation, referred to algorithms and operations governing the behaviour of automation (Lee and See 2004). The operator would tent to trust automation, if the algorithms can be understood enable them to achieve their goal. When trust is considered as an intention or behaviour, there is a potential to confuse its effect with the effects of other factors influencing behaviours such as workload, situation awareness and self-confidence of the operator (Lee and Moray 1994; Riley 1994). Trust has been predominately referred to as an attitude (Jones and George 1998). When focussing on trust in an organisational context, such as a towards the pharmacy, it its influences pharmacists' reputation, gossip and formal and informal roles affecting the trust of people who have never had any direct contact with the trustee. For example, when relayed to an individual the pharmacist would not be trusted based on the ability of the individual person but because of their underlying education and regulatory structures set by the GPhC that governments the role of the pharmacist (Kramer 1999). This may also influence trust based upon the pharmacy company for which they work for.

2.9 Different types of robots used

Moreover, having considered the various outcomes which have evaluated dispensing technologies, the examination of the different models and brands of dispensing machines being used were explored. The ROWA robot dispensing machines were common in evaluating dispensing robots used in pharmacy practice (James et al. 2013; Berdot et al. 2019; Ruhle, Braun and Ostermann 2009; Beard & Smith 2013). ROWA machines were said to provide specialist storage automation and digital solutions for pharmacies. The idea behind ROWA machines are to free up space with systems for higher efficiency and better customer retention (GmbH 2020).

James et al. (2013b) evaluated the ROWA speedcase, ARX Ltd and in Franklin et al. (2008) also evaluated the use of a ROWA speedcase, as well as a swisslog pack picker automated dispensing machine. A triple-headed machine ROWA machine with an automated labeller for each picking head was studied by Beard & Smith (2013) and Berdot et al. (2019) recently evaluated the ROWA® system from ARX®. The dispensing robot Xmax (ARX) was studied by Rodriguez-Gonzalez et al. (2018), this machine used produced barcodes for the identification of packaged medications and were randomly stored maximising capacity of the robot. Two robots were installed: one for refrigerated items and one for non-refrigerated items. Both machines delivered drugs to different patient care points using a conveyor belt system (Rodriguez-Gonzalez et al. 2018).

Studies have also shown evaluations of other robots including the McKesson Rx robot, examined by Bepko, Moore & Coleman (2009) for its implementation to ensure medication safety in a hospital. In a study conducted by Palttala et al. (2013) two smaller dose dispensing process lines (Tosho Main-Topra 2441CE, Japan) and seven larger dose dispensing process lines (Tosho Xana-4001U2, Japan) were used. Chapuis et al. (2015) reported a study using the OmniRx ADS.

2.10 Comparators used

The previous section acknowledged various dispensing robots used to dispense medication, literature has also identified various comparators used to evaluate dispensing technologies such as pre- and post-implementation of dispensing technologies (Noparatayaporn et al. 2016; Ward et al. 2012; Angelo, Christensen & Ferreri et al. 2005; Bepko, Moore & Coleman 2009; Berdot et al. 2019; Chapuis et al. 2015; Sather et al. 2007; Tan et al. 2009; James et al. 2011; James et al. 2013; Rodriguez-Gonzalez et al. 2018; Silverstein 2010; Summerfield et al. 2011; James et al. 2013) patient waiting time (Tan et al. 2009), dispensary staff time (Chapuis et al. 2015) and dispensary space (Ruhle, Braun and Ostermann 2009). Whereas, Paltalla et al. (2013) compared 9 different automated dispensing systems and Wekre et al. (2011) compared perceptions between different groups of health personnel.

Several studies have shown to use the comparators of pre- and post-implementation of dispensing technologies (Noparatayaporn et al. 2016; Ward et al. 2012; Angelo, Christensen & Ferreri et al. 2005; Bepko, Moore & Coleman 2009; Berdot et al. 2019; Chapuis et al. 2015; Sather et al. 2007; Tan et al. 2009; James et al. 2011; James et al. 2013; Rodriguez-Gonzalez et al. 2018; Silverstein 2010; Summerfield et al. 2011; James et al. 2013). This allows comparison of the use of a new technology with existing processes currently in place.

Additionally, patient waiting times have also been used as a comparator, in a computer simulation study by Tan et al. (2009) evaluating the prototype automated dispensing system on waiting time in an outpatient pharmacy. Interestingly, the results were highly dependent on the number of pharmacists, although the speed of the system needed to be doubled concomitantly with the increase in the number of pharmacists to reduce waiting time below 30 minutes. The faster processing allows the number of pharmacy technicians to be reduced from 11-8, whilst holding patients constant (Tan et al. 2009). Overall, this study demonstrated that the use of dispensing technology alone will not reduce the waiting time of prescriptions.

After the installation of an automated dispensing system, Chapuis et al. (2015) reported time spent by nurses and pharmacy technicians on medication-related work activities, in three adult intensive care units. Pharmacy technicians an additional 3.5 hours per day (mean value) across three intensive care units, on floor stock activities. Less time was spent on preparing boxes [-0.74 hours/day (mean value)] (Chapuis et al. 2015). Although more time [+1.72 hours/day (mean value)] was spent preparing medications in medication exchange carts for restocking the automated dispensing system (Chapuis et al. 2015). Pharmacy technicians spent an additional 3.5 hours per day (mean value) managing the automated dispensing machines (Chapuis et al. 2015). It is needs to be noted that the work sampling work-sampling method used by Chapuis et al. (2015) was limited due to the fact that it is an indirect measure of time and only provides an estimation of the time spent performing different activities.

Additionally, comparisons have been made by Ruhle, Braun and Ostermann (2009) of the effects of automation on dispensary space. Literature showed a saving in floor space after the implementation of a robotic dispensing machine. The use of a ROWA dispensing machine was found to occupy on average $12.1m^2$, initially the robotic dispensing machine replaced the conventional storage-system such as pull-out drawers was found to be $21.16m^2$ (Ruhle, Braun and Ostermann 2009). The difference in floor space between the robotic dispensing machine and pull-out drawer's storage system was $9.06m^2$ (Ruhle, Braun and Ostermann 2009). This showed a saving of 40% (p=0.26) of floor space in the dispensary. Over 50% (59%) of pharmacies were found to use this space gained for additional behind-the-counter (no customer access) and self-display area, where the average gain in area amounted to 57% (Ruhle, Braun and Ostermann 2009).

2.11 Further research

Overall, this review has explored various outcomes used to assess dispensing technologies. However, the need the need for high quality research is apparent particularly diverse research covering various levels of care and of different scales (Boyd and Chafee 2019). Boyd and Chafee (2019) conducted a critical evaluation of pharmacy automation and robotic systems.

They demonstrated the need for national and international professional organisations to assist the creation of expert panels to standardise the process related to the evaluation of pharmacy automation and robotic systems (Boyd and Chafee 2019). It was also recommended that expert panels describe outcomes that need to be included in evaluations such as patient safety and financial stewardship (Boyd and Chafee 2019). These outcomes were also discussed in this literature review chapter. Pharmacy is a profession based upon evidence-based practice, therefore having criteria to evaluate dispensing technologies may help with the implementation of systems in community pharmacy. Medication are recommended based upon evidence, therefore perhaps technologies should follow the same guidance. Additionally, perhaps pharmacy leaders should advocate support high quality research with robotic dispensing (Boyd and Chafee 2019).

2.12 Changing the role of the pharmacist

Evidently, the implementation of robotic dispensing would aid the change in the role of the community pharmacist. The integration of robotic dispensing and electronic prescribing was found to change the role of the dispensary pharmacist, whereby pharmacists are no longer in control of the dispensary process (Beard and Smith 2013; Magadzire 2017). However, more studies need to be conducted in order to compare and contrast these findings with different types of robotic dispensing methods such as robotic dispensing and pharmacy automation. Already, literature does exist stating lessons learnt that need to be learnt from pharmacy automation such as the need for trained health information technology staff that understand both the healthcare setting and the technology in a study conducted in Saudi Arabia (Muallem 2015). However, again these findings were limited as they are preliminary results.

With the suggestions from the Department of Health, in introducing large scale dispensing methods such as hub and spoke to free up the pharmacists' time is looking like the future of pharmacy (Department of Health and NHS England 2015). The future plans of the NHS (NHS England 2014) involve pushing pharmacists to a more clinical role; pharmacists are now able to become independent prescribers, allowing them to provide additional support to GPs and creating an out of hours service.

2.13 Gaps in literature

This chapter highlighted findings from the literature review conducted, which gave an overview of different types of dispensing technologies, such as multidose drug dispensing and automated dispensing machines, as well as participant groups such as healthcare professionals such as pharmacists, GPs and pharmacists and patients. Various interventions used in this study included, medication and administration errors, perceptions and financial implications were also examined. No literature has been produced regarding the general public as a sample group in regard to dispensing technologies and this is a gap that will be fulfilled from findings from this thesis. Hub and spoke dispensing has not been evaluated in literature, despite being a suggestion by the Department of Health and highlighted in the NHS plan, Five Year Forward View. Similar dispensing methods to the hub and spoke model include multi-dose drug dispensing and a CDU used in South Africa evaluated by Magadzire et al. (2017). The gaps identified in literature have demonstrated further work needs to be conducted in this area.

In chapter three, the methodology of evaluating the general public and community pharmacists' perceptions of using robotic dispensing methods have been explained in further detail.

Chapter three: Methodology Chapter

3.1 Introduction

The literature review and background chapter helped identify gaps in the literature concerning different outcome measures used to evaluate the use of robotics in a pharmacy setting, as well as identifying population groups have been studied. The review helped provide a foundation to the aims and objectives of this PhD, to explore the research problem of the lack of literature involving the general public and around the large scaled dispensing method hub and spoke dispensing. For this reasoning, a cross-sectional survey was considered to be the most appropriate method, using quantitative methodology, to collate data for analysis on the general public population and community pharmacists perceptions of robotic dispensing.

Two sample groups were used to explore the research aims and objectives. The first sample group were community pharmacists in England. The second sample group were members of the general public in England. The idea was to identify common findings within and between the two sample groups. Additionally, to evaluate these to explore the possible positive and negative matters that could affect members of the general public being pharmacy users and community pharmacists being those that practice pharmacy. This led to the conduction of two studies:

- **Study One:** Community pharmacists' perceptions of using robotic dispensing methods 'hub and spoke dispensing' and 'pharmacy automation' for dispensing in community pharmacies in England

- **Study Two:** The general public perception of using robotic dispensing methods 'hub and spoke dispensing' and 'pharmacy automation' for dispensing in community pharmacies in England

Preliminary work involving, a literature review was conducted to identify any topics that needed be addressed in the questionnaire. A pilot study was used to test any improvements for the questionnaire, providing an ease of read for the relevant target populations.

3.2 Background

Science is a process of asking questions and is a discipline built upon assumptions (Graziano and Raulin 2013). Research often starts off with a hypothesis which is said to be the beginning of a scientific method, or an educated guess. Traditionally, experiments are conducted on developing an idea into a theory. A theory is formulated 'to explain, predict, and understand phenomena and, in many cases, to challenge and extend existing knowledge within the limits of critical bounding assumptions'. The theoretical framework then introduces and describes the theory that explains why the research problem exists (University of Southern California, 2018).

The philosophical side of the expansion of scientific methods can be explained by the term 'empiricism.' An empirical method is an *"inductive, proceeding from observation or experiment"* (Morick 1980: 129). This then distinguished the term 'inductive reasoning', Copi and Cohen (2009) explained this to involve 'using more abstract and general ideas to return to the specific', which created an inductive approach to research. However, Popper (1959) rejected the observational-inductive approach. Popper (1959) deemed in order for a hypothesis to be a regarded as scientific, it needs to be appropriate for falsifiability and testability, in other words it needed to be proven as false. If a theory can explain any possible outcome, this could then support the fact that anything is possible, promoting the idea of 'deductive reasoning.' Graziano and Raulin (2013) define deductive reasoning to involve 'making predictions about future observations'.

Popper's hypothesis was that enumerative induction does not exist as psychological reasoning, it supports the development a hypothetico-deductive method where, 'the philosophers and methodologists of science use to refer to the scientific practice of validating theories by means of formulating hypotheses and deriving and testing conclusions'. The principle of the hypothetico-deductive method was said to be linked with a scientific approach to research. To put it simply, this meant learning from experience (Lawson 2005). Research is said to be a mixture of inductive and deductive reasoning. However, more so a deductive approach as the deductions may turn into hypotheses (Graziano and Raulin 2013).

Following on, another stage that needs to be considered when planning research is the social research paradigm that will be chosen to be followed. Oakley (1995) defined a research paradigm as ‘a way of breaking down the complexity of the real world that tells their adherents what to do’. To provide a foundation to research paradigms, new researchers are introduced to qualitative and quantitative methods as research paradigms, offering a basic framework for dividing different types of knowledge. Within these two broad paradigms five paradigms exist: positivism, post-positivism, interpretivism, critical and postmodern (Blaxter, Hughes and Tight 2010).

From a scientific perspective, the positivism approach is often supported. This approach involves the view that social science should mirror, or as close as possible, those of the natural sciences. The idea is for the researcher to be detached from objectives of the research and to be objective itself. Common methods of data collection of this approach include questionnaires and experiments where the reality of data can be collected. This then allows interpretation to be made leading to control and predictability of the data (Blaxter, Hughes and Tight 2010). However, some argue that positivism is a poor foundation for research and investigation in any case or realm (Nissen 1985; Orilikowski & Baroudi 1991). There are also claims that positivism is self-contradictory, as it is not happening naturally independent from the observer and may cause associated problems with the underpinning of positivism (Quine 1980). To summarise, positivism could simply look into the happenings or occurrence that are formed by the researcher therefore, not representing what is happening in reality (Stahl 2003).

3.3. Theory used in pharmacy practice research

Having considered the background from the social underpinnings of research. This section has provided a focus on the basis of theory-based pharmacy practice research upon other fields such as sociology, psychology, anthropology, pedagogy and health economics. Theories based in pharmacy practice research can help researchers identify research questions, topics and subjects that need to be explored. Frameworks are provided in pharmacy practice research, instead of using a 'trial and error' approach. Instead, by using a social and humanistic science approach, where the researcher is then provided with an explanatory framework for interpreting questions and answers (Nosrgaard, Morgall & Bissell 2000). Using such theories, is said to have different purposes depending on the research area and question. These purposes range from explanations and predictions, which are adopted from the positivism approach (Nosrgaard, Morgall & Bissell 2000).. Where, research is undertaken to comprehend and critique the interpretivist and critical research traditions. Resulting in, health related research use a positivist approach. For example, in a pharmacy practice research approach, if we were to look at compliance or adherence to medication, each type of view would have a different outlook. A positivist view would explore how to make a patient 'one hundred percent compliant'. This demonstrates that this type of view tries to predict and control a situation, whereas an interpretivist researcher would try and understand the patient's reflections in relation to medication behaviour (Nosrgaard, Morgall & Bissell 2000).

The philosophical research base of this programme of work followed a positivist theoretical perspective. The rationale for this research paradigm was due to the collection of quantifiable data that lead to statistical analysis. The studies in this programme of work found the researcher was independent from the study and there were no provisions for human interests within the study. The researcher concentrated on topics derived from literature which also led to the choice of a positivist philosophical perspective. Although, explanations can be made for the relationships observed for the relationships observed, no hypotheses were pre-formed before the administration of the survey. Therefore, a true positivist approach was not adopted rather a broadly (neo)-positivist approach.

An interpretivist approach, the use of a naturalist approach of data collection such as interviews and observation were not suitable for this programme of work, as it was hoped to generalise findings for community pharmacists, as opposed to exploring what findings were unique. The desired information the researcher wanted to collate was ascertaining how many of both study groups thought about a particular topic in contrast to the interpretivist approach which would divulge into why the population thought what they thought and what types of problems they were confronted with and how they would deal with them.

3.4 Qualitative and quantitative approaches

Quantitative methodology is empirical research where data is essentially numerical. Whereas, qualitative methodology is empirical methodology where data is primarily non-numerical (Tenenbaum, Gershgoren & Schinke 2011). As a whole quantitative research tends to be large scale and representative of populations. While, qualitative research involves collecting and analysing information in many forms often not involving numbers. Subjectivism is associated with a qualitative paradigms and objectivism is associated with quantitative paradigms (Blaxter, Hughes and Tight 2010). Qualitative researchers are often associated with being interpretivists and quantitative researchers are associated with being positivists (Johnson and Onwuegbuzie 2004). Table 3.1 has highlighted the differences between qualitative and quantitative research.

Qualitative paradigms	Quantitative paradigms
Concerned with understanding behaviours from actors' own frames of reference	Advocates the use of quantitative methods
Naturalistic and uncontrolled observation	Obtrusive and controlled measurement
Subjective	Objective
Close to the data; the "insider" perspective	Removed from the data; the "outsider" perspective
Grounded, discovery-oriented, exploratory, expansionist, descriptive and inductive	Ungrounded, verification-oriented, confirmatory, reductionist, inferential, and hypothetico-deductive
Process-oriented	Outcome-oriented
Valid; "real", "rich", and "deep" data	Reliable; "hard", and replicable data
Ungeneralisable; single case studies	Generalisable; multiple case studies
Holistic	Particularistic
Assumes a dynamic reality	Assumes a stable reality

Table 3.1. The differences between qualitative and quantitative research (Blaxter, Hughes and Tight 2010) sourced from Oakley 1999: 156

Quantitative research is 'the numerical representation and manipulation of observations for the purpose of describing and explaining the phenomena that those observations reflect' (Sukamolson 2010). In summary, numerical data is collected based on the manipulations of observations, which is then analysed by statistics. In research, the use of the mathematics behind analytical methods is often a hindrance to researchers in conducting quantitative research. It is a common misconception for most people to perceive quantitative research, to be specifically applicable to 'quantitative data'. Often, different research methods are used to make data appear 'quantitative'. In research, it is essential to use the correct type of research instruments to make sure the correct data is collected using the corrected analytical statistical methods. Examples of quantitative research methods include surveys, correlational research, experimental research and causal-comparative research.

Overall, qualitative research can be seen as exploring general views of an area, thereby forming theories and models. Quantitative research is then often used to further test these theories allowing statistical analysis to be conducted, to further explore the hypothesis. There have been many philosophical issues against qualitative and quantitative paradigms, however those seem to confuse the logic of justification. It was Kuhn (1962) who defined what a paradigm was, he then was later told to further explain what he meant. He then explained a paradigm to be a general concept, included in a group of researchers having a common education and agreement on 'exemplars' of high-quality research or thinking (Kuhn 1977). Researchers should use strategies that complement one another in their strengths and non-overlap in their weaknesses (Johnson and Turner 2003). In regards, to qualitative and quantitative research the same should be applied.

For example, the logic of justification does not necessarily predict a certain method of data collection and then followed by data analytical methods that researchers must use (Johnson et al. 2004). A researcher must gain an understanding of strengths and weaknesses of both paradigms and decide what is most suited (Johnson and Onwuegbuzie 2004). The strengths and weaknesses of quantitative research have been described in Table 3.2.

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Table 3.2. Strengths and Weaknesses of Quantitative Research (Johnson and Onwuegbuzie 2004)

Overall, in both studies quantitative methodology has been used with few questions of a qualitative nature. As quantitative research is used to 'generalise the truth about samples found in populations' (Sukamolson 2010). it was the chosen methodology as these studies aimed to generalise the findings within the community pharmacist and the general public population. Very minimal qualitative elements were use in the questionnaire as one open ended question was included to give a chance for participants to further expand on their answers for multiple choice questions with an 'other' option. A quantitative paradigm with some questions of a qualitative element was decided, particularly as no research has been undertaken on the general public perception on the use of robotics in community pharmacies in England, particularly hub and spoke dispensing.

A qualitative approach was not adopted as the researcher was not concerned with understating of the perceptions of the participants, rather to find a generalised perception of the general public and community pharmacists in the use of robotics in community pharmacy dispensing. In this programme of work the idea was to test and examine relationships amongst variables through statistical analysis, in contrast to a qualitative approach where this would mean exploring and understanding the meanings of groups and individuals. A mixed method approach also could have been another viable option however this was not feasible due to time constraints and the budget of the project.

The researcher intended to capture reality through the use of research instruments such as questionnaires as carried out through this programme of work (add reference 182). Although positivists have been critiqued for failing to measure the meanings of situations to people which would follow an interpretivist approach (180). For this reason, both studies adopted quantitative methodology with few questions of a qualitative nature. As quantitative research is used to 'generalise the truth about samples found in populations' (Sukamolson 2010). It was the chosen methodology as these studies aimed to generalise the findings within the community pharmacist and the general public population. Very minimal qualitative elements were use in the questionnaire as one open ended question was included to give a chance for participants to further expand on their answers for multiple choice questions with an 'other' option. A quantitative paradigm with some questions of a qualitative element was decided, particularly as no research has been undertaken on the general public perception on the use of robotics in community pharmacies in England, particularly hub and spoke dispensing.

The scales for most questions used a 5-point Likert scales such as : strongly agree, agree, neither agree nor disagree, disagree or strongly disagree, where to an extent measurement are controlled as participants are choosing an option. Therefore, a broad positivist approach can be said to have been used, as hypotheses had not been drawn, therefore not truly being classed at positivist. An semi-insider perspective was used for these studies as the researcher is a community pharmacist researching into their own profession. Therefore, the researcher had a common understanding of the issues associated in community pharmacy. However, a full insider perspective was not appropriate as the general public population was also being studied.

3.5 Preliminary work

The literature review helped identify two common factors that were found in previous literature around the perceptions of robotics with pharmacists and patients, as well as medication errors and robotics in pharmacy. The common factors derived from literature, stipulated questions asked in both surveys. Research highlighted the general public perception had not been explored neither had the topic of 'hub and spoke' dispensing. With the Department of Health suggesting the use of large scaled dispensing such and 'hub and spoke dispensing,' and the current adoption of pharmacy automation in hospital and few community pharmacies, it was decided to explore these two robotic dispensing methods. The key difference between the two robotic dispensing being off-site (hub and spoke) and on-site (pharmacy automation) robotic dispensing.

3.6 Overview of the study design

The term 'research design,' Oppenheim (1992: 6) described as,

'a basic plan or strategy of the research, and the logic behind it, which will make it possible and valid to draw more general conclusions from'.

Once considering the aims and objective outlined in the beginning of this programme of work it was decided to adopt cross-sectional survey methodology. This methodology of data collection was deemed as appropriate as it helped address gaps, as identified in the literature review, relating to community pharmacists' and the general public perception of using robotics for dispensing in community pharmacies in England.

3.6.1 Survey methodology

A survey is an example of a research technique used for collection and generation of data (Oppenheim 1992). Surveys are 'information collection methods used to describe, compare, or explain individual and societal knowledge, feelings, values, preferences and behaviour'. Various instruments can be used to carry out a survey, such as a self-completion postal questionnaire that can be filled out alone or with assistance or an interview done over the phone or in person (Fink 2017). The most common instrument used is a questionnaire which is a ‘list of questions administered to survey participants’ (Bresee 2014). Surveys can be self-administered i.e. online or postal (Fink 2017). Questionnaires can be used to sample data from large populations. Self-administered postal questionnaires can reach large geographic areas and be completed anywhere (Fink 2017). These types of questionnaire can be posted out to large numbers at a low cost compared to interviews which are a lot more expensive. Enclosing a pre-paid envelope can help encourage participants to respond (Office for National Statistics 2017).

3.6.1.1 Cross-sectional design

A cross-sectional survey design was employed for both studies. This type of survey is used to sample a population at one point in time as opposed to a longitudinal survey which follows a population over a long period of time (Oppenheim 1992). For the purpose of these studies a cross-sectional design represented the sample populations at a particular point in time. Cross sectional surveys aim to target different members of a population to make them representative of a whole population (Office of National Statistics 2017). This design is often used to document the prevalence of particular characteristics in a population. They also allow for relations between variables and differences between subgroups in a population to be assessed such as region worked or lived in (Visser et al. 2014). For example, assessing the perceptions of the general public or pharmacists’ who live or work in a specific region towards using robotics in community pharmacy dispensing. Table 3.3 described the advantages and disadvantages of using a cross-sectional study.

Table 3.3 Advantages and Disadvantages of a Cross-Sectional Study (Thelle and Laake 2015)

3.6.1.2 Postal surveys

A postal survey was adopted for both studies. Online and telephone surveys were disregarded as distributing surveys to pharmacists and members of the general public emerged to be difficult. Obtaining email addresses or even distributing an online link for the survey was not applicable. Therefore, postal surveys were deemed most appropriate as obtaining addresses of community pharmacies or home addresses of the public was a more accessible option. Table 3.4 has detailed the advantages and disadvantages of postal surveys.

Table 3.4 Advantages and Disadvantages of Postal Surveys (Fink 2007: 15-18)

3.6.1.2.1 Postal surveys distribution method

An adapted version of the 3-point-of-contact protocol adapted from Dillman (2000) was used for the distribution of postal surveys for both study designs. The protocol for both studies involved:

1. A survey packet containing: a cover letter explaining the purpose of the study, a participant information sheet, a consent from, survey and a pre-paid self-addressed envelope
2. A follow up letter and second survey packet was sent again two weeks after for the second posting
3. Another follow up letter alongside a survey packet was sent again for a final posting two weeks after.

3.7 Sampling Methods

Various sampling methods exist in quantitative research and were considered in this programme of work. The most common types of probability sampling techniques are simple random, systematic sampling, stratified and cluster sampling (California State University 2018).

Both studies used stratified random sampling, where the population was divided into subgroups, known as stratums. Within each stratum, the group shared similar characteristics such as the same pharmacy owner for the study one and for study two common characteristics being geographical location etc. Furthermore, within each stratum stratified random sampling was undertaken ensuring all groups were adequately represented in the final sample (California State University 2018). The sampling method was selected as specific groups were stratified to proportionally represented the stratum . This method aimed to give a true representation of the samples being observed, compared to other sampling methods. For example, in both study's context, a member of the general public or a community pharmacy was selected and assigned a participant reference number. Then by using a random number generator, such as =RAND in Microsoft Excel, a participant was selected from their representative group and a sample was created. Therefore, ensuring each member of the population had an equal chance of being selected, reducing the risk of bias.

Following on, simple random sampling is where the researcher develops an accurate sampling frame, selecting elements from frame, using a mathematically random procedure. The exact element is then located which is selected for the inclusion of the sample (California State University 2018). Although, simple random sampling is a random sample from the whole population, in both these studies this was not possible to obtain a complete list of population member, therefore, was ruled out (Black 1999).

Systematic sampling is where elements are selected using a sampling interval (i.e. selecting every tenth case), informing the researcher how to select elements from a sampling frame by skipping the frame before selecting the sample. In comparison, to simple random sampling, a more even number spread of the sample is achieved (California State University 2018). This method can only be used if a complete list of the population is available which was not possible to do in this programme of work (Barreiro and Albandoz 2001).

Cluster sampling is where the population divides into a number of clusters, which have a range of characteristics. Clusters are then chosen at random and the sub-population is chosen within the cluster forming the sample (California State University 2018). This sampling method didn't fit the criteria of this study as clusters in a level must be equivalent. Although, cluster sampling does allow to randomly select with no single list of population lists but local lists do (Black 1999).

3.8 Survey for community pharmacists

Study one examined the perceptions of community pharmacists towards robotic dispensing. This study was conducted from May 2018 – June 2018, where self-administered postal surveys were distributed to community pharmacists around England.

3.8.1 Sample size

A priori sample size calculation, via survey monkey was used to carry out an adequate sample size, representative of the population. The Office for National Statistics calculated the population estimate for pharmacists in 2017 to be approximately 43,677 pharmacists in England from January – December 2016. The population estimate was inputted into Survey Monkey, using a 5% margin of error and 95% confidence interval, this generated the required number of responses from the sample population to be 381. The ASHP national surveys of pharmacy practice in hospital settings from 2013-2017, reported an average response rate of around 27.2% (Pederson, Schneider and Scheckelhoff 2013,2014,2015,2016,2017). This was taken as an average response rate of 30%, to be classified as reasonable based on previous pharmacy practice research. Therefore, to obtain approximately 381 responses, a sample size of 1207 was needed. However, due to budget constraints 1000 community pharmacies were selected for study one.

3.8.2 Sampling strategy

The sampling strategy for study one has been described, covered how community pharmacies were identified to represent the current community pharmacy market.

3.8.2.1 Pharmacy type

Firstly, a list of registered pharmacies in Great Britain was obtained from the General Pharmaceutical Council website and at the time was dated 02/01/2018. The database contained the contact details of community pharmacies including: the trading name, address line 1, 2 and 3, town, county, country, postcode, region, owner name and premises type.

An article produced by the Pharmaceutical Journal titled, *'Community pharmacy in Great Britain 2016: a fragmented market'*, was used help identify the types of community pharmacy such as multiples and independents. For example, an independent pharmacy was defined as a pharmacy where a company owned 5 pharmacies or less, a small independent pharmacy was classified as owning between 6-99 pharmacies and large multiples owning 100 or more pharmacies. However, for the purpose of this study community pharmacies were defined as independent community pharmacy if the company owns 5 pharmacies or less and an independent community pharmacy chain if the pharmacy company owned 6 or more pharmacies.

3.8.2.2 Market ownership

The GPhC register of registered pharmacy premises recorded a total of 14,415 in Great Britain. The register identified 302 hospital pharmacies, 1 internet pharmacy, 19 prison pharmacies and 10 temporary pharmacies. Additionally, at the time 1293 pharmacies were located in Scotland and 746 pharmacies in Wales. However, for the purpose of this study these were all not included in study one, as the focus of this study was on community pharmacies in England. Furthermore, this programme of work identified 12,044 community pharmacies in England. A total of 7,466 multiple pharmacies were found and 4,578 independent pharmacies.

Owner	Pharmacies	Type	Market Ownership %	If 1000
W M Morrison Supermarkets Plc	99	Large multiple	0.82	8
Superdrug Stores Plc	187	Large multiple	1.55	16
Day Lewis Plc	225	Large multiple	1.87	19
Asda Stores	239	Large multiple	1.98	20
Tesco Stores Ltd	355	Large multiple	2.95	29
Bestway National Chemists Limited	584	Large multiple	4.85	48
Lloyds Pharmacy Ltd	1,493	Large multiple	12.40	124
Boots UK	1,949	Large multiple	16.18	162
Arun Sharma Chemists Ltd	6	Small multiple	0.05	0
B.K. Kandola Ltd	6	Small multiple	0.05	0
Davison (Chemist) Ltd	6	Small multiple	0.05	0
Donald G Hayden (Chemists) Ltd	6	Small multiple	0.05	0
East of England Co-operative Society	6	Small multiple	0.05	0
Fairman Chemists Ltd	6	Small multiple	0.05	0
Farah Chemists Ltd	6	Small multiple	0.05	0
G Whitfield Ltd	6	Small multiple	0.05	0
Geloo Brothers Ltd	6	Small multiple	0.05	0
Mansons Chemists Ltd	6	Small multiple	0.05	0
Mayfair Pharmacare Limited	6	Small multiple	0.05	0
Meraj Ltd	6	Small multiple	0.05	0
Morningside Leicester Ltd	6	Small multiple	0.05	0
North Meols Pharmacy Ltd	6	Small multiple	0.05	0
Osbon Limited	6	Small multiple	0.05	0
Pharma-Z Ltd	6	Small multiple	0.05	0
Poolearth Torquay Limited	6	Small multiple	0.05	0
Preddy Newco Ltd	6	Small multiple	0.05	0
Repeat Prescription Order Line Limited	6	Small multiple	0.05	0
Rosemead Ltd	6	Small multiple	0.05	0
Shires Pharmacies Limited	6	Small multiple	0.05	0
The Pillbox & Case Co Ltd	6	Small multiple	0.05	0
Twin Ventures International Ltd.	6	Small multiple	0.05	0
Yorcare Limited	6	Small multiple	0.05	0
Aston Chemists Ltd	7	Small multiple	0.06	1
Clockwork Retail Ltd	7	Small multiple	0.06	1
Cornwells Chemists Ltd	7	Small multiple	0.06	1
E-Nova Healthcare Limited	7	Small multiple	0.06	1
Esom's Ltd	7	Small multiple	0.06	1
Gill & Schofield Pharmaceutical Chemists Ltd	7	Small multiple	0.06	1
Greenlight Healthcare Ltd	7	Small multiple	0.06	1

Owner	Pharmacies	Type	Market Ownership %	If 1000
Hyperchem Limited	7	Small multiple	0.06	1
James Storer Powell	7	Small multiple	0.06	1
Lo's Pharmacy Ltd	7	Small multiple	0.06	1
M & B Healthcare Ltd	7	Small multiple	0.06	1
M S Birk Pharmacy Ltd	7	Small multiple	0.06	1
M Whitfield Ltd	7	Small multiple	0.06	1
Matrix Primary Healthcare Ltd	7	Small multiple	0.06	1
Medicare Chemists Ltd.	7	Small multiple	0.06	1
Medicine Clinic Limited	7	Small multiple	0.06	1
Napclan Retail Ltd	7	Small multiple	0.06	1
Newline Pharmacy Limited	7	Small multiple	0.06	1
Northwood Dispensing Chemist Ltd	7	Small multiple	0.06	1
Saffron Apothecaries (Leicester) Ltd	7	Small multiple	0.06	1
Strandhaven Ltd	7	Small multiple	0.06	1
Surreal Medicare Limited	7	Small multiple	0.06	1
Vittoria Healthcare Ltd	7	Small multiple	0.06	1
W M Brown (Kingshurst) Ltd	7	Small multiple	0.06	1
Adam Myers Ltd	8	Small multiple	0.07	1
APA Ltd.	8	Small multiple	0.07	1
Niemans Chemists Ltd	8	Small multiple	0.07	1
Pyramid Pharma Pharmaceuticals Limited	8	Small multiple	0.07	1
Shadforth Pharmaceutical Co Ltd	8	Small multiple	0.07	1
Shiraz & Sons Limited	8	Small multiple	0.07	1
Tayzana Ltd	8	Small multiple	0.07	1
B.J. Wilson Ltd	9	Small multiple	0.07	1
Day - Night Pharmacy Limited	9	Small multiple	0.07	1
Medimpo Ltd.	9	Small multiple	0.07	1
Newbridge (Healthcare) Limited	9	Small multiple	0.07	1
Sedem Ltd.	9	Small multiple	0.07	1
Sutton Chase Ltd	9	Small multiple	0.07	1
Tri-Pharma Limited	9	Small multiple	0.07	1
Warwick Healthcare Limited	9	Small multiple	0.07	1
Whittle Pharmacies Limited	9	Small multiple	0.07	1
Allcures Plc	10	Small multiple	0.08	1
Blundell's Pharmacy	10	Small multiple	0.08	1
Butt & Hobbs Limited	10	Small multiple	0.08	1
Daleacre Healthcare Ltd	10	Small multiple	0.08	1
Micheal Franklin (Chemists) Ltd	10	Small multiple	0.08	1
Wise Pharmacies Limited	10	Small multiple	0.08	1
Aim Rx Ltd	11	Small multiple	0.09	1

Owner	Pharmacies	Type	Market Ownership %	If 1000
Ashaeve Limited	11	Small multiple	0.09	1
Freshphase Limited	11	Small multiple	0.09	1
H J Everett	11	Small multiple	0.09	1
J M McGill	11	Small multiple	0.09	1
John Ware Ltd	11	Small multiple	0.09	1
Pearl Chemist Ltd	11	Small multiple	0.09	1
Pharmacy Care Plus Limited	11	Small multiple	0.09	1
Shaunaks Ltd	11	Small multiple	0.09	1
Borno Chemists Ltd	12	Small multiple	0.10	1
Dean & Smedley Ltd	12	Small multiple	0.10	1
M E J Hingley & Co Ltd	12	Small multiple	0.10	1
A & S Shillam Limited	13	Small multiple	0.11	1
Delmergate Ltd	13	Small multiple	0.11	1
K.S.C IT Limited	13	Small multiple	0.11	1
Secret Potions Limited	13	Small multiple	0.11	1
Ashchem Limited	15	Small multiple	0.12	1
Hollowood Chemists Ltd	15	Small multiple	0.12	1
Manichem Ltd	16	Small multiple	0.13	1
Medipharmacy Limited	16	Small multiple	0.13	1
Sharief Healthcare Limited	16	Small multiple	0.13	1
X-Pharm Ltd	16	Small multiple	0.13	1
SKF. Lo (Chemists) Ltd	17	Small multiple	0.14	1
Badham Pharmacy Limited	18	Small multiple	0.15	1
Knights Chemist Limited	18	Small multiple	0.15	1
Sykes Chemist Ltd	18	Small multiple	0.15	1
The Hub Pharmacy Limited	18	Small multiple	0.15	1
Jardines (U.K.) Ltd	20	Small multiple	0.17	2
Safedale Ltd	20	Small multiple	0.17	2
A M G Healthcare Limited	22	Small multiple	0.18	2
Pillbox Chemists Ltd	22	Small multiple	0.18	2
H A McParland Ltd	24	Small multiple	0.20	2
Pasab Ltd	25	Small multiple	0.21	2
Canterbury Pharmacies Ltd	26	Small multiple	0.22	2
Rajja Ltd	26	Small multiple	0.22	2
C G Murray & Sons Ltd	27	Small multiple	0.22	2
Laville Ltd	28	Small multiple	0.23	2
ABC Drugs Stores Limited	29	Small multiple	0.24	2
Jhoots Healthcare Limited	33	Small multiple	0.27	3
West Midlands Co-operative Chemists Ltd	33	Small multiple	0.27	3

Owner	Pharmacies	Type	Market Ownership %	If 1000
Norchem Healthcare Ltd	35	Small multiple	0.29	3
Whitworth Chemists Ltd	35	Small multiple	0.29	3
W R Evans Healthcare Ltd	42	Small multiple	0.35	3
Dudley Taylor Pharmacies Ltd	47	Small multiple	0.39	4
Lincoln Co-operative Chemists Ltd	49	Small multiple	0.41	4
Waremoss Ltd	54	Small multiple	0.45	4
H. I. Weldrick Ltd	62	Small multiple	0.51	5
PCT Healthcare Limited	80	Small multiple	0.66	7
Paydens Ltd	86	Small multiple	0.71	7
Gorgemead Ltd	211	Large multiple	1.75	18
L.Rowland & Co (Retail) Ltd	420	Large multiple	3.49	35
Independents	4,578		**38.01**	380
			100.00	**1000**

Table 3.5. Pharmacy owners, pharmacy type and market ownership, if integer is 1000. Due to rounding formulas in Excel some of the percentages were rounded down and not up.

3.8.2.3 Stratified sampling for pharmacists

Table 3.5 has described how community pharmacies were classified and selected to make up a sample of 1000 community pharmacies in study one. Furthermore, each stratum was classified as one pharmacy company. The percentage market ownership each pharmacy company holds within the community pharmacy market was calculated. The market ownership was defined as the proportion of pharmacies by number of pharmacies owned. This percentage was then used to work out the sampling fractions for each stratum, resulting in stratified random sampling proportionate to each pharmacy company. Resulting in different sampling fractions used within each stratum (Visser, Krosnick and Lavrakas 2000). This ensured the sample population had been represented properly.

The market ownership of the pharmacy owner was calculated as follows:

$$\frac{Number\ of\ pharmacies\ owned}{Total\ number\ of\ community\ pharmacies}\ x\ 100 = Market\ ownership\ of\ each\ pharmacy\ owner$$

The stratified random sampling fractions were calculated as follows:

$$\frac{Number\ of\ pharmacies\ owned}{Total\ number\ of\ community\ pharmacies}\ x\ 1000 = Sample\ number\ per\ pharmacy\ owner$$

Moreover, in Table 3.5 community pharmacies were organised by pharmacy type: independent or multiple depending on their proportion of the pharmacy market. Pharmacies were separated according to their owner, and then defined as a large multiple pharmacy (owning 7 pharmacies or more), small multiple pharmacy (6-7), otherwise they were independent (owning 5 pharmacies or less). Within each stratum, a stratified random sample calculation was performed using the =RANDBETWEEN (min,max) function in Microsoft Excel, according to the 'if 1000 column' in Table 3.5. For example, at the time of classification of pharmacy types, Boots UK owned 1949 community pharmacies in England, which represented 16.18% of the community pharmacy market. The calculation for the Boots UK strata resulted in 162 pharmacies being selected out of 1000 community pharmacies.

3.8.3 Pilot study for pharmacists

To begin the data collection process, a piloting of the survey was undertaken to examine the feasibility and test the logistics of the study design, whilst also providing an insight to potential problems of the questionnaire. The pilot study cover letter, participant information sheet and consent form and survey are located in Appendix 1- Study One: cover letter (pilot study), Appendix 2- Study One: participant information sheet (pilot study) and Appendix 3- Study One: consent from and survey (pilot study) respectively.

A pilot questionnaire was sent out to 50 community pharmacists, representing 5% (50/1000) of the target population of 1000 community pharmacists for study one. A response rate of

62% (31/50) was observed in the pilot study. The sample was restricted to pharmacists working in community pharmacy at the time of posting, whether it was in an independent pharmacy, small multiple pharmacy or large multiple pharmacy (including supermarket pharmacies).

Community pharmacists were sent a copy of the questionnaire, cover letter, and participant information sheet. A comments box was implemented at the end of the questionnaire for participants to make any comments or suggest improvements for the questionnaire. Alternatively, respondents were able annotate the questionnaire with their comments. Improvements made to the questionnaire following the pilot study included changes terminology used in questions or enhancing the clarity of questions and the addition of options for some multiple choice questions. For some questions, a please tick all that apply bracket was added to questions which could have multiple responses. Table 3.6 below highlighted alterations made to the questionnaire for the main study and explanations to why changes had occurred.

Type of change made	Changes made within the questionnaire	Before pilot study	After pilot study	Reason for change being made
Additional options added	To questions where other options pharmacists could add to, an other (please state) option was added	No other option	Other option added	Another option needed to added as pharmacists may have other barriers they feel they have, that have not been covered in the question.
Additional options added	Questions giving options of hugely increased/decreased	Hugely increased/decreased	Significantly increased/decreased	Suggestions from a couple of participants to change the terminology
Additional options added	Potential problems and hub and spoke dispensing question	Prescription lost on travel, Longer for patients to get medication, Clinical check being done in store, Other (please state)	Prescription medication lost on travel, Longer for patients to get medication, Clinical check being done in store by a different pharmacist, Hub and spoke dispensing not being able to dispense all items (i.e. fridge lines, appliances etc.), Increased time spent matching prescription bags, sent from the hub, to the original prescription in store, Scanning of prescriptions from pharmacy (spoke) to the hub, No problems, Other (please state)	In the other option of this question, the same options were being suggested, therefore these then formed options such as, increased time matching prescription bags to original prescriptions in store, not dispensing fridge lines etc
Additional options added	Potential problems for pharmacy automation question	Patients more likely to come into the pharmacy, Makes the pharmacy look more appealing, Shows the advancement of pharmacy with technology user, Other (please state)	Takes up too much space in the pharmacy, Looks unappealing in the pharmacy, Patients may be less likely to come into a pharmacy with a robotic dispensing machine, Risk of human error when operating the machine, No problems, Other (please state)	In the other option of this question, the same options were being suggested, therefore these then formed options such as risk of human error when operating the machine
Additional options added	Potential benefits for pharmacy automation question	Patients more likely to come into the pharmacy, Makes the pharmacy look more appealing, Shows the advancement of pharmacy with	Patients more likely to come into the pharmacy, Makes the pharmacy look more appealing, Shows the advancement of pharmacy with technology user, Prevent pharmacist from self-checking, Other (please state)	In the other option of this question, the same options were being suggested, therefore forming an option to the question such as prevent pharmacist from self-checking

Type of change made	Changes made within the questionnaire	Before pilot study	After pilot study	Reason for change being made
		technology user, Other (please state)		
Additional options added	Option added to types of error question with implementation of a dispensing robot	Errors with stock count, Errors with filling up the dispensing robot with stock, Technical errors (malfunctioning in the robotic dispensing machine), Medication errors (wrong drug/wrong strength/ wrong dose), Other (please state)	Errors with stock count, Errors with filling up the dispensing robot with stock, Technical errors (malfunctioning in the robotic dispensing machine), Medication errors (wrong drug/wrong strength/ wrong dose), Picking errors by the dispensing robot, Other (please state)	
Answer selections made clearer	Add in a please tick all that applies option	No please tick all that applies option	Please tick all that applies op	Add in a please tick all that applies option to certain questions where more than one option may be ticked. Participants appeared to more than one option, although the question did not clearly state this.
Answer selections made clearer	Please tick the most appropriate response was added in brackets to the question.	Question didn't have a bracket with stating please tick the most appropriate response.	(Please tick the most appropriate response)	This option was added to specific questions, where the participant may have enough knowledge of the topic. Feedback "Questions like this one need to say something like "choose the option that best fits your view" perhaps. Otherwise, people love ticking several boxes"
Typographical change	Wording of pharmacist shift question changed	current /immediate past shift as a pharmacist	current/recent shift	Simple for the participant to understand
Typographical change	Wording of waiting times question changed	During your current/ immediate past pharmacist shift, how	During your current/recent pharmacist shift, what was the average prescription waiting times, **during busy periods**?	The wording of the question was too long and may not be clear to the participant that the question was

Type of change made	Changes made within the questionnaire	Before pilot study	After pilot study	Reason for change being made
		long were you instructing patients for prescription waiting times during busy time periods?		about average prescription waiting times
Typographical change	Wording of question to change, as it appeared as a leading question	What would you like to spend more time doing?	If robotics were to free up time spent dispensing and checking medication. What would you like to spend more time doing? (Please tick all that apply)	Feedback from a participant, "the way this is worded assumes there is something else that pharmacists would prefer to do. I'd steer clear of leading questions"
Typographical change	Changing the term "non-pharmacy" to "non-dispensing" staff	Lead to job losses amongst non-pharmacy staff	Lead to job losses amongst non-dispensing staff	The term "non-pharmacy" to "non-dispensing" staff is clearer. Participant feedback suggested this new term, to make the differentiation between staff that do not dispense and staff that do.
Typographical changes	Wording changed for one of the options on potentials benefits of hub and spoke dispensing option	Prescriptions being checked a numerous number of times	Prescriptions being checked for accuracy multiple times	Two participants suggested emphasising the numerous check being for accuracy

Table 3.6 . Changes made to pharmacist survey after pilot study

3.8.4 Contact details of pharmacies

The previous section highlighted the sampling method used in study one. Following on, this section has given further detail on the structure of the questionnaire in study one. As the sample population for this study was community pharmacists, questionnaires were addressed to the pharmacist, to clearly state who the questionnaire needed to be filled out by. A pharmacist registered with the GPhC who worked in community pharmacy was able to participate in this study.

3.8.4.1 Inclusion and exclusion criteria

The research aims and objectives related specifically to community pharmacy practice within England. Therefore, pharmacists from different sectors and working outside England were excluded from this study.

3.8.5 The structure of the questionnaire

This questionnaire was designed based on topics areas highlighted in the literature review and the pilot study examined the any changes that needed to be made to study one. A final version of the questionnaire is located in Appendix 9- Study One: consent form and survey (main study).

The questionnaire contained eight sections which were: occupational details, pharmacy practice, dispensing, hub and spoke dispensing, pharmacy automation and dispensing, hub and spoke dispensing and pharmacy automation, healthcare and demographic details and are detailed below.

3.8.5.1 Occupational details

This section collected data on the occupational status of the pharmacist. Questions covered related to the employment status of the pharmacist and types of community pharmacy worked in. This section also asked respondents any additional qualifications or annotations the pharmacist held in addition to their pharmacy degree.

3.8.5.2 Pharmacy practice

The questions in this section were designed to investigate perceptions community pharmacists had towards current community pharmacy practice, as well obtaining information on the pharmacy environment in which they worked in. The definition of healthcare advice was given defined at the start of the section as '*expert knowledge and suggestions on conditions and treatments*', to ensure community pharmacists understood the term in the context of this study. Questions included how many staff members a pharmacist worked with during their last or current shift and the amount of time pharmacists spent counselling patients. Respondents were also questioned if they have enough time to provide healthcare advice to patients using a 5-point Likert scale from very satisfied to very dissatisfied.

Community pharmacists were also questioned on their extent of agreement (strongly agree, agree, neither agree nor disagree, disagree and strongly disagree) on tasks they felt pharmacists were spending too much time on. These tasks were identified in the literature review and were as follows:

- Administrative activities i.e. paperwork, office work
- Checking medication
- Filing away prescriptions
- Dispensing
- Ordering patient medication
- Pharmacy services
- Stock checks/ordering stock
- Other activities

A multiple response question was also included in this section on various barriers respondents viewed pharmacists faced when providing healthcare advice to patients. Barriers identified from literature the included:

- Staff shortages
- Lack of resources/spaces available
- Lack of personal motivation

- Fear of changing role
- Do not feel it is part of their role
- Lack of understanding of healthcare advice
- No barriers
- Other barriers

3.8.5.3 Dispensing

Questions in this section were designed to gather information about pharmacists' experience towards the current dispensing process. A multiple response question was included in this section. Respondents were asked what format prescriptions were primarily received by the pharmacy, in the form of a multiple response question options included paper, electronic and other types of prescription. Questions were also asked about 'waiting prescriptions', where a definition was also given on this term.

One question asked during the current/recent shift of the pharmacist shift, what was the average prescription waiting time during busy periods, options included:

- Below 5 minutes
- Up to 10 minutes
- Up to 15 minutes
- Over 15 minutes.

A further question also asked the extent of satisfaction pharmacists had towards to available time they had to check 'waiting prescriptions', using a 5-point Likert scale from very satisfied to very dissatisfied. Another multiple response question was also asked in this section stating "*if robotics were to free up time spent dispensing and checking medication. What would you like to spend more time doing?*". Options to answer this question, identified from literature and through policies outlined by healthcare providers were:

- Giving healthcare advice
- Pharmacy services
- Joining other healthcare professionals in providing healthcare advice to patients
- Counselling patients on medication

- Other

3.8.5.4 Hub and spoke dispensing

The term hub and spoke dispensing was defined at the start as it is quite a novel term that many may not be familiar with and respondents were asked if they had heard of this type of dispensing. Two questions covered included the extent of trust towards hub and spoke dispensing, in replacing the manual labour of pharmacy staff in dispensing medication and trust towards relying on another pharmacist to oversee the dispensing process at the hub when the clinical check is done by the pharmacist in store. These questions were based on findings from the literature review and linked with issues highlighted by pharmacy organisations. A 5-point Likert scale was used to access each question ranging from strongly trust to strongly distrust. Furthermore, one question in this section assessed the extent to which hub and spoke dispensing would influence on medication errors and the time taken to get prescriptions. Similar options for each question included: increase, decrease, no influence or do not know.

One question was designed to assess the effects hub and spoke dispensing would have on claims made by health care bodies. Respondents were asked the extent to which they agree or disagree that hub and spoke would:

- Lower operating costs
- Enable pharmacists to spend more time giving healthcare advice
- Lead to job losses amongst non-dispensing staff
- Lead to job losses amongst pharmacists
- Change the job role of a pharmacist

A 5-point Likert scale was used to assess each item ranging from strongly agree to strongly disagree. Another question identified from the literature assessed the impact respondents perceived hub and spoke would have on the workload of the pharmacist, with a 5-point Likert scale ranging from significantly increased to significantly decreased.

A multiple response question related to potential problems respondents perceived towards hub and spoke dispensing included:

- Prescription medication lost on travel
- Longer for patient to get medication
- Clinical check being done in store by a different pharmacist
- Hub and spoke dispensing not being able to dispense all items (i.e. fridge lines, appliances etc.)
- Increased time spent matching prescription bags, sent from the hub, to the original prescription in store
- Scanning of prescriptions from pharmacy (spoke) to the hub
- No problems
- Other

A multiple response question also assessed the perceived benefits of hub and spoke which included:

- Less time spent dispensing
- Having two different pharmacists overseeing checks at the hub and spoke
- More time for pharmacists to utilise their clinical skills through services and advice
- Prescriptions being checked for accuracy multiple times
- No benefits
- Other

Both of these questions were identified from the literature, highlighted from pharmacy organisations and from comments acknowledged in the pilot study.

3.8.5.5 Pharmacy automation

The term pharmacy automation was defined at the start as it is quite a novel term that many may not be familiar with. Questions in this section complemented those asked towards the perceptions of hub and spoke. The options for the multiple response questions on the potential perceived problems and benefits of pharmacy automation differed. Potential problems questioned about included:

- Takes up too much space in the pharmacy
- Looks unappealing in the pharmacy
- Patients may be less likely to come into a pharmacy with a robotic dispensing machine
- Risk of human error when operating the machine
- Slow down dispensing process, especially when dispensing multiple medications
- No problems
- Other problems

Potential benefits questions about included:

- Patients more likely to come into the pharmacy
- Makes the pharmacy look more appealing
- Shows the advancement of pharmacy with technology
- Prevent pharmacist from self-checking
- Other

3.8.5.6 Hub and spoke dispensing & pharmacy automation

One 5-point Likert scale question was designed to assess the extent of trust respondents had towards the accuracy of a robot in dispensing medication. The answer scale again used a 5-point Likert ranging from strongly trust to strongly distrust. One multiple response question was designed to assess the types of errors participants think are more likely to occur with the implementation of a dispensing robot, which included options identified from the literature including:

- Errors with stock count
- Errors with filling up the dispensing robot with stock
- Technical errors (malfunctioning in the robotic dispensing machine)
- Medication errors (wrong drug/wrong strength/ wrong dose/wrong quantity)
- Picking errors by the dispensing robot
- Other

Another question evaluated the implications respondents thought a dispensing robot would have on the productivity in dispensing prescriptions. A 5-point Likert scale was used ranging from significantly increased to significantly decreased. The final question in this section asked the extent to which respondents agreed *"robotic dispensing in pharmacy will hinder patients from using the pharmacy"*. A 5-point Likert scale assessed the perceptions of respondent which ranged from strongly agree to strongly disagree.

3.8.5.7 Healthcare

This section questioned the influence robotics in pharmacy would have on the quality of health care services using a 5-point Likert scale ranging from significantly improved to significantly reduced. One question assessed the prefer location of dispensing, options included:

- I would prefer dispensing to be done on-site
- I do not mind where dispensing takes place
- I would prefer dispensing to be done off-site

Another question assessed the preferred dispensing method of the respondent with options including:

- Current method of dispensing
- Hub and spoke dispensing
- Pharmacy automation
- Either hub and spoke dispensing or pharmacy automation
- I do not mind
- None of the above

The final question in this section allowed respondents to document any other comments they had regarding hub and spoke dispensing or pharmacy automation.

3.8.5.8 Demographic details

This section included demographic questions around age, sex, ethnicity and regions of England in they work in.

3.8.6 Covering letters and reminders for pharmacists

A cover letter was sent alongside each questionnaire located in Appendix 7- Study One: cover letter (main study). The cover letter included details such as the:

- Name, address and contact information of the lead researcher
- Background and aim of the research
- Information on the approval of ethical approval from Coventry University HLS ethics
- Provisional date the questionnaire needed to be returned back by; details of how to return the questionnaire
- Emphasis on confidentiality and the participation in the study is voluntary
- Information on contacting the lead researcher if they had any questions or queries.

3.8.7 Participant information sheet for pharmacists

A participant information sheet was also sent alongside the questionnaire as detailed in Appendix 8- Study One: Participant information sheet (main study). The sheet detailed information on:

- Study title
- Purpose of the study
- Why the participant has been chosen
- Information on the participant of the study; details of what will happen if the participant takes part
- Possible disadvantages and risks of taking part in the study; possible benefits of taking part in the study
- Information on what happens if something goes wrong; confidentiality
- What will happen with the results of the study
- Who is organising and funding the research
- Who has reviewed the study and contact details of the researcher.

3.8.8 Data collection procedures for pharmacist study

During the first posting, 1000 questionnaires, consent forms, participant information sheets, cover letters and freepost self-addressed return envelope (SAE) were posted to community pharmacies across England. Two weeks later the same documents were sent out again to those respondents who had not responded. Followed by a final posting which was also sent out two weeks after to those who had not responded.

The questionnaire and cover letter were addressed to the pharmacist, with each questionnaire containing a unique participant reference number, which was then recorded into a database when inputting questionnaire data. This allowed anonymisation and stopped respondents receiving a further mailing if they had already posted back the completed questionnaire back or did not to wish to participate in the study. It is important to note that there may have been a delay in receiving post or when sending out post. As a test post was sent using a 1st class business reply envelope, this took approximately five days even though Royal Mail stated 1st class postage normally is aimed to be delivered the next working day.

3.8.9 Further notes on sample size for pharmacist study

The sample size used for this study was 1000 community pharmacists. After the questionnaire was sent out, the sample size was reduced due to questionnaires being returned, as pharmacies were no longer at the given address. Data of pharmacies was obtained from the General Pharmaceutical Council website, dated 02.01.18. Surveys were sent from May 2018 -June 2018, so in this period when the sampling method was undertaken some pharmacies might have changed addresses or closed down. Six questionnaires were sent back and note 'returned to sender', therefore reducing the sample size too 994.

3.8.10 Survey response rate for pharmacist study

The Excel database set up containing the name and address of the pharmacy, including name of the pharmacy and pharmacy owner and a corresponding participant reference number. Information on when questionnaires were sent was noted down as well as those who returned a completed questionnaire. A total of 161 completed questionnaires were sent back, giving a total response rate 16.2% (161/994). As previously stated, the ASHP national surveys of pharmacy practice in hospital settings from 2013-2017, reported an average response rate of around 27.2%. (Pederson, Schneider and Scheckelhoff 2013,2014,2015,2016,2017).

3.9 Survey for the General Public

This study was conducted from November 2018 – December 2018, and self-administered postal surveys were sent out to members of the general public for study two.

3.9.1 Sample size for the General Public survey

An a priori sample size calculation using survey monkey was used to carry out an adequate sample size, representative of the population. The ONS calculated there to be a population estimate in mid-2006 of 55,268,067 residents living in England. The ONS stated there to be 40,246,635 local government electors and 38,693,859 parliamentary electors, this statistic was taken from 2017 electoral statistics (ONS 2017). In 2017, 23,878,837 members of the general public had opted out of the open register (ONS 2017). This statistic was taken from the '*electors opted out of the open register for England and Wales, 2013-2017*'. This resulted in 16,367,798 members of the general public on the open register. Survey Monkey calculated the required number of responses from the sample population to be 385, at a 5% margin of error and 95% confidence interval.

3.9.2 Sampling strategy for Local Authorities

The sampling strategy used to select local authorities in England has been explained in this section. Local authorities were selected based on their populations, geographical location, rurality and the indices of multiple deprivation (IMD) to ensure a representative sample of England was obtained.

3.9.2.1 Geographical Location for Local Authorities in England

England contains nine different regions: East Midlands, East of England, London, North East, North West, South East, South West, West Midlands and Yorkshire and the Humberside.

Within these nine regions, contains three hundred and twenty-six local authorities as shown in Table 3.7.

Region	Number of Local Authorities
East Midlands	40
East of England	47
London	33
North East	12
North West	39
South East	67
South West	37
West Midlands	30
Yorkshire and The Humberside	21
Total	326

Table 3.7 Number of Local Authorities in each region of England (Office for National Statistics 2011)

3.9.2.2 Rurality of Local Authorities in England

Data was obtained from the Office of National Statistics, 2011 Rural-Urban Classification of Local Authorities and other geographies (Office for National Statistics 2011). This document classified local authorities as either rural or urban (Table 3.8).

Classification category by ONS	Rural or Urban
Mainly Rural (rural including hub towns ≥80%)	Rural
Largely Rural (rural including hub towns 50-79%)	Rural
Urban with Significant Rural (rural including hub towns 26-49%)	Urban
Urban with City and Town	Urban
Urban with Minor Conurbation	Urban
Urban with Major Conurbation	Urban

Table 3.8 Classification of categories according to rurality

3.9.2.3 Indices of Multiple Deprivation (IMD)

IMD scores were obtained from the ONS, Ministry of Housing, Communities & Local Government for 2015. The 326 local authorities in England were split into quintiles and ranked by their rank of average score for classification as seen in Table 3.9.

Region	Rural LA	Urban LA	Total
London	0	33	33
North East	2	10	12
North West	6	33	39
South East	14	53	67
East Midlands	18	22	40
West Midlands	7	23	30
East of England	18	29	47
South West	20	17	37
Yorkshire and the Humberside	6	15	21
Total	**91**	**235**	**326**

Table 3.9 Number of rural and urban local authorities per region of England

Table 3.10 showed the five quintiles of Indices of Multiple Deprivation according to their rank of average score categories.

Classification	Rank of average score
1	1-65
2	66-130
3	131-196
4	197-261
5	262 -326

Table 3.10 Indices of Multiple Deprivation (IMD) in quintiles according to rank of average score per Local Authority (Office for National Statistics 2015)

The quintile classification and rurality of each local authority were combined. These were classified from 'Rural 1' (high deprivation) to 'Rural 5' (low deprivation) and from 'Urban 1' (high deprivation) to 'Urban 5' (low deprivation) (Table 3.11). A percentage weighting of each category (Rural 1 to Urban 5), was weighted from a sample size of 20. The weighting if the sample size was 20, as an integer was then established (Table 3.12).

Rurality/Region	East Midlands	East of England	London	North East	North West	South East	South West	West Midlands	Yorkshire and the Humber	Total
Rural 1	1	1	0	0	0	0	0	0	0	2
Rural 2	1	3	0	1	2	2	3	0	0	12
Rural 3	4	2	0	1	1	1	8	5	1	23
Rural 4	7	8	0	0	2	1	6	1	5	30
Rural 5	5	4	0	0	1	10	3	1	0	24
Urban 1	5	4	12	6	17	3	2	6	8	63
Urban 2	7	6	8	4	7	8	4	4	5	53
Urban 3	4	5	6	0	5	12	4	7	0	43
Urban 4	5	**7**	5	0	4	6	3	4	1	35
Urban 5	1	7	2	0	0	24	4	2	1	41
Total	40	47	33	12	39	67	37	30	21	326

Table 3.11 Local Authorities, geographical circumstance (rural or urban) and IMD quintile by region in England

Rurality/ Region	East Midlands	East of England	London	North East	North West	South East	South West	West Midlands	Yorkshire and the Humber	Total	%	If 20	If 20 (integers)
Rural 1	1	1	0	0	0	0	0	0	0	2	0.61	0.12	0
Rural 2	1	3	0	1	2	2	3	0	0	12	3.68	0.74	1
Rural 3	4	2	0	1	1	1	8	5	1	23	7.06	1.41	1
Rural 4	7	8	0	0	2	1	6	1	5	30	9.20	1.84	2
Rural 5	5	4	0	0	1	10	3	1	0	24	7.36	1.47	1
Urban 1	5	4	12	6	17	3	2	6	8	63	19.33	3.87	4
Urban 2	7	6	8	4	7	8	4	4	5	53	16.26	3.25	3
Urban 3	4	5	6	0	5	12	4	7	0	43	13.19	2.64	3
Urban 4	5	7	5	0	4	6	3	4	1	35	10.74	2.15	2
Urban 5	1	7	2	0	0	24	4	2	1	41	12.58	2.52	3
Total	40	47	33	12	39	67	37	30	21	326	100.00	20.00	20

Table 3.12 Local Authorities, geographical circumstance (rural or urban) and IMD quintile by each region, using an integer sample of 20

3.9.2.4 Population

As well as the geographical circumstance and IMD quintile for each local authority, the population also needed to be considered to represent the English population. The population percentage data, the total number of local authorities proportionate to the total number of selected local authorities out of 20 (Table 3.13).

Rurality/Region	East Midlands	East of England	London	North East	North West	South East	South West	West Midlands	Yorkshire and the Humber	Total	%	If 20	If 20 (integers)
Rural 1	1	1	0	0	0	0	0	0	0	2	0.61	0.12	0
Rural 2	1	3	0	1	2	2	3	0	0	12	3.68	0.74	1
Rural 3	4	2	0	1	1	1	8	5	1	23	7.06	1.41	1
Rural 4	7	8	0	0	2	1	6	1	5	30	9.20	1.84	2
Rural 5	5	4	0	0	1	10	3	1	0	24	7.36	1.47	1
Urban 1	5	4	12	6	17	3	2	6	8	63	19.33	3.87	4
Urban 2	7	6	8	4	7	8	4	4	5	53	16.26	3.25	3
Urban 3	4	5	6	0	5	12	4	7	0	43	13.19	2.64	3
Urban 4	5	7	5	0	4	6	3	4	1	35	10.74	2.15	2
Urban 5	1	7	2	0	0	24	4	2	1	41	12.58	2.52	3
Total	40	47	33	12	39	67	37	30	21	326	100.00	20.00	20
Population	4,725,390	6,129,005	8,769,659	2,636,589	7,223,961	9,030,347	5,516,973	5,810,773	5,425,370	55,268,067			
Population (%)	8.55	11.09	15.87	4.77	13.07	16.34	9.98	10.51	9.82	100.00			
If 20	1.71	2.22	3.17	0.95	2.61	3.27	2.00	2.10	1.96	20.00			
If 20 (integers)	2	2	3	1	3	3	2	2	2	20			

Table 3.13 Local Authorities, geographical circumstances (rural or urban) and IMD quintile by each region, using an integer sample of 20 according to population

3.9.2.5 Final Weighting and Selection

Table 3.13 aided the final selection of the appropriate number of local authorities that were randomly selected. The stratified random sampling method within each region, local authorities were randomly selected in accordance with their classification. Local authorities were chosen accordingly as displayed in Table 3.14. Table 3.15 shows what local authorities were selected.

Rurality/Region	East Midlands	East of England	London	North East	North West	South East	South West	West Midlands	Yorkshire and the Humber	Total
Rural 1										0
Rural 2		1								1
Rural 3							1			1
Rural 4		1							1	2
Rural 5						1				1
Urban 1			1	1	1				1	4
Urban 2	1		1		1					3
Urban 3	1					1		1		3
Urban 4					1			1		2
Urban 5			1			1	1			3
Total	2	2	3	1	3	3	2	2	2	20

Table 3.14. Sampling method of Local Authorities

Rurality/Region	East Midlands	East of England	London	North East	North West	South East	South West	West Midlands	Yorkshire and the Humber
Rural 1									
Rural 2		King's Lynn and West Norfolk							
Rural 3							Mendip		
Rural 4		Mid Suffolk							Craven
Rural 5						Wealden			
Urban 1			Barking and Dagenham	Redcar and Cleveland	Bolton				North East Lincolnshire
Urban 2	Northampton		Kensington and Chelsea		Wigan				
Urban 3	Amber Valley					Dartford		Redditch	
Urban 4					South Ribble			South Staffordshire	
Urban 5			Kingston Upon Thames			Tunbridge Wells	East Dorset		

Table 3.15 Sampling method with chosen Local Authorities

The sampling method used in study two, considered geographical location, geographical circumstance and population for the local authorities selected. Data of electorates who were part of the open register was available to purchase. The initial attempt to contact local authorities was from April 2018. Each local authority had a slightly different method of obtaining information. Initially, a letter was emailed to local authorities, stating background information of study two requesting details of approximately 1000 electorates on the open register. Not all local authorities, complied with this request and either supplied sequential data from certain parts of the register, close to 1000, or sent a list of how many electorates were in each district or several districts were chosen to as close to 1000 as possible (Table 3.16). Therefore, contact details of approximately 20,000 electorates were obtained, from which 100 were randomly selected (excluding those who were chosen in the pilot study) from each local authority. Therefore, a total of 2000 electorates details were used for this study. The final spreadsheet data fields included:

- Participant reference code
- Forename
- Surname
- Address Line 1
- Address Line 2
- Address Line 3
- Address Line 4
- Address Line 5
- Address Line 6
- Postcode

Local Authority	Region	Number of Data acquired	Type of Data
Amber Valley	East Midlands	1018	Sequential
Northampton	East Midlands	1284	Sequential
King's Lynn and West Norfolk	East of England	1269	Sequential
Mid Suffolk	East of England	1273	Sequential
Barking and Dagenham	London	1540	Sequential
Kensington and Chelsea	London	1137	Sequential
Kingston upon Thames	London	1217	Sequential
Redcar and Cleveland	North East	1000	Random
Bolton	North West	1233	Sequential
Wigan	North West	1215	Sequential
South Ribble	North West	1472	Sequential
Wealden	South East	1340	Sequential
Dartford	South East	1018	Sequential
Tunbridge Wells	South East	1047	Sequential
Mendip[1]	South West	559	Sequential
East Dorset	South West	1079	Sequential
Redditch	West Midlands	1144	Sequential
South Staffordshire	West Midlands	1010	Sequential
Craven	Yorkshire and the Humberside	1030	Sequential
North East Lincolnshire	Yorkshire and the Humberside	2393	Sequential

Table 3.16 Type and amount of data acquired for each Local Authority

[1]Mendip is a small district and not many people lived there.

3.9.3 Pilot study for General Public Study

To begin the data collection of study two, a pilot study was conducted as done for study one. Twenty electorates were selected from five local authorities based on the sampling method explained. The local authorities used were Wealden, East Dorset, Wigan, North East Lincolnshire and South Staffordshire. A pilot study was sent out to 100 members of the general public, proportionate to 20% (20/2000) of the sample size for the main study. A sample of n=4 was identified for the pilot, with a response rate of 4% (4/100). Pilot surveys were sent out in August 2018 and participants were given 3 weeks to send back their responses.

Members of the general public were sent out a copy of the questionnaire and consent form, a cover letter, pre-paid envelope and a participant information sheet. A box at the end of the questionnaire was provided for feedback from the participant as well as note enabling them to annotate the questionnaire for any suggested improvements. The suggestions and comments made by participants in the pilot study led to a few alterations in the survey that have been detailed in the table below (Table 3.17).

Type of change made	Changes made	Before pilot	After pilot	Why the change?
Additional options added	More options added to medication errors question	Right drug, wrong instructions (dose) Right drug, wrong strength of drug Wrong drug Right drug, wrong dispensing label Other (please state)………	Right medicine, wrong strength Right medicine, wrong dose (instructions on how to take medication) Right medicine, wrong patient Wrong medicine, right strength Wrong medicine, wrong strength Wrong medicine, right dose (instructions on how to take medication) Wrong medicine, wrong dose (instructions on how to take medication) Wrong medicine, right patient Wrong medicine, wrong patient Other (please state)……..	As an option was given by a participant which didn't fit the options. Therefore, adding more combinations seemed more feasible.
Allowing respondents, the opportunity to make further comments	Comments box to explain some answers	No comments box to explain answers	Q7f) Any, other comments you have regarding hub and spoke dispensing or pharmacy automation, or further comments on other questions (please state the question number if so)?	To allow participants to further explain their answers in multiple choice questions if they wish to further do so.
Making the questionnaire easier to understand	Definition of pharmacy automation changed.	"*The use of robots **(on-site dispensing robot)** to handle and distribute medicines in pharmacy stores (on-site)"*	"*The use of robots to handle and distribute medicines in pharmacy stores (on-site), before or after being clinically checked by the pharmacist"*	General public participants didn't realise the pharmacist still clinically checked the prescription
Making the questionnaire easier to understand	Definitions appearing on relevant pages of the survey, so participants do not have to keep flicking back. Also, making the definition stand out on the participant information sheet.	Definition just appeared under the sub title.	Definition on every page where needed, i.e. each page of the relevant subsection	Participant commented that as it is a unique topic some people might be put off by the intricacies. Therefore, making the survey more pariticpant friendly.

Table 3.17 Changes made before and after pilot for General Public survey

3.9.4 Structure of the questionnaire

The questionnaire complemented study one and also made up of the following sections: occupational details, pharmacy user, dispensing, hub and spoke dispensing, pharmacy automation and dispensing, hub and spoke dispensing and pharmacy automation, healthcare and demographic details.

3.9.4.1 Occupational details

The questions in this section related to the employment status and highest level of education of the participant.

3.9.4.2 Pharmacy user

Healthcare advice was defined at the start of the section. This section established whether or not the participant had used a community pharmacy in the past 12 months and what they use the pharmacy for. If the participant had not used a pharmacy in the past year, they were ask to move onto questions later on in the section. The options for the type of pharmacy last visited by the respondent differed to study one, where the independent community chain and independent community pharmacy options were combined.

One multiple response question required participants to detail what they used a pharmacy for, split into medical (prescriptions, purchase over the counter medication, healthcare services advice on a healthcare problem and other) and non-medical (purchase non-medical items i.e. food and drink, disposal of unwanted medicines and other) reasonings. This reasoning was detailed on the uses of a community pharmacy detailed by the PSNC. Respondents who selected a medical reason answered the extent of agreement to which they felt they had enough time to speak to pharmacy staff (including the pharmacist), using a 5-point Likert scale ranging from strongly agree to agree. The same scale was used for respondents towards the extent of their agreement that pharmacists had enough time to provide healthcare advice to patients. Another multiple question highlighted research from the literature review suggesting pharmacists not having enough time to provide health care to patients and respondents were asked to choose reasonings for this included:

- Too much time spent checking medications in the dispensary (back of pharmacy)
- Staff shortages
- Too much time spent doing other activities
- Other

The final question of this section concerned places participants obtained healthcare advice from apart from their doctors, options included:

- Pharmacies
- NHS walk-in Centre
- Accident and emergency (A&E)
- Online medical website (i.e. NHS Choices, Mayoclinic, patient.co.uk etc.)
- Online pharmacy websites (i.e. Boots, LloydsPharmacy etc.)
- NHS 111/other non-emergency telephonic healthcare advice services

3.9.4.3 Dispensing

Dispensing was defined at the start of the section as the general public may not have been familiar with the term. This section only focussed on participants who had used a pharmacy to get prescription medication. Respondents were also how the prescription got to the pharmacy, if the prescription had been brought by themselves to the pharmacy. The general public were asked further questions about their experience, including if they waited for the prescription or called back later. Additionally, respondents were also asked to report their extent of satisfaction using a 5-point Likert scale ranging from very satisfied to very dissatisfied with the time it took to get their prescription medication. The literature review identified medication errors as a common error with robotic dispensing therefore, respondents were asked if they had ever experienced an error. Those that her were asked to detail the type of error, when they had realised the error had occurred and whether or not they would go to the prescriber again. Options for this question includes:

- I would go back to the pharmacy/prescriber again
- I would not go back to the pharmacy/prescriber again
- I do not know
- Other

The final question in this section used a 5-point Likert scale ranging from strongly trust to strongly distrust and a do not know option was also included, in case this question causes distress to the respondent on their trust towards the pharmacy or prescriber after experiencing the error.

3.9.4.4 Hub and spoke dispensing

The term hub and spoke dispensing is defined at the start as it is quite a novel term that many may not be familiar with. The majority of questions in this section complemented the hub and spoke dispensing section in study one. A differing question asked respondents their extent of trust towards hub and spoke using a robotic dispensing off-site to make up their medication, using a 5-point Likert scale ranging from strongly trust to strongly distrust with a do not know option to assess their opinion. Another question added to this study, investigated the perceptions participants perceived hub and spoke would have on the job role of the pharmacists, a 5-point Likert scale with a do not know option ranged from:

- It will replace all pharmacists/pharmacy staff job roles
- It will replace most of the job roles of pharmacists/pharmacy staff
- It will replace some of the job roles of pharmacists/pharmacy staff
- It will not replace the job roles of pharmacists/pharmacy staff

The final additional question in this section stated hub and spoke was claimed to give pharmacists more time to provide health care services, respondents answered this question with a 5-point Likert scale from strongly agree to strongly disagree and a do not know option.

3.9.4.5 Pharmacy automation

The term pharmacy automation was defined at the start as it is quite a novel term that many may not be familiar with. Again, questions from this section complemented those from the pharmacy automation section in study one. A differing question asked respondents their extent of trust towards pharmacy automation making up their medication on-site using a robotic dispensing off-site, using a 5-point Likert scale ranging from strongly trust to strongly distrust with a do not know option to assess their opinion. The question in regards to the influence of pharmacy automation on the job roles of pharmacists and pharmacy staff were also asked in this section as in the previous hub and spoke section, as well as on the extent of agreement towards claims pharmacy automation would provide more time for pharmacists to provide health care services.

3.9.4.6 Hub and spoke dispensing & pharmacy automation

The questions in this section complimented those in the same section in study one. However, the multiple-response question on the types of errors respondents were most likely to occur with the implementation of a dispensing robot, omitted the picking errors by dispensing robot option, as respondents may not have known the meaning of this option.

3.9.4.7 Healthcare

The questions in this section complemented those in the healthcare section in study one. Additional questions were also asked in this study, firstly respondents were asked what method of dispensing they felt would most likely provide pharmacists with more time to provide healthcare to patients, options included:

- Current method of dispensing
- Hub and spoke dispensing
- Pharmacy automation
- Either hub and spoke dispensing or pharmacy automation
- Do not know
- None of the above

General public participants were also asked if hub and spoke or pharmacy automation, provide pharmacists with more time to provide healthcare services to patients, what types of services would they like pharmacists to provide. This was asked in the form of a multiple response question with options including:

- Minor ailment scheme
- Patient group directive such as morning after pill
- Out of hours support
- Medicines assessment and compliance support

- On demand availability of specialist drugs
- Gluten free food supply
- Disease specific medicines management
- INR monitoring (i.e. for oral anticoagulants such as warfarin)
- Independent prescribing by pharmacists
- Needle and syringe exchange
- Stop smoking
- Supervised consumption

3.9.4.8 Demographic details

Demographic questions complemented those in study one.

3.9.5 Covering letters, reminders and participant information sheet

Alongside each questionnaire a cover letter was sent as seen in Appendix 10- Study Two: cover letter (main study), as well as a participant information sheet as shown in Appendix 11- Study Two: participant information sheet (main study). These documents complemented those used in study one. However, changes in data protection meant a data protection section was added to the participant information sheet informing participants of the changes in place. The changed being Data Protection Act 1998 which was enforced up until 24th May 2018 and the General Data Protection Regulation thereafter. This section was updated in compliance with the University Data Protection Officer. The sheet also included sections on who complaints needed to be made too.

3.9.6 Data collection procedures

The data collection process followed the same process as study one, however 2000 questionnaires were posted out instead of 1000.

3.9.7 Further notes on sample size

The sample size used for this study was 2000 members of the general public. After the questionnaire was sent out, the sample size was reduced due to 1945, as questionnaires were returned, as participants were no longer at the given address. Data was obtained from selected local authorities in England from April 2018-October 2018. Surveys were sent from November 2018 – December 2018, so in this period when the sampling method was undertaken some participants may have moved address.

3.10 Data preparation for study one and study two

Questionnaires were returned and checked to see all sections were completed. Some questions contained a non-response. However, it didn't seem the respondents had any difficulty in answering questions.

Data from questionnaires were inputted into a pre-designed template in Microsoft Excel. A code scheme was used with corresponding code values for question and answer categories. For example, for strongly agree=1, agree=2, neither agree nor disagree=3, disagree=4 and strongly disagree=5. This allowed easy identification when data was inputted into Microsoft Excel. This was then screened to see if any codes fell outside the expected ranges. Once completed, this data set was imported into SPSS 25 for Mac. The data set was then screened for the presence or absence of responses using frequency checks. A standard practice of entering 10% of the questionnaire data twice into Excel was performed, which allowed for the checking of any systematic errors.

The question responses with open ended answers were recorded into a table in Microsoft Excel. This was then converted into RTF (Rich Text Format) using Microsoft Word and imported into NVivo 12. Thematic analysis was used to analyse any key themes identified, and this allowed the development of a coding framework. Following on, all responses were then coded and placed into distinct nodes.

3.10.1 Data analysis

Data analysis in this programme of work involved both descriptive and statistical analysis. Firstly, this section explains the process of descriptive analysis, conducted for study one and study two.

3.10.1.1 Descriptive analysis

To begin the data analyses of both studies, descriptive analysis was conducted. Firstly, frequencies displayed how the data was distributed, allowing key points to identified, determining what associations can be made. Bivariate analyses were undertaken to see the associations between dependent and independent variables. The next stage of the data analysis described analytical methods used.

3.10.2 Statistical analysis

Dependent variables (such as the trust respondents had with hub and spoke dispensing or pharmacy automation replacing the manual labour of pharmacy staff) were cross tabulated with a number of independent variables. The Independent variables examined for study one were:

- Age;
- Sex;
- Types of community pharmacy worked in;
- Area worked in; and,
- Type of pharmacist

The independent variables for study two were:

- Age
- Sex
- Type of pharmacy last visited
- Highest education level of the respondent
- Region lived in

Cross-tabulations were performed without any hypotheses being predicted between independent and dependent variables.

The questionnaire contained exclusively ordinal and nominal categorical data. Non-parametric tests were used for statistical analysis depending on the data type, as shown in the Table 3.18.

Dependent variable (Data type)	Independent variable (Data type)	Statistical test to be used
Nominal	Nominal	Chi-squared
Ordinal	Nominal	Mann-Whitney U/Kruskall-Wallis
Ordinal	Ordinal	Spearman correlation

Table 3.18. Variable types and statistical tests used

These statistical tests generated values (p valve) associated with a level of significance, i.e. 5%. If the p value was significant it would fall below 0.05, resulting there in a statistically significant association or relationship between the two variables. In this scenario the null hypothesis has been rejected, at a 5% level of statistical significance. If the p value is above 0.05, this means the result is not statistically significant (Dancey and Reidy 2011).

Cross-tabulations were used to evaluate any common frequencies between demographics on the general publics or community pharmacists' views in studies one and two. Further statistical analysis was conducted between the same dependent variables from studies one and two to indicate any relationships or significant differences.

3.10.2.1 Non-parametric tests

Non-parametric tests are the choice of tests used when data does not fit a normal distribution, as demonstrated in this programme of work. Analysis for significant differences between demographics was carried out using Mann-Whitney U tests for independent groups with two variables and Kruskal-Wallis for independent groups with more than two variables to assess any differences between groups. Spearman's rho correlations indicated relationships between two ordinal variables.

3.10.2.2 Chi-squared

This non-parametric test was used for nominal categorical data. The Chi-squared test allowed the researcher to discover whether or not there is a relationship between two categorical variables, allowing for the test for association to occur (Dancey and Reidy 2011).

3.10.2.3 Mann-Whitney U test and Kruskal-Wallis Test

The Mann-Whitney U test enabled the researcher to make two comparisons, by performing pairwise comparisons. Kruskall-Wallis is the non-parametric equivalent of ANOVA, it is similar to Mann-Whitney U however comparisons are made with more than two independent groups. Both these tests are based on the ranks of scores, the test looks for a significant difference between the mean ranks of some or all conditions. These test only will tell the researcher if this is a significant difference between the conditions, and not which conditions are different from each other (Dancey and Reidy 2011).

3.10.2.4 Spearman's rho correlation

A Spearman's rho correlation is the non-parametric version of Pearson's product moment correlation. Spearman's rho transfers the original scores into ranks before calculations are performed (and the correlation coefficient is determined accordingly, + indicates a positive relationship and – indicates a negative relationship Dancey and Reidy 2011). The strength of magnitude of the relationship is indicated by how close to the 1 the coefficient value is, the p value indicates the statistical significance (Dancey and Reidy 2011).

3.11 Limitations

Survey methodology detailed in this chapter was used in study one and study two, questionnaires were the chosen data collection instruments as with every data collection method they came with its associated disadvantages. A self-administered questionnaire required a basic proficiency in reading and writing depending on the format, with the general public sample the levels of proficiency were not known, which may have been a barrier to filling out the survey (Fink 2007). However, it can be assumed community pharmacists' had the required level of proficiency due the qualifications in which they hold.

The majority of the questions in this questionnaire were pre-coded response questions which some participants may have found difficult to understand (Bowling 1997). Additionally, as this is a topic where members of the general public may not be familiar with, it was essential that the questionnaire was easy for participants to understand including the pharmacist populations. Measures were put into place to ensure terminology and question wording were not ambiguous and easy to understand, through the piloting both of studies. However, postal questionnaires cannot detect if participants were having trouble completing the questionnaire, as the researcher was not actively present. Even though, the contact details of the lead researcher were given in the accompanying participant information sheet for participants to contact the researcher when needed.

Motivation is another characteristic associated with the completion of questionnaires, as with postal questionnaires there is not much control in motivating participants as there is no direct contact with them, which again explain the response rate (Visser et al. 2014). Low response rates are associated with postal questionnaires and was the case in both of these studies (Fink 2007). Measures were put into place to try and boost responses, such as sending out the questionnaire a maximum of 3 times to non-respondents and including minimal open-ended questions. The questionnaire length was tested in the pilot studies and took approximately 15 minutes to fill out, however again it cannot be said that this was a hinderance, as data was not collected on time completion for the main study.

Additionally, there was no evidence participants have answered questions honestly, and there could also be a sense of bias particularly with the community pharmacist population as pharmacists may to depict themselves in a good light, known as 'social desirability bias'. Reasoning behind this type of bias can include projecting a favourable image of themselves and avoiding any negative evaluations, although results from this programme of work were anonymous. This may have resulted in the over reporting of socially desirable attitudes and the underreporting of socially undesirable behaviours or attitudes. This type of bias is classed as one of the respondent-related sources of error (Lavrakas 2008).

Study two reported blank questionnaires were sent back, the researcher assumed they participant was not interested in the study. Some respondents for both studies commented that they did not wish to participate, due to not being interested or not having the time. Furthermore, knowing the reasoning behind why participants did not respond would have been useful, such as they were not interested in the questionnaire or may have had trouble understanding. Such information was unable to be obtained as participants have the right to not give reasoning for their participation, complying with CU ethics guidelines.

Another limitation may have been that at the time of gathering data for selecting participants, the data of names and addresses of those who were on the open register changed daily and collected a few months before surveys were posted out contacting local authorities was a timely process. This may have resulting in out of date details of participants when posting the questionnaires. However this is a factor which cannot be avoided as parts of the electoral registered for purchased and data was given on the day of purchase. Furthermore, the list of registered pharmacies on the General Pharmaceutical Council website was also updated regularly and again, as a sampling strategy is followed as described earlier on, checking for daily changes would not have be feasible.

Documenting multiple responses was difficult to monitor. When study one was conducted GDPR had not yet been implemented and CU ethics stated only a tick box consent needed to be included in the questionnaire, no signature or name of the participant was needed. As study one was posted out to community pharmacies as opposed to names of pharmacist, this meant that there was no detection on checking whether or not pharmacists had completed the survey multiple times when working at different sites. Although, only one copy of the survey was accepted from each pharmacy, which was a way of trying to minimise this limitation, and it is hoped that pharmacists would only fill out questionnaire once. GDPR was introduced before sending out study two, therefore signed consent that also ignore names was included, although questionnaires were posted out to named individuals.

Finally, the royal mail post appeared to have delays, where replies were received from some participants stating that they had already completed the questionnaire after receiving it for the second or third time. Questionnaire packs were prepared the day before posting, questionnaires that sent back on the day of posting were not taken out of the posting of that day, as these were collected after.

3.12 Summary

This chapter described the process of undertaking work for study one and study two. Methodology was described, as a cross-sectional design, where postal questionnaires were distributed to two different target groups in a three-point posting system to community pharmacists and members of the general public. The sampling method for both these studies were described, and the data preparation and analysis of data was described in this chapter. The findings of the research strategy used in study one and study two have been described in the next two results chapters.

Chapter 4: Results on the perceptions of pharmacists on robotic dispensing

4.1 Introduction

This chapter described results and analysis of study one for community pharmacists working across England in 2018. Details of the methodology for study one has been documented in chapter three.

4.2 Socio-demographics characteristics of survey's respondents

4.2.1 Pharmacist Population response

The community pharmacy company stratums were proportional to the percentage share they held within the community pharmacy market as detailed in chapter three. The final response rate of community pharmacists was 16% (n=161/994). The response was higher in female pharmacist respondents 53% (86/161) compared to male pharmacist respondents 45% (72/161). The demographic details have been displayed in Table 4.1. In comparison to data from the survey of registered pharmacy professionals in 2019 where there were 79,770 registrants from 11th June – 22nd July 2019, this study represented 0.2% (161/79,770) of the register General Pharmaceutical Council (2019b). During this timeframe 24,405 were male and 55,333 were female. However, this study was conducted in 2018 therefore newly qualified pharmacists would have been added.

4.2.2 Demographic details

Independent variable		(n=)	%
Sex (n=161)	Male	72	45
	Female	86	53
	Prefer not to say	3	2
Age (years) (n=160)	19-25	23	14
	26-39	76	48
	40-59	49	30
	60 and over	12	8
Employment status (n=161)	Employed	128	80
	Locum	20	12
	Other	13	8
Region[1] (n=155)	North East	6	4
	North West	25	16
	Yorkshire and the Humberside	17	11
	East Midlands	15	10
	West Midlands	19	12
	East of England	7	5
	London	24	15
	South East	17	11
	South West	25	16
Ethnicity[2] (n=153)	White-British	72	47
	White - Any other White background	13	8
	Black or Black British - African	9	6
	Mixed - White and Black African	1	1
	Asian – Indian	27	18
	Asian - Pakistani	11	7
	Asian - Asian or Asian British	9	6
	Asian - Any other Asian background	2	1
	Chinese or other ethnic group – Chinese	3	2
	Prefer not to say	6	4
Type of community pharmacy last worked at* (n=167)	Multiple	69	41
	Supermarket	6	4
	Independent chain	34	20
	Independent	56	34
	Other	2	1

Table 4.1. Demographic details of respondents.

*This was a multiple response question

		Sex %	
		Male	Female
Type of community pharmacy[1]	Multiple (n=67)	39	61
	Supermarket (n=6)	83	17
	Independent chain (n=33)	45	55
	Independent (n=56)	52	48
Employment status	Employed (n=126)	42	58
	Locum (n=19)	58	42
	Other (n=13)	62	38

Table 4.2 The sex of community pharmacist respondents according to types of community pharmacy worked and their employment status

[1]This was a multiple response question

The sex of the pharmacist was cross tabulated with type of community pharmacy worked in and the employment status of the pharmacist (Table 4.2). Over half of respondents who had worked within a multiple community pharmacy were female (61%, 41/67). The majority of employed pharmacists were found to be female (58%, 73/126) and the majority of locum pharmacists were male (58%, 11/19).

		Employment status %		
		Employed	Locum	Other
Type of community pharmacy[1]	Multiple (n=69)	96	4	0
	Supermarket (n=6)	67	33	0
	Independent chain (n=34)	74	26	0
	Independent (n=43)	72	28	0
Regions	North East (n=6)	83	0	17
	North West (n=25)	92	0	8
	Yorkshire and the Humberside (n=17)	100	0	0
	East Midlands (n=15)	80	20	0
	West Midlands (n=19)	84	11	5
	East of England (n=7)	100	0	0
	London (n=24)	50	29	21
	South East (n=17)	82	18	0
	South West (n=25)	80	4	16

Table 4.3 The employment status of a community pharmacist according to the type of community pharmacy worked in and the current region worked in by the pharmacist

[1]This was a multiple response question

Table 4.3 reported the majority of pharmacists working in all types of community pharmacy were employed. Employed pharmacists were also commonly found to work in all regions of England.

4.2.3 Response rate comparisons

4.2.3.1 Annual population survey 2018 vs community pharmacists in robotics survey

The annual population survey 2018 (Office for National Statistics 2018) provided pharmacist populations estimates from January – December 2018. Survey responses (%) for the annual population survey and study one were calculated according to the sex of the respondent as displayed in Table 4.4.

Survey type statistics	Male		Female	
	%	n=	%	n=
Annual population survey 2018	33.8	19,687	66.2	38,504
Community pharmacists in robotics survey (study one)	44.7	72	53.4	86

Table 4.4. The populations and differences between the pharmacists in annual population survey 2018 (Office for National Statistics 2018) and community pharmacists in robotic survey (study one)

4.2.3.2 Response rates within different types of community pharmacy

The number of surveys distributed according to their pharmacy type were recorded in Table 4.5. Survey response rates for each type of community pharmacy were reported where multiple community pharmacies had the highest proportion of responses (42%, 69/165). Following on, 141 surveys were posted to independent chain community pharmacies, and a response rate of 14.1% (34/141) was exhibited (Table 4.5).

Type of community pharmacy	Number of surveys sent according to market ownership (n=)	Percentage of surveys sent according to market ownership %	Number of replies from pharmacists (n=)	Percentage of replies from pharmacists (n=165) %	Response rate within the number of surveys sent to each type of community pharmacy %
Multiple	422	42.2	69	42	16
Supermarket	57	5.7	6	4	11
Independent chain	141	14.1	34	21	24
Independent	380	38.0	56	34	15
Total	1000	100	165	100.0	-

Table 4.5 Proportion and percentages of the number of surveys sent according to market ownership held and received NB this was a multiple response question. Types of pharmacy: Multiple community pharmacy (99 or more): Superdrug, Gorgemead Ltd, Day Lewis Plc, L Rowland & Co (Retail) Ltd, Bestway National Chemists Limited, LloydsPharmacy Ltd, Boots UL; Supermarket community pharmacies: W M Morrisons Supermarkets Plc, Asda Stores, Tesco Stores Ltd; Independent chain community pharmacies (6-99 pharmacies) and Independent Community Pharmacies (5 or less). Due to rounding, percentages may not always appear to add up to 100%,

4.2.4 Regional comparisons

4.2.4.1 Community workforce survey (2017) vs community pharmacists in robotics survey

Table 4.6 displayed the response rates for study one and the community pharmacist workforce survey 2017 (Health Education England 2018). In the community pharmacist workforce 2017 survey (Health Education England 2018), a response rate of 30.8% of pharmacists was reported compared to 29.8% in the pharmacists and robotics survey. Similarly, showing a difference in response rates of 1.0% between the two surveys (Table 4.6). Furthermore, the community pharmacy workforce survey (Health Education England 2018), split their regions as followed:

- North of England: North West, North East and Yorkshire & Humberside
- Midlands and East of England: West Midlands, North Midlands, Central Midlands and East of England
- South of England: South West, Wessex and Thames Valley
- London & South East: North West London, South London, North Central & East London and South East

Whereas the categories in study one included: North East, South East, North West, North East, West Midlands, East Midlands, East of England, Yorkshire and the Humberside and East of England. To allow further comparisons between the two surveys, regions were recategorised ensuring the local authorities were in the agreed regions. Especially as differences occurred when local authorities such as Kent, Surrey and Sussex had moved into the South region after the survey, as part of London and South East. Therefore, the reclassification was done as follows to allow comparison:

- North: North West, North East and Yorkshire and the Humberside
- Midlands & East: West Midlands, East of Midlands and East of England
- London & South: South West, South East and London

Survey	North[1]		Midlands & East[2]		London & South[3]		Total
	%	n=	%	n=	%	n=	n=
Community pharmacist workforce survey 2017	30.8	7,183	29.8	6,941	39.3	9,161	23,285
Community pharmacists in robotics survey	31	48	26	41	43	66	155

Table 4.6 A table to show the % difference between the pharmacist population in the community pharmacist workforce survey 2017 (Health Education England 2018) compared to this study on pharmacists and views on robotics in community pharmacy. [1]North: North West, North East and Yorkshire and the Humberside, [2]Midlands & East: West Midlands, East Midlands and East of England. [3]London & South: South West, South East and London. Due to rounding, percentages may not always appear to add up to 100%.

4.2.4.2 Annual population survey 2018 and proportion of respondents from each region

Response rates in the annual population survey 2018 for pharmacists and the results from this study were have been reported in Table 4.7. It needs to considered that the Office for National Statistics (2018) annual population survey 2018 for pharmacists, displayed pharmacists that work in all sectors of pharmacy, however study one focused on those pharmacists working in community pharmacy. Therefore, the different sectors of pharmacists potentially could be an explanation for the large percentage differences.

	North East		North West		Yorkshire & The Humberside		East Midlands		West Midlands		East of England		London		South East		South West		Total
	%	n=	%	n=	%	n=	%	n=	%	n=	%	n=	%	n=	%	n=	%	n=	n=
Annual population survey 2018	2.8	1309	17.2	8036	7.4	3437	5.9	2769	13.4	6226	11.1	5187	21.9	10232	12.7	5904	7.6	3553	46653
Community pharmacists in robotics survey	3.9	6	16.1	25	11.0	17	9.7	15	12.3	19	4.5	7	15.5	24	11.0	17	16.1	25	155

Table 4.7 . A table to show the populations and differences between pharmacists in the annual population survey 2018 (Office for National Statistics 2018) and pharmacists in the robotics survey.

4.2.5 Type of community pharmacy worked in

This question was a multiple response question. Respondents were asked to report what types of community pharmacy they worked in. Community pharmacies were classified as demonstrated in Table 4.8.

Type of community pharmacy	Number of pharmacy outlets
Multiple community pharmacy i.e. Boots, Lloyds Pharmacy, Superdrug etc.	$n \geq 99$
Supermarket community pharmacy i.e. Asda, Morrisons, Tesco etc.	-
Independent chain community pharmacy	$6 \leq n < 99$
Independent community pharmacy	$n \leq 5$

Table 4.8. Classification of types of community pharmacy

4.3 Pharmacy practice

Pharmacists were asked their experiences of current pharmacy practice; these results were analysed and have been presented in this section.

4.3.1 Number of staff in the pharmacy

On average, 38% (61/161) of community pharmacists had between 1-2 or 3-4 members (39%, 62/161) additional members of staff during their previous pharmacy shift.

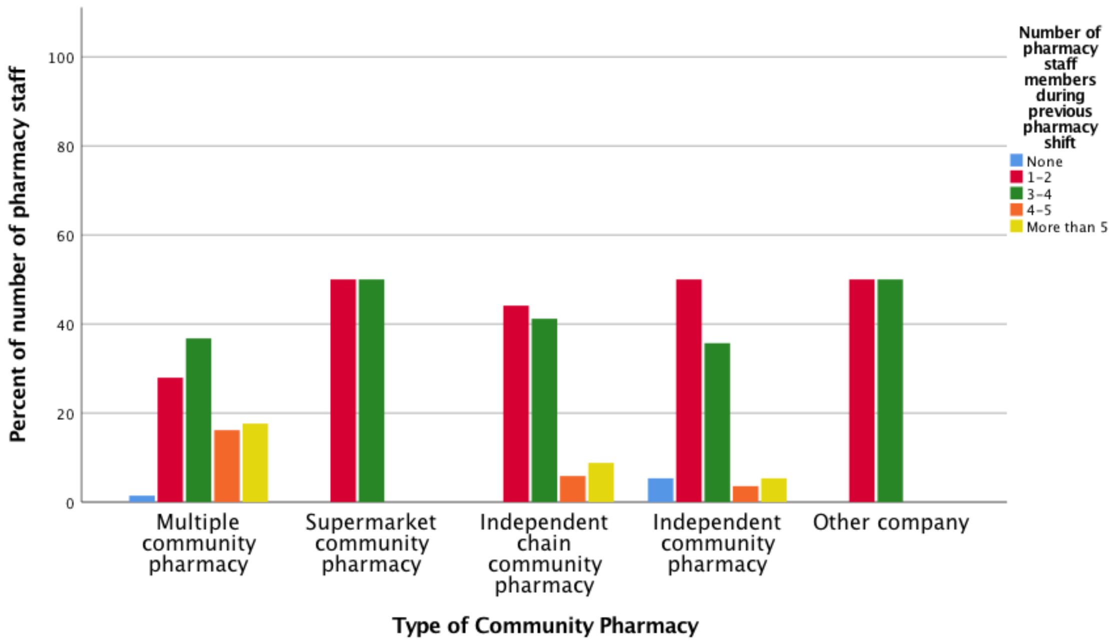

Figure 4.1. A clustered bar chart of the type of pharmacy[1] by the number of staff members in the previous pharmacy shift
[1]This was a multiple response question

Nearly 40% (38%, 26/69) of multiple community pharmacies had 3-4 additional members of staff during their current or previous pharmacy shift. Supermarket pharmacies: (50%, 3/6) either had between 1-2 or 3-4; independent community pharmacies between 1-2 (50%, 28/56) and the other company reporting having between 1-2 additional staff members during their current or previous pharmacy shift.

4.3.2 Average counselling time for patients by pharmacists

Respondents were asked to detail data about their counselling time durations during their current or previous pharmacy shift (Table 4.9). Data was also collected on participants satisfaction with the amount of time available (Table 4.10). Mostly, pharmacists (52%, 83/161) reported to spend >1 minute to 3 minutes counselling (Table 4.9).

Counselling time[2]	%	(n=)
Up to 1 minute	28	44
>1 minute to 3 minutes	52	83
>3 to 5 minutes	11	18
>5 minutes	9	14

Table 4.9. Average counselling time by pharmacist per patient

4.3.2.1 Average counselling time for patients by pharmacists and the satisfaction with the counselling time

Average counselling time spent by the pharmacist per patient	Satisfaction with the amount of counselling time pharmacists had %				
	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
up to 1 minute (n=44)	5	32	20	27	16
>1 minute to 3 minutes (n=82)	10	45	21	22	2
> 3 minutes to 5 minutes (n=18)	6	50	17	22	6
> 5 minutes (n=14)	36	29	7	7	21
Correlation coefficient	-0.196[1]				
p=	0.014[*]				

Table 4.10. Average counselling time for patients by pharmacists' cross tabulated with the satisfaction with the amount of counselling time pharmacists had. *Due to rounding, percentages may not always appear to add up to 100%.*

[1]Correlation is significant at the 0.01 level (2-tailed)

[*]Spearman's rho correlation was performed

A Spearman's rho correlation test was run to determine the relationship between the average amount of time a pharmacist spent counselling a patient and the satisfaction the pharmacist had with the time spent counselling. There was a weak negative correlation between the two variables, (r_s =-0.196, p=0.014), which was statistically significant, at a 95% confidence interval. The more counselling time a pharmacist had, the more they were satisfied with the amount of counselling time they had (Table 4.10).

4.3.3 Tasks in pharmacy

Following on, community pharmacists were asked the extent of agreement they had towards pharmacists spending too much time on specific tasks. The tasks included: administrative activities i.e. paperwork, office work, checking medication, filing away prescriptions, dispensing, ordering patient medication, pharmacy services and stock checking or ordering stock (Table 4.11). A 5-point Likert scale was used and this was recoded into the following categories: strongly agree/agree, neither agree nor disagree and strongly disagree/disagree.

Pharmacists also reported they were spending too much time dealing with queries, providing and providing services (Appendix 13- Other tasks pharmacist believe they are spending too much time on). A Kruskal-Wallis reported significant differences between the employment status of the pharmacist and that pharmacists were spending too much time dispensing ($p=0.039$), providing pharmacy services ($p=0.042$) and stock checking or ordering stock ($p=0.001$).

Tasks pharmacists think they are spending too much time doing	Strongly agree/agree %	Neither agree nor disagree %	Strongly disagree/disagree %
Administrative tasks[*] (n=157)	82	12	6
Checking medication[^] (n=157)	54	24	22
Filing away prescriptions[$] (n=156)	38	22	40
Dispensing[1] (n=155)	38	24	39
Ordering patient medication[1] (n=155)	50	18	32
Pharmacy services[2] (n=154)	30	16	54
Stock checking/ordering stock[1] (n=155)	44	22	34

Table 4.11 Extent to which pharmacists believe they are spending too much time on tasks

4.3.4 Barriers pharmacists face when providing healthcare care advice to patients

This section focused on barriers that pharmacists felt they faced when providing healthcare advice to patients, as displayed in Table 4.12. A Chi-squared test was conducted to assess any association (or lack thereof) between the type of community pharmacy worked in and staff shortages. A relationship was identified between a pharmacist working in a multiple community pharmacy and staff shortages ($\chi^2=16.475$, df=1, $\rho=0.000$). A relationship was also acknowledged between working within an independent pharmacy and staff shortages ($\chi^2=8.634$, df=1, $\rho=0.003$) (Appendix 14-study one: results of Chi-square tests between staff shortages and the type of community pharmacy worked in and accompanying p values).

Barriers pharmacists face when providing healthcare advice to patients*	(n=)
Staff shortages	110
Lack of resources/space	71
Fear of changing role	28
Not part of job role	17
Lack of personal motivation	5
Lack of understanding of healthcare advice	13
No barriers	20
Other barriers	37

Table 4.12 Barrier's pharmacists face when providing healthcare advice to patients

*This was a multiple response question

4.4 Dispensing

This section presented information about the processes involved in dispensing, including prescription waiting times. Data was also collected on tasks pharmacists would like to spend more time doing (Table 4.14).

4.4.1 Prescription waiting times

		Average prescription waiting time (n=)			
		Below 5 minutes	Up to 10 minutes	Up to 15 minutes	Over 15 minutes
Satisfaction with checking time (n=)	Very satisfied/satisfied	61	42	9	2
	Neither satisfied nor dissatisfied	3	14	5	1
	Very dissatisfied/ dissatisfied	3	10	5	3
	p=	0.000			
	R_s=	0.393 (significant at the 0.01 level, 2 tailed)			

Table 4.13 Average prescription waiting time and satisfaction with checking time for pharmacists. The following options were combined: very satisfied/satisfied, neither satisfied nor dissatisfied and very dissatisfied/dissatisfied

A prescription waiting time of below 5 minutes was reported by 42% (67/158) of respondents. Over 70% (72%, 115/160) of community pharmacists were very satisfied or satisfied with the amount of time they had to check medication. A weak positive correlation was identified between the average prescription waiting time and the satisfaction pharmacists had towards checking waiting prescriptions (R_s=0.393, p=0.000).

4.4.2 Tasks pharmacists would like to spend more time doing

Tasks pharmacists would like to spend more time doing[2] (n=161)	%
Giving healthcare advice	70
Pharmacy services	88
Joining other healthcare professionals in providing healthcare advice to patients	59
Counselling patients on medication	78
Other activities	9

Table 4.14 Tasks pharmacists would like to spend more time doing

[2]This was a multiple response question

Nearly 90% (141/161) of pharmacists reported they would like to spend more time providing pharmacy services. These results are unsolicited and can only be considered conservative estimates, as pharmacists may have also wished to spend their time doing other tasks.

4.5 Hub and spoke dispensing

This section focused on community pharmacists' perceptions of hub and spoke dispensing. Data around pharmacist's trust towards aspects of hub and spoke dispensing, influences on factors such as operating costs as well as the influence on medication errors and time taken for patients to get their prescription medication were recorded.

4.5.1 Pharmacists' perceptions on hub and spoke dispensing

The majority of pharmacists (84%, 136/161) had heard of hub and spoke dispensing. Pharmacists were asked to report their views on hub and spoke dispensing with reference to factors such as trust, and claims made about the advantages of hub and spoke dispensing such as 'lowering operating costs' and 'enabling pharmacists more time in providing healthcare advice to patients'. A 5-point Likert scale was used for these questions, either consisting of 1=strongly trust/agree, 2=trust/agree, 3=neither trust not distrust/neither agree nor disagree, 4=distrust/disagree and 5=strongly distrust/disagree. The 5-point Likert scale was recoded into 3-point scale, consisting of strongly trust/agree or trust/agree; neither trust nor distrust/neither agree nor disagree; strongly distrust/disagree or distrust/disagree.

4.5.1.1 Trust and hub and spoke dispensing

Overall, 43%, (70/161) of respondents reported to strongly distrust or distrust hub and spoke dispensing replacing the manual labour of pharmacy staff in dispensing their medication. Closer inspection of Table 4.15, displayed a statistically significant difference between the employment status groups of the pharmacist and the extent of trust towards hub and spoke replacing the manual labour of pharmacy staff in dispensing medication (p=0.007). Where, 40% (51/128) of employed pharmacists and 40.0% (8/20) locum pharmacists reported to distrust hub and spoke dispensing in replacing the manual labour of the dispensing process. Statistical differences were also reported with whether or whether not pharmacists worked in an independent community pharmacy and the extent of trust they have with hub and spoke dispensing in replacing the manual labour of pharmacy staff in dispensing medication (p=0.021) (Table 4.15).

Under 50% (45%, 73/161) of pharmacists strongly trusted or trusted another pharmacist overseeing the dispensing process at the hub. Table 4.15 illustrated nearly 50% (48 %, 61/128) of employed pharmacists and 50% (10/20) locum pharmacists also strongly trusted or trusted relying on another pharmacist to oversee the dispensing process at the hub, when the clinical check was done by the pharmacist in store (Table 4.15). The employment status of the pharmacist also reported statistical differences between extent of trust on relying on another pharmacist to oversee the dispensing process at the hub, when the clinical check is done by the pharmacist in store (p=0.006), as displayed in Table 4.15

Independent variables		Employment status %			Type of pharmacy worked in[1] %				
		Employed (n=128)	Locum (n=20)	Other (n=13)	Multiple (n=69)	Supermarket (n=6)	Independent chain (n=34)	Independent (n=56)	Other (n=2)
Trust and labour[1]	Strongly trust/trust	28	30	0	33	17	32	11	50
	Neither trust nor distrust	32	30	15	29	17	18	39	0
	Strongly distrust/distrust	40	40	85	38	67	50	50	50
	P=	**0.007***			**0.089$**	**0.300$**	**0.877$**	**0.021$**	**0.819$**
Trust pharmacists relying on their peers at the hub[2]	Strongly trust/trust	48	50	15	54	50	44	34	100
	Neither trust nor distrust	26	20	7	17	17	24	30	0
	Strongly distrust/distrust	27	30	77	29	33	32	36	0
	P=	**0.006***			**0.162$**	**0.927$**	**0.850$**	**0.073$**	**0.207$**

Table 4.15. Pharmacists trust in hub and spoke dispensing according to their employment status and type pf pharmacy worked in. [1]Extent of pharmacists' trust in replacing the manual labour of pharmacy staff in dispensing medication (Median: employed=2.00, locum=2.00, other= 3.00, multiple=2.00, supermarket=3.00,independent chain=2.50, independent=2.50, other=2.00) [2]Extent of pharmacists' trust on replying on another pharmacist to oversee the dispensing process at the hub, when the clinical check is done by the pharmacist in store (Median: employed=2.00, locum=1.50, other=3.00, multiple=1.00, supermarket=1.50, independent chain=2.00, independent= 2.00 and other=1.00) The following categories were recombined: Strongly trust and trust, neither trust nor distrust, strongly distrust and distrust. Due to rounding, percentages may not always appear to add up to 100%.

[1]This was a multiple response question

*Kruskal-Wallis test was performed

$Mann-Whitney U test was performed

4.5.2 Pharmacists' views on the claims of hub and spoke dispensing

As mentioned previously pharmacists were asked to report whether or not they agreed with the claims offered by hub and spoke such as lowering operating costs and enabling pharmacists more time in providing healthcare advice to patients. These dependent variables were cross tabulated with the employment status of the pharmacist and types of community pharmacy worked in by the respondents.

Overall, respondents reported to strongly agreed or agreed (50%, 80/160) hub and spoke dispensing would lower operating costs or enable pharmacists more time to provide healthcare advice to patients (59%, 95/161). A Kruskal Wallis test reported a statistically significant difference between the employment status of the pharmacist and the extent to which pharmacist's believe hub and spoke dispensing will lower operating costs (p=0.02) (Table 4.16). Also, statistically significant differences between the employment status of the pharmacist and the extent to which hub and spoke dispensing will enable pharmacists more time to provide healthcare advice to patients were reported (p=0.025) (Table 4.16). Within the employment status groups of the pharmacist, 52% (67/128) of employed and 58% (11/19) of locum pharmacists reported hub and spoke would lower operating costs (Table 4.16). Additionally, whether or not respondents had worked in a supermarket community pharmacy also reported significant differences of opinion regarding the extent to which they agree hub and spoke will lower operating costs (p=0.019). Following on considering the age of the respondent, 54% (41/76) of pharmacists were aged between 26-39 and strongly agreed/agreed hub and spoke would lower operating costs.

Table 4.16 also displayed 60% (95/160) of pharmacists to either strongly agree or agree hub and spoke would enable pharmacists more time to provide healthcare advice to patients. Additionally, a statistically significant weak positive correlation using Spearman's Rho correlation was performed between the age of the pharmacist and the extent to which pharmacists agree hub and spoke dispensing enable pharmacists more time to give healthcare advice to patients The older the pharmacist the more they disagreed hub and spoke dispensing would enable pharmacists more time to give healthcare advice to patients (r_s=0.172; significant at 0.05 level; p=0.034) (Table 4.17).

Independent variables		Employment status %			Type of pharmacy worked in[1] %				
		Employed (n=128)	**Locum (n=19)**	**Other (n= 13)**	**Multiple (n= 69)**	**Supermarket (n=6)**	**Independent chain (n=34)**	**Independent (n=55)**	**Other (n=2)**
Lower operating costs	Strongly agree/agree	52	58	15	54	100	47	42	100
	Neither agree nor disagree	19	16	23	22	0	9	22	0
	Strongly disagree/disagree	29	26	62	25	0	44	36	0
	P=	**0.020***			**0.228**	**0.019**	**0.295**	**0.158**	**0.256**
More time for pharmacists to provide healthcare advice		**Employed (n=128)**	**Locum (n=19)**	**Other (n=13)**	**Multiple (n=69)**	**Supermarket (n=5)**	**Independent chain (n=33)**	**Independent (n=56)**	**Other (n=2)**
	Strongly agree/agree	60	74	31	58	100	67	55	100
	Neither agree nor disagree	18	26	31	16	0	15	29	0
	Strongly disagree/disagree	22	0	38	26	0	18	16	0
	P=	**0.025***			**0.471^**	**0.070^**	**0.391^**	**0.807^**	**0.180**

Table 4.16 Pharmacists agreement to whether or not hub and spoke dispensing will lower operating costs (median: employed=1.00, locum=1.00, other=3.00, multiple=1.00, supermarket=1.00, independent community chain=2.00, independent=2.00 and other=1.00) or enable pharmacists more time provide healthcare advice to patients (median: employed= 1.00, locum=1.00, other=2.00, multiple=1.00, supermarket=1.00, independent community chain=1.00, independent=1.00 and other=1.00), according to their employment status and type of pharmacy worked in . The following categories were recombined: Strongly agree and agree, neither agree nor disagree, strongly disagree and disagree. Due to rounding, percentages may not always appear to add up to 100%.

[1]This was a multiple response question

*Kruskal-Wallis test was performed

^Mann-Whitney U Test was performed

Independent variables		Age %			
		19-25 (n=23)	26-39 (n=76)	40-59 (n=48)	60 and over (n=12)
Lowering operating costs	Strongly agree/agree	30	54	48	67
	Neither agree nor disagree	26	16	23	8
	Strongly disagree/disagree	44	30	29	25
	Total (n=)	**23**	**76**	**48**	**12**
	P=	**0.430$**			
More time for pharmacists to provide healthcare advice		**19-25 (n=23)**	**26-39 (n=75)**	**40-59 (n=49)**	**60 and over (n=12)**
	Strongly agree/agree	74	64	47	58
	Neither agree nor disagree	17	13	31	17
	Strongly disagree/disagree	9	23	22	25
	P=	**0.034$**			

Table 4.17 Pharmacist's agreement to whether or not hub and spoke dispensing will lower operating costs or enable pharmacists more time provide healthcare advice to patients, according to the age of the pharmacist. The following categories were recombined: Strongly agree and agree, neither agree nor disagree, strongly disagree and disagree. Due to rounding, percentages may not always appear to add up to 100%.

*Kruskal-Wallis test was performed

$Spearman's rho correlation was performed

4.5.2.1 Influence hub and spoke dispensing will have on medication errors, time taken to get prescriptions and the workload of pharmacists

Respondents were asked to report the influence they perceived hub and spoke would have on factors such as medication errors, time taken for patients to get prescription as well as on the workload of the pharmacist. Table 4.18 illustrated pharmacists' opinions on whether or not they view hub and spoke to increase medication errors, time taken for patients to get their prescriptions and on influences on the workload of the pharmacist. These dependent variables were cross tabulated with the employment status of the pharmacist and the types of community pharmacy worked in by the respondent. On the whole, pharmacists perceived hub and spoke to decrease medication errors (32%, 52/161). The majority of respondents (66%, 107/161) reported hub and spoke to increase the time taken to get their prescription. The majority (46%, 73/160) of respondents reported workload of the pharmacist to neither be increased or decreased with the implementation of hub and spoke dispensing.

4.5.2.2 Influence hub and spoke dispensing will have on medication errors, time taken to get prescriptions and the workload of pharmacists

Independent variables		Employment status %			Type of pharmacy worked in[1] %				
		Employed (n=127)	Locum (n=20)	Other (n=12)	Multiple (n=68)	Supermarket (n=6)	Independent chain (n=34)	Independent (n=35)	Other (n=2)
Medication errors	**Increase**	23	20	50	22	17	32	29	50
	Decrease	35	40	0	41	50	29	18	50
	No influence	21	10	50	21	0	21	16	0
	Do not know	22	30	0	16	33	18	36	0
Time taken to get RX		**Employed (n=128)**	**Locum (n=20)**	**Other (n=13)**	**Multiple (n=69)**	**Supermarket (n=12)**	**Independent chain (n=52)**	**Independent (n=56)**	**Other (n=2)**
	Increase	67	60	69	42	50	65	71	50
	Decrease	13	20	0	70	0	12	4	50
	No influence	9	10	0	64	50	65	71	0
	Do not know	10	10	31	4	0	12	21	0
Workload of pharmacist		**Employed (n=125)**	**Locum (n=19)**	**Other (n=12)**	**Multiple (n=69)**	**Supermarket (n=6)**	**Independent chain (n=34)**	**Independent (n=55)**	**Other (n=2)**
	Significantly increase/increase	11	5	25	29	33	21	24	0
	Neither increase nor decrease	17	11	0	38	33	47	51	50
	Significantly decrease/decrease	72	84	75	33	33	32	25	50

Table 4.18 The influence pharmacists view hub and spoke dispensing will increase medication errors or on the time taken to get a prescription or have on the workload of pharmacists by their employment status and type of pharmacy worked in. [2]Answer categories were recoded as follows: significantly increase/increase, neither increase nor decrease, significantly decrease/decrease. Due to rounding, percentages may not always appear to add up to 100%.

[1]This was a multiple response question

4.5.4 Potential problems and benefits with hub and spoke dispensing

Respondents were asked to report potential problems and benefits they thought would occur with hub and spoke dispensing as displayed in Table 4.19 and 4.20. Other potential problems with hub and spoke dispensing included stock issues (Appendix 15- Study One: other potential problems with hub and spoke dispensing). These results are unsolicited and can only be considered conservative estimates, as pharmacists may believe their to be other problems or benefits with hub and spoke dispensing.

Problems with hub and spoke dispensing[1] (n=161)	%
Medication lost on travel	76
Longer for patients to get medication	81
Clinical check in store in by different pharmacist	52
Hub and Spoke not dispensing all items i.e. fridge lines, appliances	89
Increased time matching Rx bag from hub with original Rx in store	84
Scanning of Rx from the spoke to the hub	50
No problems	1
Other problems	16

Table 4.19 Potential problems with hub and spoke dispensing

[1]This was a multiple response question

Benefits with hub and spoke dispensing[2] (n=161)	%
Less time spent dispensing	50
Having two different pharmacists overseeing checks at hub and spoke	25
More time for pharmacists to utilise their clinical skills – services and advice	65
Rx being checked for accuracy multiple times	37
No benefits	14
Other benefits	1

Table 4.20 Potential benefits with hub and spoke dispensing

[2]This was a multiple response question

4.6 Pharmacy automation

This section focused on community pharmacists' perceptions of pharmacy automation. Similarly, to section 4.5, respondents were asked to report the influence pharmacy automation would have on factors such as medication errors, the workload of the pharmacist and the time taken for patients to get their prescription medication.

4.6.1 Pharmacists' perceptions on pharmacy automation

Over 80% (83%, 133/160) of community pharmacists had heard of pharmacy automation. Respondents were asked to report their views of the pharmacy automation would have on factors such as trust, and claims made about by the Department of Health about the claims of large-scaled dispensing in relation to pharmacy automation, such as lowering operating costs. A 5-point Likert scale were used for these questions, either consisting of 1=strongly trust/agree, 2=trust/agree, 3=neither trust not distrust/neither agree nor disagree, 4=distrust/disagree and 5= strongly distrust/disagree. The 5-point Likert scale was recoded into 3-point scale, consisting of strongly trust/agree or trust/agree; neither trust nor distrust/neither agree nor disagree; strongly distrust/disagree or distrust/disagree.

4.6.2.1 Trust and pharmacy automation

No statistical differences in relation to the extent of trust pharmacists had towards pharmacy automation replacing the manual labour of pharmacy staff in dispensing medication as the dependent variable with the employment status of the pharmacist and various types of community pharmacies worked in by the respondent as independent variables (Table 4.21). Overall, 40% (64/161) of pharmacists neither trusted nor distrusted pharmacy automation in replacing the manual labour of pharmacy staff in dispensing medication (Table 4.18). This dependent variable was cross tabulated with the employment status of the pharmacist and the type of community pharmacies worked in by the pharmacist. As can be seen from Table 4.18, 41% (52/127) of employed pharmacists' and those who had worked in a multiple community pharmacy (40%, 27/68) neither trusted nor distrusted pharmacy automation replacing the manual labour of pharmacy staff in dispensing medication. Whereas, 40% (8/20) of locum pharmacists reported to either strongly trust or trust the dependent variable (Table 4.21)

Independent variables		Employment status %			Type of pharmacy worked in[1] %				
		Employed (n=127)	Locum (n=20)	Other (n=13)	Multiple (n=68)	Supermarket (n=6)	Independent chain (n=34)	Independent (n=56)	Other (n=2)
Trust & pharmacy automation[2]	Strongly trust/trust	36	40	8	32	33	35	32	50
	Neither trust nor distrust	41	30	46	40	17	32	43	50
	Strongly distrust/ distrust	23	30	46	28	50	32	25	0
	P=	**0.069***			**0.545$**	**0.441$**	**0.652$**	**0.831$**	**-**

Table 4.21 Pharmacist's trust pharmacy automation according to their employment status and type pf pharmacy worked in. [2]Extent of pharmacists' trust in replacing the manual labour of pharmacy staff in dispensing medication. The following categories were recombined: Strongly agree and agree, neither agree nor disagree, strongly disagree and disagree. Due to rounding, percentages may not always appear to add up to 100%.

[1]This was a multiple response question

*Kruskal-Wallis test was performed

$Mann-Whitney U test was performed

4.6.2.2 Influence pharmacy automation will have on medication errors and time taken to get prescriptions and on the workload of pharmacists

Table 4.22 presented an overview of community pharmacists' perceptions on whether or not they view pharmacy automation to increase medication errors, time taken for patients to get their prescriptions and on influences on the workload of the pharmacist. These dependent variables were cross tabulated with the employment status of the pharmacist and the types of community pharmacy worked in by the respondent. This study reported 42% (68/161) of pharmacists to perceive pharmacy automation to decrease medication errors. Pharmacy automation was also observed to increase the time taken to get the prescription from the pharmacy (39%, 62/161) and 53% (86/161) reported pharmacy automation would neither increase nor decrease workload by respondents.

Independent variables		Employment status %			Type of pharmacy worked in[1] %				
		Employed (n=128)	Locum (n=20)	Other (n=13)	Multiple (n=69)	Supermarket (n=6)	Independent chain (n=34)	Independent (n=56)	Other (n=2)
Medication errors	Increase	12	15	38	12	0	18	18	50
	Decrease	45	50	8	43	33	47	36	0
	No influence	26	20	31	25	33	21	30	50
	Do not know	18	15	23	20	33	15	16	0
Time taken to get Rx		Employed (n=128)	Locum (n=20)	Other (n=13)	Multiple (n=69)	Supermarket (n=6)	Independent chain (n=34)	Independent (n=56)	Other (n=2)
	Increase	37	40	54	41	50	35	38	50
	Decrease	30	20	15	28	0	27	27	50
	No influence	23	30	8	22	0	29	21	0
	Do not know	10	10	23	10	50	9	14	0
Workload of pharmacist		Employed (n=127)	Locum (n=19)	Other (n=13)	Multiple (n=68)	Supermarket (n=5)	Independent chain (n=33)	Independent (n=56)	Other (n=2)
	Significantly increased/increased	24	37	38	28	20	18	29	0
	Neither increased/decreased	54	53	54	47	60	64	61	50
	Significantly decreased/decreased	22	11	8	25	20	18	11	50

Table 4.22 The influence pharmacists view pharmacy automation will increase medication errors or on the time taken to get a prescription or have on the workload of pharmacists by their employment status and type of pharmacy worked in. The no change/do not know category was recombined. Due to rounding, percentages may not always appear to add up to 100%.

[1]This was a multiple response question

4.6.3 Pharmacists' views on the claims of pharmacy automation

In this section, respondents were asked to report whether or not they agreed with the claims offered by large scaled dispensing in relation to pharmacy automation such as lowering operating costs and enabling pharmacists more time in providing healthcare advice to patients. These dependent variables were cross tabulated with the employment status of the pharmacist and types of community pharmacy worked in by the pharmacist.

Pharmacist respondents (44%, 71/161) strongly agreed or agreed the implementation of pharmacy automation would lower operating costs. Similarly, 70% (112/159) of pharmacists also reported to strongly agree or agree (55%, 88/161) pharmacy automation would enable more time for pharmacists in providing healthcare advice to patients. Furthermore, considering the age of the pharmacist as an independent variable and with the dependent variables in relation to claims made towards large scaled dispensing in this case pharmacy automation, no significant correlations were reported as displayed in Table 4.23.

Independent variables		**Age (years) %**			
		19-25 (n=23)	**26-39 (n=75)**	**40-59 (n=48)**	**60 and over (n=12)**
Lowering operating costs	Strongly agree/agree	4	19	17	0
	Neither agree nor disagree	52	49	52	67
	Strongly disagree/disagree	44	32	31	33
	P=	**0.551***			
More time for pharmacists to provide healthcare advice		**19-25 (n=23)**	**26-39 (n=74)**	**40-59 (n=49)**	**60 and over (n=12)**
	Strongly agree/agree	9	20	10	0
	Neither agree nor disagree	83	61	76	83
	Strongly disagree/disagree	9	19	14	17
	P=	**0.396***			

Table 4.23 Pharmacists agreement to whether or not pharmacy automation will lower operating costs or enable pharmacists more time provide healthcare advice to patients, according to the age of the pharmacist. The following categories were recombined: Strongly agree and agree, neither agree nor disagree, strongly disagree and disagree. Due to rounding, percentages may not always appear to add up to 100%.

*Spearman's rho correlation was performed

However, a Kruskal Wallis test (Table 4.24) reported a statistically significant difference between the employment status of the pharmacist and the extent to which pharmacists agree pharmacy automation would lower operating costs (p=0.010) and also between the employment status of the pharmacist and the extent to which pharmacy automation will enable pharmacists more time to provide healthcare advice to patients (p=0.012). Mann-Whitney U test also reported statistically significant differences between the pharmacy automation lowering operating costs and whether or not pharmacists worked in a multiple community pharmacy (p=0.003); or whether or not a pharmacist worked in a supermarket community pharmacy (p=0.003), as seen in Table 4.24.

Independent variables		Employment status (%)			Type of pharmacy worked in[1] (%)				
		Employed (n=126)	**Locum (n=20)**	**Other (n=13)**	**Multiple (n=68)**	**Supermarket (n=6)**	**Independent chain (n=33)**	**Independent (n=56)**	**Other (n=2)**
Lowering operating costs	Strongly agree/agree	14	30	0	54	83	45	34	0
	Neither agree nor disagree	56	40	31	25	17	9	25	50
	Strongly disagree/disagree	30	30	69	21	0	45	41	50
	P=	**0.010**[*]			**0.003**[^]	**0.003**[^]	**0.208**[^]	**0.093**[^]	-
		Employed (n=127)	**Locum (n=19)**	**Other (n=13)**	**Multiple (n=69)**	**Supermarket (n=5)**	**Independent chain (n=32)**	**Independent (n=56)**	**Other (n=2)**
More time for pharmacists to provide healthcare advice	Strongly agree/agree	12	32	8	54	80	56	59	50
	Neither agree nor disagree	73	63	54	32	20	22	27	50
	Strongly disagree/disagree	15	5	38	14	0	22	14	0
	P=	**0.012**[*]			**0.501**[^]	**0.082**[^]	**0.841**[^]	**0.982**[^]	**-**

Table 4.24. Pharmacists agreement to whether or not pharmacy automation will lower operating costs or enable pharmacists more time provide healthcare advice to patients, according to the employment status and the type of pharmacy last worked in by the pharmacist. The following categories were recombined: Strongly agree and agree, neither agree nor disagree, strongly disagree and disagree. Due to rounding, percentages may not always appear to add up to 100%.

[1]This was a multiple response question

[*]Kruskal-Wallis was performed

[^]Mann-Whitney U test was performed

4.6.4 Potential problems and benefits with pharmacy automation

Pharmacist participants were asked to report potential problems (Table 4.25) and benefits (Table 4.26) they thought would occur with pharmacy automation. Other potential problems included smaller pharmacies being at risk and less pharmacies for patients to access, and pharmacy will be less patient focused (Appendix 16- Study One: other potential problems with pharmacy automation). These results are unsolicited and can only be considered conservative estimates, as pharmacists may have also perceive there to be other problems of benefits of pharmacy automation.

Problems with pharmacy automation[1] (n=161)	%
Takes up too much space in the pharmacy	78
Looks unappealing in the pharmacy	25
Patients may be less likely to come into a pharmacy with a robotic dispensing machine	22
Risk of human error when operating the machine	64
Slow down dispensing process, especially when dispensing multiple medications	49
No problems	2
Other problems	14

Table 4.25 Potential problems with pharmacy automation

[1]This was a multiple response question

Benefits with pharmacy automation[2] (n=161)	%
Patients more likely to come into the pharmacy	4
Makes the pharmacy look more appealing	12
Shows the advancement of pharmacy with technology	75
Prevent pharmacist from self-checking	59
Other problems	10

Table 4.26 Potential benefits of pharmacy automation

[2]This was a multiple response question

Other benefits included the potential for remote working (Appendix 17- Study One: other potential benefits with pharmacy automation).

4.7 Hub and spoke dispensing & pharmacy automation

This section focused on questions assessing the impact both types of robotic dispensing will have within community pharmacy perceived by respondents. Dependent variables including: the accuracy, productivity with robotic dispensing and whether or not robotic dispensing would hinder patients from using a community pharmacy were cross tabulated with the employment status of the pharmacist and types of community pharmacy the respondent had worked in.

4.7.1 Pharmacists' perceptions of Implications of robotic dispensing on the accuracy, productivity of dispensing medication and on its hinderance of using a pharmacy

In regard to the accuracy of a robotic dispensing machine, 43% (69/161) reported to strongly trust/trust the machine. Over 50% (53%, 84/159) of respondents viewed the productivity of a dispensing robot to significantly increase or increase dispensing. Interestingly, 40% (64/161) neither agreed nor disagreed on whether or not robotic dispensing would hinder patients from using the pharmacy. A statistically significant difference (p=0.01) was reported between the employment status of the pharmacist and the extent to which they trust the accuracy of medication of the robot in dispensing medication (Appendix 18- Study One: statistical tests and cross-tubulations or robotic dispensing methods).

4.7.2 Type of errors likely to occur with implementation of a dispensing robot

Pharmacist participants were asked to report what types of errors they thought were likely to occur with the use of a dispensing robot. Responses are displayed in Table 4.27.

Type of error[1] (n=161)	%
Errors with stock count	39
Errors with filling up the dispensing robot with stock	75
Technical errors (malfunctioning in the robotic dispensing machine)	86
Medication errors (wrong drug/wrong strength/wrong dose/wrong quantity)	33
Picking errors by the dispensing robot	42
Other	5

Table 4.27. Type of errors likely to occur with the implantation of a dispensing robot

[1]This was a multiple response question

Other types of errors include if the wrong stock is put in the machine, the wrong stock comes out and the mismatching of barcodes and medication bags (Appendix 19- Study One: other types of error likely to occur with a dispensing robot). These results are unsolicited and can only be considered conservative estimates, as pharmacists may have also perceive there to be other types of error with a dispensing robot.

4.8 Healthcare

The questions in this section focused on robotics and healthcare as well as the preferred dispensing methods by respondents.

4.8.1 Dispensing preferences

Over 80% (82%, 132/161) of pharmacists preferred dispensing to be taken place on-site of the pharmacy. The majority of pharmacists (53%, 86/161) preferred the current method of dispensing. Out of the two methods of robotic dispensing, pharmacy automation (16%, 25/161) was preferred over hub and spoke dispensing (9%, 15/161) (Table 4.28).

Location of dispensing % (n=161)	
On-site	82
I do not mind	12
Off-site	6
Preferred method of dispensing % (n=161)	
Current method of dispensing	53
Hub and spoke dispensing	9
Pharmacy automation	16
Either hub and spoke dispensing or pharmacy automation	9
I do not mind	10
None of the above	3

Table 4.28 Pharmacists' dispensing preferences

A cross-tabulation was performed between the preferred location and method of dispensing, as seen in Table 4.29. A chi-squared test was unable to be performed due to cell counts being below 5. The purpose of this table was to view if there was a pattern between whether or not the on-site dispensing methods (current method and pharmacy automation) or off-site dispensing (hub and spoke) and the preferred location of dispensing. Cross-tabulation helps map out relations between categorical variables that otherwise might have been overlooked.

Dispensing preferences		**Method of dispensing (n=)**				
		Current method	**Hub and spoke**	**Pharmacy automation**	**Either hub and spoke or pharmacy automation**	**Do not mind/ none of the above**
Location of dispensing	**On-site**	85	3	23	8	12
	Do not mind	1	6	2	4	7
	Off-site	0	6	0	2	1

Table 4.29 Preferred location and method of dispensing

4.8.2 Other comments pharmacists had about hub and spoke dispensing & pharmacy automation

Open ended questions were imported from Microsoft word and imported into NVivo 12 and then subjected to thematic analysis. Results were split up into advantages (Appendix 20- Study One: advantages of hub and spoke dispensing) and disadvantages (Appendix 22- Study One: disadvantages of hub and spoke dispensing) of hub and spoke and advantages (Appendix 21- Study One: advantages of pharmacy automation) and disadvantages (Appendix 23- Study One of pharmacy automation). Other comments were also included as a separate category as documented in Appendix 24- Study One: other comments of dispensing.

4.9 Summary of Pharmacist study results chapter

The findings presented in this chapter described community pharmacists' perceptions towards the use of hub and spoke dispensing and pharmacy automation, as well as considering their dispensing preferences.

Section 4.3 reported information regarding pharmacy practice. Respondents reports mostly having between 3-4 (39%, 62/161) or 1-2 (38%, 61/161) of additional staff members of staff members during their current or previous pharmacy shift. A counselling time of between 1 and 3 minutes was recorded in the survey results by 52% (83/161) of pharmacist respondents. A weak negative correlation was identified between the average counselling time spent by the pharmacist and the satisfaction they had with the amount of counselling time they had. In other words, the more counselling time a pharmacist had, the higher the satisfaction they had with their available counselling time. Pharmacists were also asked to report the extent to which they agreed they were spending too much time on specific tasks listed. Over 80% (82, 129/158) of respondents viewed administrative tasks to be a duty to which they were spending too much time on and 54% (85/157) reported checking medication to be a another task. Additionally, staff shortages were perceived as common barrier by pharmacists when providing healthcare advice to patients (Section 4.3). This study also identified a significant difference between whether or not a pharmacist worked in a multiple pharmacy and reported staff shortages as a barrier, and the same reported for working within an independent pharmacy.

Section 4.4 reported data around dispensing, including prescription waiting times. On average over 40% of respondents (42%, 67/158) reported a prescription waiting time of below 5 minutes. If robotic dispensing allowed pharmacists more time to undertaken other activities, nearly 90% (88%, 141/161) of pharmacists reported they would like to spend more time doing pharmacy services. However, these results are unsolicited and does not mean that they also would like to spend more time performing other tasks.

Section 4.5 highlighted pharmacists' perceptions on factors relating to hub and spoke dispensing and section 4.6 highlighted pharmacist's perceptions towards pharmacy automation. Despite the suggestions set out by the Department of Health for adoption of large scaled dispensing such as hub and spoke, the majority of respondents lacked trust in hub and spoke dispensing replacing the manual labour of pharmacy staff in dispensing medication. Although, pharmacists did show to trust their peer pharmacists at the hub in overseeing the dispensing process, whilst the clinical check was done in store.

The employment status of the pharmacist, and whether or not a pharmacist worked within an independent community pharmacy reported statistically significant differences in the extent of trust pharmacists had towards replacing the manual labour of pharmacy staff in dispensing medication. Employed and locum pharmacists exhibited distrust towards hub and spoke replacing the manual labour of pharmacy staff, as well as trusting their pharmacist peers at the hub as did other types of pharmacists. The employment status of the pharmacist also reflected a significant difference to the extent of pharmacists' trust towards their peers at the hub.

On the other hand, no trust or distrust was exhibited by respondents towards pharmacy automation, replacing the manual labour of pharmacy staff in dispensing medication. Further analysis showed locum pharmacists reported to strongly trust/trust towards the replacement of labour, whereas employed pharmacists exhibited neither trust nor distrust (Section 4.6). Survey results reported no significant differences between this dependent variable being the replacement in manual labour by pharmacy automation in relation to the employment status and type of community pharmacies worked in by the respondent (Section 4.6).

Following, a justification set out by the Department of Health, stated the introduction of large-scale dispensing may 'lower operating costs' for large-scaled dispensing processes such as hub and spoke dispensing, whereby pharmacist respondents were perceived to agree with this claim. Moreover, dispensing methods such as hub and spoke were proposed to release pharmacists from the dispensing function enabling them more time in providing healthcare advice to patients, again survey respondents also agreed with this claim. Further analysis displayed statistically significant differences between employment statuses of the pharmacist and the extent of agreement that participants had towards claims made about hub and spoke enabling more time for pharmacists to provide healthcare advice to patients (Section 4.5). A relationship was also identified between the age of the pharmacist and the extent to which pharmacists perceived hub and spoke would give pharmacists more time in providing healthcare advice to patients (Section 4.5). In simpler terms, the older a pharmacist was the more they disagreed hub and spoke would enable pharmacists more time in providing healthcare advice to patients.

However, with respect to pharmacy automation, respondents agreed pharmacy automation would lower operating costs. Further analysis also displayed statistically significant differences between the different employment statuses of the pharmacist and the extent to which pharmacists agreed pharmacy automation would lower operating costs. Additionally, whether or not a respondent did or did not work with a multiple or supermarket pharmacy also reported statistically significant differences of opinion. As found with hub and spoke, pharmacists also agreed pharmacy automation would provide pharmacists more time in providing healthcare advice to patients. Although, the various types of employment statuses of the pharmacist exhibited differences between the extent of agreement respondents has towards pharmacy automation enabling pharmacists more time to provide healthcare advice to patients. However, contrary to hub and spoke no relationships were identified between the age of the pharmacist and they extent to which they agree pharmacy automation would enable them more time in providing healthcare advice to patients and lowering operating costs.

Following on with the topic of patient safety, medication errors were perceived to be decreased with hub and spoke, however neither an increase of decrease in workload was reported to not be a factor that was influential by hub and spoke. However, pharmacists perceived hub and spoke to increase the time taken for patients to get their prescription medication (Section 4.5). Following on, benefits of hub and spoke included less time spent dispensing and more time for pharmacists to utilise their clinical skills through services and advice (Section 4.5). Pharmacists respondents reported problems with hub and spoke including not being able to dispense all medication such as fridge lines and appliances. Additionally, the hub and spoke process was perceived to cause an increase in time with matching prescription bags from the hub with the original prescription from in store.

On the other hand, respondents viewed pharmacy automation to decrease medication errors. Although, pharmacy automation was perceived to increase the time for patients to get their prescriptions. Again, as seen with hub and spoke, neither an increase nor decrease in workload was shown towards the implementation of pharmacy automation. Additionally, potential benefits of pharmacy automation included showing the advancement of pharmacy with technology and preventing pharmacists from self-checking. Although, pharmacy automation was perceived to take too much space in the pharmacy and the risk of human error when operating the machine, as potential problems.

Following on, section 4.7 depicted the use of robotic dispensing, in terms of its accuracy, productivity effects and whether or not it would hinder patients from using the pharmacy. The accuracy of a robot was generally reported to be trusted by pharmacists and was also viewed to increase the productivity of dispensing. Further analysis, demonstrated statistically significantly differences between the employment statuses of the pharmacist and the extent to which pharmacists trusted robotic dispensing with the accuracy in dispensing medication. Technical errors and errors when filling up the robotic dispensing machine were mostly reported by respondents for the use of a robotic dispensing machine.

Additionally, section 4.8 concluded the results for this study, detailing results on healthcare, including dispensing preferences. Over 80% (82%, 132/161) of respondents preferred dispensing to take place on-site of the pharmacy. With over half 53% (86/161) of pharmacists preferring the current method of dispensing, followed by 16% (25/161) reporting pharmacy automation to be the preferred method and 9% (15/161) hub and spoke dispensing.

Overall, chapter 4 of this thesis has described pharmacists' attitudes towards the idea of the implementation of robotic dispensing methods: hub and spoke and pharmacy automation in community pharmacies in England. The final chapter of this programme of work has discussed and summarised the findings of the research. The next chapter has presented results on the general public perception of using robotic dispensing methods: hub and spoke and pharmacy automation for dispensing in community pharmacies in England.

Chapter 5: Results on the perceptions of the General Public on robotic dispensing

5.1 Introduction

The chapter has described and analysed results from study two, where postal surveys were sent out to the general public across England in 2018. Further details of the methodology used in study two have been detailed in chapter three.

5.2 Socio-demographic characteristics of survey's respondents

5.2.1 General public response rate

Electoral data from the open register were used to select the general public population used in study two, representing the geographical and population of England, as documented in chapter three. The final response rate of community pharmacists was 9.7 % (188/1945). In 2017-2018 England had 38,371,000 parliamentary electors, this survey had respondents representing 1.0% of the parliamentary electors in 2017-18 (ONS 2018). Fifty-five out of the 2000 participants were withdrawn from the study due to reasons such as, not interested address had gone away or they were deceased (Table 5.1).

Reason for no response	Number of returns	% (n=1945)
No/RTS*	103/16 = 119	6.1
RTS* – address gone away	49	2.5
Deceased	6	0.3
No by email	13	0.7

Table 5.1 Participants reasoning for no response in the survey

*Return to Sender

5.2.2 Demographic details

The demographic of respondents have been displayed in Table 5.2.

Independent variable		(n=)	%
Sex (n=186)	Male	79	42
	Female	107	58
Age (years) (n=188)	19-25	8	4
	26-39	12	6
	40-59	49	26
	60 and over	117	62
	Prefer not to say	2	1
Employment status (n=184)	Employed	60	33
	Self-employed	10	5
	Unemployed (job seeking)	1	1
	Unemployed (not job seeking)	1	1
	Student	3	2
	Retired	95	51
	Unable to do work	7	4
	Homemaker	4	2
	Other	3	2
Region (n=187)	North East	8	4
	North West	42	22
	Yorkshire and the Humberside	14	7
	East Midlands	14	7
	West Midlands	13	7
	East of England	19	10
	London	10	5
	South East	40	21
	South West	27	14
Ethnicity (n=183)	White-British	170	93
	White - Any other White background	9	5
	Black or Black British - African	2	1
	Mixed – Any other background	1	1
	Asian – Indian	1	1
Type of community pharmacy last visited (n=157)	Multiple	56	36
	Supermarket	12	8
	Independent chain	82	52
	Do not know	6	4
	Other	1	1
Highest level of education (n=186)	Primary school	2	1
	Secondary school	77	41
	Sixth form/college level	39	21
	Bachelor's degree or equivalent	42	23
	Master's degree or equivalent	12	6
	Doctoral or equivalent	2	1
	None of the above	3	2
	Other	9	5

Table 5.2. Demographic details of General Public respondents. Due to rounding, percentages may not always appear to add up to 100%.

Independent community chain pharmacies or independent community pharmacies were commonly last visited by respondents living in the North West (52%, 16/31), South East (78%, 28/36), West Midlands (62%, 8/13), East of England (65%, 11/17). Whereas, other regions either had mostly last visited a multiple community pharmacy with the exception of the East Midlands (60%, 6/10) where a supermarket pharmacy was the most common pharmacy last visited (Table 5.3).

		Type of community pharmacy (%)			
		Multiple	Supermarket	Independent community	Do not know
Region	**North East (n=8)**	50	0	50	0
	North West (n=31)	42	3	52	3
	Yorkshire and the Humberside (n=13)	92	0	8	0
	East Midlands (n=10)	30	60	10	0
	West Midlands (n=13)	31	0	62	8
	East of England (n=17)	24	0	65	12
	London (n=9)	44	11	44	0
	South East (n=36)	14	3	78	6
	South West (n=18)	39	17	44	0

Table 5.3 Type of pharmacy last visited by the respondent according to the region in which they live in. Due to rounding, percentages may not always appear to add up to 100%.

5.2.3 Response rate comparisons

5.2.3.1 Number of electors per region in 2018 in relation to the number of respondents in this study

The percentage differences were calculated between the number of respondents study two and the number of electors in 2018 according to the region of the respondent or electorate (Table 5.4).

Region	Original sample sent	Response rate according to number of surveys sent (%)	Number of electors in 2018 (n=)	Respondents in study two (n=)	Proportion of study two respondents presenting electors in 2018 (10^{-6} %)
North East	100	8	1,908,452	8	4.2
North West	300	14	5,346,331	42	7.9
Yorkshire and the Humber	200	7	3,927,288	14	3.6
East Midlands	200	7	3,515,008	14	4.0
West Midlands	200	7	4,174,527	13	3.1
East of England	200	10	4,538,489	19	4.2
London	300	3	5,905,554	10	1.7
South East	300	13	6,637,006	40	6.0
South West	200	14	4,180,724	27	6.5
England	2000	-	40,133,379	188	-

Table 5.4 Representation of the General Public and robotics survey respondents in proportional to number of electors by region in 2018 (ONS 2019).

5.2 Pharmacy user

This section reported data on pharmacy use, over 90% (93%, 169/182) of general public respondents had used a pharmacy in the past twelve months. Respondents that had not used a pharmacy in the past twelve months were asked to skip to question 2e of the questionnaire.

5.2.1 Type of community pharmacy used

Ninety per cent (169/188) of respondents had used a pharmacy in the past 12 months. The minority of general public respondents in this survey last visited an independent community pharmacy chain (49%, 82/169), followed by a multiple community pharmacy (33%, 56/169) (Figure 5.1).

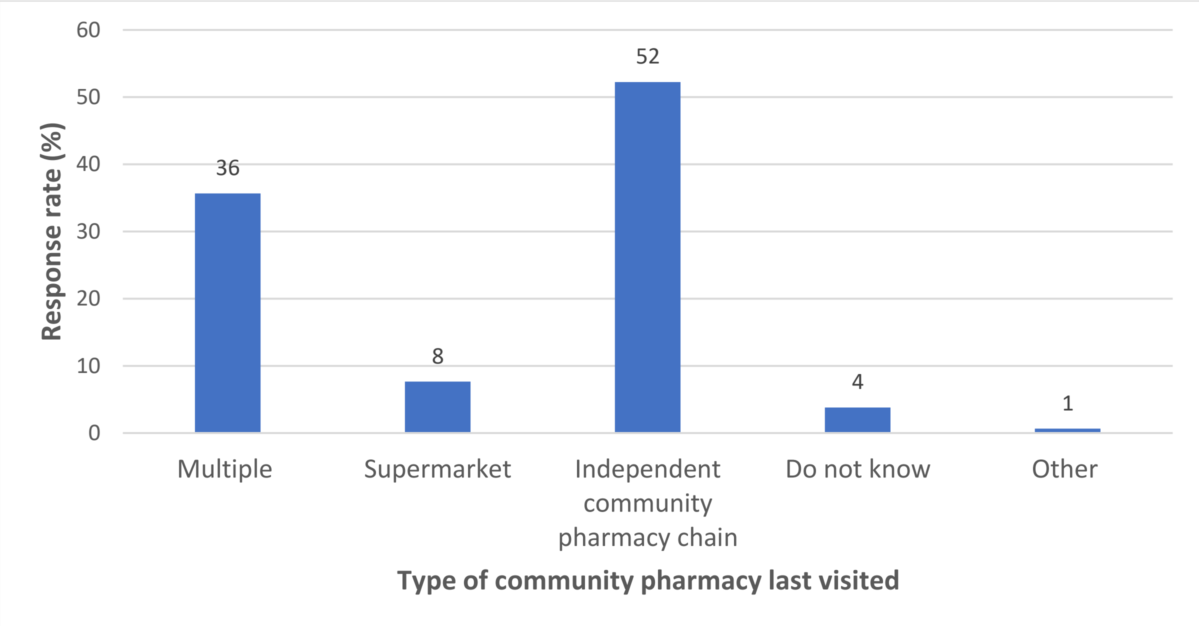

Figure 5.1 A bar chart to show the type of community pharmacy last visited by the respondent

5.2.1.1 General Public reasons for pharmacy use

Respondents were also questioned on their reasoning for their use of a community pharmacy. Options for the question, were split into medical and non-medical purposes as displayed in Table 5.5. Other reasons included: cosmetics, flu vaccinations, hair care and reasoning in which participants did not state.

Medical[1] (n=169)	(%)
Prescriptions	99
OTC	54
Healthcare services	8
Advice on healthcare problem	28
Other	1
Non-medical[1] (n=169)	**(n=)**
Purchasing non-medical items	14
Disposal of unwanted medicines	21
Other	2

Table 5.5 Reasons why respondent use the pharmacy

[1]This was a multiple response question

5.2.2 General Public view on pharmacist's time available

Additionally, questions also assessed the perceptions of participants experience with community pharmacy practice. General public participants were asked about extent to which they agreed pharmacists had enough time to provide healthcare advice to patients and if they felt they had enough time to speak to pharmacy staff, including the pharmacist. These variables were cross tabulated with the age of the respondent and the last type of community pharmacy visited. No significant differences were reported between the dependent variables and the last time of pharmacy visited by the respondent (Appendix 25- Study Two: dispensing perceptions cross-tabulated with community pharmacy last visited).

Over 40% of respondents (47%, 88/188) either strongly agreed or agreed that they had enough time to speak to pharmacy staff, including the pharmacist. This question was only asked to those who has used a pharmacy in the past 12 months. A weak negative correlation was identified between the age of the pharmacist and the extent to which the respondent agreed they had enough time to speak to pharmacy staff ($p=0.045$, $r_S=-0.153$) as displayed in Table 5.6. In other words, the older the participant was the more they disagreed with the amount of time they had to speak to the pharmacist.

Over 75% of participants (77%, 144/188) strongly agreed or agreed pharmacists had enough time to provide healthcare services to patients. Another weak negative correlation using a Spearman's Rho correlation (Table 5.6) was identified between the age of the pharmacist and the extent to which the respondent agreed pharmacists have enough time to provide healthcare advice to patients ($p=0.015$, $r_s=-0.179$). Meaning, the older the general public participant, the more they disagree with pharmacists having enough time to provide healthcare advice to patients.

Independent variables		Age %				
		18-25 (n=8)	**26-39 (n=12)**	**40-59 (n=46)**	**60 and over (n=106)**	**Prefer not to say (n=1)**
Enough time to speak to pharmacy staff[1]	Strongly agree/agree	88	67	76	88	100
	Neither agree nor disagree	13	33	13	9	0
	Strongly disagree/disagree	0	0	11	3	0
	P=					**0.045***
Do pharmacists have enough time to provide healthcare advice to patients[2]		**18-25 (n=8)**	**26-39 (n=11)**	**40-59 (n=48)**	**60 and over (n=116)**	**Prefer not to say (n=2)**
	Strongly agree/agree	25	9	44	54	50
	Neither agree nor disagree	63	73	31	29	50
	Strongly disagree/disagree	13	18	25	16	0
	P=					**0.015**

Table 5.6 The extent to which respondents agree [1]they had enough time to speak to pharmacy staff (including the pharmacist); [2]pharmacists have enough time to give healthcare advice to patients according to their age. Categories were recombined into: Strongly agree/agree, neither agree nor disagree or strongly disagree/disagree. Due to rounding, percentages may not always appear to add up to 100%.

*Spearman's correlation was performed

5.2.2.1 Time constraint reasons faced by pharmacists

General public participants were asked to report reasonings to why they perceived pharmacists may not have enough time to provide healthcare advice to patients, which have been displayed in Table 5.7. Other comments including respondents believing pharmacist have enough time to provide healthcare advice to patients are shown in (Appendix 29- Study Two: other comments why pharmacists don't have enough time to provide healthcare advice to patients). These results are unsolicited and can only be considered conservative estimates, as respondents may have also perceive there are other reasons why pharmacists do not have enough time to provide healthcare advice to patients.

Reason's pharmacists don't have enough time to provide healthcare advice to patients[1] (n=188)	%
Too much time checking medications in the dispensary (back of pharmacy)	48
Staff shortages	38
Too much time spent doing other activities	19
Other	14

Table 5.7 Reasons why pharmacists don't have enough time to provide healthcare advice to patients apart from time constraints

[1]This was a multiple response question

5.2.2.2 Places where respondents gain their healthcare advice from

Participants were asked to report where they obtained their healthcare advice from aside from their GP (Table 5.8). Other places where general public respondents obtained healthcare advice from included colleagues, family or friends who are healthcare professionals (Appendix 30 – Study Two: apart from GPs, where healthcare advice is obtained from). These results are unsolicited and can only be considered conservative estimates, as respondents may obtain advice for more than one resource.

Places where respondents get their healthcare advice from, apart from doctors [2] (n=188)	%
Pharmacies	61
NHS walk-in centre	8
Accident and emergency (A&E)	9
Online medical websites (i.e. Boots, LloydsPharmacy etc.)	38
NHS 111/ other non-emergency telephonic healthcare advice services	5
Other	8

Table 5.8 Places where respondents obtain their healthcare advice from, apart from doctors

[2]This was a multiple response question

5.3 Dispensing

This section displayed information about the processes involved in dispensing. Respondents reported 92% (172/188) to have used a pharmacy to obtain prescription medication. Study two, showed those aged over 60 (61%, 105/172) mostly used a pharmacy to collect prescription medication, followed by those aged between 27% (46/172) were aged between 40 and 59 years old. The general public respondents who had used a pharmacy for a prescription medication were asked to answer questions about the prescription reception and delivery process and those who hadn't were asked to move to the answering questions from the next section.

5.3.1 Method of how prescription was delivered to pharmacy

Firstly, data were collected on the method prescriptions were reached the pharmacy, options included: either on behalf of the pharmacy staff or by the respondent themselves. The majority of respondent's prescriptions were electronically sent by the prescriber to the pharmacy (51%, 86/170). Followed by, 38% (65/170) of respondents who brought their prescriptions to the pharmacy themselves.

5.3.2 Prescription waiting times

Respondents that collected their prescription themselves were asked to answer how long they waited or if they called back or had their medication delivered. Table 5.9 presented 69% (53/77) of respondents to have waited up to 30 minutes and 19% (15/77) called back for their prescriptions. Overall, 80% (52/65) report to be very satisfied or satisfied with the time it took to obtain the prescription medication.

Prescription waiting time (n=77)	%
Waited up to 30 minutes	69
Waited over 30 minutes	4
Call back for Rx later	19
Prescription gets delivered	4
Other	4

Table 5.9 Prescription waiting times

5.3.3 Medication errors

Public experiences of medication errors were reported on study two. A medication error was defined as wrong dose, wrong strength or wrong medicine. Under 10% (7%, 14/188) of participants had experienced a medication error. Further analysis showed 50% (7/14) of respondents who had last visited an independent community pharmacy chain or 36% (5/14) multiple community pharmacy had experienced an error.

5.3.3.1 Types of medication error

The type of errors experienced by the participant was recorded in study two. Table 5.10 displayed types of errors experiences, where 29% (4/14) of respondents had received the right medication but the wrong strength and 21% (3/14) the right medication however the wrong dose. Other types of error included receiving somebody else's prescription and the wrong medicine being prescribed by the doctor. It needs to be considered that the general public may be unaware of the different types of errors, resulting in reporting the incorrect error. This may have impacted on the validity of the results, as the correct options for the type of error may not have been selected.

Type of error experienced (n=14)	%
Right medicine, wrong strength	29
Right medicine, wrong dose	21
Right medicine, wrong patient	0
Wrong medicine, right strength	0
Wrong medicine, wrong strength	0
Wrong medicine, right dose	0
Wrong medicine, wrong dose	0
Wrong medicine, right patient	14
Wrong medicine, wrong patient	21
Other error	14

Table 5.10. Type of error experienced by respondents. Due to rounding, percentages may not always appear to add up to 100%.

Additionally, data were also recorded on the when the patient had realised, they had experienced a medication error. The majority of patients who had experienced a medication error, realised before taking the medication (43%, 6/14), whereas 21% (3/14) recognised this after medication administration. Nearly 80% (79% 11/14) reportedly would go back to the prescriber or pharmacy again having experienced an error. Respondents were also questioned on their trust towards the prescriber or pharmacy after experiencing a medication error. Overall, 62% (8/13) of pharmacists reported to strongly trust or trust using the pharmacy or prescriber again.

5.4 Hub and spoke dispensing

This section focused on the general public perception of factors relating to hub and spoke dispensing. Respondents were asked questions regarding trust with hub and spoke dispensing, influences on medication errors and the time taken for patients to get prescriptions. The public perception of claims made towards hub and spoke dispensing such as operating costs were also explored.

5.4.1 General Public knowledge on hub and spoke dispensing

Less than 10% (8%, 15/182) of the public reported to have heard of hub and spoke dispensing, within this 60% (9/15) were female and 40% (6/15) were male. Those who were aged 60 years and over were most likely to have heard of hub and spoke (73%, 11/15).

5.4.2 Influences of hub and spoke dispensing on trust and giving pharmacists more time to provide healthcare services to patients

Respondents were asked to report their opinions on the extent of their trust towards hub and spoke dispensing replacing the manual labour of pharmacy staff in dispensing medication. General public perceptions were also collected on the extent to which respondents trusted hub and spoke using a robotic dispensing machine in dispensing their medication off-site (i.e. not in the pharmacy); as well as the extent in which they agree with the claim that hub and spoke will provide pharmacists with more time in providing healthcare services. These dependent variables were cross tabulated with the employment status and the age of the respondent.

Overall, 39% (72/185) of public participants neither trusted nor distrusted hub and spoke replacing the manual labour of pharmacy staff in dispensing medication. Similarly, 38% (71/186) also neither trusted nor distrusted medication being made up off-site (not in the pharmacy) using a robotic dispensing machine (Table 5.11). Following on, 36% (67/185) neither agreed nor disagreed that hub and spoke would enable pharmacists more time to provide healthcare services to patients (Table 5.11).

A Kruskal-Wallis test was performed between the dependent variables and the employment status of the general public respondent. Spearman's rho correlation between the age of the participant and the dependent variables. No relationships or statistically significant differences were identified between the age of the respondent, sex, ethnicity, highest education level of the respondent or last type of community pharmacy visited by the respondent.

However, Table 5.10 reported a statistically significant difference between the employment status of the pharmacist and the extent to which they trust hub and spoke being carried out off-site of the dispensary (p=0.028).

	Extent of trust %		
	Trust & hub and spoke[1] (n=160)	Off-site and hub and spoke[2] (n=166)	More time for pharmacist to provide healthcare advice to patients and hub and spoke[3] (n=188)
Strongly trust/trust	29	27	32
Neither trust nor distrust	45	43	36
Strongly distrust/distrust	26	31	32

Table 5.11. The extent to which General Public respondents trust hub and spoke dispensing [1]replacing the manual labour of pharmacy staff in dispensing medication and [2]making up medication off-site (not in the pharmacy) using a robotic dispensing machine). The categories were recombined as: strongly trust/trust, neither trust nor distrust, strongly distrust/distrust) [3]The extent to which pharmacists agree hub and spoke dispensing will provide pharmacists more time to provide healthcare service (strongly agree/agree, neither agree nor disagree, strongly disagree/disagree). Due to rounding, percentages may not always appear to add up to 100%.

Table 5.12 has displayed a table of the employment status of the respondent being the independent variable cross-tabulated with the following dependent variables:

- Extent to which respondents trust hub and spoke replacing the manual labour of pharmacy staff in dispensing medication
- Extent of trust towards hub and spoke taking place off-site using a robotic dispensing machine
- Extent pharmacists agree hub and spoke would enable more time for pharmacists to provide healthcare advice to patients.

Table 5.13 has displayed the dependent variable with the highest level of education of the participant as the independent variable with the dependent variable listed above.

Independent variables		Employment status %				
		Employed (n=52)	Self-employed (n=10)	Unemployed (job seeking/not job seeking) (n=2)	Student/Retired /Unable to work/Homemaker (n=89)	Other (n=3)
Trust & hub and spoke[1]	Strongly trust/trust	8	0	0	3	0
	Neither trust nor distrust	29	30	0	23	0
	Strongly distrust/distrust	63	70	100	74	100
	P=	0.269*				
Off-site and hub and spoke[2]		**Employed (n=54)**	**Self-employed (n=10)**	**Unemployed (job seeking/not job seeking) (n=2)**	**Student/Retired/Unable to work/Homemaker (n=93)**	**Other (n=3)**
	Strongly trust/trust	9	0	0	2	0
	Neither trust nor distrust	26	50	0	18	0
	Strongly distrust/distrust	65	50	100	80	100
	P=	0.028*				
Pharmacist time for healthcare services and hub and spoke[3]		**Employed (n=59)**	**Self-employed (n=9)**	**Unemployed (job seeking/not job seeking) (n=1)**	**Student/Retired/Unable to work/Homemaker (n=89)**	**Other (n=2)**
	Strongly agree/agree	7	0	0	1	0
	Neither agree nor disagree	39	33	0	30	50
	Strongly disagree/disagree	54	67	100	69	50
	P=	0.737*				

*Kruskal-Wallis was performed

Table 5.12. The extent to which General Public respondents trust hub and spoke dispensing [1]replacing the manual labour of pharmacy staff in dispensing medication (median: employed=2.00, self-employed=2.00, student/retired/unable to work/homemaker=2.00, other=3.00) and [2]making up medication off-site (not in the pharmacy) using a robotic dispensing machine) (median: employed=2.00, self-employed=2.00, student/retired/unable to work/homemaker=2.00, other=3.00) The categories were recombined as: strongly trust/trust, neither trust nor distrust, strongly distrust/distrust) [3]The extent to which pharmacists agree hub and spoke dispensing will provide pharmacists more time to provide healthcare service (median: employed=2.00, self-employed=2.00, student/retired/unable to work/homemaker=2.00, other=2.00) (strongly agree/agree, neither agree nor disagree, strongly disagree/disagree) with the employment status of the respondent. Median excluded unemployed category.

Hub and spoke		Highest level of education %							
		Primary school (n=2)	Secondary school (n=64)	Sixth form/college level (n=30)	Bachelor's degree or equivalent (n=40)	Master's degree or equivalent (n=12)	Doctoral or equivalent (n=1)	None of the above (n=2)	Other (n=7)
Trust and replacing manual labour[1]	**Strongly trust/trust**	0	22	43	33	33	100	0	14
	Neither trust nor distrust	50	47	43	43	50	0	50	43
	Strongly distrust/distrust	50	31	13	25	17	0	50	43
Trust and off-site dispensing[2]		**Primary school (n=2)**	**Secondary school (n=65)**	**Sixth form/college level (n=32)**	**Bachelor's degree or equivalent (n=42)**	**Master's degree or equivalent (n=12)**	**Doctoral or equivalent (n=1)**	**None of the above (n=3)**	**Other (n=7)**
	Strongly trust/trust	0	15	41	31	50	50	0	14
	Neither trust nor distrust	50	52	41	36	25	0	33	43
	Strongly distrust/distrust	50	32	19	33	25	50	67	43
Time for healthcare advice[3]		**Primary school (n=2)**	**Secondary school (n=62)**	**Sixth form/college level (n=36)**	**Bachelor's degree or equivalent (n=38)**	**Master's degree or equivalent (n=12)**	**Doctoral or equivalent (n=1)**	**None of the above (n=3)**	**Other (n=8)**
	Strongly agree/agree	50	24	42	55	25	100	33	38
	Neither disagree nor disagree	0	50	36	26	67	0	67	38
	Strongly disagree/disagree	50	26	22	18	8	0	0	25

Table 5.13. Extent of trust respondents have to [1]Hub and spoke replacing the manual labour of the dispensing process; [2]Dispensing being carried out off-site of the pharmacy with hub and spoke (The categories were: strongly trust/trust, neither trust nor distrust and strongly distrust or distrust) 2=; [3]the extent to which respondents agree hub and spoke will give pharmacists more time to provide healthcare advice to patients (the categories were: strongly agree/agree, neither agree nor disagree, strongly disagree/disagree), according to their highest level to education. . Due to rounding, percentages may not always appear to add up to 100%.

5.4.3 Influence of hub and spoke dispensing on medication errors and time taken to get their prescriptions

Moreover, respondents were asked to report their perceptions of the influence they perceived hub and spoke to have on medication errors and the time taken for patients to obtain their prescriptions. These dependent variables were cross tabulated with the age and type of community last visited by the respondent, as independent variables (Table 5.15). As expected, 34.6% (65/188) of respondents reported to not know the influence hub and spoke would have on medication errors. However, 29.3% (55/188) reported hub and spoke to increase the time it took for patients to get their prescriptions (Table 5.14).

	Influence on the medication errors % (n=183)	Influence on the time taken to get prescriptions[2] % (n=185)
Increase	28	30
Decrease	20	26
No influence	17	19
Do not know	35	25

Table 5.14. The extent to which hub and spoke dispensing has on medication errors and the time taken for patients to get prescriptions. Categories were recombined to increase, decrease, no influence/do not know.

Independent variables		Age (years)					Type of pharmacy visited				
		18-25 (n=8)	26-39 (n=12)	40-59 (n=49)	60 years and over (n=116)	Prefer not to say (n=1)	Multiple (n=55)	Supermarket (n=12)	Independent chain (n=82)	Do not know (n=6)	Other (n=1)
Medication errors	**Increase**	38	25	29	28	0	22	25	42	33	0
	Decrease	38	25	22	17	0	29	0	15	17	0
	No influence	13	8	20	17	0	9	42	15	0	100
	Do not know	13	42	29	38	100	40	33	27	50	0
Time taken to get RX		**18-25 (n=8)**	**26-39 (n=12)**	**40-59 (n=48)**	**60 years and over (n=115)**	**Prefer not to say (n=2)**	**Multiple (n=55)**	**Supermarket (n=12)**	**Independent chain (n=81)**	**Do not know (n=6)**	**Other (n=1)**
	Increase	13	25	25	34	0	20	50	30	50	0
	Decrease	75	33	48	13	50	35	8	26	33	0
	No influence	13	17	19	19	50	13	17	23	0	100
	Do not know	0	25	8	34	0	33	25	21	17	0

Table 5.15. The extent to which respondents believe medication errors will increase, or the time taken for patients to get prescriptions will increase with the implementation of hub and spoke. The following categories were created: increase, decrease, no change/do not know. Due to rounding, percentages may not always appear to add up to 100%.

5.5 Pharmacy automation

This section focused on the general public knowledge and views of pharmacy automation. Question in this section have complemented those seen in Section 5.4.

5.5.1 General Public knowledge of pharmacy automation

Only 13% (24/188) of the sample population had heard of pharmacy automation. Whereby, within this percentage, 46% (11/24) of male respondents who had heard of pharmacy automation were male and 54% (13/24) were female. Respondents over the age of 60 years, 15% (17/117) were most likely to have heard of pharmacy automation.

5.5.2 Influences of pharmacy automation on trust and giving pharmacists more time to provide healthcare services to patients

In the general public survey, respondents were asked to record their opinion on trusting pharmacy automation in replacing the manual labour of the dispensing process and whether or not they trust pharmacy automation dispensing their medication on-site (in the pharmacy) using a dispensing robot. Respondents were also asked to record their views on the extent to which they agree that pharmacy automation will provide pharmacists more time to give healthcare advice to patients. A 5-point Likert scale was used to assess perceptions which were recoded into a 3-point Likert scale. The dependent variable in the question were cross tabulated with the age group of the respondent (Table 5.20) and the type of community pharmacy they had last visited (Table 5.19).

Overall, 34% (63/187) either strongly trust/trust or neither trust nor distrusted pharmacy automation, using a robotic dispensing machine making up their medication on-site in the pharmacy. Whereas 28% (53/187) reported to strongly trust/trust pharmacy automation in replacing the manual labour of pharmacy staff in dispensing medication. Moreover, 36% (66/185) strongly agreed or agreed pharmacy automation to enable pharmacists with more time in providing health care services to patients. A Spearman's rho correlation was performed between these two dependent variables exploring general public trust, a strong positive correlation was identified (r_s=0.833, p=0.000, at a 0.01 level), using a 3-point Likert scale for each dependent variable (Table 5.16). In other words as the extent of trust towards pharmacy automation using a robotic dispensing machine to make up medication on-site of the pharmacy increased, as did the extent of trust respondent displayed towards pharmacy automation replacing the manual labour of pharmacy staff in dispensing medication.

		Trust and on-site dispensing[2] (n=)		
		Strongly trust/trust	Neither trust nor distrust	Distrust/strongly distrust
Trust and replacing manual labour of the dispensing process[1] (n=)	Strongly trust/trust	49	3	1
	Neither trust nor distrust	11	47	5
	Distrust/strongly distrust	1	10	42
	p=	0.000		
	r_s	0.831 (at a 0.01 level, 2-tailed)		

Table 5.16. A cross-tabulation of the extent of trust towards pharmacy automation [1]replacing the manual labour of the dispensing process, [2]using a robotic dispensing on-site in the pharmacy. Spearman's rho correlations were performed

Interestingly, a fairly strong positive correlation was also apparent between the extent of trust pharmacists have towards pharmacy automation replacing the manual labour of pharmacy staff in dispensing medication and agreeing pharmacy automation will the extent of agreement that pharmacy automation will allow pharmacists' more time to provide healthcare advice to patients (r_s=0.542, p=0.000), as seen in Table 5.17. In other words, the more pharmacists distrusted pharmacy automation replacing the manual labour of pharmacy staff in dispensing medication, the more they are also disagreed pharmacy automation would provide pharmacists more time to provide healthcare advice to patients.

		Pharmacy automation and healthcare advice time[2] (n=)		
		Strongly agree/agree	Neither agree nor disagree	Strongly disagree /disagree
Trust and replacing manual labour of the dispensing process[1] (n=)	**Strongly trust/trust**	35	11	2
	Neither trust nor distrust	16	37	8
	Distrust/strongly distrust	6	14	26
	p=	0.000		
	r_s	0.542 (at a 0.01 level, 2-tailed)		

Table 5.17. A cross-tabulation of the extent of trust towards pharmacy automation [1]replacing the manual labour of the dispensing process, [2]extent of agreeing pharmacy automation will provide pharmacists more time to provide healthcare advice to patients. Spearman's rho correlations were performed

Interestingly, a fairly positive correlation was also apparent between the extent of trust pharmacists have towards pharmacy automation using a robotic dispensing robot to dispense medication on-site of the pharmacy and agreeing pharmacy automation will allow pharmacists' more time to provide healthcare advice to patients (r_s=0.505, p=0.000), as seen in Table 5.18. In other words, the more pharmacists distrusted pharmacy automation using a robotic dispensing machine on-site of the pharmacy, the more they are also disagreed pharmacy automation would provide pharmacists more time to provide healthcare advice to patients, as seen in Table 5.18.

		Pharmacy automation and healthcare advice time[2] (n=)		
		Strongly agree/agree	Neither agree nor disagree	Strongly disagree /disagree
Trust and on-site dispensing[1] (n=)	**Strongly trust/trust**	36	17	5
	Neither trust nor distrust	14	36	7
	Distrust/strongly distrust	9	13	24
	p=	0.000		
	r_s	0.505		

Table 5.18. A cross-tabulation of the extent of trust towards pharmacy automation [1]using a dispensing robotic to dispensed medication on-site of the pharmacy, [2]extent of agreeing pharmacy automation will provide pharmacists more time to provide healthcare advice to patients. Spearman's rho correlations were performed

Kruskal-Wallis tests were performed with the type of pharmacy last visited by the respondent and the dependent variables listed above. The previous types of community pharmacy the general public respondent had visited being the independent variable reported statistically significant differences with the dependent variables:

1. The extent to which respondents trusted pharmacy automation replacing the manual labour of pharmacy staff in dispensing medication (p=0.012)
2. The extent to which they agree pharmacy automation will provide pharmacists with more time in providing healthcare services to patients (p=0.021) (Table 5.19).

Statistical tests, Kruskal-Wallis were performed between the dependent variables and the employment status of the general public respondent. Spearman's rho correlation between the age of the participant and the dependent variables. Again, no relationships or significant differences were identified between the age of the respondent, sex, ethnicity, highest education level of the respondent or last type of community pharmacy visited by the respondent.

Independent variables		Type of Pharmacy last visited by the respondent (%)				
		Multiple (n=48)	**Supermarket (n=12)**	**Independent/ independent chain (n=77)**	**Do not know (n=4)**	**Other (n=1)**
Trust & pharmacy automation[1]	**Strongly trust/trust**	48	17	19	50	100
	Neither trust nor distrust	27	33	43	25	0
	Strongly distrust/distrust	25	50	38	25	0
	P=	**0.012$**				
On-site dispensing and pharmacy automation[2]		**Multiple (n=56)**	**Supermarket (n=12)**	**Independent/ independent chain (n=82)**	**Do not know (n=6)**	**Other (n=1)**
	Strongly trust/trust	38	33	24	67	100
	Neither trust nor distrust	30	33	42	17	0
	Strongly distrust/distrust	32	33	34	17	0
	P=	**0.422$**				
More time for health care services and pharmacy automation[3]		**Multiple (n=47)**	**Supermarket (n=11)**	**Independent/ Independent chain (n=69)**	**Do not know (n=6)**	**Other (n=1)**
	Strongly agree/agree	53	36	29	50	100
	Neither agree nor disagree	36	36	43	17	0
	Strongly disagree/disagree	11	27	28	33	0
	P=	**0.021$**				

Table 5.19. The extent to which General Public respondents [1]trust pharmacy automation replacing the manual labour of pharmacy staff in dispensing medication (median: multiple=1.00, supermarket=3.00); [2]trust medication being made up on-site in the pharmacy) using a robotic dispensing machine (median: multiple=2.00, supermarket=3.00). Categories were recombined into: strongly trust/trust, neither trust nor distrust and strongly distrust/distrust. [3]The extent to which pharmacists agree pharmacy automation will provide pharmacists more time to provide healthcare services (Median: multiple=1.00, supermarket=3.00, independent=3.00). Categories were recombined into: strongly agree/agree, neither agree nor disagree and strongly disagree/disagree). These dependent variables were cross tabulated with the type of pharmacy last visited by the respondent. Medians excluded the do not know option. Due to rounding, percentages may not always appear to add up to 100%.

$Kruskal-Wallis test was performed- (*Do not know option was excluded from statistical test*)

A weak positive correlation was identified was between the age of the respondent and the extent to which they trusted pharmacy automation in using a robotic dispensing machine to make up their medication on-site, using Spearman's rank correlation coefficient (Table 5.20). Otherwise explained, the older the general public respondent, they more they distrust their medication being made up on site using robotics on site. A weak positive correlation was apparent between the age of the pharmacist and the extent to which they agree pharmacy automation will trust medication being made up on-site of the pharmacy (r_S=0.831, p=0.000). Again, the older the pharmacist, the more likely they are to disagree with this.

Independent variables		**Age (years) %**				
		18-25 (n=7)	**26-39 (n=11)**	**40-59 (n=47)**	**60 and over (n=103)**	**Prefer not to say (n=1)**
Trust, labour and pharmacy automation[1]	**Strongly trust/trust**	71	9	36	28	100
	Neither trust nor distrust	29	27	36	40	0
	Strongly distrust/distrust	0	64	28	32	0
	p=	**0.529$**				
Trust, on-site and pharmacy automation[2]		**18-25 (n=8)**	**26-39 (n=12)**	**40-59 (n=48)**	**60 and over (n=117)**	**Prefer not to say (n=2)**
	Strongly trust/distrust	88	25	44	27	50
	Neither trust nor distrust	13	25	27	39	0
	Strongly distrust/distrust	0	50	29	34	50
	P=	**0.040$**				
More time with pharmacy automation[3]		**18-25 (n=8)**	**26-39 (n=9)**	**40-59 (n=45)**	**60 and over (n=96)**	**Prefer not to say (n=2)**
	Strongly agree/agree	88	22	53	33	50
	Neither agree nor disagree	13	44	24	47	50
	Strongly disagree/disagree	0	33	22	20	0
	P=	**0.069$**				

Table 5.20. The extent to which General Public respondents [1]trust pharmacy automation replacing the manual labour of pharmacy staff in dispensing medication; [2]trust medication being made up on-site in the pharmacy) using a robotic dispensing machine. Categories were recombined into: strongly trust/trust, neither trust nor distrust and strongly distrust/distrust. [3]The extent to which pharmacists agree pharmacy automation will provide pharmacists more time to provide healthcare services. Categories were recombined into: strongly agree/agree, neither agree nor disagree and strongly disagree/disagree). These dependent variables were cross tabulated with the age of the respondent. Due to rounding, percentages may not always appear to add up to 100%.

$Spearman's rho correlation was performed – *(Prefer not to say option was omitted from the statistical test*

5.5.3 Influence of pharmacy automation on medication errors and time taken to get their prescriptions

In this part of the section, general public respondents were asked to detail their opinion on the influence pharmacy automation would have on the rate of dispensing errors and the time taken to get prescription medications. The question answer categories were recombined into increase, decrease or no change/do not know. These dependent variables were then cross tabulated with the age and the last type of community pharmacy visited by the respondent as displayed in Table 5.21. Overall, 28% (53/185) of respondents did not know influence pharmacy automation would have on the rate of medication errors with the introduction of pharmacy automation (Table 5.21). Although, 39% (72/186) of the general public participants reported pharmacy automation to decrease the time taken for patients to get their prescriptions. A cross-tabulation of the age of the respondent and the influence they perceived pharmacy automation would have medication errors and the time taken for patients to get their prescription was displayed in Table 5.22.

	Influence on the medication errors (n=183) %	Influence on the time taken to get prescriptions (n=184) %
Increase	25	19
Decrease	25	39
No influence	22	23
Do not know	28	19

Table 5.21. The extent to which pharmacy automation has on medication errors and the time taken for patients to get prescriptions. Categories were recombined to increase, decrease, no influence/do not know.

Pharmacy automation		Age (years) %					Type of pharmacy worked in[1]				
		18-25 (n=8)	**26-39 (n=12)**	**40-59 (n=48)**	**60 years and over (n=115)**	**Prefer not to say (n=2)**	**Multiple (n=56)**	**Supermarket (n=12)**	**Independent chain (n=81)**	**Do not know (n=6)**	**Other (n=1)**
Errors[1]	**Increase**	13	33	27	24	0	20	33	33	17	0
	Decrease	50	25	27	22	50	34	8	16	17	0
	No influence	13	17	25	22	0	14	33	24	17	100
	Do not know	25	25	21	32	50	32	25	27	50	0
Time taken to get RX[2]		**18-25 (n=8)**	**26-39 (n=12)**	**40-59 (n=49)**	**60 years and over (n=115)**	**Prefer not to say (n=2)**	**Multiple (n=56)**	**Supermarket (n=12)**	**Independent chain (n=81)**	**Do not know (n=7)**	**Other (n=1)**
	Increase	13	25	10	23	0	16	33	16	17	0
	Decrease	75	42	55	29	50	41	33	41	33	100
	No influence	13	17	22	25	50	16	25	26	33	0
	Do not know	0	17	12	23	0	27	8	17	17	0

Table 5.22. The influence respondents view to have on [1]The rate of medication errors; [2]The influence on the time taken to ger prescription medication. The categories were recombined as follows: increase, decrease or no change/do not know. Due to rounding, percentages may not always appear to add up to 100%.

5.6 Hub and spoke dispensing and pharmacy automation

This section focused on questions regarding both types of robotic dispensing and the impact participants perceive this would have within community pharmacy. Dependent variables included: the accuracy, productivity with robotic dispensing and whether or not robotic dispensing would hinder patients from using a community pharmacy. These dependent variables were cross tabulated with independent variables being: age group of the pharmacist and the last type of community pharmacy visited by the respondent.

5.6.1 General public perception of implications of robotic dispensing on the accuracy, productivity of dispensing medication and on its hinderance of using a pharmacy

With respect to the accuracy of robotic dispensing 36% (59/165) reported to strongly trust or trust this. In addition, 62% (89/144) of general public participants perceived robotic dispensing to significantly increase or increase the productivity of dispensing. A weak positive correlation (r_s=0.173, p=0.039) was found between the age of the general public respondent and the influence robotic dispensing would have on the productivity of dispensing (Appendix 30 - Study Two: cross-tabulations and statistical tests of robotic dispensing with age). Therefore, the older the participant the more they disagreed the productivity of dispensing will be increased when using robotic dispensing. Interestingly, 37% (59/159) of respondents strongly disagreed or disagreed robotic dispensing would hinder patients from using a community pharmacy. A relationship was identified between the last type of community pharmacy visited and the extent to which robotic dispensing would be a hinderance, where significant differences (p=0.025) between each pharmacy type were reported (Appendix 31- study two: cross-tabulations and statistical tests of robotic dispensing with pharmacy type last visited).

5.6.2 Types of errors likely to occur with implementation of a dispensing robot

Table 5.23 displayed the types of errors respondents think will most likely occur with the use of a dispensing robot to dispense medication. These results are unsolicited and can only be considered conservative estimates, as respondents may perceive there to also be other types of error that may occur with a dispensing robot.

Types of error^ (n=188)	%
Errors with stock count	16
Errors with filling up the dispensing robot with stock	36
Technical errors (malfunctioning in the robotic dispensing machine)	62
Medication errors (wrong drug/wrong strength/ wrong dose)	29
Do not know	20
Other	1

Table 5.23. Types of error likely to occur with robotic dispensing

^This was a multiple response question

5.7 Healthcare

The questions in this section focused on robotics and healthcare as well as preferred dispensing methods. To begin this section, the general public reported what services they would like pharmacists to provide, if they had more time due to the implementation of robotic dispensing. Table 5.24 displayed services including minor ailments (69%, 130/188) and out of hours support (55%, 104/188) to be services preferred by participants, with the proclaimed free time robotic dispensing offers. These results are unsolicited and can only be considered conservative estimates, as respondents may also would like pharmacists to provide other types of services.

Types of services[1] (n=188)	%
Minor ailment scheme	69
Patient group directive such as morning after pill	25
Out of hours support	55
Medicines assessment and compliance support	36
On demand availability of specialist drugs	26
Gluten free food supply	15
Disease specific medicines management	21
INR monitoring	22
Independent prescribing by pharmacists	29
Needle and syringe exchange	22
Stop smoking	27
Supervised consumption	15
Other	4

Table 5.24. Services respondents would like pharmacists to provide if hub and spoke dispensing and pharmacy automation provides pharmacists with more time to provide healthcare services. [1]This was a multiple response question

5.7.1 Dispensing preferences

This section reported data on the dispensing preferences by general public respondents. Under 65% (64%, 120/181) of respondents preferred dispensing to be taken place on-site of the pharmacy. The majority of respondents (53%, 98/186) preferred the current method of dispensing and also reported the current method of dispensing (29%, 53/184) to provide pharmacists more time giving healthcare advice to patients. Out of the two robotic dispensing methods pharmacy automation (10%, 18/186) was preferred and 14% (25/184) viewed pharmacy automation to give pharmacists more time in providing healthcare advice to patients and 22% (41/184) reported either of the two robotic dispensing methods to do so (Table 5.25).

Location of dispensing[1] (n=181)	%
On-site	66
I do not mind	33
Off-site	1
Preferred method of dispensing[2] (n=186)	**%**
Current method of dispensing	53
Hub and spoke dispensing	4
Pharmacy automation	10
Either hub and spoke dispensing or pharmacy automation	12
I do not mind	22
None of the above	1
Method of dispensing that would provide pharmacists more time to give healthcare advice to patients[3] (n=184)	**%**
Current method of dispensing	29
Hub and spoke dispensing	9
Pharmacy automation	14
Either hub and spoke dispensing or pharmacy automation	22
I do not mind	22
None of the above	4

Table 5.25. Preferred location and type of dispensing; the dispensing method in which respondents would provide pharmacists more time in providing healthcare advice to patients. Due to rounding, percentages may not always appear to add up to 100%.

5.7.2 Other comments respondents had about hub and spoke dispensing and 'pharmacy automation or any other comments they had

Open ended questions were imported from Microsoft Word into NVivo 12 and then subjected to thematic analysis. Results were split into advantages (Appendix 31 - Study Two: advantages of robotics), disadvantages (Appendix 32 - Study Two: disadvantages of robotics) and other comments of robotics (Appendix 33 - Study Two: other comments towards robotic dispensing). The advantages (Appendix 34 - Study Two: advantages of pharmacy automation) and disadvantages of pharmacy automation (Appendix 35- Study Two: disadvantages of pharmacy automation) were also displayed in the relevant appendices, as well as the advantages (Appendix 37 - Study Two: advantages of hub and spoke dispensing) disadvantages of hub and spoke (Appendix 38 - Study Two: disadvantages of hub and spoke dispensing).

5.8 Summary of General Public results chapter

The findings reported in this chapter described the general public perception towards hub and spoke dispensing and pharmacy automation, as well as exploring respondents dispensing preferences.

Section 5.2 reported data on topics around experiences and perceptions of pharmacy use, such as the type of community pharmacy used, reasons for use and the public perception of the time pharmacists currently have available. Medical and non-medical purposes for community pharmacy use were recorded. Under 100% (99%, 167/169) of participants used pharmacies for prescription use. On the whole respondents agreed they had enough time to speak to the pharmacist. Further analysis identified older patients agreed with either the amount of time they had to speak to pharmacy staff or strongly disagreed or disagreed pharmacists had enough time to provide healthcare services to patients and that they had enough time to speak to pharmacy staff. Respondents were asked to identify possible reasonings as to why pharmacists do not have enough time to provide healthcare advice to patients as identified by previous literature, reasons included too much time spent checking medications in the dispensary and staff shortages. Furthermore, aside from GP's respondents were reported to mostly obtain healthcare advice from pharmacies.

Section 5.3 collected data on various stages in the dispensing process. Firstly, the reasons for pharmacy used included medical and non-medical purposes. The majority of patients had used a pharmacy to collect prescription medication (92%, 172/188), and were mostly aged over 60 years (61%, 105/172). Furthermore, patients who had bought prescriptions in which they waited for to be dispensed mostly waited up to 30 minutes (69%, 53/77). Respondents who had used a community pharmacy to collect prescription medication in the last 12 months were questioned about their experiences with selected questions.

The next part of section 5.3 documented information on whether or not patients had experienced a medication error. Fourteen respondents reported that they had experienced a medication error. Medication errors experienced by respondents included 'right medication, wrong strength' (29%, 4/14) or 'right medication, wrong dose' (21%, 3/14). Realisation of medication errors by patients were mostly found before taking the medication for less than of the respondents (43%, 6/14). After experiencing an error, the majority (62%, 8/13) would trust the prescriber or pharmacy again.

Following on, data on the general public perception of hub and spoke was reported in section 5.4, and for pharmacy automation in section 5.5. Firstly, only (8%, 15/182) respondents had actually heard of hub and spoke dispensing, and the majority of those were over the age of 60 (Section 5.4). Whereas, 13% (24/188) of the public had heard of pharmacy automation, with 15% (17/117) being over the age of 60. General public participants trust towards factors of hub and spoke dispensing (Section 5.4) and pharmacy automation (Section 5.5) were explored as well as their perceptions to the influence these robotic dispensing methods would have on the amount of free time available for pharmacists. Overall, neither trust nor distrust was shown by the majority of respondents towards hub and spoke replacing the manual labour of pharmacy staff in the dispensing medication, as well as towards medication being made up off-site (not in the pharmacy). Furthermore, no agreement or disagreement was displayed towards whether or not hub and spoke would provide pharmacists with more time providing healthcare advice to patients. Further analysis identified no relationships or significant differences between the age or last type of community pharmacy visited by the respondent with the dependent variables with regard to hub and spoke (Section 4.4). Although, statistically significant differences were discovered between the employment statuses of the respondent and the extent of trust they had towards hub and spoke being undertaken off-site of the pharmacy.

Whereas, respondents reported to strongly trust or trust pharmacy automation replacing the manual labour of pharmacy staff in dispensing medication. However, a split opinion was shown (either strongly trust/trust or neither trust nor distrust), towards a robotic dispensing machine being used to make up medication on-site of the pharmacy towards pharmacy automation.

Moreover, unlike opinions displayed towards hub and spoke, respondents perceived to strongly agree/agree pharmacy automation would enable pharmacists more time to provide health services to patients. Further analysis identified relationships within the age group of respondents, in order words the older the participant was the more, they distrusted medication being made on-site with the use of a robotic dispensing machine with pharmacy automation (Section 4.5). Further analysis reported statistically significant differences between the last type of community pharmacy visited by general public respondents and the extent to which they agreed pharmacy automation will enable pharmacists more time providing healthcare advice to patients and trust towards pharmacy automation replacing the manual labour of dispensing medication. Overall respondents did not know the influence hub and spoke, or pharmacy automation would have on medication errors. However, respondents perceived hub and spoke to increase the time for patients to get prescriptions, however pharmacy automation to decrease the time to get prescription medication.

Section 5.6 reported data on robotic dispensing in terms of effects on productivity and accuracy and whether or not it was perceived as a hinderance by the general public for using the pharmacy. On the whole, robotics dispensing was seen to significantly increase or increase the productivity of dispensing prescriptions. A correlation was discovered with regards to the age of the participant, in other words the older the participant was the more they disagreed pharmacy automation would increase the productivity of dispensing (Section 5.6). Another result that emerged from the data was that robotic dispensing was not perceived as a hinderance by most participants; where statistically significant differences were reported between the various types of community pharmacies last visited by the respondent and the dependent variable in question (Section 5.6). Furthermore, participants also perceived errors such as technical errors, including malfunctioning in the robotic dispensing machine and errors with filling up the dispensing robot to be most likely with a dispensing robot.

Data regarding healthcare was recorded in section 5.7 concluding the results in study two. Services such as the minor ailment scheme and out of hours support were in demand by survey respondents, if hub and spoke or pharmacy automation provided them with more time in providing healthcare services. Dispensing preferences were also reported, in regards to location and preferred methods. Over 65% (66%, 120/181) of participants preferred dispensing to be carried out on-site. On the whole, over 50% (53%, 98/184) of general public survey respondents favoured the current method of dispensing and 29% (53/184) also reported the current method of dispensing to provide pharmacists more time to give healthcare advice to patients.

Chapter 5 of this thesis described the general public perceptions of the implementation of robotic dispensing methods: hub and spoke and pharmacy automation in community pharmacies in England. The discussion section of this programme of work has summarised and discussed findings from chapter 4 and 5. Recommendations based on these findings and associated legislations and policies have been made at the end of this programme of work. The final part of this chapter describes comparisons of similar data from study one and two.

Chapter 6: Discussion and conclusion

6.1 Introduction

Chapters four and five presented the findings of the research conducted for this programme of work. The main aim of these studies was to investigate the general public and pharmacists' perceptions of using robotic dispensing methods 'hub and spoke dispensing' and 'pharmacy automation' in community pharmacies in England. Results around pharmacy practice and pharmacy use, dispensing, hub and spoke dispensing and pharmacy automation and healthcare have been described in both studies. The perceptions of both community pharmacists and the general public were examined and described. This research will add to the ongoing debate of the introduction of robotic dispensing methods in community pharmacy practice. Including, ways in which pharmacy can proceed and maximise the potential benefits of introducing robotic dispensing or rethink the dispensing model to one that is preferred by pharmacists and the general public.

The chapter has started with the research strengths and limitations followed by the researcher's reflexivity of the research journey. The discussion of findings within studies one and two compared against previous literature, and in relation to healthcare policies have also been covered in this chapter. Finally, the chapter ends with a summary of the research, implications for policy and practice as well as research.

6.2 Research strengths and limitations

Pharmacy practice research into automation has been ongoing for over a decade. However, research regarding the method of hub and spoke is a relatively new field and very timely as proposals of were set out by Department of Health in 2015. The research conducted in this programme of work has been the first to explore the perceptions of community pharmacists and the general public on using robotic dispensing 'hub and spoke' and 'pharmacy automation.' This programme of work has been one of the first to add to the knowledge of how the general public perceive the introduction of robotics to the dispensing process and on how pharmacists and the general public perceive 'hub and spoke' dispensing.

Moreover, looking back through history within pharmacy practice research, pharmacists have found to be more familiar with quantitative methods than qualitative methods (Smith 2010b). In pharmacy practice research, examples of quantitative methods include non-experimental methods such as observational methods and experimental research methods (Austin and Sutton 2018). The use of survey-based research in this thesis allowed the systematic collection of data in relation to community pharmacists and the general public regarding their perceptions towards robotic dispensing (Austin and Sutton 2018). The adoption of this type of research also helped to describe the characteristics of participants in both studies and presented their opinion, attitudes and practices towards robotic dispensing. (Creswell 2015).

A total of 1000 community pharmacists and 2000 members of the general public were contacted to participate in research for study one and study two retrospectively. Both studies required adherence to strict timescales due to the posting schedule, administration and delivery of questionnaires. The surveys were conducted at two different time periods, therefore lessons learnt from the distribution of surveys in study one, were resolved in study two. A quantitative study was used for both study designs, as it is provided a standardisation of the data in obtaining perceptions of the general public and pharmacists towards robotic dispensing. Questions in the questionnaire were developed based around topics identified from the literature review.

Although, research methods used in this programme of work were associated with a number of strengths, the limitations also needed to be acknowledged. A literature review was undertaken to formulate the questions in the surveys for each study. However, the literature review conducted was not classified as a systematic review, even though searching was conducted systematically. As the review was not answering a clearly defined question, rather a general topic, a literature review using systematic searching was deemed most appropriate, to gain understanding of the topic (Kysh 2013). As this was not a formal systematic review, there was a potential for bias, during study selection and interpretation, as the PICO guide was not used, quality assessment of the included studies was not undertaken.

Additionally, even though the use of a quantitative approach was seen as the most relevant approach, some may argue a mixed methods approach may have allowed a more in-depth investigation of topics. The practice of mixed-methods approaches are becoming increasingly common in pharmacy practice research, however they are still relatively limited (Hadi et al. 2012). The researcher felt the use of quantitative methodology allowed the generalisability of results to larger populations and the application of statistical processes to refine and show patterns emerging from the data (Gunnell 2016). The researcher also acknowledged if the survey was able to be conducted online, it may have also yielded more participants to be contacted for both studies and perhaps a higher response rate. However, those without computer access would be at a disadvantage. Therefore, postal surveys were deemed the most appropriate method.

Previous research has shown questionnaire responses from healthcare professionals to be relatively low (Presseau et al. 2011). This programme of work supports Presseau et al. (2011) where a further limitation of this work were the low response rates in both questionnaires (pharmacist response rate: 16.2% (161/994); general public response rate: 9.67% (188/1845)). It also needs to be noted that neither study, exceeded the minimum number required according to the power calculation, 381 for pharmacists and 385 for the general public, at a 5% margin and error and 9% confidence level. To achieve this 1207 were needed to be posted out to pharmacists. However, due to budget constraints this was not achievable, and only 1000 surveys were sent to community pharmacies. The general public study required 1220 surveys to be posted out in order to achieve the minimum number of responses, however this was achieved as surveys were sent out to 2000 members of the general public.

Whilst previous studies have been conducted in pharmacy practice research in relation to the general public. Lower response rates were found in the general public survey in comparison to the community pharmacist survey. A previous study exploring the general public and community pharmacists' perceptions of the professionalism of community pharmacists yielded a similar response rate of 15.7% (1537/9669) (Turner 2016). However, the study by Turner (2016) had a much larger sample size compared to studies in this programme of work. Furthermore, a study in 2015 assessed support for community pharmacy-based alcohol interventions in a Scottish general public postal survey, where a response rate of 26.6% (1573/6000) was reported (Fitzgerald et al. 2015). However, whilst studies in this thesis also used similar methodology including provision of a pre-paid envelope, cover letter, and reminder letters sent with each posting; response rates were still low. Although, Fitzgerald et al. (2015) also entered respondents into a prize draw for £50 of shopping vouchers, perhaps this could have been considered in studies within this programme of work.

Another study explored the general public views on pharmacy public health services: currently situations and opportunities in the future, where a response rate of 25.3% was reported (908/3596) (Saramunee et al. 2015). However again the study by Saramunee et al. (2015) used a much higher sample size which may have led to more responses. The distribution of more questionnaires to members of the public may have led to a higher response rate in study two however, this was not possible due to budget restrictions. The lack of knowledge of robotic dispensing by the general public topic or unwillingness to participate could also have been a factor as to why response rates were low in study two.

A similar response rate was observed in study one of this programme of work and a GPhC facilitated survey conducted by Enventure Research in 2019 (General Pharmaceutical Council 2019b). The GPhC registrant survey observed an overall response rate of 23.1% (18,394/79,770) for pharmacists and pharmacy technicians. The response rate for pharmacists was 15.5% (12,368/79,770). An email was sent to every GPhC registrant, followed by four reminders for those who had not responded to the survey (General Pharmaceutical Council 2019b).

Whereas, in study one surveys were posted out to 1000 community pharmacists followed by two reminders to those who had not responded to the survey. Study one reported a 16.2% (161/994) response rate, whereby community pharmacies were targeted according to the GPhC register of pharmacy premises, as access was not available to the community pharmacy register or email addresses of community pharmacists. Therefore, this could explain the low response rate identified in study one. Low response rates could also have occurred in study one as questionnaires were sent to community pharmacies rather than pharmacists home addresses. A previous study exploring the perceptions of community pharmacists and the general public of the professional status of community pharmacists, gained a greater sample size of 9999 community pharmacists. This large sample size was obtained as access for the email addresses of community pharmacists were obtained from the GPhC, yielding a response rate of 7.1% (706/9999) (Turner 2016). Even though, postal surveys were an expensive and time-consuming process they allowed access to a wider population for this programme of work. However, using the method was accompanied by limitations. Postal surveys eliminate the face to face interaction in research and may have been a factor yielding a low response rate in study one and two. In other words, if respondents were able to have face to face contact with the researcher, this may have helped to address any further questions they had in regard to the research studies.

Moreover, the participation of community pharmacists in pharmacy practice research in the UK has been identified as been relatively low (Twigg et al. 2013). Community pharmacists have been reported to want to participate in research, particularly those working for a multiple chain pharmacy wanting to engage more than those working in independent pharmacies (Crilly et al. 2017). Previous literature has shown community pharmacists wanting to be involved in research relating to their day-to-day practice, especially in relation to health promotion and patient care (Crilly et al. 2017). Barriers for the lack of completion in research have included a lack of time, lack of remuneration and insufficient training (Crilly et al. 2017). Furthermore, having a strong belief in the importance and value of pharmacy practice research has been reported to be a critical motivation force for pharmacist's participation in research (Awaisu and Alsalimy 2014). Additionally, the experience of being involved in pharmacy practice research has been reported to encourage the development of positive attitudes to research and a willingness to undertake and participate in future research (Kritikos et al. 2013).

6.3 Reflexivity on the research journey

Reflexivity is defined as "*an attitude of attending systematically to the context of knowledge construction, especially to the effect of the researcher, at every step of the research process*" (Robert Wood Johnson Foundation 2008). It is a factor that needs to be considered within research, as it is a part of the research journey. For this programme of work, the researcher with aid of a supervisory team, had the task of designing the methodology for the research undertaken in study one and two. This included data collection, analysis and interpretation as well as the compilation of this programme of work. The following section highlighted the role of the researcher and has highlighted aspects of the journey throughout their agenda of work.

The research was performed by a GPhC registered pharmacist with a practice background in community pharmacy. They also had a keen interest in community pharmacy research and the use of robotics for community pharmacy dispensing. Various meetings with the supervisory team lead to the interest of robotic dispensing methods ‘hub and spoke’ and ‘pharmacy automation’ being the decided area of research, in relation to perceptions of the general public and community pharmacists in England. Although, the researcher had a little experience in research and did not fully understand the sociological underpinnings of the research in study. Furthermore, the unexpected and uninformed last-minute departure of the researcher’s former director of studies, lead to a disruption of this research. This resulted in the change of the initial topic of study, at the end of the researcher’s second year of study. This led to undue stress to the researcher, however, was slowly overcome when the research had gotten back on track. A subject expertise on the research team was then recruited from a different institution to the researcher and a new topic of study was formed.

The first step of research in this programme of work consisted of reading a considerable amount of literature relating to research methods in healthcare. Once the researcher had familiarised themselves with sociological research methods in healthcare, literature regarding the history of robotics and the use of robotics in pharmacy dispensing were explored. A large amount of research was sifted through, initially this was overwhelming for the researcher. However, this was soon overcome with time, as the researcher gained a deeper understanding of the literature explored.

Additionally, once the literature was accumulated and research gaps in the published literature were identified, aims and methodological approaches were then explored. A quantitative method was adopted, as the researcher thought it was the best approach to collect data on community pharmacists and the general public, as methods of contacting each target population were limited. Postal surveys were deemed the most appropriate to give the most meaningful results. The researcher led the studies for this programme of work, in two stages.

Both questionnaires were developed from a literature review, highlighting topic areas regarding robotics and pharmacy, as well as from the piloting of both studies. The pilot for study one (community pharmacists) yielded a good response rate. However, the response rate for the piloting of study two (general public) was relatively low. After a discussion with the supervisory team, the researcher decided to double the initial sample size of 1000 participants for study two, to increase the likeliness of receiving an adequate number of responses from the general public. This decision led to many physical and mental strains for the data preparation and collection of this study one and two, as both studies were of a large scale. However, after completing this process, this experience was found to be beneficial to the researcher and improved the researcher's competence. Various skills were improved such as administration techniques, organisation skills, data collection and analysis.

Overall, conducting this research lead to the researcher being more competent and confident in leading a large-scaled research project. The researcher's skills had become improved, from undertaking literature reviews, to developing and trialling questions for large scaled studies as well as analysing and interpreting data. Presentation skills were also developed where research was disseminated to a range of different audiences. The research journey was perceived by the researcher to be rewarding, despite all difficulties that had arisen along the way, where invaluable skills were proudly developed and presented in this programme of work.

The next section has discussed results reported in this this programme of work, in comparison to previous literature and healthcare policies. The chapter has ended with final conclusions and future recommendations for further research and policy.

6.4 Discussion of findings

The main findings resulting from this research have been summarised and discussed in the following sections of this chapter:

- Section 6.3.1: Dispensing services in pharmacy
- Section 6.3.2 Accountability and responsibility with robotic dispensing
- Section 6.3.3: Financial implications of robotic dispensing
- Section 6.3.4: Current community pharmacy practice
- Section 6.3.5: Changing role of the community pharmacist

6.4.1 Dispensing services in pharmacy

Firstly, this chapter has started off with reiterating the differences between the two robotic dispensing methods 'hub and spoke' and 'pharmacy automation' which have been explored within this programme of work. Hub and spoke was described as the process where prescriptions are received from the spoke (pharmacy), where they are clinically checked by the pharmacist and sent electronically to the 'hub' (an off-site dispensary) where they are assembled (by a robotic dispensing unit), under the supervision of another pharmacist and returned back to the 'spoke' (pharmacy). Whereas, pharmacy automation is the process of using robots to handle and distribute medicines in pharmacy stores (on-site dispensing robot), before or after being clinically checked by the pharmacist.

6.4.1.1 Existing models of hub and spoke and pharmacy automation

Previous literature has stated three types of centralised dispensing models to exist consisting of the automated multi-dose dispensing service in Australia, Denmark, Finland, Norway Sweden, Scandinavia and the Netherlands (Elliot 2014; Johnell and Fastbom 2008; Sinnemaki et al.2013; Spink et al. 2017). The second model including the chronic dispensing unit provided by the public health sector in South Africa and the third model being the UK hub and spoke model (Spinks et al. 2017). Most literature identified regarding robotic dispensing, concerned the method of pharmacy automation. Early stages of automation were developed during the industrial revolution, where over time automated dispensing systems have been used in NHS hospitals, for original pack automated dispensing. This eliminated bulk dispensing for loose tablets and made stock control more manageable. However, this was also found as a deterrent for a hospital pharmacy as hospital dispensing involves a mix of bulk dispensing, particular frequently used medicines such as paracetamol.

Community pharmacists and general public respondents were questioned about their knowledge of both robotic dispensing methods. Perhaps not so surprisingly, nearly 85% of community pharmacists had knowledge of hub and spoke dispensing, whereas under 10% general public respondents had heard of hub and spoke. The few general public respondents who had heard of hub and spoke dispensing were mostly over the age of 60. Previous research has shown 70% (761) of those aged 65-74 had used a pharmacy to collect prescription medication, compared to 49% (698) for those aged between 35-44 (Boardman et al. 2005). Study two with the support of previous literature has demonstrated that most pharmacy users are over the age of 60 (Boardman et al. 2005). Therefore, respondents over the age of 60 may have more knowledge about the on goings within pharmacy practice than younger respondents. Following on, over 80% of pharmacists from study one had heard of pharmacy automation in comparison to over 10% of general public respondents in study two. Although, general public respondents were more knowledgeable about pharmacy automation compared to hub and spoke dispensing.

6.4.1.2 Dispensing preferences

The two robotic dispensing methods explored in this programme of work either had dispensing taking place on-site of the pharmacy using a robotic dispensing system with the process of pharmacy automation or off-site using the hub and spoke process. General public and community pharmacists respondents documented their dispensing preferences with the options of the current method of dispensing, hub and spoke or pharmacy automation.

The current method of dispensing was found to be most preferential in both studies. Dispensing was also preferred to be carried out on-site of the pharmacy by community pharmacists and the general public. Pharmacy automation was the preferred method of robotic dispensing, this result further supports the idea that community pharmacists and preferred dispensing to be undertaken on-site of the pharmacy. In relation to robotic dispensing specifically, over 10% of general public respondents reported to prefer either method of robotic dispensing, followed by nearly 10% preferring pharmacy automation. General public respondents perceived the current method of dispensing to free up the most time for pharmacists in providing healthcare advice to patients.

Moreover, alongside dispensing preferences, the general public were also asked to report the extent of their trust towards dispensing occurring on-site or off-site of the pharmacy, using a robotic dispensing machine. Mixed responses were given towards robotic taking place on-site of the pharmacy with pharmacy automation. Where, nearly 40% of general public respondents either trusted or neither trusted nor distrusted dispensing taking place on-site using a robotic dispensing machine with pharmacy automation. Additionally, the type of pharmacy previously visited by the general public respondent also displayed differences of opinion. Nearly 50% of respondents last visiting a multiple community strongly trusted or trusted a robotic dispensing machine in dispensing medication on-site, whereas 50% of those last visiting an independent or independent chain pharmacy strongly distrusted or distrusted.

Under 40% of general public respondents also reported to neither trust nor distrust medication being made up off-site (not in the pharmacy) using a robotic dispensing machine. Results from study two do not support previous literature as no were associations between the types of pharmacy worked in and whether or not the respondent had negative or positive views around hub and spoke dispensing were found in comparison to the NPA study in 2016 (National Pharmacy Association 2016). However, it was unclear as to what a negative or positive view consisted of in the NPA survey, this made comparisons with findings from studies one and two with the NPA study difficult. Although, associations in study two were found between pharmacy automation and type of pharmacy last visited by the respondent as explained further along this chapter.

6.4.1.2.1 Digital literacy and general public respondents

The digital literacy of a population is a topic that should be considered with the implementation of technologies. Technology is a part of society's everyday lives, where even young children are using technologies for leisure time activities as well as for information retrieval (Martin 2008). The elder generation have previously reported in wanting to keep up with technology, as they do not want to lose touch with society.

Moreover, age and trust towards the location of dispensing also exhibited relationships in study two. Older patients distrusted medication being made up on-site more than younger patients by a dispensing robot. This finding could be explained by the fact that those over the age of 60 find it more difficult and time consuming to learn how to use or about new technologies in comparison to when they were younger (Schaefer et al. 2016). This further supports the idea of those aged over 60 years have displayed anxiety towards computer use (Schaefer et al. 2016). However, this literature is limited to the physical use of technology, whereas findings in study two are regarding the perceptions of the proposed implementation of dispensing technologies. However, in this instance of robotic dispensing, general public participants are not physically using the technology, but are recipients of the use of technology for dispensing their medication. Therefore, this suggests that perhaps educating patients particularly elderly patients on the use of robotic dispensing technologies once implementation has occurred may help to ease any anxieties they may have.

6.4.2 Accountability and responsibility with robotic dispensing

The legalities of the implementation of robotic dispensing have also been discussed in this programme of work. In the UK model, the hub and spoke are both classified as registered pharmacies, resulting in a pharmacist needing to be present at each premises as dictated by pharmacy law. As the process, of hub and spoke involves the spoke pharmacist relying on the hub pharmacist overseeing dispensing at the hub whilst the clinical check is undertaken by the spoke pharmacist and vice versa, interpersonal trust between pharmacists was explored in study one. Under 50% of community pharmacist respondents trusted relying on another pharmacist overseeing the dispensing process at the hub, when the clinical check is done by the pharmacist in store. Differences of opinion were shown between the employment statuses of pharmacists. Half of locum pharmacists and under half of employed pharmacists trusted another pharmacist to oversee dispensing at the hub, whilst a clinical check is done by themselves in store. However, other types of pharmacists did not share the same opinion, as they strongly distrusted or distrusted their peers at the hub.

To develop on this further, employed pharmacists at the spoke would be relying on an employed pharmacist of the same company at the hub. Current legislation dictates both the hub and spoke must be of the legal entity, in other words, the same company. The hub and spoke model is currently in favour of multiple pharmacies, meaning employee pharmacists at the hub and spoke are likely to be colleagues, this could imply element of trust between pharmacists as they work for the same company as supported in study one. However, changes are in place so that the hub and spoke can be of different legal entities making it more viable and create a level playing field for independent pharmacies.

Study one explored the extent of trust a pharmacist had towards trusting another pharmacist at the hub to oversee the dispensing process whilst they perform the clinical check in the spoke pharmacy. However, this aspect of the hub and spoke process leaves a grey area in terms of accountability and responsibility of clinical and dispensing errors. The current hub and spoke model dictates dispensing is carried out at the 'hub' which is at a different location to the 'spoke' (pharmacy). The GPhC states it must be clear as to which pharmacist is responsible for which part of the service as well as other pharmacy staff involved. The inter-company model refers to operations at the hub and spoke being of different legal entities and an intra-company model where operations would be from the same legal entity. The current hub and spoke models is in favour of the intra-company model for example multiples such as LloydsPharmacy, and not for inter-company for the likes of independent community pharmacies. Results from study one demonstrated how community pharmacist respondents who had worked in independent pharmacies either strongly trusted or distrust or strongly distrusted relying on another pharmacist overseeing the dispensing process at the hub whilst the clinical check is done in the spoke pharmacy by themselves. Whereas, over 50% of pharmacists who had worked in a multiple community pharmacy strongly trusted or trusted relying on another pharmacist at the hub.

As the current UK hub and spoke model is not feasible for independent pharmacies. Changes in legislation have been proposed to amend Section 10 of the Medicines Act 1968 and the Human Medicines Regulation 2012. The amendment would mean that pharmacies of different legal entities can used the same hub, hoping to be a more level playing field for independent pharmacies (General Pharmaceutical Council 2019). For example, independent pharmacies could contract the use of a hub from another company. However, in terms of the accountability and responsibility of medication errors, the GPhC states it is up to the provider of the pharmacy service meaning ‘the hub’ to provide the service safely and effectively and due diligence to be carried out (General Pharmaceutical Council 2019). However, leaving this to the decision of individual pharmacy companies as opposed to setting clear guidance, could lead to potential problems of locum pharmacists working for different companies or perhaps when independent pharmacies are using third party hubs.

Moreover, the NPA believe there to be gaps in the accountability frameworks, particularly as the superintendent pharmacist differs in the ‘inter-company’ model. The NPA believe that it would be the duty of care for the hub pharmacist for clinical errors, and where the errors were not spotted, they cannot delegate the duty of care as the hub is a registered pharmacy (National Pharmacy Association 2016.). However, as the National Pharmacy Association represents community pharmacies on a meso professional level, this perhaps cannot be relayed to pharmacist individuals themselves on a micro level.

Pharmacy2U have recently announced plans of launching a hub, HubRx, and spoke facility for independent pharmacies, following the Medicines and Medical Devices Bill (Pharmacy Magazine 2020). The new legislation highlighted in the bill announced pharmacies will be able to use hubs of different legal entities. Leader of Pharmacy2U, Daniel Lee, believed the introduction of the hub would “*level the playing field between independents and multiples*”. Lee also claimed independents would see time-saving benefits where they would be able to outsource up to 70% of their dispensing workload (Pharmacy Magazine 2020). Former border member of the NPA, Mike Hewitson is due to join HubRx as a non-executive director. Perhaps, as the implementation of the UK hub and spoke model has been implemented throughout all types of community pharmacies, clearer guidance for multiples and independent pharmacies could be set out by pharmacy companies. This can be supported by Boyd and Chafee (2019) recommended expert panels needing to describe measures that needed to be included in evaluations of pharmacy automation and robotic systems such as patient safety and financial stewardship.

6.4.2.1 Trust towards robotic dispensing systems

The previous section discussed findings with respect to interpersonal trust between pharmacists regarding the process of hub and spoke. System trust has also been discussed in this study, for the purpose of this study it was the extent to which general public and pharmacist respondents trusted hub and spoke and pharmacy automation replacing the manual labour of pharmacy staff in dispensing medication. Studies one and two were the first in literature to compare the perceptions of the general public and community pharmacists, therefore comparisons to previous literature is limited. A mismatch of different opinions was observed between community pharmacists and the general public, to the extent in which they trust hub or spoke or even pharmacy automation replacing the manual labour of pharmacy staff in dispensing medication. Under 45% of community pharmacist participants distrusted hub and spoke replacing the manual labour of pharmacy staff, whereas under 40% of general public respondents neither trusted nor distrusted the replacement in labour. Study two results also identified correlations between trust towards pharmacy automation and the influence the dispensing process had on enabling pharmacists with more time in providing healthcare advice to patients. Results showed as the extent of trust towards pharmacy automation using robotic dispensing to make up medication on-site of the pharmacy increased, as did the extent to which respondents trusted pharmacy automation replacing the manual labour of the dispensing process. This further supports the idea that general public respondents prefered dispensing to take place on-site, and pharmacy automation being the preferred method of dispensing.

Multidose drug dispensing is a robotic dispensing model closest to the UK model of hub and spoke dispensing. Previous literature has found a lack of trust observed by nurses with early experiences in multidose drug dispensing, as once multidose bags had arrived from the pharmacy these were double checked by nurses however this was considered to be unnecessary in the written routines dealing with multidose drug dispensing (Wekre, Melby and Grimso 2010). However, this can be explained by nurses having formerly experienced errors therefore displayed a lack of trust. When tasks performed by automation, that could easily be performed by humans, causes error this has led to a severe degrading in trust and reliance. Research has shown operators with a lack of knowledge of details of how a technological system works tends to distrust systems (Lee and See 2004). For example, where a task performed by automation, that could easily be performed by humans causes errors. A severe degradation of trust and reliance towards automation has been shown (Madhavan et al. 2006).

The replacement of human labour with robotics has found to cause potential social issues to the general public, such as limited interaction with pharmacy staff when picking up their prescription medication (Kramer 1999). The trust observed from members of the general public to a pharmacist, is not based on the individual pharmacist but rather than underlying education and regulatory structures set out by the GPhC and the government regarding the role of the pharmacist (Kramer 1999). The trust the general public had towards a pharmacist, influences the reputation of the company in which they are working for at the time. Therefore, trust has shown to potentially influence the type of pharmacy visited according to previous experiences with the pharmacist working in the store. However, this study failed to support this as the type of pharmacy last visited by the respondents did not show significant differences.

A difference in opinion was also exhibited between the general public and community pharmacists with the replacement of manual labour of pharmacy staff in dispensing medication with pharmacy automation. A third of general public respondents either strongly trusted or trusted or neither trusted nor distrusted the replacement in labour by pharmacy automation. Whereas, nearly 40% of pharmacists neither trusted nor distrusted pharmacy automation replacing the manual labour of pharmacy staff in dispensing medication. The lack of literature makes it increasingly difficult to compare these findings. However, an attempt to understand the relationship can be explored with previous literature. Firstly, in both robotic dispensing processes, the organisation of workflow in dispensing medication is reorganised in comparison to the current manual dispensing process. The change in workflow, means that not only are patients trusting pharmacy staff to trust their medication, they would now be also trusting a robot to replace processes such as the labelling and picking of medication. Therefore, understanding the trust both general public and pharmacist respondents is important for the implementation of systems (Bachmann 2001). The importance of trust in technologies is important with healthcare professionals particularly in the early implementation of robotic dispensing processes (Wekre, Grismo and Melby 2010). This could help further improve the employment of robotic dispensing processes when rolled out to community pharmacies all over the UK.

6.4.2.1.1 Trust towards robotic dispensing and the employment status of the pharmacist or type of pharmacy worked in

The employment status of community pharmacists exhibited differences of opinions towards the extent of trust towards hub and spoke dispensing. Nearly 50% of employed and under 50% of locum pharmacists trusted another pharmacist to oversee dispensing at the hub, whilst a clinical check is done by themselves in store. To develop on this further, employed pharmacists at the spoke would be relying on an employed pharmacist of the same company at the hub. An explanation for differences of opinion between the locum and employed pharmacists could be that fact employed pharmacists may be more familiar with SOPs of a company than locum pharmacists, meaning, employed pharmacists are more familiar with the dispensing processes. Likewise, locum pharmacists are self-employed and may work for different pharmacy companies. Although, statistically significant differences of opinion were not found between the employment statuses of pharmacists in regard to the extent of trust they had towards trusting pharmacy automation in replacing the manual labour in dispensing medication. Over 40% of employed pharmacists neither trusted nor whereas 40% of pharmacists strongly trusted or trusted the replacement of labour.

Moreover, the last type of community pharmacy visited by the general public respondent exploited differences of opinion towards the extent of trust pharmacists have in replacing the manual labour of dispensing in dispensing medication. Nearly 50% of respondents last visiting a multiple community pharmacy strongly trusted or trusted the replacement of labour by pharmacy automation, whereas 50% of those last visiting a supermarket pharmacy distrusted and one third visiting an independent or independent chain neither trusted nor distrusted the replacement of labour. Additionally, whether or not a community pharmacist had or had not worked in an independent pharmacy displayed different of opinions towards hub and spoke replacing the manual labour of pharmacy staff in dispensing medication. Half of respondents who had worked in an independent pharmacy strongly distrusted or distrusted the replacement in labour.

6.4.2.2 Medication errors and accuracy of dispensing

The previous section had discussed system and interpersonal trust towards robotic dispensing. This section has discussed experiences the general public have had with medication errors and their perceptions of robotic on the accuracy of dispensing. The general public and community pharmacist respondents' perceptions of the influence both robotic dispensing methods would have on medication errors were also discussed.

The current manual method of dispensing, have found the occurrence of medication errors to mostly occur in busier pharmacies, particularly at times when pharmacies are found to be busier than normal (Ashcroft et al. 2005a,b). Examples including telephone interruptions and not having the usual dispensing staff (Ashcroft et al. 2005a,b). However, errors with robotic dispensing machines are not limited to medication and dispensing errors. Other types of errors were reported in both studies, including errors when entering prescription data onto the computer or errors with stock as found in literature (Angelo, Christensen and Ferreri 2005).

Medication or dispensing errors were popular outcomes use to evaluate robotic dispensing as presented in the literature review. They have been used as an indicator for assessing patient safety (Ashcroft et al. 2005a,b). General public respondents were asked their experiences of these types of errors. Less than 10% of general public respondents had reported to have experienced a medication error. A medication error for the purpose of this study was classed as combinations of right or wrong medicine, right or wrong strength, right or wrong dose and right or wrong patient. Common types of medication error experienced were reported in study two included right medication but wrong strength and right medication but wrong dose. Other errors reported in the literature include the errors when counting medication, or errors occurring when a specific quantity is needed (Rodriquez-Gonzalez et al. 2018). Furthermore, when considering the implementation of hub and spoke, less than a third of pharmacists perceived hub and spoke to decrease medication errors. This perception by pharmacist’s support claims made about hub and spoke also stated a hub and spoke to reduce dispensing errors (The Pharmaceutical Journal 2020). Typically, the occurrence of medication errors has found to happen in two phases, when entering prescription data onto the pharmacy information system and when filling the automated dose dispensing bag (Cheung et al. 2014).

The process of hub and spoke was perceived to decrease medication errors by over 30% of pharmacists and increase error’s by over 25% of general public respondents. Cheung et al. (2014) compared the occurrence of medication incidents in hospital and community pharmacies. Most dispensary incidents were found to occur in community pharmacies in comparison to hospitals in the Netherlands (Cheung et al. 2014). Multi-dose dispensing founded most incidents to occur when entering the prescription into the pharmacy information system or when filling the automated dose dispensing bag (Cheung et al 2014).

Pharmacy automation was perceived to decrease medication errors by over 40% by community pharmacists whereas, over 25% of general public respondents reported ‘do not know’. These findings are consistent with that of Rodriguez-Gonzalez et al. (2018) and James et al. (2013b), where medication errors have been reported to be reduced. James et al. (2013b) evaluated an automated dispensing system in a hospital pharmacy in the UK and Rodriguez et al. (2018) used a robotic original pack dispensing system in an outpatient pharmacy. Both systems used followed the process of pharmacy automation as dispensing robots were on-site of the hospital pharmacies. However, results from both studies do not support Beard and Smith (2013) with the process of pharmacy automation. The implementation of a dispensing robot in combination with electronic prescribing by Beard and Smith (2013) was not found to adversely affect dispensing errors, errors were found two months post-automation however not errors detected seven months after. The combined robotic dispensing- electronic prescribing used by Beard and Smith (2013), meant that as the prescriber had electronically prescribed the medication, they were also writing the dispensing label. Perhaps, this combined technology could be the reason why errors were not adversely affected.

Alongside medication errors, pharmacists in study one also perceived other errors to occur with robotic dispensing, such as technical errors and errors associated with filling up the dispensing robot and stock counts, these findings are also consistent with Angelo, Christensen and Ferreri (2015). Even though, study one reported pharmacists to believe pharmacy automation will decrease medication errors also in agreement with the literature, some pharmacists believe it is their duty to have an active role in the dispensing process (Novek 2000). Literature has highlighted how some pharmacists believe other occupations may incorrectly enter or check drug orders (Novek 2000).

In addition, the Chief Pharmaceutical Officer, Keith Ridge, claimed errors rates within community pharmacy are higher than other countries who have adopted automated dispensing. However, this is contrary to Celesio, who have adopted a hub and spoke model, claiming hub and spoke could increase efficiencies as well as reduce errors. Future studies would help evaluate the effects of the implementation of hub and spoke and medication errors, allowing a comparison with other robotic dispensing methods such as pharmacy automation and evaluate the experiences of community pharmacists and the general public.

6.4.2.3 Anxiety and medication errors

Having previously discussed community pharmacists and the general public perception of the influence on robotic dispensing errors, the effects of anxiety and medication errors have also been explored in relation to previous literature. Firstly, study one explored the trust community pharmacists had towards trusting the accuracy of a robotic dispensing machine. Under 50% of community pharmacist respondents strongly trusted or trusted the accuracy of a robotic dispensing machine in dispensing medication. Statistically significant differences of opinion were shown between the employment statuses of the pharmacist, where below 50% of employed pharmacists or locum pharmacists strongly trusted or distrusted and over 50% of other types of pharmacist distrusted the accuracy of the robotic dispensing machine. The results from this study support the opinions of the former board of management of the NPA, Mike Hewitson, who believed companies with their own automated assembly processes will be able to demand high levels of training and accuracy before allowing staff to use their hub-and-spoke system.

As highlighted earlier, medication errors are a popular outcome that have been used to evaluate dispensing technologies. The high occurrence of medication errors, in particular errors of omissions have resulted in pharmacist not reporting them using hospital reporting system (Williams, Phipps and Ashcroft 2013). For this reason, the underreporting of errors may have occurred in studies, as pharmacists may have exhibited some anxiety towards the reporting of errors (Williams, Phipps and Ashcroft 2013). Interestingly, previous literature has highlighted situations in which anxiety causes errors and links between the two have been found (Schell and Grasha 2000). Firstly, the discovery of the error leads to a small amount of anxiety, making a second error more probable (Schell and Grasha 2000). This is explained by the interruption of the cognitive system by the interplay of these two factors, resulting in an increase in errors (Schell and Grasha 2000).

Moreover, anxiety and accuracy of dispensing have also been found to be linked to factors such as extraversion, intelligence, stress and environmental nose (Jerath, Hasiji and Malhotra 1993; Schoenfled 1995; Ballard 1996). Psychological factors have also shown been shown to moderate the relationship between anxiety and accuracy. Psychological variables such as task frustration have been found to affect participants anxiety after the completion of a simulated pharmacy dispensing task in a study by Schell and Grasha (2000).

Having explored the effects of robotic dispensing errors in relation to anxiety, it needs to be considered how the pharmacy environment may also be influential on the occurrence of an error. Robotics may only help to reduce medication errors as opposed to those caused by the pharmacy environment, consisting of the open plan design of dispensaries, professional isolation, public interruptions and other distractions. These distractions on top of dispensing have displayed to be causes that have developed stress in pharmacies, especially in the public sector (McCann, Adair and Hughes 2009).

6.4.3 Financial implications of robotic dispensing

Respondents from both surveys were asked their opinions to whether or not both robotic dispensing methods would lower operating costs, as suggested by the Department of Health and NHS England (2015) that hub and spoke dispensing would lower operating costs. Nearly half of community pharmacists strongly agreed or agreed hub and spoke would lower operating costs. Significant differences of opinion were reported between the employment status of the pharmacist, on the topic of hub and spoke or pharmacy automation lowering operating costs. Half of employed and nearly 60% locum pharmacists also agreed operating costs would be lowered. Although, other types of pharmacists strongly disagreed or disagreed hub and spoke would lower operating costs.

However, the former chair of the National Pharmacy Association (NPA), believed there to be little evidence to back up hub and spoke reducing operating costs (Elvidge 2016). This supports findings from the literature review conducted in this thesis, as no literature was found around hub and spoke and the influence of operating costs. Instead, the literature described the process of automation, rather than hub and spoke. Further research into this topic needs to be conducted. Study two displayed below 55% of community pharmacists strongly agreed or agreed pharmacy automation would lower operating costs. Further analysis displayed statistically significant differences of opinion were also found between the employment statuses of the pharmacist, where 40% of locum pharmacists neither agreed nor agreed, 40% of employed pharmacists strongly agreed or agreed and nearly 70% disagreed pharmacy automation would lower operating costs. Significant differences of opinion were also found between whether or not a pharmacist had worked within a multiple community pharmacy or a supermarket pharmacy. The majority of respondents who had or had not worked within a multiple of supermarket pharmacy strongly agreed or agreed operating costs would be lower with pharmacy automation. Results from study one were supported by previous literature, one study showed robotic dispensing has shown to reduce cost situations. In this context, cost situations included costings per year such as acquisition and installation costs, capital costs and operating costs (Ruhle, Braun and Ostermann 2009). Half of the pharmacies in the study by Ruhle, Braun and Ostermann (2009) found cost situations to improve, although under 50% remained unchanged and only a few pharmacies found cost situations to have increased (Ruhle, Braun and Ostermann 2009). Pharmacies whose sales were greater than 2 million, reported to benefit from cost savings more than those with a lower annual sales volume (Ruhle, Braun and Ostermann 2009). The total costs of the installation of a robotic dispensing robot were found to be 24303 euros per year. This was approximately the same as the personnel costs of a pharmaceutical technical assistant per year.

Again, results from this study are limited as a dispensing machine from a single supplier was used, therefore results cannot be extrapolated to another dispensing machine or even hub and spoke process (Ruhle, Braun and Ostermann 2009). Automation has also been reported to lower the cost of drug storage (Chapuis et al. 2015). Pharmacists in this study were not asked whether or not they had used robotic dispensing, therefore no information was obtained with types of dispensing robots, limiting the results of this study. Previous literature (Ruhle, Braun and Ostermann 2009; Chapuis et al. 2015) has involved participants physically using robotic dispensing machines, whereas studies in this thesis have explored perceptions of the idea of using such machine with potential users (pharmacists) and recipients (general public) of the process if dispensing is facilities by robotic dispensing technologies.

6.4.3.1 Economic model of dispensing

As mentioned timelessly throughout this thesis, the large scaled dispensing method suggested by the Department of Health was hub and spoke dispensing. The dispensing model involved reducing the pharmacists time spent dispensing, creating more free time to undertake other activities such as the provision of healthcare advice to patients. Over 50% of pharmacists in study one perceived the productivity of dispensing to significantly increase or increase with robotic dispensing.

Previous research has discussed the economics of hub and spoke dispensing, the Department of Health claimed hub and spoke would lower operating costs. This model has proposed to be economically efficient if the number of staff are decreased, thereby decreasing labour costs with the implementation of a dispensing machine and lower operating costs. Pharmacists also agreed operating costs would be reduced with hub and spoke and even pharmacy automation. In an ideal world this model would make economic sense, however the reduction in staff may pose risk to patient safety, as stated by the former board of management of the NPA, Mike Hewitson. Where, this could in fact result in pharmacists checking their own working, due to the risks proposed to patient safety. This is said to be an issue at it eliminates the safety gains from automation, as pharmacists would still be checking their own work.

The consultation document regarding the implementation of hub and spoke states if 60% of medicines were dispensed by hub and spoke models, this would result in a 10% reduction of pharmacist labour costs and 25% reduction in pharmacy technician labour costs (National Pharmacy Association 2016). This would then mean a 2.5-5% increase of pharmacist labour costs and 6.25-12.5% increase of pharmacy technician labour costs at the hub (National Pharmacy Association 2016). In order for this model to be cost-effective and reduce operating costs, labour costs need to be brought down resulting in a reduction of staff members. Conversely, with staff shortages being reported as a problem in the study and the hub and spoke model requiring a reduction in labour costs. This may raise issues as if community pharmacies are currently suffering from staff shortages and labour costs are driven down by a change to the dispensing model, this may pose as a safety risk for pharmacies to operate safely as agreed by the former chair of the NPA.

In order for hub and spoke to be economically efficient, a 25-35% of a pharmacy's total prescriptions need to be dispensed using hub and spoke, for the delivery of services to patient (National Pharmacy Association 2016). A previous survey has shown if less than 25% of a pharmacy's total prescriptions are put towards hub and spoke, this would not be efficient for the delivery of services to patients (National Pharmacy Association 2016). Where, over 35% of dispensing if shifted to hub and spoke, shows no benefit to the delivery of services to patients. Therefore, the total prescription volume is a factor that needs to be considered when thinking of implementing this hub and spoke. This may be an issue for small independent pharmacies. Over 60% of pharmacists working in a single independent pharmacy reported negative attitudes towards hub and spoke, whereas over 80% working for pharmacy companies owning 11 or more branches reported positive attitudes in the NPA survey.

The proposed amendments in Section 10, Medicines Act 1968 and the Human Medicine Regulations 2012, have meant that independent pharmacies should potentially be able to achieve 25-35% of their total pharmacy prescriptions being sent to their chosen third-party hub, making it more economically viable for them. The cost of implementing a hub and spoke model, using a basic financial model, mocked the average pharmacy and was found to equant to £20,000 (National Pharmacy Association 2016). If costings were above £20,000, only a few benefits would be seen such as income from services and OTC sales and staff reductions. Costings of the model included payment for hub services which may result in a reduction in purchase margin (National Pharmacy Association 2016). The rewriting of SOPs, due diligence on the hub provider and the training and educating of staff would also add to further costings. Explicit consent would also need to be obtained from patients allowing the transfer of patient data from their existing pharmacy to a pharmacy of a different legal entity. Also including validation costs and the IT infrastructure costings (National Pharmacy Association 2016). The current UK model of hub and spoke would not be financially viable where costings would exceed £20,000.

However, the setting of a study including the types of community pharmacy needs to be explored in relation to costings. For example, hospital trusts that have previously adopted robotic dispensing methods must have already had the capital to do so (The Audit Commission 2001). Further analysis into one setting for example the various types of community pharmacy would help policymakers and companies with respect to intra and intercompany models. The spoonful of sugar report also highlight the need for further guidance to be develop to enable economies of scale and standardisation of costs (The Audit Commission 2001).

6.4.4 Current community pharmacy practice

The main essential service provided by community pharmacies in England is dispensing. The service is described as '*the supply of medicines and appliances ordered on NHS prescriptions, together with information and advice, to enable safe and effective use by patients and carers, and maintenance of appropriate records*' (PSNC 2020). The community pharmacist is responsible for performing appropriate legal, clinical and accuracy checks. The current method of dispensing involves the use of some technologies including and not limited to electronic tablet counters, electronic prescription services and the labelling of medications with computerised pharmacy dispensing systems. The NHS long term plan stated automated services were viewed in ways to make systems smarter (NHS England 2019). However, digital options also included electronic prescribing where medicines could be collected from their local pharmacy, or for patients needing urgent treatment care or with the use of an out of hours service (NHS England 2019).

Community pharmacists were questioned about their experience in current pharmacy practice. The majority of community pharmacists had worked in a multiple community pharmacy, with on average, between 3 and 4 additional members of staff during their previous pharmacy shift. While, community pharmacists working in independent pharmacies reported working alongside 1 to 2 additional staff members. Pharmacy owners have been advised to taking a tailored and flexible approach to staffing levels, in ensuring people receive safe and effective care from every registered pharmacy (General Pharmaceutical Council 2018).

In order for hub and spoke to be economically efficient, staffing levels must also be reduced to lower operating costs. Furthermore, one study found the staffing level in hospital pharmacy to be 11-16 staff per day pre-automation and 10-15 people post automation (James et al. 2013b). However, this data needs to be approached with caution, as the study took place in hospital pharmacy therefore, not a representative sample of the setting being studied, in this case being community pharmacy. Adequate staffing members would have to be discussed amongst pharmacy members if robotic dispensing was implemented, having carried out risk assessments then making judgements on the appropriate number of staff and skill mix. Contingency plans must also be put into place if short- or long-term absences of staff occur, whether or not if they are planned or unplanned. Pharmacy staff and the responsible pharmacist must be aware of such plans as stated in principle two of the pharmacist standards. In order for the implementation of hub and spoke or pharmacy automation to be cost effective, staffing needs to be reduced. Therefore, pharmacy companies would perhaps need to draw up procedures in case of planned or unplanned staff absences with the proposed implementation of robotic dispensing.

6.4.4.1 Experiences of counselling in community pharmacy

Community pharmacists were asked to detail their counselling experiences during their previous pharmacy shift. On average, pharmacists reported to spend 1-3 minutes counselling each patient on their medications, during their current or recent pharmacy shift worked. This finding is also consistent with that of Alfadl, Alrasheedy and Alhassun (2018) who reported pharmacists to spend, on average, one minute each patient in community pharmacies on their medication. Pharmacist in study one were satisfied with the amount of counselling time they had per patient during their recent or current pharmacy shift. However, literature does not support this finding as, there is no ideal amount of time to spend on counselling patient as this is dependent on factors such as patients’ conditions, as well as the pharmacists work schedule (Arshad et al. 2011). Therefore, measuring a pharmacist’s satisfaction with the amount of available counselling time they have is also influential on factors such as the workload of the pharmacist and the nature of the patient’s health.

Barriers community pharmacists faced with the provision were also reported, where over 35% reported staff shortages to be a barrier followed by over 20% reporting a lack of resources or space. Interestingly, a relationship was identified between whether or not a pharmacist had worked within a multiple community pharmacy and staff shortages. Under 10% of pharmacists reported a fear of changing role and few pharmacists reported a lack of understanding of healthcare advice. This finding was supported by previous literature where a lack of clinical knowledge has been seen as a major obstacle in the capability of community pharmacists taking enough time to provide adequate counselling to patients (Wabe et al. 2011). This suggests pharmacists not having enough time to provide healthcare advice to patients may not be the only barrier.

Additionally, community pharmacists detailed activities in which they viewed they were spending too much time on. The majority of pharmacists strongly agreed or agreed pharmacists were spending too much time on administrative tasks checking medication, ordering patient medication and stock checking or order stock. This finding broadly supports the work of another study where the endorsement of prescriptions and clerical health-related work appeared to be a common daily activity in which pharmacists are spending part of their day on, in an observational study (Davies, Burners, Taylor 2014). Interestingly, over 50% of community pharmacists strongly disagreed or disagreed pharmacists were spending too much time on pharmacy services. These findings help confirm pharmacists perceive that they are not spending the majority of their time on pharmacy services and more so on dispensing related activities.

6.4.5 Community pharmacy uses

The previous section discussed experiences of both the general public and community pharmacies of counselling in community pharmacies. General public respondents were also asked reasons as to why they use a community pharmacy. Firstly, the majority of respondents who had visited a pharmacy in the past 12 months had previously used an independent or independent community pharmacy chain. A do not know option was added to this question to help the respondent overcome any confusion they may have had. Examples of the types of community pharmacies were given to respondents, for example, multiples (boots, LloydsPharmacy, Superdrug etc.), supermarket (Asda, Morrisons, Tesco etc.) to also help avoid confusion. Although, confusion may have still occurred amongst respondents as it was not feasible to list the name of every community pharmacy company in England.

Nearly 90% of the general public had commonly used community pharmacies for prescription use, followed by under 50% for OTC medicines and a quarter on advice for a healthcare problem. This finding is contrary to previous studies where 34.7% of general public respondents in a study conducted in Northern Ireland previously reported community pharmacy use to be for non-prescription medicines (McElnay, Nicholl and Grainger-Rousseau (1993). This was found particularly for those under the age of 25 and were also less likely to use the same pharmacy twice. Another common use for community pharmacies has found to be for obtaining pharmacist’s advice by 29.3% of the general public in a study by McElnay, Nicholl and Grainger-Rousseau (1993). Although, the general public have perceived community pharmacists to be the supplier of medicines (Gidman and Cowley 2013). Community pharmacy use by the general public has also been used for convenience when they were unable to access their GP (Gidman and Cowley 2013). Interestingly, the pharmacy environment and retail setting were not seen to be ideal for private healthcare consultations.

6.4.5.1 Dispensing process in community pharmacists

The previous section discussed the various uses of a community pharmacy, this section has focussed on the dispensing function and process of community pharmacy. The dispensing process begins with prescribers electronically prescribing prescriptions using the electronic prescription service which has been adopted GP by 93% of GP surgeries (Buckland 2019). Over 45% of general public respondents had their prescriptions sent electronically by the prescriber to the pharmacy. This service uses an algorithm and was designed to streamline the dispensing process allowing future prospects for artificial intelligence and analytics advancing personalised medicine (Buckland 2019). The uptake of this service has also been used in combination with robotic dispensing (Beard and Smith 2013).

Robotic dispensing itself has found to speed up the dispensing process (Buckland 2019). Dispensing speed is a factor influential on the time taken for patients to get their prescriptions and on the prescription waiting times given out to patients by community pharmacists. Mostly, nearly 30% of general public respondents waited up to 30 minutes for 'waiting prescriptions.' Whilst, over 40% of community pharmacists commonly reported waiting times below 5 or up to 10 minutes and were overall, satisfied with the time they had to check medication. A correlation was identified between prescription waiting times and time pharmacists had to check medication. Longer prescription waiting times were associated with dissatisfaction amongst pharmacists with the time they had to check medication. Furthermore, the implementation of a chronic dispensing unit in Africa, a similar process to the UK hub and spoke model has found to reduce prescription waiting times. (Du Plesis 2015; Du Toit, Dames and Boshoff 2008; Munvikwa 2011). Prescription waiting times have also been found to be highly dependent on the number of pharmacists, in a computer simulation study by Tan et al. (2009).

Findings from this programme of work alongside the literature suggest a need for a change in the dispensing process. The influence robotic dispensing had on the time taken to obtain prescription is an outcome that has not be explored in literature, although dispensing speed has been explored (Rodriguez et al. 2018). As robotic dispensing has found to improve dispensing speed, the implementation may also help to improve the satisfaction of pharmacists with the time they have to check medication. This can be further explained by the fact either hub and spoke or pharmacy automation, removes the accuracy checking of the dispensing process, meaning in theory pharmacists would only need to conduct clinical checks. Following on, perhaps not so surprisingly, pharmacists perceived hub and spoke to increase the time taken for patients to obtain their prescription's. A reasoning for this could be that hub and spoke dispensing means that the dispensing of prescriptions occurs at the hub, and then medications are transported back to the spoke (pharmacy), which may result in the increased times for patients to get their prescriptions. The dispensing of multiple prescriptions was also reported to slow down the dispensing process in this programme of work, again explaining the extended time for patients obtaining their prescription.

Hub and spoke not being able to dispense all items such as fridge lines and appliances and CD's was a common problem reported. However, literature which has demonstrated the dispensing of items such as controlled drugs pre- and post-automation in a process in the process of pharmacy automation in a hospital setting (James et al. 2011). This finding may be another explanation to the increased time for patients to obtain their prescriptions. One unanticipated finding was that pharmacists reported pharmacy automation to decrease the time taken for patients to get their prescriptions. Furthermore, this finding could be further explained by the fact that pharmacy automation takes places on-site of the pharmacy, therefore transit times of medication do not need to be taken into consideration as needed with hub and spoke. Whilst, as expected the general public either did not know or viewed there to be no change with each dispensing method to the time taken for patients to obtain their prescription.

The guidance for registered pharmacies providing pharmacy services at a distance including on the internet, set out by the GPhC, states an initial risk assessment should be undertaken ensuring medicines are delivered safely and effectively. Principle 4 of the pharmacy standards informs pharmacy owners to 'assess the suitability and timescale of the method of supply dispatch and delivery such as refrigeration medicines and controlled drugs' (General Pharmaceutical Council 2019). This guidance has left the decision to pharmacy owners, therefore different companies may have different standard operating procedures for the dispensing of fridge lines or controlled drugs with the methods such as hub and spoke. An implication of this will mean that patients using multiple pharmacies may be confused when ordering medication such as controlled drugs or fridge lines. Additionally, locum pharmacists will need to be made aware of the different procedures of the handling of such drugs when in on their pharmacy shift.

6.4.6 Changing the role of the community pharmacist

The previous section highlighted the perceptions of the public and community pharmacists towards aspects of current pharmacy practice. This section has discussed the ever so changing role of the community pharmacist and how the proposed implementation is perceived to affect this.

Traditionally, pharmacists have found to be compounders of medicine, where grocers were involved in compounding spiced wines, herbs and drugs and selling them to the public (Giam et al. 2011). History has found the transitioning of pharmacists from manufacturing extemporaneous preparations to the passing on the manufacturing of medicines to pharmaceutical companies. This was then followed by the production of standardised original pack dispensing such as a calendar pack of 28 tablets. The use of these packs has shown to aid the process of robotic dispensing, as the robot picks the full calendar packs of medication. The spoonful of sugar report also advocated the increased use of patient packs (Buisson 2003). The role of the pharmacist has been changing over many years, for example Hepler and Strand (1990) believed pharmacists to be responsible for the provision of pharmaceutical care to patients. The Nuffield Report in 1989 highlighted how a degree in pharmacy is an over qualification for reading a label on a box then comparing it with details on a prescription form (Roberts 1988). The report also underlined how dispensing has been found to be in an unstoppable decline (Roberts 1989).

NHS policies have been involved in changing the role of the pharmacist, ranging from the NHS Plan in the year 2000 to recent policies such as the NHS Five Year Forward View in 2014 for the role of pharmacists to change, the proposed implementation of robotic dispensing has been proposed to free up pharmacists' time to do other activities such as the provision of healthcare services to patients. The plan describes the role of community pharmacists to become more adaptable in providing more pharmaceutical care to patients. For many years the NHS believes pharmacy is a profession that is underutilised, as stated historically throughout various policies such as the NHS Plan 2000, Pharmacy in the Future, A Vision for Pharmacy in the New NHS in 2013 and various other policies. Community pharmacy has previously been reported as an untapped resource for health improvement and should be the first point of call for healthcare services (Department of Health 2003).

Both types of respondents were questioned about their experience or perceptions of the provision or use of services within community pharmacy, with the current dispensing method as well as with robotic dispensing. Pharmacists have a role in providing services to patients, such as smoking cessation, blood pressure management and cholesterol management (General Pharmaceutical Council 2020f). Factors affecting the provision of services have been discussed in this section.

Previous research has highlighted pharmacists expressing a concern of a lack of time to counsel patients with the current method of dispensing (Angelo, Christensen and Ferreri 2015). In study two, the general public were asked to record their perceptions as to why they think pharmacists undergo time constraints when providing healthcare advice to patients. Approximately 40% of respondents believed pharmacists to be spending too much time checking medication in the dispensary and over 30% reported staff shortages to be a reasoning. These findings support previous observations made by Davies, Burners, Taylor (2014) and Turner (2016) where pharmacists have been found to spend most of their working day on prescription related activities. There has been an ongoing debate as to whether community pharmacists are overqualified dispensers or health professionals (Harding 1989). Particularly, as pharmacists have found to dedicate most of their time dispensing as opposed to dedicating their time to their patient or providing pharmaceutical care (Rutter et al. 1998; Lea, Corlett and Rogers 2012). However, contrary to findings from this study, this was found to be independent of factors influencing a pharmacist's time such as workload or staffing levels. Instead, pharmacists have been found to be previously placed inappropriately, completing the same work as dispensers (Lea, Corlett and Rogers 2012).

The Department of Health and Social Care, NHS England and PSNC (2019), highlighted the need for introducing for dispensing to become more efficient. The NHS Plan published in the year 2000 outlined plans for pharmacists to spend more time attending to the clinical needs of patients (NHS 2000), with the NHS Five Year Forward View in the year 2014, outlining ways in which pharmacists can support out of hours care, including building up the publics' understanding of how pharmacies can help them deal with minor ailments (PSNC, 2014).

The demand for pharmacists having a more active role in supporting out of care has been demonstrated in this thesis. Aside from doctors, general public respondents were described to obtain healthcare advice from community pharmacies. This finding supports the ideologies in the NHS five-year plan, as pharmacies were highlighted as the secondary source of healthcare to GP surgeries. Additionally, with pharmacists able to become independent prescribers, there has been more scope for pharmacists to prescribe medicines, run clinics and work alongside GPs in practice (Mann et al. 2017). Community pharmacist independent prescribers have found to play a positive role in general practice. For example, prescription requests have been triaged to the community pharmacist independent prescriber and the GP has been able to check their own medication knowledge with the pharmacist (Mann et al. 2017).

The time of community pharmacists is limited, the only way to create more time for other potentially more rewarding activities, is to reduce time spent on other less rewarding activities such as dispensing. Despite, the primary function of community pharmacy business is dispensing (Lea, Corlett and Rogers 2012). This programme of work has shown a demand for community pharmacists wanting to spend more time on the provision of pharmacy services to patients, as previously discussed. Therefore, pharmacists in study one reporting wanting to spent time on undertake other activities such as the provision of healthcare services to patients, implies a problem with a lack of time. In fact, the work of pharmacists in other countries no longer involves dispensing, instead being responsible for the provision of medicines and giving advice (Taylor and Harding 2001). Perhaps this is something that needs to be adapted in England by policymakers, in order for pharmacists to play a more active role in healthcare outlined in the NHS and perceived by public and pharmacists in this programme of work.

6.4.6.1 Robotic dispensing and pharmacy workload

The former section examined the changing role of the pharmacist. This section has discussed the workload of the community pharmacist and the effects robotic dispensing may have on workload. Robotic dispensing has been a proposed way of creating more time for pharmacists to engage in other activities such as the provision of healthcare services to patients. The perceptions of the potential implementation of robotic dispensing would have on the workload of pharmacy staff and the time taken for patients to get their prescriptions were explored. As mentioned in the literature review, dispensary workload was found to increase post automation (James et al. 2011, 2013b). Workload measures included elemental tasks of the dispensing process, ranging from prescription reception to the final check and issue of medication to the patients (James et al. 2011). James et al. (2011) also used robotic dispensing including individually dispensed items such as controlled drugs, MDS and drugs that require specific monitoring such as clozapine (James et al. 2011).

However, results from study one did not support previous literature where community pharmacists reported the workload of pharmacists to neither increase or decrease with the employment of either hub and spoke or pharmacy automation. The CDU, similar to hub and spoke, was found to reduce the workload of pharmacists by reducing pharmacy staff from repetitive and time-consuming tasks that detract them from patient focussed elements and decongest health facilities (Magadzire et el al. 2015). Pharmacists had an increased time in counselling and the ability to serve double the number of people they served prior to CDU implementation (Du Plesis 2015; Du Toit, Dames and Boshoff 2008). The dispensing unit was also found to relieve pharmacists of mundane dispensing tasks, although this was only reported amongst two pharmacists (Magadzire et al. 2015).

The unit was an out-sourced dispensing, public sector centralised dispensing service and dispensed medications for stable patients with chronic conditions. The CDU process firstly, collected prescriptions for stable chronic patients from healthcare facilities, dispensed the medicines and then returns the complete patient medicine parcel to the facilities in which the patient attends, such as appointments with their doctor or nurse (Mathys 2015). Additionally, the hub and spoke process currently deals with spoke pharmacies from the same company, meaning the same legal company. However, the CDU covers healthcare facilities as opposed to pharmacies themselves. In the CDU process, it is in fact the contractor themselves responsible for the specific supply chain. The difference between the UK hub and spoke model and the South African model is that it is provided through the private sector. In the UK hub and spoke model, a central hub dispenses medication an electronic prescription which it is then delivered to the pharmacy (spoke) for collection by the consumer (Spinks et al. 2017). Hub and spoke accounts for approximately two thirds of England's prescriptions (Elvidge 2016).

A possible reasoning for pharmacists perceiving there to be no increase or decrease with the hub and spoke model, could be explained by workload being shifted from one task to another (National Pharmacy Association 2016). Resulting, in no real difference being seen in the effects of robotic dispensing on pharmacy workload. Although, the NPA survey found respondents to be happy shifting part of their workload using the process of hub and spoke (National Pharmacy Association 2016). To further explain, a shift in workload included the extended time spent matching prescriptions with items dispensed from the hub. This was a common potential problem reported by pharmacists in study one with the hub and spoke model. The hub and spoke model only removes prescription assembly, as processes such as receiving prescriptions, data input and handing out prescriptions are still carried out at the spoke (National Pharmacy Association, 2016). Previous research has shown pharmacists in favour of shifting the dispensing of regular repeats or nursing home workloads and MDS to hub and spoke dispensing (National Pharmacy Association 2016). The workload of the community pharmacist with the current method of dispensing has been shown to be linked with pharmacists experiencing moderate or severe (44.4%) or extreme or panic (55.8%) levels of anxiety (Jocić and Krajnović 2014). This programme of work has perceived the process of hub and spoke to be have found a shift in workload as opposed to a reduction, therefore pharmacists anxiety levels may still remain the same.

6.4.6.2 Stress and pharmacy workload

Increased levels of stress have been shown to occur due to an increase in workload and longer working hours in community pharmacy (Shaun and Hassell 2006). This has been caused by pharmacists having too much work to do, having unreasonable company targets or even undertaking tasks taking them away from direct contact with patients (Shaun and Hassell 2006). They have been shown to be prone to occupational stress and high levels of burnout defined as burnout syndrome and combustion (Jocić and Krajnović 2014). This has even resulted in pharmacists leaving their jobs as permanent employees and becoming self-employed locum pharmacists (Shann and Hassell 2006). A low satisfaction, disillusionment in work and widespread stress has also been found with female pharmacists (Gidman et al. 2007). Concerningly, patient safety has also been detailed as a worry due to working conditions pharmacists have previously experienced (Gidman et al. 2007). Study one was unable to support previous literature in the effects of robotic dispensing methods on the workload of the pharmacists. One of the issues that emerged from the results in study one could be the lack of experience with dispensing technologies making it difficult for community pharmacists to comment upon.

Although, as previously described some pharmacists prefer to be a part of the dispensing process, particularly in checks that perhaps could be passed onto technicians (Novek 2000). Therefore, it could be assumed that concerns about reducing their workload are not of an issue to all pharmacists, more so the resistance of adopting automation being the problem. Literature has also highlighted automation perceived to threaten pharmacists' job and their control of expertise (Novek 2000). Previous literature has demonstrated how automation has in fact worsened the conditions of technicians work much of which was highly repetitive and stressful, geared to machine tending and churning out packaged medicines in a 24-hour cycle (Novek 2000).

Interestingly, having discussed the implications of robotics on the workload of the pharmacist and the creation of proposed free time. An Increased workload has been found to be related to an increase in job related stress and decreased job satisfaction by pharmacists (Lee Corlett and Rogers 2012). This programme of work has demonstrated how some pharmacists have shown a resistance to changing their job role, as they believe the provision of healthcare advice not to be a part of their job role whilst others have a fear of changing their role. The replacement of manual labour by robotic machine, could in fact cause further effects to pharmacy staff, including unemployment, suffer from the loss of identify as a profession on a meso level, or even as an individual on a micro level. A reduction in self-esteem could also be a factor.

6.4.6.3 Robotic dispensing and service provision

The previous section discussed the effects of robotic dispensing with pharmacy workloads. This section has discussed the effects of robotic dispensing on service provision. Robotic dispensing has been expressed as a way to make dispensing more efficient, the perceptions of the public and pharmacists has explored this potential advantage or disadvantage. Firstly, the available time pharmacists have with the current and perceptions of proposed implementation of robotic dispensing methods have been explored.

Automation has found to shift pharmacy practice from technical dispensing activities to the provision of patient care service. One unanticipated finding identified in study two was the agreement of general public participants that they perceived pharmacists have enough time to speak to patients. This finding was surprising as the Department of Health believe the dispensing model needs to be changed in order to free up pharmacist’s time to provide healthcare advice to patients, whereas the general public do not feel there is a need to do so. However, older general public respondents did not believe pharmacists had enough time to give healthcare advice to patients.

Pharmacists and general public respondents were both asked about their perceptions on the influence both robotic dispensing methods would have on service provision. Interestingly, results did show significant differences of opinion between community pharmacists and the general public with the extent of agreement to whether or not hub and spoke would provide pharmacists more time in providing healthcare advice to patients. Nearly 50% of community pharmacists agreed hub and spoke would enable pharmacists more time providing healthcare advice to patients, whereas over 30% of general public respondents neither agreed nor disagreed. Overall, similar opinions were displayed between both types of respondents towards the on-site robotic dispensing method, where over 35% of general public and 70% of community pharmacist respondents agreed the process of pharmacy automation would enable pharmacists more time to provide healthcare advice to patients.

A correlation was also observed between the age of the pharmacist and the extent of agreement towards hub and spoke enabling pharmacists more time to provide healthcare advice to patients. In other words, the older the pharmacist the more they disagreed hub and spoke would give pharmacists more time to provide healthcare advice to patients. These differences could be explained by the fact that the hub and spoke model "*challenges the traditional role of community pharmacies*" as stated by Celesio. Further explanations could be the fact that older pharmacists are more reluctant to change their roles and provide pharmaceutical care to patients, or with their experience this would not be the case. More experienced pharmacists have been shown to be less supportive than younger pharmacists in the provision of pharmaceutical care (Dunlop and Shaw 2002). Older pharmacists have also found to believe there to be a lack of patient demand for pharmaceutical care than younger pharmacists (Dunlop and Shaw 2002). However, this could be explained by the lack of patient awareness of a pharmacist's ability to provide pharmaceutical care to patients (Dunlop and Shaw 2002). If older pharmacists are found to be unwilling to promote pharmaceutical care to patients, then this would be the challenge for the provision of service would be with younger pharmacists (Dunlop and Shaw 2002).

Again, results from this study are consistent with previous literature and with findings from NPA reports which show evidence of releasing pharmacists from the dispensing process in providing more services (National Pharmacy Association 2016). However, in order for this to happen a dispensing volume of between 25-35% was said to be ideal for starting to deliver more services, with the hub and spoke model creating more capacity (National Pharmacy Association 2016). Above 35%, was found to be a plateau whereby the capacity created by hub and spoke, was found not to be enough services to fulfil this capacity (National Pharmacy Association 2016). Although differences of opinion were reported regarding pharmacy automation and the employment status of the pharmacist.

Even though, the implementation of hub and spoke was proposed to free up pharmacists' time to provide more healthcare advice to patients. Community pharmacists also reported benefits of robotic dispensing including, more time for pharmacists to use their clinical skills and provide services and advice to patients and less time spent dispensing. However, these perceptions do not support previous literature where automation was not found to have a significant influence on activities such as counselling durations of community pharmacists (Cavaco and Krookas 2014). Innovating new ways of delivering care is something that was stated in the 5-year plan, with the NHS Long Term Plan outlining increasing digital options in supporting clinical care such as making systems smarter with the use of automated services and artificial intelligence. It has been reported how the general public have previously shown a lack of awareness of the pharmacy's capacity of providing healthcare services (Krska and Morecroft 2010). Therefore, educating the public on the expanded role of community pharmacies could help overcome this.

Additionally, alongside the aid of technology, the Community Pharmacy Contractual Framework for 2019/20 to 2023/24 highlighted the encouragement of pharmacists to work alongside other healthcare professionals, thereby utilising their knowledge for fully integrated community-based health care. Automation also has shown improvement of patient satisfaction with considerations of patient needs and in explanation of the information of patients (Angelo, Christensen and Ferreri 2015).

6.7 Conclusions

Overall, this chapter brought together data from two studies, where various discussion points were identified. By considering the data from each study it was possible to better understand the general public and community pharmacists' perceptions towards robotic dispensing methods 'hub and spoke' and 'pharmacy automation'. The first discussion point related to the general public and community pharmacists' perceptions of dispensing services in pharmacy, including their dispensing preferences. The second discussion point examined the topic of accountability and responsibility with robotic dispensing, including the general public and pharmacists trust towards robotic dispensing. This study added to the literature confirming that trust was shown by pharmacists to their peers overseeing the dispensing process at the hub and by public towards trusting the process of pharmacy automation. The third discussion point deliberated the implications of robotics into pharmacy practice, covering financial, types of errors and economic efficiencies. This study added to the literature concerning community pharmacists' perceptions of the operating costs regarding hub and spoke and pharmacy automation. The penultimate discussion point explored public and community pharmacists' perceptions of the current method of dispensing. This study added to the literature on prescription waiting times, counselling durations and the perceptions on the available time of the community pharmacist. The last discussion point also deliberated the ongoing topic of the changing role of the community pharmacist with robotic dispensing, including perceptions on public expectations of the community pharmacist. This study added to the literature exploring perceptions on whether or not robotic dispensing would create more free time for the community pharmacist. Furthermore, the study also added to literature detailing how pharmacists would like to spend their free time created by robotic dispensing and preferences of services reported by the general public.

6.8 Implications for policy and practice

The letter sent out by the Department of Health in 2015 to community pharmacists suggesting large scaled dispensing methods, such as hub and spoke lead to the formation of this research. Alongside, proposals set out in the NHS Five Year Forward View 2014, building up the public understanding of how pharmacies can help patient with minor ailments, healthcare services and be used for out of hours care. Community pharmacists' role has changed over the years where they are now able to become independent prescribers and currently have roles in GP surgeries (NHS England 2014). However, pharmacist's role is still predominantly focussed on medicines supply. The idea of using technology as an aid of delivering healthcare services was also mentioned in the review (NHS England 2014).

The findings of this programme of work have implications for community pharmacy practice specifically relating to both the general public and pharmacists: dispensing preferences, issues around accountability and responsibility in relation to trust towards robotic dispensing, perceptions of current pharmacy practice and the changing role of the pharmacist and perceptions of the financial implications of robotic dispensing.

The aim of this programme of work was to investigate areas around dispensing in community pharmacy practice, relating to specifically robotic dispensing methods, hub and spoke and pharmacy automation. In this context it was important to examine opinions of pharmacists and the general public.

This programme of work has shown that the current method of dispensing was preferential by both community pharmacists and general public respondents, as well as for dispensing to be carried out on-site. Therefore, pharmacy automation was the most preferred dispensing method out of the two robotic dispensing methods explored in this thesis. Preferred methods and location of dispensing have not previously been discussed within literature. Although, the majority of pharmacists in the NPA survey reported hub and spoke to have a negative impact on their patients, pharmacy company and the overall community pharmacy network (National Pharmacy Association 2016).

Moreover, the hub and spoke model has previously raised issues around the topic of accountability and responsibility of medication errors. This study demonstrated pharmacists to overall trust their peers at the hub to oversee the dispensing process when the clinical is conducted in store, where locum and employed pharmacists also trusting their peers whereas, other types of pharmacists included pharmacy owners did not. The UK hub and spoke model has not been evaluated in literature, however multidose dispensing, a method similar to hub and spoke has previously found nurses to exhibit a lack of trust. Multidose bags coming into the pharmacy were being double checks however this was considered unnecessary in the process. The current hub and spoke model is only applicable to spokes and hubs belonging to the same legal entity, however proposals have been drawn up amending Section 10 of the Medicines Act allowing pharmacies of different legal entities to do so. The NPA have previously stated the current hub and spoke model to favour large multiple pharmacies, as small independent pharmacies may not be able to uptake the financial costs, such as third-party costs to hubs (National Pharmacy Association 2016). The NPA has also shown worries to independent pharmacies being tied up to a single wholesaler in order to gain access to the third-party hub.

However, this topic has raised issues of accountability of dispensing errors amongst membership bodies such as the PDA, with the hub and spoke process. If an error were to occur, it is unclear as to whether the hub or spoke pharmacist who would be responsible. The

GPhC provides guidance on the matters however it is up to the pharmacy providers to clearly out line accountability matters. Issues with accountability also lying with pharmacy companies using third party hubs, where the GPhC state it to be the duty of the service provider to provide the service safe and effectively. This is an area, in which clearer guidance needs to be implemented by the regulator or pharmacy companies to ensure problems do not ensure with the issues of accountability.

Pharmacy2U have recently announced plans of launching a hub, HubRx, and spoke facility for independent pharmacies, following the Medicines and Medical Devices Bill (Pharmacy Magazine 2020). The new legislation highlighted in the bill announced pharmacies will be able to use hubs of different legal entities. Leader of Pharmacy2U, Daniel Lee, believed the introduction of the hub would "*level the playing field between independents and multiples.*" Lee also claimed independents would see time-saving benefits where they would be able to outsource up to 70% of their dispensing workload (Pharmacy Magazine 2020). Former board member of the NPA, Mike Hewitson is due to join HubRx as a non-executive director.

This programme of work has revealed pharmacists agreed the implementation of either hub and spoke and pharmacy automation would lower operating costs. The perceptions pharmacists displayed are in line with the proposal set out by the Department of Health (2015). The perceptions towards whether or not robotic dispensing would lower operating costs have not been previously discussed. The implementation of a dispensing robot has been found to improve yearly costs such as acquisition and installation costs and operating costs (Ruhle, Braun and Ostermann 2009). The automation of dispensing has also been found to lower the cost of drug storage (Chapuis et al. 2015). Previous literature has reflected the use of the pharmacy automation process. The NPA model of the economic efficiencies of dispensing, showed if 25-35% of a pharmacy's total dispensing volume was shifted to hub and spoke would be economically efficient for the delivery of service to patients. Above or below this threshold either creates a plateau effect or not enough dispensing volume or economic efficiency (National Pharmacy Association 2016). Future studies evaluating the financial implications of both robotic dispensing in different types of community will allow comparisons once the UK hub and spoke model has been implemented across the UK.

This work has focussed on the perceptions robotic dispensing has on releasing pharmacists from their dispensing function and providing them with the time to conduct other activities such as providing more healthcare advice and services to patients. Both pharmacists and the general public perceived the process of pharmacy automation to provide pharmacists more time to provide healthcare advice to patients. Dispensing is an essential service provided by all community pharmacies, where enhanced services such as Medicines Use Reviews and the New Medicine Service are also provided. However, pharmacists have been found dedicate the majority of their time dispensing as opposed to providing pharmaceutical care to patients (Rutter et al. 1998; Lea, Corlett and Rogers 2012). Pharmacists have also reported to have a lack of time counselling patients on their medication with the current method of dispensing (Angelo, Christensen and Ferreri 2015). Pharmacists have previously been found to still spend more than 60% of their time involved with dispensing activities that could be performed by technicians and automation (Anderson 1999).

If robotic dispensing created more time for pharmacists, this programme of work founded community pharmacists wanting to spend more time providing pharmacy services to patients, counselling patients on their medication and giving healthcare advice to patients. The general public reported wanting pharmacists to spend more time providing healthcare services such as minor ailments, medicines assessments, compliance support, stop smoking, out of hours support and independent prescribing, if hub and spoke or pharmacy automation created more time for pharmacists. The demand from both community pharmacists and the general public for activities aside from dispensing has been demonstrated in this programme of work. Perhaps, changes to the current dispensing process could also be reviewed to facilitate this. Pharmacists have previously shown to spend most of their working day dispensing (Lea, Corlett and Rodgers 2012), showing a need to ease pharmacists' workload. However, no sense of urgency has been found by respondents in freeing up pharmacist time particularly for the delivery of pharmaceutical care to patients. However, previous literature has failed to demonstrate no significant changes on time spent counselling with the implementation of automation (Cavaco and Krookas 2014).

The lack of knowledge of both robotic dispensing method by the general public, may be attributable due to the fact that the proposed introduction of large-scale dispensing methods has not yet been implemented. Therefore, any form of promotion of this change in dispensing to the public would not have been done. Pharmacy news in the media is often on topics that have been already implemented, which often professional bodies have also commented on (Savage 2015). The use of robotics in community pharmacy dispensing is a relatively new topic and is most unlikely to be in the media, as it is not implemented in many community pharmacies within England. It may be advisable therefore for the leaders of healthcare such as NHS England and the Department of Health and Social Care to partner up with professional bodies such as the PDA, RPS and PSNC to spread news when the proposed changes are implemented within community pharmacy practice. Raising awareness of the proposed changes when implemented in pharmacy practice, could be done by encouraging institutions and the leaders of healthcare to encourage general public research in proposed changes to pharmacies in healthcare policies. Despite the general public still receiving their medication, any changes in the usual process of receiving their medication such as time delays will need to be reported. If a patient uses an independent pharmacy consent will need to be obtained share patient details with the hub pharmacy, which is a different pharmacy company. Therefore, patients would need to be informed of reasonings for the need of consent. A key policy priority should therefore be to plan research involving perceptions with technology on recipients and users of the technology, in relation to trust. GPhC principles indicate the patient to be the first concern, therefore by considering trusts of the users as well as the recipients of the product of the technology may help to ensure a smoother implementation of dispensing technologies.

Overall, the results from this programme of work may help professional bodies and community pharmacies on how to manage the future implementation of dispensing technologies with considerations to the type of method and perceptions of both community pharmacists and the general public. Outcomes from the literature alongside further analysis of the public and community pharmacists' perceptions in this programme of work have been discussed. However, even though various outcomes have been used to evaluate dispensing technologies, perhaps policymakers need to describe measures that need to be included in evaluations such as patient safety, financial stewardship and user satisfaction (Boyd and Chafee 2019).

6.7 Implications for Research

A major drawback of this research was the low response from both groups. As pharmacy is a profession that relies on evidence-based practice, it is important there are sufficient number of participants for the generalisability of results. These issues have also been experienced by previous researchers, as obtaining high response rates appears to be very difficult (Dewsbury et al. 2015). The use of the open electoral roll register and list of GPhC registered pharmacies within the UK still yielded a relatively low response rate.

The low response rate seen within study one, it appears pharmacists have previously shown a lack of participation in pharmacy practice research. Response rates for community pharmacist research have shown to be twice as low as than general pharmacy practice research within the UK (Twigg et al. 2013). Pharmacists need to be motivated in participating in research, however time constraints have also been so to be a barrier to the participation of research (Crilly et al. 2017). Even though, response rates for this study were low, questionnaires are a sufficient measure of data collection for engaging with diverse populations. To encourage the participation of research by community pharmacists, perhaps the GPhC, could encourage the participation of pharmacy-based research as a component of their continuing professional development cycles. By making it a requirement for one CPD record to be an involvement in pharmacy research could help increase the participation.

Additionally, the researcher in this study was unable to obtain the contact details for example, email addresses of pharmacists or pharmacies. Therefore, in order to increase levels of pharmacy-based research across England, the GPhC could facilitate this by using the pharmacist register as previously conducted. This would make it easier for obtaining contact details of pharmacists who would like to participate in research. needs to be created, thereby strengthening the pharmacy profession in further research.

The general public perception were investigated in study two. Future researchers should acknowledge the fact that even though the general public have shown to use pharmacies for prescription related matters, the general public has expressed a demand for pharmacists to provide more services to patients, moving away from their dispensing function. Pharmacy is profession based upon evidence base practice; therefore, the use of technology may also need follow the same path. The development of more evidence-based literature for either pharmacy automation or hub and spoke may help the implementation of helping pharmacies deciding which robotic dispensing method to adopt. Also, providing a thorough platform for the evaluation of technologies so that they can be widely used in community pharmacy.

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Appendix 1 – Study One: cover letter (pilot study)

Recipient Name
Centre for Sport, Exercise and Life Sciences (CSELS)
Faculty of Health and Life Sciences
Science and Health Building
Priory Street
Coventry University, CV1 5FB

Dear Sir/Madam:

[Insert date]

Re: The use of robotics in community pharmacy
I am writing to you in order to take part in a research study, investigating pharmacists' perception of the use of robotics in pharmacy. You are requested to answer questions relating to two different types of robotic dispensing methods:

- **Hub and spoke dispensing**: *"Prescriptions are received from the 'spoke' (pharmacy) and are sent electronically to the 'hub' (an off-site dispensary), where they are assembled (by a robotic dispensing unit) and returned back to the 'spoke' (pharmacy)."*
- **Pharmacy automation: "***The use of robots to handle and distribute medicines in pharmacy stores (on- site)."*

Background
In 2015, the Department of Health wrote a letter to all community pharmacies explaining the cuts in funding for community pharmacies/chemists falling from £2.8 billion-£2.63 billion. With these cuts, the Department of Health believe that efficiencies need to be made, such as lowering operating costs through large-scaled dispensing such as 'hub and spoke' arrangements. The idea behind introducing robotics in pharmacy is to free up the pharmacists' time to provide more healthcare to patients.
I would like you to take part in this questionnaire, to see your perceptions of the use of robotics in community pharmacy/chemists. This model of dispensing is being slowly rolled out and it is important to hear your views as this model will have a direct impact on you. The questionnaire should take around 15-20 minutes to fill out, a self-addressed envelope is enclosed and I would be grateful if you could return it to me by [**insert date here**]. The participation in this questionnaire study is voluntary and data from these surveys will be anonymous. This study has ethical approval from Coventry University.
If you have any queries or concerns please do not hesitate to contact me via email (gahiri@uni.coventry.ac.uk). I will look forward to receiving your completed questionnaire.

Yours sincerely,
Imandeep Kaur Gahir RPharmS

Appendix 2- Study One: participant information sheet (pilot study)

Study title: Community pharmacists' perceptions of hub and spoke dispensing and pharmacy automation in community pharmacies based in England.

Purpose of the study:
In 2014, the NHS rolled out a five-year plan to improve the way healthcare is delivered in England. In 2015, the Department of Health (DH) sent out a letter to all community pharmacies in England, stating cuts in the community pharmacy budget from 2.8 billion to 2.63 billion. With these budget cuts, the DH suggested efficiencies that needed to be made.
One suggestion was the introduction of large scaled dispensing, known as '*hub and spoke dispensing'*. The use of '*pharmacy automation'* is currently used in hospital pharmacy. Both these methods involve the use of robotics in preparing medicines against a prescription (also known as dispensing).
Hub and spoke dispensing can be defined as where:
'*Prescriptions received by 'spoke' (pharmacy) and are sent electronically to the 'hub'* ***(off-site dispensing robot)*** *where they are assembled and returned back to the 'spoke' (pharmacy)'*
Pharmacy automation can be defined as:
"*The use of robots* ***(on-site dispensing robot)*** *to handle and distribute medicines in pharmacy stores (on-site)"*
As part of my PhD, for this particular study I will be looking at community pharmacists' perceptions of the use of two different types of robotics in community pharmacy dispensing. I will be doing this by posting out questionnaires to community pharmacies in England.

Why have I been chosen?
The reason for your selection in this study, is to see your views on two different dispensing methods using robotics in community pharmacy: hub and spoke dispensing and pharmacy automation. As these new methods directly affect the general public, it is important to see their thoughts on these two methods of dispensing.

Do I have to take part?
No, Participants were randomly selected from electoral poll data, obtained from local authorities. Your participation in this survey is entirely voluntary and data from your responses will be anonymised. If you change your mind for taking part in this study, please contact myself via email and provide me with your participant information number. All your data will then be destroyed and not used as part of the study. If you decide not to participate there will be no consequences.

What will happen to me if I take part?
You will be posted a questionnaire to complete, which should take approximately 15 minutes. You will then need to post the questionnaire back, in the self-addressed envelope provided.

What are the possible disadvantages and risks of taking part?
Some of the questions may be a bit difficult to understand. I have tried to clearly explain the more technical words that aren't readily used outside a pharmacy setting, in more detail. If you don't understand a question there is a 'don't know' option. Another possible disadvantage, is that it may take you a little while to complete, the estimated time is around 15 minutes. However, it is a mainly a tick box questionnaire and very little writing is required.

What are the possible benefits of taking part?
As a member of the general public, your view on the new proposed methods of introducing robotics in community pharmacy is very important. As these potential future policy changes have a direct

impact upon the way medicines are prepared for yourself, it is important to see your views, for potential future policy developments. Taking part in this research, will be helpful for conducting my research and will be a way for you to be involved in useful research, especially with the current changes in healthcare.

What if something goes wrong?
If any changes happen in the study, I will contact you as soon as possible, using your method of contact as indicated on your consent from. As mentioned before, if you chose to change your mind about taking part in the study, please contact myself via email, with your participant identification number and you will then be withdrawn from the study and your results will be destroyed and not used in the study.

Will my taking part in the study be kept confidential?
Yes, only I will have access to the raw data. All consent forms and questionnaires will be locked in filing cabinets in key card accessed offices on Coventry University premises for 5 years. The questionaries' and consent forms will be stored in separate filing cabinets. Only my two research supervisors based at Coventry University, and I will have access to the filing cabinet.

Each questionnaire and consent form will have a participant identification number to anonymise the data. When the data is entered into a Microsoft excel spreadsheet, the data will be associated with a participant identification number, access to the file will, be password protected and only accessed by research supervisor and myself.

What will happen to the results of the research study?
Results from this study will be written up as part of my thesis for my PhD. Results may also be presented at academic conferences and/ or written for publication in peer reviewed academic journals.

Who is organising and funding the research?
The research is organised by myself, Imandeep Kaur Gahir, who is a PhD student at Coventry University, Health and Life Sciences. This project if not externally funded.

Who has reviewed the study?
This study has been through Coventry University Peer Review process and been approved.

Contact for further information
Imandeep Kaur Gahir
Email: gahiri@uni.coventry.ac.uk

Appendix 3- Study One: consent form and survey (pilot study)

Pharmacist survey

Centre for Sport, Exercise and Life Sciences (CSELS)
Faculty of Health and Life Sciences
Science and Health Building
Priory Street
Coventry
CV1 5FB

How Are We Doing?
Please take a few minutes to fill out this survey on your perceptions of the use of ‘hub and spoke dispensing’ and ‘pharmacy automation’ in pharmacy. The Centre for Sport, Exercise and Life Sciences appreciates your feedback and your answers will be kept confidential. Thank you for your participation.
Please **tick** the boxes below as appropriate.

I have read and I understand the participant information sheet for this study.	
By handing this questionnaire back to you, completed, I am giving my consent for you to use my questionnaire answers in this research study.	
I understand that I have the right to withdraw my questionnaire at any point, but contacting the researcher using the details on the participant information sheet and quoting the participant reference code written at the top of this questionnaire.	
I have made a note of my participant reference code	

Section 1: Occupational details

Q1a) What type of pharmacist are you?

☐ **Employed**
☐ **Locum**
☐ **Other (please state)…… …………**

Q1b) What type of community pharmacy do you work in? (Please tick all that apply)

☐ **Multiple community pharmacy (200 pharmacies or more i.e. boots, LLoydspharmacy, Superdrug etc.)**
☐ **Supermarket community pharmacy (i.e. Asda, Morrisons, Tesco etc.)**
☐ **Independent chain community pharmacy (6-200 pharmacies)**
☐ **Independent community pharmacy (5 pharmacies or less)**
☐ **Pharmacy head office**
☐ **Other (please state)…… ………**

Q1c) What additional qualifications/ annotations do you hold in addition to your MPharm degree? (Please tick all that apply)

☐ **Post graduate diploma**
☐ **MSc (excluding MPharm)**
☐ **PhD/ DPharm/ PharmD**
☐ **Supplementary prescriber**
☐ **Independent prescriber**
☐ **Other (please state)…… ………..**

Section 2: Pharmacy practice

Healthcare advice can be defined as:

'*Expert knowledge and suggestions on conditions and treatments*'

Q2a) During your current /immediate past shift as a pharmacist, how many staff members did you work with in the dispensary?

☐ **None**
☐ **1-2**
☐ **3-4**
☐ **4-5**
☐ **Above 5**

Q2b) During your current/immediate past shift as a pharmacist, on average how much time did you spend counselling each patient on their medication?

☐ **Up to 1 minute**
☐ **> 1 minute to 3 minutes**
☐ **> 3 minutes to 5minutes**
☐ **> 5 minutes**

Q2c) 'I feel I had enough time to give healthcare advice to patient's.' Do you agree or disagree with this statement?

☐ **Strongly agree**
☐ **Agree**
☐ **Neither agree nor disagree**
☐ **Disagree**
☐ **Strongly disagree**

Q2d) Do you believe pharmacists are spending too much time…? (Please tick appropriately)

Task	**Strongly agree**	**Agree**	**Neither agree nor disagree**	**Disagree**	**Strongly disagree**
☐ **Ordering medication**					
☐ **Dispensing/checking medication**					
☐ **Stock checks/ ordering stock**					
☐ **Administrative activities**					
☐ **Other activities (please state)………. …… …… …… …… …… …… ……………………….**					

Q2e) What barriers do you feel pharmacists face when providing healthcare advice to patients? (Please tick all that apply)

☐ **Staff shortages**
☐ **Lack of resources/space available**
☐ **Lack of personal motivation**
☐ **Fear of changing role**
☐ **Do not feel it is part of their job role**
☐ **Lack of understanding of healthcare advice**

Section 3: Dispensing

Q3a) During your current/ immediate past pharmacist shift, what format of prescriptions were received by the pharmacy?

☐ **Paper prescriptions**
☐ **Electronic prescriptions (Electronic Prescription Service – EPS)**
☐ **Other (please state)…….. ……….**

Waiting prescriptions can be defined as:

'*Prescriptions brought in and waited for to be dispensed and checked by the pharmacist*.'

Q3b) During your current/ immediate past pharmacist shift, how long were you instructing patients for prescription waiting times during busy time periods?

☐ **Below 5 minutes**
☐ **Up to 10 minutes**
☐ **Up to 15 minutes**
☐ **Over 15 minutes**

Q3c) How satisfied were you with the time you had available to check 'waiting prescriptions?'

☐ **Very satisfied**
☐ **Satisfied**
☐ **Neither satisfied nor dissatisfied**
☐ **Dissatisfied**
☐ **Very dissatisfied**

Q3d) What would you like to spend more time doing?

☐ **Giving healthcare advice**
☐ **Pharmacy services**
☐ **Joining other healthcare professionals in providing healthcare advice to patients**
☐ **Counselling patients on medication**
☐ **Other (please state)………**

Section 4: Hub & spoke dispensing

Hub and spoke dispensing is defined as:

*"Prescriptions are received from the '**spoke**' (pharmacy) and sent electronically to the '**hub**' (an off-site dispensary) where they are assembled (by a robotic dispensing unit) and returned back to the '**spoke**' (pharmacy)*

Q4a) Before reading the definitions above, had you ever heard of hub and spoke dispensing in pharmacy?

☐ **Yes**
☐ **No**

Trust and hub and spoke dispensing

Q4b) How much do you trust hub and spoke dispensing, in replacing the manual labour of pharmacy staff in dispensing medication?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**

Hub and spoke dispensing process

Q4c) What influence do you think hub and spoke dispensing will have on medication errors?

☐ **Increase in the rate of medication errors**
☐ **Decrease the rate of medication errors**
☐ **No influence on the rate of medication errors**
☐ **Do not know**

Q4d) How do you think the hub and spoke dispensing will influence the time taken to get prescription medications?

☐ **Increase the time taken to get prescription medications from the pharmacy**
☐ **Decrease the time taken to get prescription medications from the pharmacy**
☐ **No change to the time taken to get prescription medications from the pharmacy**
☐ **Do not know**

Pharmacy staff and hub and spoke dispensing
Q4e) Please indicate if you agree or disagree with the following statements.
Greater adoption of hub and spoke dispensing will…

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Lower operating costs	☐	☐	☐	☐	☐
Enable pharmacists to spend more time giving healthcare advice	☐	☐	☐	☐	☐
Lead to job losses amongst non-pharmacy staff	☐	☐	☐	☐	☐
Lead to job losses amongst pharmacists	☐	☐	☐	☐	☐
Change the job role of a pharmacist?	☐	☐	☐	☐	☐

Q4f) What impact do you think hub and spoke dispensing will have on the workload of pharmacists?

☐ **The workload of pharmacists will be hugely increased**
☐ **The workload of pharmacists will be increased**
☐ **The workload of pharmacists will neither be increased or decreased**
☐ **The workload of pharmacists will be decreased**
☐ **The workload of pharmacists will be hugely decreased**

Q4g) How much do you trust relying on another pharmacist to oversee the dispensing process at the hub, when the clinical check is done in store by the pharmacist in store?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**

Q4h) What potential problems do you see being associated with hub and spoke dispensing? (Please tick all that apply)

☐ **Prescription lost on travel**
☐ **Longer for patients to get medication**
☐ **Clinical check being done in store**
☐ **Other (please state)……….**

Q4i) What potential benefits do you see with hub and spoke dispensing? (Please tick all the apply)

☐ **Less time spent dispensing**
☐ **Having two different pharmacists overseeing checks at the hub and spoke**
☐ **More time for pharmacists to do utilize their clinical skills through services and advice**
☐ **Prescriptions being checked a numerous number of times**
☐ **Other (please state)……….**

Section 5: Pharmacy automation & Dispensing

Pharmacy automation is defined as:

"*The use of robots to handle and distribute medicines in pharmacy stores (on-site)*"?

Q5a) Before reading the definitions above, had you ever heard of the use of pharmacy automation in pharmacy?

☐ **Yes**
☐ **No**

Trust and pharmacy automation

Q5b) How much do you trust pharmacy automation, in replacing the manual labour of pharmacy staff in dispensing medication?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**

Pharmacy automation dispensing process

Q5c) What influence do you think pharmacy automation will have on medication errors?

☐ **Increase in the rate of medication errors**
☐ **Decrease the rate of medication errors**
☐ **No influence on the rate of medication errors**
☐ **Do not know**

Q5d) How do you think pharmacy automation will influence the time taken to get prescription medications?

☐ **Increase the time taken to get prescription medications from the pharmacy**
☐ **Decrease the time taken to get prescription medications from the pharmacy**
☐ **No change to the time taken to get prescription medications from the pharmacy**
☐ **Do not know**

Pharmacy staff and pharmacy automation

Q5e) Please indicate if you agree or disagree with the following statements.

Greater adoption of pharmacy automation will…

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Lower operating costs	☐	☐	☐	☐	☐
Enable pharmacists to spend more time giving healthcare advice	☐	☐	☐	☐	☐
Lead to job losses amongst non-pharmacy staff	☐	☐	☐	☐	☐
Lead to job losses amongst pharmacists	☐	☐	☐	☐	☐
Change the job role of a pharmacist?	☐	☐	☐	☐	☐

Q5f) What impact do you think pharmacy automation will have on the workload of pharmacists?

- ☐ **The workload of pharmacists will be hugely increased**
- ☐ **The workload of pharmacists will be increased**
- ☐ **The workload of pharmacists will be neither increased or decreased**
- ☐ **The workload of pharmacists will be decreased**
- ☐ **The workload of pharmacists will be hugely decreased**

Q5g) What potential problems do you think pharmacy automation will have?

- ☐ **Takes up too much space in the pharmacy**
- ☐ **Looks unappealing in the pharmacy**
- ☐ **Patients may be less likely to come into a pharmacy with a robotic dispensing machine**
- ☐ **Other (please state)……….……….**

Q5h) What benefits do you think pharmacy automation will have?

- ☐ **Patients more likely to come into the pharmacy**
- ☐ **Makes the pharmacy look more appealing**
- ☐ **Shows the advancement of pharmacy with technology user**
- ☐ **Other (please state)……….……….**

Section 6: Hub and spoke dispensing & pharmacy automation

Q6a) How much do you trust the accuracy of medication of robot in dispensing medication?

- ☐ **Strongly trust**
- ☐ **Trust**
- ☐ **Neither trust nor distrust**
- ☐ **Distrust**
- ☐ **Strongly distrust**

Q6b) What type of errors do you think are more likely to occur with the implementation of a dispensing robot?

- ☐ **Errors with stock count**
- ☐ **Errors with filling up the dispensing robot with stock**
- ☐ **Technical errors (malfunctioning in the robotic dispensing machine)**
- ☐ **Medication errors (wrong drug/wrong strength/ wrong dose)**
- ☐ **Other (please state)……**

Q6c) What implication do you think a dispensing robot will have upon the productivity upon dispensing prescriptions?

- ☐ **The productivity will be hugely increased**
- ☐ **The productivity will be increased**
- ☐ **The productivity will neither be increased or decreased**
- ☐ **The productivity will be decreased**
- ☐ **The productivity will be hugely decreased**

Q6d) 'Robotic dispensing in pharmacy will hinder patients from using the pharmacy.' Do you agree or disagree with this claim?

- ☐ **Strongly agree**
- ☐ **Agree**
- ☐ **Neither agree nor disagree**
- ☐ **Disagree**
- ☐ **Strongly disagree**

Section 7: Health care

Q7a) What impact do you think hub and spoke dispensing and pharmacy automation will have on the quality of health care services provided by pharmacists?

- ☐ **The quality of health care services provided by pharmacists will be improved**
- ☐ **The quality of health care services provided by pharmacists will be slightly improved**
- ☐ **The quality of health care services provided by pharmacists will neither improve or be reduced**
- ☐ **The quality of health care services provided by pharmacists will be slightly reduced**
- ☐ **The quality of health care services provided by pharmacists will be reduced**

Q7b) Would you prefer dispensing to be done on-site or off-site?

- ☐ **I would prefer dispensing to be done on-site**
- ☐ **I do not mind where dispensing takes place**
- ☐ **I would prefer dispensing to be done off-site**

Q7c) What type of dispensing method would you prefer?

- ☐ **Current method of dispensing**
- ☐ **Hub and spoke dispensing**
- ☐ **Pharmacy automation**
- ☐ **Either hub and spoke dispensing or pharmacy automation**
- ☐ **I do not mind**

Q7d) Any, other comments you have regarding hub and spoke dispensing or pharmacy automation?

Section 8: Demographic details

Q8a) What is your age?

- ☐ **18 years or under**
- ☐ **19-25 years**
- ☐ **26-39 years**
- ☐ **40-59 years**
- ☐ **60 years and over**

Q8b) What is your sex?

- ☐ **Male**
- ☐ **Female**
- ☐ **Prefer not to say**

Q8c) What ethnicity best describes you?

White

- ☐ **British**
- ☐ **Any other White background**

Black or Black British

- ☐ **Caribbean**
- ☐ **African**
- ☐ **Other Black background (please state)**

Mixed

- ☐ **White and Black Caribbean**
- ☐ **White and Black African**
- ☐ **White and Asian**
- ☐ **Any other Mixed background (please state)**

Asian
☐ **Indian**
☐ **Pakistani**
☐ **Bangladeshi**
☐ **Asian or Asian British**
☐ **Any other Asian background (please state)**

Chinese or other ethnic group
☐ **Chinese**
☐ **Any other ethnic group (please state)**

☐ **Prefer not to say**

Q8d) In England, what region are you currently working in?
☐ **North East**
☐ **North West**
☐ **Yorkshire and Humberside**
☐ **East Midlands**
☐ **West Midlands**
☐ **East of England**
☐ **London**
☐ **South East**
☐ **South West**

For pilot study, online
Please make note of any comments you wish to make about this questionnaire
(any suggestions you have to improve the questionnaire).

Appendix 4- Study Two: cover letter (pilot study)

Imandeep Kaur Gahir, Coventry University
Centre for Sport, Exercise and Life Sciences (CSELS)
Faculty of Health and Life Sciences
Room 3.07, Science and Health Building,
Priory Street, CV1 5FB

Dear Sir/Madam: 17th August 2018

Re: Pilot study: The use of robotics in community pharmacy

I am writing to you to take part in a research **pilot/test** study investigating the general public perception of the use of robotics in pharmacy. You are requested to answer questions relating to two different types of robotic dispensing methods:

- **Hub and spoke dispensing**: *"Prescriptions are received from the 'spoke' (pharmacy) and are sent electronically to the 'hub' (an off-site dispensary), where they are assembled (by a robotic dispensing unit) and returned back to the 'spoke' (pharmacy)."*
- **Pharmacy automation: "***The use of robots to handle and distribute medicines in pharmacy stores (on- site)."*

Background

In 2015, the Department of Health wrote a letter to all community pharmacies explaining the cuts in funding for community pharmacies/chemists falling from £2.8 billion- £2.63 billion. With these cuts, the Department of Health believe that efficiencies need to be made, such as lowering operating costs through large-scaled dispensing such as 'hub and spoke' arrangements. The idea behind introducing robotics in pharmacy is to free up the pharmacists' time to provide more healthcare to patients.

I would like you to take part in this questionnaire, to see your perceptions of the use of robotics in community pharmacy/chemists. This model of dispensing is slowly being rolled out and it is important to hear your views, as this model will have a direct impact on you. The questionnaire should take around 15-20 minutes to fill out, a pre-paid self-addressed envelope is enclosed, and I would be grateful if you could return it to me by approximately

The participation in this questionnaire study is voluntary and data from these surveys will be anonymous. No personal or sensitive information will be disclosed in this research. This study has ethical approval from Coventry University (P61622).

PILOT STUDY USE ONLY - This is a pilot/test survey, so please feel free to annotate the survey as you go along and fill in the comments box at the end, for any improvements you suggest, such as making things easier to understand for the main survey. If you have any queries or concerns, or prefer not to be contacted, please do not hesitate to contact me via email (gahiri@uni.coventry.ac.uk). I will remove you from future postings if you do not want to be contacted.

I will look forward to receiving your completed pilot survey, suggesting improvements that need to be made. Thank you for your time.

Yours sincerely,

Imandeep Kaur Gahir RPharmS

Appendix 5- Study Two: participant information sheet (pilot study)

You are being invited to take part in research on the general public perception of using robotics in community pharmacy. Imandeep Kaur Gahir, a pharmacist and PhD student at Coventry University is leading this research. Before you decide to take part, it is important you understand why the research is being conducted and what it will involve. Please take time to read the following information carefully.

Study title: The general public perception of using hub and spoke dispensing and pharmacy automation, in community pharmacies in England.

Purpose of the study:
In 2014, the NHS rolled out a five-year plan to improve the way healthcare is delivered in England. In 2015, the Department of Health (DH) sent out a letter to all community pharmacies in England, stating cuts in the community pharmacy budget from 2.8 billion to 2.63 billion. With these budget cuts, the DH suggested efficiencies that needed to be made.

One suggestion was the introduction of large scaled dispensing, known as '*hub and spoke dispensing'*. The use of '*pharmacy automation'* is currently used in hospital pharmacy. Both these methods involve the use of robotics in preparing medicines against a prescription (also known as dispensing).

Hub and spoke dispensing can be defined as where:
'*Prescriptions received by 'spoke' (pharmacy) and are sent electronically to the 'hub' (off-site dispensing robot) where they are assembled and returned back to the 'spoke' (pharmacy)'*

Pharmacy automation can be defined as:
"*The use of robots (on-site dispensing robot) to handle and distribute medicines in pharmacy stores (on-site)"*
As part of my PhD, for this particular study I will be looking at the general public perception of the use of two different types of robotics in community pharmacy dispensing (the making up of medicine against a prescription). I will be doing this by posting out questionnaires to the general public.

Why have I been chosen?
The reason for your selection in this study, is to assess your views on two different dispensing methods, using robotics in community pharmacy: hub and spoke dispensing and pharmacy automation. As these new methods directly affect the general public, it is important to evaluate your thoughts on these two methods of dispensing. You were randomly selected from electoral roll data, which was obtained from the open register (which you are a part of) in the local authority, in which you live within.

Do I have to take part?
No, you do not have to take part. Participants were randomly selected from electoral poll data, obtained from local authorities for the purpose of conducting research for public interest. Your participation in this survey is entirely voluntary and data from your responses will be anonymised. If at any time (up to the date when data are fully anonymised) you decide you do not wish to take part, please contact myself via email and provide me with your participant reference number. You are free to withdraw your information from the project data set at any time up until the data are fully anonymised in our records, which is stated on the consent form. All your data will then be destroyed and not used as part of the study. If you decide not to participate there will be no

consequences. You should note that your data may be used in the production of formal research outputs (e.g. journal articles, conference papers, theses and reports) prior to this date and so you are advised to contact the university at the earliest opportunity should you wish to withdraw from the study. To withdraw, please contact the lead researcher (contact details are provided below). Please also contact the Research Support Office at ethics.hls@coventry.ac.uk so that your request can be dealt with promptly in the event of the lead researcher's absence. You do not need to give a reason. A decision to withdraw, or not to take part, will not affect you in any way.

What will happen to me if I take part?
You will be asked to complete a questionnaire, which should take approximately 15 minutes. You will then need to post the questionnaire back, in the prepaid self-addressed envelope provided.

What are the possible disadvantages and risks of taking part?
This study has been reviewed and approved through Coventry University's formal research ethics procedure. There are no significant risks associated with participation. Some of the questions may be a bit difficult to understand. The leader researcher has tried to clearly explain the more technical words that aren't readily used outside a pharmacy setting, in more detail. If you don't understand a question there is a 'don't know' option for some questions. Another possible disadvantage, is that it may take you a little while to complete, the estimated time is around 15 minutes. However, it is a mainly a tick box questionnaire and very little writing is required.

What are the possible benefits of taking part?
As a member of the general public, your view on the new proposed methods of introducing robotics in community pharmacy is very important. As these potential future policy changes have a direct impact upon the way medicines are prepared for yourself, it is important to see your views, for potential future policy developments. Taking part in this research, will be helpful for conducting my research and will be a way for you to be involved in useful research, especially with the current changes in healthcare. It gives you a chance to have your say in the new proposed methods of dispensing.

What if something goes wrong?
If any changes happen in the study, the lead researcher will contact you as soon as possible, using your method of contact as indicated on your consent from. As mentioned before, if you chose to change your mind about taking part in the study, please contact myself via email, with your participant reference number. You are free to withdraw your information from the project data set at any time up until the data are fully anonymised in our records, which is stated on the consent form. You will then be withdrawn from the study and your results will be destroyed and not used in the study.

Will my taking part in the study be kept confidential?
Yes, data will be processed in accordance with the Data Protection Act 1998 (up until 24th May 2018) and the General Data Protection Regulation 2016 (GDPR) thereafter. All information collected about you will be kept strictly confidential and only the lead researcher and the lead researcher's supervisors will have access to the raw data. Unless they are fully anonymised in our records, your data will be referred to by a unique participant reference number rather than by name. All consent forms and questionnaires will be locked securely in filing cabinets on Coventry University premises for 5 years after the project has finished. The questionaries' and consent forms will be stored in separate filing cabinets in order to minimise risk in the event of a data breach.
Each questionnaire and consent form will have a participant reference number to anonymise the data. When the data is entered into a Microsoft excel spreadsheet, the data will be associated with a participant identification number, access to the file will, be password protected and only accessed

by research supervisors and the lead researcher. The lead researcher will take responsibility for data destruction and all collected data will be destroyed securely on or before 30th September 2024.

Data Protection Rights
Coventry University and the lead researcher are Data Controllers for the information you provide. You have the right to access information held about you. Your right of access can be exercised in accordance with the Data Protection Act 1998 (up until 24th May 2018) and the General Data Protection Regulation thereafter. You also have other rights including rights of correction, erasure, objection, and data portability, up to the point when the data you provide is anonymised. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer - enquiry.ipu@coventry.ac.uk or myself as the researcher.

What will happen to the results of the research study?
Results from this study will be written up as part of my thesis for my PhD. Results may also be presented at academic conferences and/ or written for publication in peer reviewed academic journals, reports and presentations. Quotes or key findings will always be made anonymous in any formal outputs.

Making a Complaint
If you are unhappy with any aspect of this research, please first contact the lead researcher, Imandeep Kaur Gahir, email: gahiri@uni.coventry.ac.uk. If you still have concerns and wish to make a formal complaint, please write to Professor Oliver Sparagano.

Professor Oliver Sparagano
Associate Pro-Vice-Chancellor (Research)
Coventry University
Coventry CV1 5FB
Email: Olivier.Sparagano@coventry.ac.uk
In your letter please provide information about the research project, specify the name of the researcher and detail the nature of your complaint.

Who is organising and funding the research?
The research is organised by myself, Imandeep Kaur Gahir, who is a PhD student at Coventry University, Health and Life Sciences. This project is not externally funded.

Who has reviewed the study?
This study has been through Coventry University Peer Review process, project: P61622 and has been approved.

Contact for further information

Lead Researcher: Imandeep Kaur Gahir
Role: PhD student/pharmacist
Email: gahiri@uni.coventry.ac.uk
Room 3.07, Science and Health Building
Science and Health Building
Priory Street, Coventry
CV1 5FB

Director of studies: Dr Afthab Hussain
Role: Course Director MSc Pharmacology and Drug Discovery
Email: apx301@coventry.ac.uk
Science and Health Building
Priory Street, Coventry
CV1 5FB

Appendix 6: Study Two: consent form and survey (pilot study)

Participant reference number:-
…….

You are invited to take part in this research study for the purpose of collecting data on the general public perception of using **robotics** in community pharmacy dispensing such as **'hub and spoke dispensing' and 'pharmacy automation'.** Before you decide to take part, you must **read the accompanying Participant Information Sheet.**

Please do not hesitate to ask questions if anything is unclear or if you would like more information about any aspect of this research. It is important that you feel able to take the necessary time to decide whether or not you wish to take part. If you are happy to participate, please confirm your consent by **circling YES** against each of the below statements and then signing and dating the form as participant. Thank you for your participation in this study. Your help is much appreciated.

1	**I confirm that I have read and understood the Participant Information Sheet for the above study and have had the opportunity to ask questions**	**YES**	**NO**
2	**I understand my participation is voluntary and that I am free to withdraw my data, without giving a reason, by contacting the lead researcher and the Research Support Office at any time up until the date of** 30th November 2018.	**YES**	**NO**
3	**I have noted down my participant number (top left of this Consent Form) which may be required by the lead researcher if I wish to withdraw from the study**	**YES**	**NO**
4	**I understand that all the information I provide will be held securely and treated confidentially**	**YES**	**NO**
5	**I am happy for the information I provide to be used (anonymously) in academic papers and other formal research outputs**	**YES**	**NO**
6	**I agree to take part in the above study**	**YES**	**NO**

Participant's Name	**Date**	**Signature**
Researcher	**Date**	**Signature**

Section 1: Occupational details

Q1a) What best describes your employment status?

☐ **Employed**
☐ **Self-employed**
☐ **Unemployed and currently looking for work**
☐ **Unemployed and not currently looking for work**
☐ **Student**
☐ **Retired**
☐ **Unable to work**
☐ **Homemaker**
☐ **Other (please state)……**

Q1b) What is the highest level of education you have completed?

☐ **Primary school**
☐ **Secondary school**
☐ **Sixth form/college level**
☐ **Bachelor's degree or equivalent**
☐ **Master's degree or equivalent**
☐ **Doctoral or equivalent**
☐ **Post-doctoral or equivalent**
☐ **None of the above**
☐ **Other (please state)………**

Section 2: Pharmacy user

Q2a) Have you used a pharmacy in the past 12 months? (If **yes,** please move to question **2b**, if **no**, please move to question **2e**)

☐ **Yes**
☐ **No**

Q2b) What type of community pharmacy/ chemist did you last visit?

☐ **Multiple community pharmacy (i.e. company owns 200 pharmacies or more Boots, LloydsPharmacy, Superdrug etc.)**
☐ **Supermarket community pharmacy (i.e. Asda, Morrisons, Tesco etc.)**
☐ **Independent community pharmacy chain/ independent community pharmacy**
☐ **I do not know**
☐ **Other (please state)………**

Q2c) What do you use a pharmacy for? (Please tick all that apply)

Medical	**Non-medical**
☐ **Prescriptions**	☐ Purchase non-medical items i.e. food and drink
☐ **Purchase over the counter medication**	☐ Disposal of unwanted medicines

☐ **Healthcare services**	☐ Other (please state)………………………………….
☐ **Advice on a healthcare problem**	**If any of these options from this section ONLY have been ticked please move to question 2e**
☐ **Other (please state)……………………………….**	
If any of these options from this section ONLY have been ticked please move to question 2d	
If options have been ticked from the Healthcare and medicines section and Non-medical section – please complete both 2d and 2e	

Q2d) Healthcare and medicines - During the last time you visited a pharmacy, do you feel you were given enough time to speak to the pharmacy staff (including the pharmacist)?

☐ **Strongly agree**
☐ **Agree**
☐ **Neither agree nor disagree**
☐ **Disagree**
☐ **Strongly disagree**

Q2e) Do you believe that pharmacists have enough time to provide healthcare advice to patients?

☐ **Strongly agree**
☐ **Agree**
☐ **Neither agree nor disagree**
☐ **Disagree**
☐ **Strongly disagree**

Q2f) Research suggests that due to time constraints, pharmacists do not have enough time to provide health care to patients. Why do you think this is? (Please tick all that apply)

☐ **Too much time spent checking medications in the dispensary (back of pharmacy)**
☐ **Staff shortages**
☐ **Too much time spent doing other activities**
☐ **Other (please state)……….……….**

Q2g) Apart from doctors, where do you normally get your healthcare advice from? (Please tick all that apply)

☐ **Pharmacies**
☐ **NHS walk-in Centre**
☐ **Accident and emergency (A&E)**
☐ **Online medical websites (i.e. NHS Choices, Mayoclinic, patient.co.uk etc.)**
☐ **Online pharmacy websites (i.e. Boots, LLoydspharmacy etc.)**
☐ **NHS 111/ other non-emergency telephonic healthcare advice services**
☐ **Other (please state)……….……….**

Section 3: Dispensing

Dispensing is defined by:

'*The making up and giving out of medicines, according to a prescription by a prescriber (i.e. doctor, dentist, nurse etc.)*'

Q3a) Have you ever used a pharmacy to get a prescription medication? (If **yes**, please move to **question 3b**; if **no**, please move to section 4)

☐ Yes

☐ No

Q3b) How did the prescription get to the pharmacy?

☐ **It was collected by myself and brought to the pharmacy**	**Please move to question 3c)**
☐ **It was collected on behalf of myself and brought to the pharmacy**	Please move to question 3e)
☐ **It was collected by the pharmacy staff**	
☐ **It was sent electronically from the prescriber (i.e. doctor, dentist, nurse etc.) to the pharmacy**	
☐ **Other (please state)……**	

Q3c) If you collected the prescription yourself, did you wait for the prescription or call back later?

☐ **I waited up to 30 minutes**
☐ **I waited over 30 minutes**
☐ **I called back for my prescription later**
☐ **I get my prescription delivered**
☐ **Other (please state)……..**

Q3d) How satisfied were you with the time it took to get your medication?

☐ **Very satisfied**
☐ **Satisfied**
☐ **Neither satisfied nor dissatisfied**
☐ **Dissatisfied**
☐ **Very dissatisfied**

Medication errors

Q3e) Have you ever experienced a medication error **(wrong dose/ strength or wrong medicine)**? (If **yes**, please move to **question 3f**; if **no**, please move to **section 4**)

☐ **Yes**
☐ **No**

Q3f) What type of error did you experience?

☐ **Right drug, wrong instructions (dose)**
☐ **Right drug, wrong strength of drug**
☐ **Wrong drug**
☐ **Right drug, wrong dispensing label**
☐ **Other (please state)……..**

Q3g) When did you realise the medication error had occurred?

☐ **Before taking the medication**
☐ **After taking the medication**
☐ **Other (please state)……….**

Q3h) Would you go back to the pharmacy/prescriber again?

☐ **I would go back to the pharmacy/prescriber again**
☐ **I would not go back to the pharmacy/prescriber again**
☐ **I do not know**
☐ **Other (please state)……….**

Q3i) After experiencing the error, how much would you trust the pharmacy/prescriber again?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**
☐ **I do not know**

Section 4: Hub & spoke dispensing

Hub and spoke dispensing is defined by:
*"Prescriptions are received from the '**spoke**' (pharmacy) where they are clinically checked by a pharmacist, and sent electronically to the '**hub**' (an off-site dispensary) where they are assembled (by a robotic dispensing unit), under the supervision of another pharmacist and returned back to the '**spoke**' (pharmacy)"*

Q4a) Before reading the definition above, had you ever heard of hub and spoke dispensing in pharmacy?

☐ **Yes**
☐ **No**

Trust and hub and spoke dispensing
Q4b) How much do you trust hub and spoke dispensing, in replacing the manual labour of pharmacy staff in dispensing medication?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**
☐ **Do not know**

Q4c) How much do you trust your medication being made up **off-site (not in the pharmacy)** using a robotic dispensing machine?

☐ **Strongly trust**

☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**
☐ **Do not know**

Hub and spoke dispensing process

Q4d) What influence do you think hub and spoke dispensing will have on medication errors? (Please tick the most appropriate response)

☐ **Increase in the rate of medication errors**
☐ **Decrease the rate of medication errors**
☐ **No influence on the rate of medication errors**
☐ **Do not know**

Q4e) How do you think hub and spoke dispensing will influence the time taken to get prescription medications? (Please tick the most appropriate response)

☐ **Increase the time taken to get prescription medications from the pharmacy**
☐ **Decrease the time taken to get prescription medications from the pharmacy**
☐ **No change to the time taken to get prescription medications from the pharmacy**
☐ **Do not know**

Pharmacy staff and hub and spoke

Q4f) To what extent do you think hub and spoke dispensing will replace the job roles of pharmacists, with the majority of dispensing being done at a different site?

☐ **It will replace all pharmacists/ pharmacy staff job roles**
☐ **It will replace most of the job roles of pharmacists/ pharmacy staff**
☐ **It will replace some of the job roles of pharmacists/ pharmacy staff**
☐ **It will not replace the job roles of pharmacists/ pharmacy staff**
☐ **I do not know**

Q4g) Hub and spoke dispensing is claimed to give pharmacists more time to provide health care services. With regards to hub and spoke dispensing, do you agree or disagree with this claim?

☐ **Strongly agree**
☐ **Agree**
☐ **Neither agree nor disagree**
☐ **Disagree**
☐ **Strongly disagree**

Section 5: Pharmacy automation & Dispensing

Pharmacy automation is defined as:

"*The use of robots to handle and distribute medicines in pharmacy stores (on-site)"*?

Q5a) Before reading the definition above, had you ever heard of the use of pharmacy automation in pharmacy?

☐ **Yes**
☐ **No**

Trust and pharmacy automation

Q5b) How much do you trust pharmacy automation, in replacing the manual labour of pharmacy staff in dispensing medication?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**
☐ **Do not know**

Q5c) How much do you trust your medication being made up **on-site (in the pharmacy)** using a robotic dispensing machine?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Do not know**

Pharmacy automation dispensing process

Q5d) What influence do you think pharmacy automation will have on medication errors? (Please tick the most appropriate response)

☐ **Increase in the rate of medication errors**
☐ **Decrease the rate of medication errors**
☐ **No influence on the rate of medication errors**
☐ **Do not know**

Q5e) How do you think pharmacy automation will influence the time taken to get prescription medications? (Please tick the most appropriate response)

☐ **Increase the time taken to get prescription medications from the pharmacy**
☐ **Decrease the time taken to get prescription medications from the pharmacy**
☐ **No change to the time taken to get prescription medications from the pharmacy**
☐ **Do not know**

Pharmacy staff and pharmacy automation

Q5f) To what extent do you think pharmacy automation will replace the job roles of pharmacists, with dispensing being done by a robot in the pharmacy?

☐ **It will replace all pharmacists/ pharmacy staff job roles**
☐ **It will replace most of the job roles of pharmacists/ pharmacy staff**
☐ **It will replace some of the job roles of pharmacists/ pharmacy staff**
☐ **It will not replace the job roles of pharmacists/ pharmacy staff**
☐ **I do not know**

Q5g) Pharmacy automation is claimed to give pharmacists more time to provide health care services. With regards to pharmacy automation, do you agree or disagree with this claim?

☐ **Strongly agree**
☐ **Agree**
☐ **Neither agree nor disagree**
☐ **Disagree**
☐ **Strongly disagree**

Section 6: Hub and spoke dispensing & pharmacy automation

Q6a) How much do you trust the accuracy of robots in dispensing medication?

☐ **Strongly trust**

☐ Trust
☐ Neither trust nor distrust
☐ Distrust
☐ Strongly distrust
☐ Do not know

Q6b) What type of errors do you think are more likely to occur with the implementation of a dispensing robot? (Please tick all that apply)

☐ Errors with stock count
☐ Errors with filling up the dispensing robot with stock
☐ Technical errors (malfunctioning in the robotic dispensing machine)
☐ Medication errors (wrong drug/wrong strength/ wrong dose)
☐ Do not know
☐ Other (please state)…… ………..

Q6c) What implication do you think a dispensing robot will have upon the productivity upon dispensing prescriptions? (Please tick the most appropriate response)

☐ The productivity will be hugely increased
☐ The productivity will be increased
☐ The productivity will neither be increased or decreased
☐ The productivity will be decreased
☐ The productivity will be hugely decreased
☐ Do not know

Q6d) 'Robotic dispensing in pharmacy will hinder patients from using the pharmacy.' Do you agree or disagree with this claim?

☐ Strongly agree
☐ Agree
☐ Neither agree nor disagree
☐ Disagree
☐ Strongly disagree
☐ Do not know

Section 7: Healthcare

Q7a) What method of dispensing do you think is most likely to provide pharmacists more time to provide healthcare to patients?

☐ Current method of dispensing
☐ Hub and spoke dispensing
☐ Pharmacy automation
☐ Either hub and spoke dispensing or pharmacy automation
☐ I do not know
☐ None of the above

Q7b) If, Hub and spoke dispensing or pharmacy automation, provided pharmacists with more time to provide health care services, what types of services would you like pharmacists to provide? (Please tick all that apply)

☐ Minor ailment scheme

☐ **Patient group directive such as morning after pill**
☐ **Out of hours support**
☐ **Medicines assessment and compliance support**
☐ **On demand availability of specialist drugs**
☐ **Gluten free food supply**
☐ **Disease specific medicines management**
☐ **INR monitoring (i.e. for oral anticoagulants such as warfarin)**
☐ **Independent prescribing by pharmacists**
☐ **Needle and syringe exchange**
☐ **Stop smoking**
☐ **Supervised consumption**
☐ **Other (please state)……….**

Q7c) What impact do you think hub and spoke dispensing and pharmacy automation will have on the quality of health care services provided by pharmacists? (Please tick the most appropriate response)

☐ **The quality of health care services provided by pharmacists will be improved**
☐ **The quality of health care services provided by pharmacists will be slightly improved**
☐ **The quality of health care services provided by pharmacists will neither improve or be reduced**
☐ **The quality of health care services provided by pharmacists will be slightly reduced**
☐ **The quality of health care services provided by pharmacists will be reduced**

Q7d) Would you prefer dispensing to be done on-site or off-site?

☐ **I would prefer dispensing to be done on-site**
☐ **I do not mind where dispensing takes place**
☐ **I would prefer dispensing to be done off-site**

Q7e What type of dispensing method would you prefer?

☐ **Current method of dispensing**
☐ **Hub and spoke dispensing**
☐ **Pharmacy automation**
☐ **Either hub and spoke dispensing or pharmacy automation**
☐ **I do not mind**
☐ **None of the above**

Q7f) Any, other comments you have regarding hub and spoke dispensing or pharmacy automation?

Section 8: Demographic details
Q8a) What is your age?

☐ **18-25 years**

☐ **26-39 years**
☐ **40-59 years**
☐ **60 years and over**
☐ **Prefer not to say**

Q8b) What is your sex?

☐ **Male**
☐ **Female**
☐ **Prefer not to say**

Q8c) Which ethnicity best describes you?

White ☐ **British** ☐ **Any other White background (please state)………**
Black or Black British ☐ **Caribbean** ☐ **African** ☐ **Any other Black background (please state)……..**
Mixed ☐ **White and Black Caribbean** ☐ **White and Black African** ☐ **White and Asian** ☐ **Any other Mixed background (please state)…….**
Asian ☐ **Indian** ☐ **Pakistani** ☐ **Bangladeshi** ☐ **Asian or Asian British** ☐ **Any other Asian background (please state)……**
Chinese or other ethnic group ☐ **Chinese** ☐ **Any other ethnic group (please state)……**
☐ **Prefer not to say**

Q8d) In England, what region do you live in?

☐ **North East**
☐ **North West**
☐ **Yorkshire and Humberside**

☐ **East Midlands**
☐ **West Midlands**
☐ **East of England**
☐ **London**
☐ **South East**
☐ **South West**

For pilot study
Please make note of any comments you wish to make about this questionnaire (any suggestions you have to improve the questionnaire).

On average, how long did it take you to complete the questionnaire?

☐ **Up to 5 minutes**
☐ **Up to 10 minutes**
☐ **Up to 15 minutes**
☐ **Up to 20 minutes**
☐ **Above 20 minutes**

Appendix 7 – Study One: cover letter (main study)

Coventry University, Imandeep Kaur Gahir
Centre for Sport, Exercise and Life Sciences (CSELS)
Faculty of Health and Life Sciences
Science and Health Building
Room 3.07
Much Park Street, Coventry
CV1 2DS

Dear Pharmacist: Date

Re: The use of robotics in community pharmacy

I am writing to you in order to take part in a research study investigating pharmacists' perceptions of the use of robotics in pharmacies. You are requested to answer questions relating to two different types of robotic dispensing methods:

Hub and spoke dispensing: *"Prescriptions are received from the 'spoke' (pharmacy) and are sent electronically to the 'hub' (an off-site dispensary), where they are assembled (by a robotic dispensing unit) and returned back to the 'spoke' (pharmacy)."*

Pharmacy automation: "*The use of robots to handle and distribute medicines in pharmacy stores (on- site)."*

Background

In 2015, the Department of Health wrote a letter to all community pharmacies explaining the cuts in funding for community pharmacies/chemists falling from £2.8 billion-£2.63 billion. With these cuts, the Department of Health believe that efficiencies need to be made, such as lowering operating costs through large-scaled dispensing such as 'hub and spoke' arrangements. The idea behind introducing robotics in pharmacy, is to free up the pharmacists' time to provide more healthcare to patients.

I would like you to take part in this questionnaire, to understand your perceptions regarding the use of robotics in community pharmacy/chemists. This model of dispensing is being slowly rolled out and it is important to hear your views as this model will have a direct impact on you. The questionnaire should take around 15-20 minutes to fill out, a pre-paid, self-addressed envelope is enclosed, and I would be grateful if you could return it to me by approximately: (insert data)The participation in this questionnaire study is voluntary and data from these surveys will be anonymous. This study has ethical approval from Coventry University (P61622). If you have any queries or concerns, please do not hesitate to contact me via email (gahiri@uni.coventry.ac.uk). I look forward to receiving your completed questionnaire.

Yours sincerely,

Imandeep Kaur Gahir RPharmS

Appendix 8- Study One: Participant information sheet (main study)

Study title:
Community pharmacists' perceptions of hub and spoke dispensing and pharmacy automation in community pharmacies based in England.

Purpose of the study:
In 2014, the NHS rolled out a five-year plan to improve the way healthcare is delivered in England. In 2015, the Department of Health (DH) sent out a letter to all community pharmacies in England, stating cuts in the community pharmacy budget from 2.8 billion to 2.63 billion. With these budget cuts, the DH suggested efficiencies that needed to be made.
One suggestion was the introduction of large scaled dispensing, known as '*hub and spoke dispensing*'. The use of '*pharmacy automation*' is currently used in hospital pharmacy. Both these methods involve the use of robotics in dispensing medicines.

Hub and spoke dispensing can be defined as where:
'*Prescriptions are received by 'spoke' (pharmacy) and are sent electronically to the 'hub'* ***(off-site dispensing robot)*** *where they are assembled and returned back to the 'spoke' (pharmacy)'*

Pharmacy automation can be defined as:
"*The use of robots* ***(on-site dispensing robot)*** *to handle and distribute medicines in pharmacy stores (on-site)"*

As part of my PhD, for this particular study I will be looking at community pharmacists' perceptions of the use of two different types of robotics in community pharmacy dispensing. I will be doing this by posting out questionnaires to community pharmacies in England.

Why have I been chosen?
The reason for your selection in this study, is to see your views on using different robotic dispensing in community pharmacy: hub and spoke dispensing and pharmacy automation. As these new methods directly affect your profession, it is important to see your thoughts on these two methods of dispensing.

Do I have to take part?
No, your participation in this survey is entirely voluntary and data from your responses will be anonymised so that they cannot be attributable to you. If you change your mind and decide you no longer wish to take part in this study, you can do so at any time and without question or reason. Please contact me via email and provide me with your participant information number in order for all your data to be destroyed and not used as part of the study.

What will happen to me if I take part?
You will be posted a questionnaire to complete, which should take approximately 15 minutes. You will then need to post the questionnaire back, using the pre-paid self-addressed envelope provided.

What are the possible disadvantages and risks of taking part?
All due care has been taken to ensure the questions and information provided are as understandable as possible. If you don't understand a question or would prefer not to answer a certain question, there is a 'do not know' option for you to use. The estimated survey time is around 15 minutes;

however, it can be completed in less. Questions are presented mainly as a tick box questionnaire and very little writing is required for your convenience.

What are the possible benefits of taking part?
As a community pharmacist, your view on the new proposed methods of introducing robotics in community pharmacy is very important. As these potential future policy changes have a direct impact upon the way medicines are prepared, it is important to appreciate and account for your views in potential future policy developments. Taking part in this research will not only be helpful for conducting my research, but also be a way for you to engage in topical and important changes to your profession and the way you deliver healthcare.

What if something goes wrong?
As mentioned before, if you chose to change your mind about taking part in the study, please contact myself via email, with your participant identification number and you will then be withdrawn from the study and your results will be destroyed and not used in the study.

Will my taking part in the study be kept confidential?
Yes, only I will have access to the raw data. All consent forms and questionnaires will be locked in filing cabinets in key card accessed offices on Coventry University premises for 5 years. The questionaries' and consent forms will be stored in separate filing cabinets. Only my two research supervisors based at Coventry University, and I will have access to the filing cabinet.

Each questionnaire and consent form will have a participant identification number to anonymise the data. When the data is entered into a Microsoft excel spreadsheet, the data will be associated with a participant identification number, access to the file will, be password protected and only accessed by research supervisor and myself.

What will happen to the results of the research study?
Results from this study will be written up as part of my PhD thesis. Results may also be presented at academic conferences and/or written for publication in peer reviewed academic journals. All data will be anonymised prior to any dissemination.

Who is organising and funding the research?
The research is organised by myself, Imandeep Kaur Gahir, a Pharmacist and PhD student at Coventry University, Health and Life Sciences. This project if not externally funded.

Who has reviewed the study?
This study has been through the Coventry University Peer Review process and been approved.

Contact for further information
Imandeep Kaur Gahir
Email: gahiri@uni.coventry.ac.uk

Appendix 9- Study One: consent form and survey (main study)

Coventry University, Imandeep Kaur Gahir
Centre for Sport, Exercise and Life Sciences (CSELS)
Faculty of Health and Life Sciences
Science and Health Building
Room 3.07
Much Park Street, Coventry
CV1 2DS

Pharmacist survey

Participant reference code:............

How Are We Doing?
Please take a few minutes to fill out this survey on your perceptions of the use of 'hub and spoke dispensing' and 'pharmacy automation' in pharmacy. The Centre for Sport, Exercise and Life Sciences appreciates your feedback and your answers will be kept confidential. Thank you for your participation.
Please **tick** the boxes below as appropriate.

I have read and I understand the participant information sheet for this study.	☐
By handing this questionnaire back to you, completed, I am giving my consent for you to use my questionnaire answers in this research study.	☐
I understand that I have the right to withdraw my questionnaire at any point, by contacting the researcher using the details on the participant information sheet and quoting the participant reference code written at the top of this questionnaire.	☐
I have made a note of my participant reference code	☐

Section 1: Occupational details

Q1a) What type of pharmacist are you?

☐ **Employed**
☐ **Locum**
☐ **Other (please state)………**

Q1b) What type of community pharmacy do you work in? (Please tick all that apply)

☐ **Multiple community pharmacy (200 pharmacies or more i.e. Boots, LLoydsPharmacy, Superdrug etc.)**
☐ **Supermarket community pharmacy (i.e. Asda, Morrisons, Tesco etc.)**
☐ **Independent chain community pharmacy (6-200 pharmacies)**
☐ **Independent community pharmacy (5 pharmacies or less)**
☐ **Pharmacy head office**
☐ **Other (please state)…….**

Q1c) What additional qualifications/annotations do you hold in addition to your pharmacy degree? (Please tick all that apply)

☐ **Post graduate diploma**
☐ **BSc**
☐ **MSc (excluding pharmacy degree)**
☐ **PhD/ DPharm/ PharmD**
☐ **Supplementary prescriber**
☐ **Independent prescriber**
☐ **None**
☐ **Other (please state)……...**

Section 2: Pharmacy practice

Healthcare advice can be defined as:

'*Expert knowledge and suggestions on conditions and treatments*'

Q2a) During your current/recent shift as a pharmacist, how many staff members did you work with in the dispensary?

☐ **None**
☐ **1-2**
☐ **3-4**
☐ **4-5**
☐ **Above 5**

Q2b) During your current/recent shift as a pharmacist, on average how much time did you spend counselling each patient on their medication?

☐ Up to 1 minute
☐ > 1 minute to 3 minutes
☐ > 3 minutes to 5minutes
☐ > 5 minutes

Q2c) 'I feel I had enough time to give healthcare advice to patients.' Do you agree or disagree with this statement?

☐ Strongly agree
☐ Agree
☐ Neither agree nor disagree
☐ Disagree
☐ Strongly disagree

Q2d) Do you believe pharmacists are spending too much time? (Please tick appropriately)

Task	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
☐ Administrative activities i.e. paperwork, office work					
☐ Checking medication					
☐ Filing away prescriptions					
☐ Dispensing					
☐ Ordering patient medication					
☐ Pharmacy services					
☐ Stock checks/ordering stock					
☐ Other activities (please state)…… ……… ……… ……… ……… ……… ……… ………………………					

Q2e) What barriers do you feel pharmacists face when providing healthcare advice to patients? (Please tick all that apply)

☐ Staff shortages
☐ Lack of resources/space available
☐ Lack of personal motivation
☐ Fear of changing role

☐ **Do not feel it is part of their job role**
☐ **Lack of understanding of healthcare advice**
☐ **No barriers**
☐ **Other (please state)………..**

Section 3: Dispensing

Q3a) During your current/recent pharmacist shift, what format of prescriptions were received by the pharmacy? (Please tick all that apply)

☐ **Paper prescriptions**
☐ **Electronic prescriptions (Electronic Prescription Service – EPS)**
☐ **Other (please state)………..**

Waiting prescriptions can be defined as:
'*Prescriptions brought in and waited for to be dispensed and checked by the pharmacist*.'

Q3b) During your current/recent pharmacist shift, what was the average prescription waiting times, **during busy periods**?

☐ **Below 5 minutes**
☐ **Up to 10 minutes**
☐ **Up to 15 minutes**
☐ **Over 15 minutes**

Q3c) How satisfied were you with the time you had available to check 'waiting prescriptions?'

☐ **Very satisfied**
☐ **Satisfied**
☐ **Neither satisfied nor dissatisfied**
☐ **Dissatisfied**
☐ **Very dissatisfied**

Q3d) If robotics were to free up time spent dispensing and checking medication. What would you like to spend more time doing? (Please tick all that apply)

☐ **Giving healthcare advice**
☐ **Pharmacy services**
☐ **Joining other healthcare professionals in providing healthcare advice to patients**
☐ **Counselling patients on medication**
☐ **Other (please state)………**

Section 4: Hub & spoke dispensing

Hub and spoke dispensing is defined as:
*"Prescriptions are received from the '**spoke**' (pharmacy) and sent electronically to the '**hub**' (an off-site dispensary) where they are assembled (by a robotic dispensing unit) and returned back to the '**spoke**' (pharmacy)"*

Q4a) Before reading the definitions above, had you ever heard of hub and spoke dispensing in pharmacy?

☐ **Yes**

☐ **No**

Trust and hub and spoke dispensing
Q4b) How much do you trust hub and spoke dispensing, in replacing the manual labour of pharmacy staff in dispensing medication?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**

Hub and spoke dispensing process
Q4c) What influence do you think hub and spoke dispensing will have on medication errors? (Please tick the most appropriate response)

☐ **Increase in the rate of medication errors**
☐ **Decrease the rate of medication errors**
☐ **No influence on the rate of medication errors**
☐ **Do not know**

Q4d) How do you think the hub and spoke dispensing will influence the time taken to get prescription medications for patients? (Please tick the most appropriate response)

☐ **Increase the time taken to get prescription medications from the pharmacy**
☐ **Decrease the time taken to get prescription medications from the pharmacy**
☐ **No change to the time taken to get prescription medications from the pharmacy**
☐ **Do not know**

Pharmacy staff and hub and spoke dispensing
Q4e) Please indicate if you agree or disagree with the following statements.
Greater adoption of hub and spoke dispensing will…

	Strongly agree	**Agree**	**Neither agree nor disagree**	**Disagree**	**Strongly disagree**
Lower operating costs	☐	☐	☐	☐	☐
Enable pharmacists to spend more time giving healthcare advice	☐	☐	☐	☐	☐
Lead to job losses amongst non-dispensing staff	☐	☐	☐	☐	☐
Lead to job losses amongst pharmacists	☐	☐	☐	☐	☐

Change the job role of a pharmacist	■	■	■	■	■

Q4f) What impact do you think hub and spoke dispensing will have on the workload of pharmacists? (Please tick the most appropriate response)

☐ **The workload of pharmacists will be significantly increased**
☐ **The workload of pharmacists will be increased**
☐ **The workload of pharmacists will neither be increased or decreased**
☐ **The workload of pharmacists will be decreased**
☐ **The workload of pharmacists will be significantly decreased**

Q4g) How much do you trust relying on another pharmacist to oversee the dispensing process at the hub, when the clinical check is done by the pharmacist in store?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**

Q4h) What potential problems do you see being associated with hub and spoke dispensing? (Please tick all that apply)

☐ **Prescription medication lost on travel**
☐ **Longer for patients to get medication**
☐ **Clinical check being done in store by a different pharmacist**
☐ **Hub and spoke dispensing not being able to dispense all items (i.e. fridge lines, appliances etc.)**
☐ **Increased time spent matching prescription bags, sent from the hub, to the original prescription in store**
☐ **Scanning of prescriptions from pharmacy (spoke) to the hub**
☐ **No problems**
☐ **Other (please state)……….……….**

Q4i) What potential benefits do you see with hub and spoke dispensing? (Please tick all that apply)

☐ **Less time spent dispensing**
☐ **Having two different pharmacists overseeing checks at the hub and spoke**
☐ **More time for pharmacists to utilise their clinical skills through services and advice**
☐ **Prescriptions being checked for accuracy multiple times**
☐ **No benefits**
☐ **Other (please state)……….……….**

Section 5: Pharmacy automation & Dispensing
Pharmacy automation is defined as:
"*The use of robots to handle and distribute medicines in pharmacy stores (on-site)*"?
Q5a) Before reading the definitions above, had you ever heard of the use of pharmacy automation in pharmacy?

☐ **Yes**
☐ **No**

Trust and pharmacy automation
Q5b) How much do you trust pharmacy automation, in replacing the manual labour of pharmacy staff in dispensing medication?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**

Pharmacy automation dispensing process

Q5c) What influence do you think pharmacy automation will have on medication errors? (Please tick the most appropriate response)

☐ **Increase in the rate of medication errors**
☐ **Decrease the rate of medication errors**
☐ **No influence on the rate of medication errors**
☐ **Do not know**

Q5d) How do you think pharmacy automation will influence the time taken to get prescription medications for patients? (Please tick the most appropriate response)

☐ **Increase the time taken to get prescription medications from the pharmacy**
☐ **Decrease the time taken to get prescription medications from the pharmacy**
☐ **No change to the time taken to get prescription medications from the pharmacy**
☐ **Do not know**

Pharmacy staff and pharmacy automation
Q5e) Please indicate if you agree or disagree with the following statements.
Greater adoption of pharmacy automation will…

	Strongly agree	**Agree**	**Neither agree nor disagree**	**Disagree**	**Strongly disagree**
Lower operating costs	☐	☐	☐	☐	☐
Enable pharmacists to spend more time giving healthcare advice	☐	☐	☐	☐	☐
Lead to job losses amongst	☐	☐	☐	☐	☐

non-dispensing staff					
Lead to job losses amongst pharmacists	■	■	■	■	■
Change the job role of a pharmacist	■	■	■	■	■

Q5f) What impact do you think pharmacy automation will have on the workload of pharmacists? (Please tick the most appropriate response)

☐ **The workload of pharmacists will be significantly increased**
☐ **The workload of pharmacists will be increased**
☐ **The workload of pharmacists will be neither increased or decreased**
☐ **The workload of pharmacists will be decreased**
☐ **The workload of pharmacists will be significantly decreased**

Q5g) What potential problems do you think pharmacy automation will have? (Please tick all that apply)

☐ **Takes up too much space in the pharmacy**
☐ **Looks unappealing in the pharmacy**
☐ **Patients may be less likely to come into a pharmacy with a robotic dispensing machine**
☐ **Risk of human error when operating the machine**
☐ **Slow down dispensing process, especially when dispensing multiple medications**
☐ **No problems**
☐ **Other (please state)……..……….**

Q5h) What benefits do you think pharmacy automation will have? (Please tick all that apply)

☐ **Patients more likely to come into the pharmacy**
☐ **Makes the pharmacy look more appealing**
☐ **Shows the advancement of pharmacy with technology**
☐ **Prevent pharmacist from self-checking**
☐ **Other (please state)……..……….**

Section 6: Hub and spoke dispensing & pharmacy automation

Q6a) How much do you trust the accuracy of medication of robot in dispensing medication?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**

Q6b) What type of errors do you think are more likely to occur with the implementation of a dispensing robot? (Please tick all that apply)

☐ **Errors with stock count**

☐ **Errors with filling up the dispensing robot with stock**
☐ **Technical errors (malfunctioning in the robotic dispensing machine)**
☐ **Medication errors (wrong drug/wrong strength/ wrong dose/wrong quantity)**
☐ **Picking errors by the dispensing robot**
☐ **Other (please state)……**

Q6c) What implication do you think a dispensing robot will have on the productivity in dispensing prescriptions?

☐ **The productivity will be significantly increased**
☐ **The productivity will be increased**
☐ **The productivity will neither be increased or decreased**
☐ **The productivity will be decreased**
☐ **The productivity will be significantly decreased**

Q6d) 'Robotic dispensing in pharmacy will hinder patients from using the pharmacy.' Do you agree or disagree with this claim?

☐ **Strongly agree**
☐ **Agree**
☐ **Neither agree nor disagree**
☐ **Disagree**
☐ **Strongly disagree**

Section 7: Healthcare

Q7a) What impact do you think hub and spoke dispensing and pharmacy automation will have on the quality of healthcare services provided by pharmacists?

☐ **The quality of health care services provided by pharmacists will be improved**
☐ **The quality of health care services provided by pharmacists will be slightly improved**
☐ **The quality of health care services provided by pharmacists will neither improve or be reduced**
☐ **The quality of health care services provided by pharmacists will be slightly reduced**
☐ **The quality of health care services provided by pharmacists will be reduced**

Q7b) Would you prefer dispensing to be done on-site or off-site?

☐ **I would prefer dispensing to be done on-site**
☐ **I do not mind where dispensing takes place**
☐ **I would prefer dispensing to be done off-site**

Q7c) What type of dispensing method would you prefer?

☐ **Current method of dispensing**
☐ **Hub and spoke dispensing**
☐ **Pharmacy automation**
☐ **Either hub and spoke dispensing or pharmacy automation**
☐ **I do not mind**
☐ **None of the above**

Q7d) Any other comments you have regarding hub and spoke dispensing or pharmacy automation?

Section 8: Demographic details

Q8a) What is your age?

☐ **18 years or under**
☐ **19-25 years**
☐ **26-39 years**
☐ **40-59 years**
☐ **60 years and over**

Q8b) What is your sex?

☐ **Male**
☐ **Female**
☐ **Prefer not to say**

Q8c) What ethnicity best describes you?

White ☐ **British** ☐ **Any other White background (please state)……………………………………………………………………………………………………….**
Black or Black British ☐ **Caribbean** ☐ **African** ☐ **Other Black background (please state)……**
Mixed ☐ **White and Black Caribbean** ☐ **White and Black African** ☐ **White and Asian** ☐ **Any other Mixed background (please state)……………………………………………………………………………………………………….**
Asian ☐ **Indian** ☐ **Pakistani** ☐ **Bangladeshi** ☐ **Asian or Asian British** ☐ **Any other Asian background (please state)……**

Chinese or other ethnic group ☐ **Chinese** ☐ **Any other ethnic group (please state)………**
☐ **Prefer not to say**

Q8d) In England, what region are you currently working in?

☐ **North East**
☐ **North West**
☐ **Yorkshire and Humberside**
☐ **East Midlands**
☐ **West Midlands**
☐ **East of England**
☐ **London**
☐ **South East**
☐ **South West**

Appendix 10- Study Two: cover letter (main study)

Imandeep Kaur Gahir,
Coventry University Centre for Sport, Exercise and Life Sciences (CSELS)
Faculty of Health and Life Sciences Room 3.07,
Science and Health Building,
Priory Street,
CV1 5FB

22nd November 2018

Dear Sir/Madam:

Re: The use of robotics in community pharmacy

Imandeep Kaur Gahir, Coventry University Centre for Sport, Exercise and Life Sciences (CSELS)
Faculty of Health and Life Sciences Room 3.07, Science and Health Building, Priory Street, CV1 5FB
22nd November 2018

I recently wrote to you to invite you to take part in a study investigating the general public perception of using robotic in community pharmacy. You are requested to answer questions relating to two different types of robotic dispensing methods:

- **Hub and spoke dispensing**: *"Prescriptions are received from the 'spoke' (pharmacy) and are sent electronically to the 'hub' (an off-site dispensary), where they are assembled (by a robotic dispensing unit) and returned back to the 'spoke' (pharmacy)."*
- **Pharmacy automation: "***The use of robots to handle and distribute medicines in pharmacy stores (on- site dispensing robot)."*

Background

In 2015, the Department of Health wrote a letter to all community pharmacies explaining the cuts in funding for community pharmacies/chemists falling from £2.8 billion- £2.63 billion. With these cuts, the Department of Health believe that efficiencies need to be made, such as lowering operating costs through large-scaled dispensing such as 'hub and spoke' arrangements. The idea behind introducing robotics in pharmacy is to free up the pharmacists' time to provide more healthcare to patients.

As I am yet to receive a completed questionnaire from yourself, I would like you to take part in this questionnaire, to see your perceptions of the use of robotics in community pharmacy/chemists. This model of dispensing is slowly being rolled out and it is important to hear your views, as this model will have a direct impact on you. The questionnaire should take around 15-20 minutes to fill out, a pre-paid self-addressed envelope is enclosed, and I would be grateful if you could return it to me by approximately: **Insert date here**

The participation in this questionnaire study is voluntary and data from these surveys will be anonymous. No personal or sensitive information will be disclosed in this research. This study has ethical approval from Coventry University (P61622).

If you have any queries or concerns, or prefer not to be contacted, please do not hesitate to contact me via email (gahiri@uni.coventry.ac.uk). I will remove you from future postings if you do not want to be contacted. Please also read the participant information sheet for further details about the research study.

I will look forward to receiving your completed questionnaire. Thank you for your time.

Yours sincerely,
Imandeep Kaur Gahir RPharmS

Appendix 11- Study Two: participant information sheet (main study)

You are being invited to take part in research on the general public perception of using robotics in community pharmacy. Imandeep Kaur Gahir, a pharmacist and PhD student at Coventry University is leading this research. Before you decide to take part, it is important you understand why the research is being conducted and what it will involve. Please take time to read the following information carefully.

Study title:
The general public perception of using hub and spoke dispensing and pharmacy automation, in community pharmacies in England.

Purpose of the study:
In 2014, the NHS rolled out a five-year plan to improve the way healthcare is delivered in England. In 2015, the Department of Health (DH) sent out a letter to all community pharmacies in England, stating cuts in the community pharmacy budget from 2.8 billion to 2.63 billion. With these budget cuts, the DH suggested efficiencies that needed to be made.
One suggestion was the introduction of large scaled dispensing, known as ***'hub and spoke dispensing'***. The use of ***'pharmacy automation'*** is currently used in hospital pharmacy. Both these methods involve the use of robotics in preparing medicines against a prescription (also known as dispensing).

Key definitions:
Hub and spoke dispensing can be defined as where:
*"Prescriptions are received from the '**spoke**' (pharmacy) where they are clinically checked by a pharmacist, and sent electronically to the '**hub**' (an off-site dispensary) where they are assembled (by a robotic dispensing unit), under the supervision of another pharmacist and returned back to the '**spoke**' (pharmacy)"*

Pharmacy automation can be defined as:
"*The use of robots **(on-site dispensing robot)** to handle and distribute medicines in pharmacy stores (on-site), before or after being clinically checked by the pharmacist"*
As part of my PhD, for this particular study I will be looking at the general public perception of the use of two different types of robotics in community pharmacy dispensing (the making up of medicines against a prescription). I will be doing this by posting out questionnaires to the general public.

Why have I been chosen?
The reason for your selection in this study, is to assess your views on two different dispensing methods, using robotics in community pharmacy: hub and spoke dispensing and pharmacy automation. As these new methods directly affect the general public, it is important to evaluate your views on these two methods of dispensing. You were randomly selected from electoral roll data, which was obtained from the open register (which you are a part of) in the local authority, in which you live within.

Do I have to take part?
No, you do not have to take part. Participants were randomly selected from electoral poll data, obtained from local authorities for the purpose of conducting research for public interest. Your participation in this survey is entirely voluntary and data from your responses will be anonymised. If at any time (up to the date when data are fully anonymised) you decide you do not wish to take part, please contact myself via email and provide me with your participant reference number. You

are free to withdraw your information from the project data set at any time up until the data are fully anonymised in our records, which is stated on the consent form. All your data will then be destroyed and not used as part of the study. If you decide not to participate there will be no consequences. You should note that your data may be used in the production of formal research outputs (e.g. journal articles, conference papers, theses and reports) prior to this date and so you are advised to contact the university at the earliest opportunity should you wish to withdraw from the study. To withdraw, please contact the lead researcher (contact details are provided below). Please also contact the Research Support Office at ethics.hls@coventry.ac.uk so that your request can be dealt with promptly in the event of the lead researcher's absence. You do not need to give a reason. A decision to withdraw, or not to take part, will not affect you in any way.

What will happen to me if I take part?
You will be asked to complete a questionnaire, which should take approximately 15 minutes. You will then need to post the questionnaire back, in the prepaid self-addressed envelope provided.

What are the possible disadvantages and risks of taking part?
This study has been reviewed and approved through Coventry University's formal research ethics procedure. There are no significant risks associated with participation. Some of the questions may be a bit difficult to understand. The leader researcher has tried to clearly explain the more technical words that aren't readily used outside a pharmacy setting, in more detail. If you don't understand a question, there is a 'don't know' option for some questions. Another possible disadvantage, is that it may take you a little while to complete, the estimated time is around 15 minutes. However, it is a mainly a tick box questionnaire and very little writing is required.

What are the possible benefits of taking part?
As a member of the general public, your view on the new proposed methods of introducing robotics in community pharmacy is very important. As these potential future policy changes have a direct impact upon the way medicines are prepared for yourself, it is important to see your views, for potential future policy developments. Taking part in this research, will be helpful for conducting my research and will be a way for you to be involved in useful research, especially with the current changes in healthcare. It gives you a chance to have your say in the new proposed methods of dispensing.

What if something goes wrong?
If any changes happen in the study, the lead researcher will contact you as soon as possible, using your method of contact as indicated on your consent from. As mentioned before, if you chose to change your mind about taking part in the study, please contact myself via email, with your participant reference number. You are free to withdraw your information from the project data set at any time up until the data are fully anonymised in our records, which is stated on the consent form. You will then be withdrawn from the study and your results will be destroyed and not used in the study.

Will my taking part in the study be kept confidential?
Yes, data will be processed in accordance with the Data Protection Act 1998 (up until 24th May 2018) and the General Data Protection Regulation 2016 (GDPR) thereafter. All information collected about you will be kept strictly confidential and only the lead researcher and the lead researcher's supervisors will have access to the raw data. Unless they are fully anonymised in our records, your data will be referred to by a unique participant reference number rather than by name. All consent forms and questionnaires will be locked securely in filing cabinets on Coventry University premises for 5 years after the project has finished. The questionaries' and consent forms will be stored in separate filing cabinets in order to minimise risk in the event of a data breach.

Each questionnaire and consent form will have a participant reference number to anonymise the data. When the data is entered into a Microsoft excel spreadsheet, the data will be associated with a participant identification number, access to the file will, be password protected and only accessed by research supervisors and the lead researcher. The lead researcher will take responsibility for data destruction and all collected data will be destroyed securely on or before 30th September 2024.

Data Protection Rights
Coventry University and the lead researcher are Data Controllers for the information you provide. You have the right to access information held about you. Your right of access can be exercised in accordance with the Data Protection Act 1998 (up until 24th May 2018) and the General Data Protection Regulation thereafter. You also have other rights including rights of correction, erasure, objection, and data portability, up to the point when the data you provide is anonymised. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer - enquiry.ipu@coventry.ac.uk or myself as the researcher.

What will happen to the results of the research study?
Results from this study will be written up as part of my thesis for my PhD. Results may also be presented at academic conferences and/ or written for publication in peer reviewed academic journals, reports and presentations. Quotes or key findings will always be made anonymous in any formal outputs.

Making a Complaint
If you are unhappy with any aspect of this research, please first contact the lead researcher, Imandeep Kaur Gahir, email: gahiri@uni.coventry.ac.uk. If you still have concerns and wish to make a formal complaint, please write to Professor Oliver Sparagano.

Professor Oliver Sparagano
Associate Pro-Vice-Chancellor (Research)
Coventry University
Coventry CV1 5FB
Email: Olivier.Sparagano@coventry.ac.uk
In your letter please provide information about the research project, specify the name of the researcher and detail the nature of your complaint.

Who is organising and funding the research?
The research is organised by myself, Imandeep Kaur Gahir, who is a PhD student at Coventry University, Health and Life Sciences. This project is not externally funded.

Who has reviewed the study?
This study has been through Coventry University Peer Review process, project: P61622 and has been approved.

Contact for further information

Lead Researcher: Imandeep Kaur Gahir
Role: PhD student/pharmacist
Email: gahiri@uni.coventry.ac.uk
Room 3.07, Science and Health Building
Science and Health Building
Priory Street, Coventry
CV1 5FB

Director of studies: Dr Afthab Hussain
Role: Course Director MSc Pharmacology and Drug Discovery
Email: apx301@coventry.ac.uk
Science and Health Building
Priory Street, Coventry
CV1 5FB

Appendix 12- Study Two: consent form and survey (main study)

Participant reference number:

You are invited to take part in this research study for the purpose of collecting data on the general public perception of using **robotics** in community pharmacy dispensing such as **'hub and spoke dispensing' and 'pharmacy automation'.** Before you decide to take part, you must **read the accompanying Participant Information Sheet.**

Please do not hesitate to ask questions if anything is unclear or if you would like more information about any aspect of this research. It is important that you feel able to take the necessary time to decide whether or not you wish to take part. If you are happy to participate, please confirm your consent by **circling YES** against each of the below statements and then signing and dating the form as participant. Thank you for your participation in this study. Your help is much appreciated.

1	**I confirm that I have read and understood the Participant Information Sheet for the above study and have had the opportunity to ask questions**	**YES**	**NO**
2	**I understand my participation is voluntary and that I am free to withdraw my data, without giving a reason, by contacting the lead researcher and the Research Support Office at any time up until the date of** 24th January 2019.	**YES**	**NO**
3	**I have noted down my participant reference number (top left of this consent form) which may be required by the lead researcher if I wish to withdraw from the study**	**YES**	**NO**
4	**I understand that all the information I provide will be held securely and treated confidentially**	**YES**	**NO**
5	**I am happy for the information I provide to be used (anonymously) in academic papers and other formal research outputs**	**YES**	**NO**
6	**I agree to take part in the above study**	**YES**	**NO**

Participant's Name	**Date**	**Signature**
Researcher	**Date**	**Signature**

Section 1: Occupational details

Q1a) What best describes your employment status?

☐ **Employed**
☐ **Self-employed**
☐ **Unemployed and currently looking for work**
☐ **Unemployed and not currently looking for work**
☐ **Student**
☐ **Retired**
☐ **Unable to work**
☐ **Homemaker**
☐ **Other (please state)……**

Q1b) What is the highest level of education you have completed?

☐ **Primary school**
☐ **Secondary school**
☐ **Sixth form/college level**
☐ **Bachelor's degree or equivalent**
☐ **Master's degree or equivalent**
☐ **Doctoral or equivalent**
☐ **Post-doctoral or equivalent**
☐ **None of the above**
☐ **Other (please state)…….**

Section 2: Pharmacy user

Q2a) Have you used a pharmacy in the past 12 months? (If **yes,** please move to question **2b**, if **no**, please move to question **2e**)

☐ **Yes**
☐ **No**

Q2b) What type of community pharmacy/ chemist did you last visit?

☐ **Multiple community pharmacy (i.e. company owns 200 pharmacies or more Boots, LloydsPharmacy, Superdrug etc.)**
☐ **Supermarket community pharmacy (i.e. Asda, Morrisons, Tesco etc.)**
☐ **Independent community pharmacy chain/ independent community pharmacy**
☐ **Do not know**
☐ **Other (please state)……….**

Q2c) What do you use a pharmacy for? (Please tick all that apply)

Medical	Non-medical
☐ **Prescriptions**	☐ Purchase non-medical items i.e. food and drink
☐ **Purchase over the counter medication**	☐ Disposal of unwanted medicines
☐ **Healthcare services**	☐ Other (please state)………………………………….
☐ **Advice on a healthcare problem**	**If any options from this (non-medical) section have ONLY been ticked, please move to question 2e**
☐ **Other (please state)……………………………….**	
If any options from this (medical) section have ONLY been ticked, please move to question 2d	
If options have been ticked from the medical and non-medical section – please complete both 2d and 2e	

Q2d) **Medical section** - During the last time you visited a pharmacy, do you feel you were given enough time to speak to the pharmacy staff (including the pharmacist)?

☐ **Strongly agree**
☐ **Agree**
☐ **Neither agree nor disagree**
☐ **Disagree**
☐ **Strongly disagree**

Q2e) Do you believe that pharmacists have enough time to provide healthcare advice to patients?

☐ **Strongly agree**
☐ **Agree**
☐ **Neither agree nor disagree**
☐ **Disagree**
☐ **Strongly disagree**

Q2f) Research suggests that due to time constraints, pharmacists do not have enough time to provide health care to patients. Why do you think this is? (Please tick all that apply)

☐ **Too much time spent checking medications in the dispensary (back of pharmacy)**
☐ **Staff shortages**
☐ **Too much time spent doing other activities**
☐ **Other (please state)…….……….**

Q2g) Apart from doctors, where do you normally get your healthcare advice from? (Please tick all that apply)

☐ **Pharmacies**
☐ **NHS walk-in Centre**
☐ **Accident and emergency (A&E)**
☐ **Online medical websites (i.e. NHS Choices, Mayoclinic, patient.co.uk etc.)**
☐ **Online pharmacy websites (i.e. Boots, LLoydspharmacy etc.)**
☐ **NHS 111/ other non-emergency telephonic healthcare advice services**
☐ **Other (please state)…….**

Section 3: Dispensing

Dispensing is defined by:

'*The making up and giving out of medicines, according to a prescription by a prescriber (i.e. doctor, dentist, nurse etc.)*'

Q3a) Have you ever used a pharmacy to get a prescription medication? (If **yes**, please move to **question 3b**; if **no**, please move to section 4)

☐ **Yes**
☐ **No**

Q3b) How did the prescription get to the pharmacy?

<table>
<tr><td>☐ It was collected by myself and brought to the pharmacy</td><td>Please move to question 3c)</td></tr>
<tr><td>☐ It was collected on behalf of myself and brought to the pharmacy</td><td rowspan="4">Please move to question 3e)</td></tr>
<tr><td>☐ It was collected by the pharmacy staff</td></tr>
<tr><td>☐ It was sent electronically from the prescriber (i.e. doctor, dentist, nurse etc.) to the pharmacy</td></tr>
<tr><td>☐ Other (please state)……</td></tr>
</table>

Q3c) If you collected the prescription yourself, did you wait for the prescription or call back later?

☐ **I waited up to 30 minutes**
☐ **I waited over 30 minutes**
☐ **I called back for my prescription later**
☐ **I get my prescription delivered**
☐ **Other (please state)…….**

Q3d) How satisfied were you with the time it took to get your medication?

☐ **Very satisfied**
☐ **Satisfied**
☐ **Neither satisfied nor dissatisfied**
☐ **Dissatisfied**
☐ **Very dissatisfied**

Medication errors

Q3e) Have you ever experienced a medication error **(wrong dose/ strength or wrong medicine)**?
(If **yes**, please move to **question 3f**; if **no**, please move to **section 4**)

☐ **Yes**
☐ **No**

Q3f) What type of error did you experience?

☐ **Right medicine, wrong strength**
☐ **Right medicine, wrong dose (instructions on how to take medication)**
☐ **Right medicine, wrong patient**
☐ **Wrong medicine, right strength**
☐ **Wrong medicine, wrong strength**
☐ **Wrong medicine, right dose (instructions on how to take medication)**
☐ **Wrong medicine, wrong dose (instructions on how to take medication)**
☐ **Wrong medicine, right patient**
☐ **Wrong medicine, wrong patient**
☐ **Other (please state)………..**

Q3g) When did you realise the medication error had occurred?

☐ **Before taking the medication**
☐ **After taking the medication**
☐ **Other (please state)………..**

Q3h) Would you go back to the pharmacy/prescriber again?

☐ **I would go back to the pharmacy/prescriber again**
☐ **I would not go back to the pharmacy/prescriber again**
☐ **I do not know**
☐ **Other (please state)………..**

Q3i) After experiencing the error, how much would you trust the pharmacy/prescriber again?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**
☐ **Do not know**

Section 4: Hub & spoke dispensing

Hub and spoke dispensing is defined by:
*"Prescriptions are received from the '**spoke**' (pharmacy) where they are clinically checked by a pharmacist, and sent electronically to the '**hub**' (an off-site dispensary) where they are assembled (by a robotic dispensing unit), under the supervision of another pharmacist and returned back to the '**spoke**' (pharmacy)"*

Q4a) Before reading the definition above, had you ever heard of hub and spoke dispensing in pharmacy?

☐ **Yes**
☐ **No**

***Hub and spoke dispensing**: "Prescriptions are received from the '**spoke**' (pharmacy) where they are clinically checked by a pharmacist, and sent electronically to the '**hub**' (an off-site dispensary) where they are assembled (by a robotic dispensing unit), under the supervision of another pharmacist and returned back to the '**spoke**' (pharmacy)"*

Trust and hub and spoke dispensing
Q4b) How much do you trust hub and spoke dispensing, in replacing the manual labour of pharmacy staff in dispensing medication?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**
☐ **Do not know**

Q4c) How much do you trust your medication being made up **off-site (not in the pharmacy)** using a robotic dispensing machine?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**
☐ **Do not know**

Hub and spoke dispensing process
Q4d) What influence do you think hub and spoke dispensing will have on medication errors? (Please tick the most appropriate response)

☐ **Increase in the rate of medication errors**
☐ **Decrease the rate of medication errors**
☐ **No influence on the rate of medication errors**
☐ **Do not know**

***Hub and spoke dispensing**: "Prescriptions are received from the '**spoke**' (pharmacy) where they are clinically checked by a pharmacist, and sent electronically to the '**hub**' (an off-site dispensary) where they are assembled (by a robotic dispensing unit), under the supervision of another pharmacist and returned back to the '**spoke**' (pharmacy)"*

Q4e) How do you think hub and spoke dispensing will influence the time taken to get prescription medications? (Please tick the most appropriate response)

☐ **Increase the time taken to get prescription medications from the pharmacy**
☐ **Decrease the time taken to get prescription medications from the pharmacy**
☐ **No change to the time taken to get prescription medications from the pharmacy**
☐ **Do not know**

Pharmacy staff and hub and spoke

Q4f) To what extent do you think hub and spoke dispensing will replace the job roles of pharmacists, with the majority of dispensing being done at a different site?

☐ **It will replace all pharmacists/ pharmacy staff job roles**
☐ **It will replace most of the job roles of pharmacists/ pharmacy staff**
☐ **It will replace some of the job roles of pharmacists/ pharmacy staff**
☐ **It will not replace the job roles of pharmacists/ pharmacy staff**
☐ **Do not know**

Q4g) Hub and spoke dispensing is claimed to give pharmacists more time to provide health care services. With regards to hub and spoke dispensing, do you agree or disagree with this claim?

☐ **Strongly agree**
☐ **Agree**
☐ **Neither agree nor disagree**
☐ **Disagree**
☐ **Strongly disagree**
☐ **Do not know**

Section 5: Pharmacy automation & Dispensing

Pharmacy automation is defined as:

"*The use of robots to handle and distribute medicines in pharmacy stores (on-site), before or after being clinically checked by the pharmacist"*

Q5a) Before reading the definition above, had you ever heard of the use of pharmacy automation in pharmacy?

☐ **Yes**
☐ **No**

Trust and pharmacy automation

Q5b) How much do you trust pharmacy automation, in replacing the manual labour of pharmacy staff in dispensing medication?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**
☐ **Do not know**

Q5c) How much do you trust your medication being made up **on-site (in the pharmacy)** using a robotic dispensing machine?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Do not know**

Pharmacy automation: "*The use of robots to handle and distribute medicines in pharmacy stores (on-site), before or after being clinically checked by the pharmacist"*

Pharmacy automation dispensing process

Q5d) What influence do you think pharmacy automation will have on medication errors? (Please tick the most appropriate response)

☐ **Increase in the rate of medication errors**
☐ **Decrease the rate of medication errors**
☐ **No influence on the rate of medication errors**
☐ **Do not know**

Q5e) How do you think pharmacy automation will influence the time taken to get prescription medications? (Please tick the most appropriate response)

☐ **Increase the time taken to get prescription medications from the pharmacy**
☐ **Decrease the time taken to get prescription medications from the pharmacy**
☐ **No change to the time taken to get prescription medications from the pharmacy**
☐ **Do not know**

Pharmacy staff and pharmacy automation

Q5f) To what extent do you think pharmacy automation will replace the job roles of pharmacists, with dispensing being done by a robot in the pharmacy?

☐ **It will replace all pharmacists/ pharmacy staff job roles**
☐ **It will replace most of the job roles of pharmacists/ pharmacy staff**
☐ **It will replace some of the job roles of pharmacists/ pharmacy staff**
☐ **It will not replace the job roles of pharmacists/ pharmacy staff**
☐ **I do not know**

Q5g) Pharmacy automation is claimed to give pharmacists more time to provide health care services. With regards to pharmacy automation, do you agree or disagree with this claim?

☐ **Strongly agree**
☐ **Agree**
☐ **Neither agree nor disagree**
☐ **Disagree**
☐ **Strongly disagree**
☐ **Do not know**

Section 6: Hub and spoke dispensing & pharmacy automation

Pharmacy automation: "*The use of robots to handle and distribute medicines in pharmacy stores (on-site), before or after being clinically checked by the pharmacist"*
Hub and spoke dispensing: *"Prescriptions are received from the '**spoke**' (pharmacy) where they are clinically checked by a pharmacist, and sent electronically to the '**hub**' (an off-site dispensary) where they are assembled (by a robotic dispensing unit), under the supervision of another pharmacist and returned back to the '**spoke**' (pharmacy)"*

Q6a) How much do you trust the accuracy of robots in dispensing medication?

☐ **Strongly trust**
☐ **Trust**
☐ **Neither trust nor distrust**
☐ **Distrust**
☐ **Strongly distrust**
☐ **Do not know**

Q6b) What type of errors do you think are more likely to occur with the implementation of a dispensing robot? (Please tick all that apply)

☐ **Errors with stock count**
☐ **Errors with filling up the dispensing robot with stock**
☐ **Technical errors (malfunctioning in the robotic dispensing machine)**
☐ **Medication errors (wrong drug/wrong strength/ wrong dose)**
☐ **Do not know**
☐ **Other (please state)………**

Q6c) What implication do you think a dispensing robot will have upon the productivity upon dispensing prescriptions? (Please tick the most appropriate response)

☐ **The productivity will be significantly increased**
☐ **The productivity will be increased**
☐ **The productivity will neither be increased or decreased**
☐ **The productivity will be decreased**
☐ **The productivity will be significantly decreased**
☐ **Do not know**

Q6d) 'Robotic dispensing in pharmacy will hinder patients from using the pharmacy.' Do you agree or disagree with this claim?

☐ **Strongly agree**
☐ **Agree**
☐ **Neither agree nor disagree**
☐ **Disagree**
☐ **Strongly disagree**
☐ **Do not know**

Section 7: Healthcare

Q7a) What method of dispensing do you think is most likely to provide pharmacists more time to provide healthcare to patients?

☐ **Current method of dispensing**
☐ **Hub and spoke dispensing**
☐ **Pharmacy automation**
☐ **Either hub and spoke dispensing or pharmacy automation**
☐ **Do not know**
☐ **None of the above**

Q7b) If, Hub and spoke dispensing or pharmacy automation, provided pharmacists with more time to provide health care services, what types of services would you like pharmacists to provide? (Please tick all that apply)

☐ **Minor ailment scheme**
☐ **Patient group directive such as morning after pill**
☐ **Out of hours support**
☐ **Medicines assessment and compliance support**
☐ **On demand availability of specialist drugs**
☐ **Gluten free food supply**
☐ **Disease specific medicines management**
☐ **INR monitoring (i.e. for oral anticoagulants such as warfarin)**
☐ **Independent prescribing by pharmacists**
☐ **Needle and syringe exchange**
☐ **Stop smoking**
☐ **Supervised consumption**
☐ **Other (please state)……..**

Q7c) What impact do you think hub and spoke dispensing and pharmacy automation will have on the quality of health care services provided by pharmacists? (Please tick the most appropriate response)

☐ **The quality of health care services provided by pharmacists will be improved**
☐ **The quality of health care services provided by pharmacists will be slightly improved**
☐ **The quality of health care services provided by pharmacists will neither improve or be reduced**
☐ **The quality of health care services provided by pharmacists will be slightly reduced**
☐ **The quality of health care services provided by pharmacists will be reduced**
☐ **Do not know**

Q7d) Would you prefer dispensing to be done on-site or off-site?

☐ **I would prefer dispensing to be done on-site**
☐ **I do not mind where dispensing takes place**
☐ **I would prefer dispensing to be done off-site**

Q7e What type of dispensing method would you prefer?

☐ **Current method of dispensing**
☐ **Hub and spoke dispensing**
☐ **Pharmacy automation**
☐ **Either hub and spoke dispensing or pharmacy automation**
☐ **Do not mind**
☐ **None of the above**

Q7f) Any, other comments you have regarding hub and spoke dispensing or pharmacy automation, or further comments on other questions (please state the question number if so)?

Section 8: Demographic details

Q8a) What is your age?

☐ **18-25 years**
☐ **26-39 years**
☐ **40-59 years**
☐ **60 years and over**
☐ **Prefer not to say**

Q8b) What is your sex?

☐ **Male**
☐ **Female**
☐ **Prefer not to say**

Q8c) Which ethnicity best describes you?

White ☐ **British** ☐ **Any other White background (please state)………**

Black or Black British ☐ **Caribbean** ☐ **African** ☐ **Any other Black background (please state)……………………………………………………………………………………………………..**
Mixed ☐ **White and Black Caribbean** ☐ **White and Black African** ☐ **White and Asian** ☐ **Any other Mixed background (please state)……………………………………………………………………………………………………….**
Asian ☐ **Indian** ☐ **Pakistani** ☐ **Bangladeshi** ☐ **Asian or Asian British** ☐ **Any other Asian background (please state)………………………………………………………………………………………………………**
Chinese or other ethnic group ☐ **Chinese** ☐ **Any other ethnic group (please state)……**
☐ **Prefer not to say**

Q8d) In England, what region do you live in?

☐ **North East**
☐ **North West**
☐ **Yorkshire and Humberside**
☐ **East Midlands**
☐ **West Midlands**
☐ **East of England**
☐ **London**
☐ **South East**
☐ **South West**
☐ **Prefer not to say**

Appendix 13- Other tasks pharmacists believe they are spending too much time doing

Theme	Comments
Dealing with queries	*"Chasing out of stock"*
	"Addressing queries"
	"Chasing out of stock medication and NCSO medications takes one hour a day"
	"Chasing "missing" electronic prescriptions"
	"Chasing restricted medication"
	"Correcting prescribing errors"
Services	*"Vaccination travel clinics"*
	"Needle exchange administration i.e. sending copies of insurance cover etc"
Tasks	*"Taking phone calls"*
Meeting deadines	*"Under pressure to meet various deadlines e.g. MUR/NMS, substance misuse, validation (CPDs), annual compliance, rp etc e.g. compliance."*
OTC	*"Selling over the counter medicines"*

Appendix 14- study one: results of Chi-square tests between staff shortages and type of community pharmacy worked in and accompanying p values

Relationship ((χ^2 with ρ 0.05) between...		
Type of pharmacy	Staff shortages	
	Frequency	P value
Multiple	85.5 (59/110)	0.000
Supermarket	100.0 (6/110)	0.089
Independent chain	55.9 (19/110)	0.079
Independent	27.3 (30/110)	0.003

Appendix 15- study one: other problems potential problems with hub and spoke dispensing

Theme	Comments
Technical problems	*"Mechanical and IT problems"*
Stock issues	*"2) Issues with emergency supplies in store, as stock no longer in main patient facing store, as has happened with dressings."*
	"4 – supply shortages! 6 – FMD"
Problems at hub	*"If there are any problems at the hub, the "spoke" pharmacy will not have the capacity to deal with the sudden increase in the workload."*
Matching up prescriptions with other patient items	*"Matching up spoke Rxs with acutes/CDs received directly to"*
Further comments	*"1) Audit – where in the process is the client's prescriptions"*
	"Who deals with errors"
	"I would not trust someone else to do clinical check. If I am RP on the day I would clinical check again anyway"
	"Disagree with whole idea completely"

Appendix 16- study one: other potential problems with pharmacy automation

Theme	Comment
Smaller pharmacies at risk and less pharmacies for patient access	*"Expense means only viable in large turnover dispensaries. This will put at risk smaller volume community pharmacies and so destroy the network of accessible locations for the public."*
Technical problems	*"Technical problems"*
Less patient focused	*"Less interactions with patients"*

Appendix 17- study one: other potential benefits with pharmacy automation

Theme	Comments
Remote working	*"Providing it doesn't break down it can work 'remotely' 24/7 i.e. I could log in on my commute and start processing Rx before I am in work."*
No benefits	*"No benefits"*

Appendix 18- Study One: statistical tests and cross-tabulations of robotic dispensing methods

Independent variables		**Employment status (%)**			**Type of pharmacy worked in[1] (%)**				
		Employed (n=126)	**Locum (n=20)**	**Other (n=13)**	**Multiple (n=68)**	**Supermarket (n=6)**	**Independent chain (n=34)**	**Independent (n=55)**	**Other (n=2)**
Accuracy and robotic dispensing	Strongly trust/trust	46	45	15	44	33	44	38	50
	Neither trust nor distrust	40	25	31	40	17	26	38	50
	Strongly distrust/distrust	14	30	54	16	50	29	24	0
	P=	**0.010***			**0.618^**	**0.238^**	**0.538^**	**0.264^**	-
Productivity and robotic dispensing		**Employed (n=126)**	**Locum (n=20)**	**Other (n=13)**	**Multiple (n=67)**	**Supermarket (n=6)**	**Independent chain (n=34)**	**Independent (n=56)**	**Other (n=2)**
	Significantly increased/increased	56	50	31	57	33	44	50	50
	Neither increased or decreased	33	40	46	33	17	38	36	50
	Significantly decreased/decreased	12	10	23	10	50	18	14	0
	P=	**0.206***			**0.363^**	**0.096^**	**0.207**	**0.558^**	**-**
Robotic dispensing hinderance		**Employed (n=126)**	**Locum (n=20)**	**Other (n=13)**	**Multiple (n=68)**	**Supermarket (n=6)**	**Independent chain (n=34)**	**Independent (n=55)**	**Other (n=2)**
	Strongly agree/agree	21	25	23	26.5 (18)	33	27	18	0
	Neither agree nor disagree	37	50	54	36.8 (25)	17	38	49	0
	Strongly disagree/disagree	41	25	23	36.8 (25)	50	35	33	100
	P=	**0.363***			**0.476^**	**0.907^**	**0.569^**	**0.796^**	**-**

Table 6. The extent (median) to which pharmacists trust the accuracy of medication of the robot in dispensing medication (1=strongly trust, 2=trust, 3= neither trust nor distrust, 4=distrust and 5 strongly distrust) (Median :employed=2.00, locum=2.00, other=3.00, multiple=2.00, supermarket=2.50, independent chain=2.00, independent=2.00,other=1.50), impact on productivity of dispensing with robotic dispensing (1=improved, 2=slightly improved, 3=neither improve or be reduced, 4=slightly reduced and 5=reduced) (Median: employed=1.00, locum=1.50, other=2.00, multiple=1.00, supermarket=1.00, independent chain=2.00, independent=1.00, other=1.50) and the extent to which pharmacists agree robotic dispensing (1=strongly agree, 2=agree, 3=neither agree nor disagree, 4=disagree and 5 =strongly disagree (Median: employed=2.00, locum=2.00, other=2.00, multiple=2.00, supermarket=2.50, independent chain=2.00, independent=2.00, other=3.00). Due to rounding percentages may not add up to 100%.

[1]This was a multiple response question, *Kruskal-Wallis test was performed and ^Mann-Whitney U Test was performed

Appendix 19- Study One: other types of error likely to occur with a dispensing robot

Other types of error	Comments
Don't know	*"Don't know"*
	"Do not know"
Reliant on technology	*"people relying on robot & sleep walking**)"*
Cannot deal with part packs	*"Dealing with part packs"*
Labelling errors	*"Labelling errors"*
Mismatching barcodes and medications bags	*"Mis matching Rx to bag of medication"*
	"Mismatching barcodes – causing wrong meds being selected"
Wrong stock put in, wrong stock comes out	*"If stock put in wrong then wrong stock is dispensed (Human error)"*

Appendix 20- Study One: advantages of hub and spoke dispensing

Theme	Comment
Able to track prescriptions	*"Operation of hub & spoke to encourage tracking of eeh Prescription from spoke to hub, and back to spoke via delivery status. This will assist enquiries from patient and build confidence with the dynamics of each prescription."*
Freeing up the pharmacists time	*"As per Q7b+c I think hub + spoke most effective in freeing up pharmacist time."*
Improving checking procedure	*"Improving the checking procedure."*
Improvements in accuracy of dispensing	*"I believe accuracy has improved but the time saving has been small."*
Reduction in costs of dispensing	*"I was initially sceptical about hub dispensing. Having now some experience of it appreciate the advantages in reducing the costs of all aspects of dispensing process."*
Removes task of dispensing repeat prescriptions	*"Hub and spoke removes the drudgery and familiarity when dispensing regular repeat prescriptions which can lead to errors and waste pharmacist's time. Acute scripts will still need to be dispensed locally by the pharmacy".*
Appears to be working well	*"We have been a pilot branch for hub and spoke automated dispensing since mid 2016. This has had a significant effect in changing how we operate."*
	"My company uses hub and spoke dispensing in same stores and provided the store is organised with a few days to spare it works really well."

Appendix 21- Study One: advantages of pharmacy automation

Theme	Comment
Improves errors	*"Significantly improves errors."*
Improves workload	*"I am originally from Denmark and work with pharmacy automation/robot for years. It is amazing tales a strain off the work load."*
Saves time	*"It worked well and saved time."*
Speeds up dispensing process	*"It speeds up the processing large piles of scripts from the surgery."*
Works well	*"I've also used a dispensing robot whilst working in a hospital outpatients dispensary. It worked well and saved time."*
Good investment	*Fantastic return of investment 10 years ago – best thing ever.*

Appendix 22- Study One: disadvantages of hub and spoke dispensing

Theme	Comment
Can only work in multiple pharmacies	*"In my opinion "Hub and spoke" dispensing can only be possible in multiple pharmacy with 100+ branches.*
Cannot dispense all types of medication i.e. fridge lines, controlled drugs	*"More and more patients now have fridge lines on their prescriptions meaning a high percentage cannot be sent which can be frustrating."*
	"My experience of hub + spoke is that CDs and fridge lines and … are not dispensed there and the planning they are sent to doesn't always get notified."
	"CDRx is going to dispense in hub and send to pharmacy?"
Cannot do acute prescriptions or emergency supply	*"Cannot take part prescription in emergency."*
Environmentally unfriendly	*"Also increase carbon footprint for hub & spoke."*
Increase in errors	*"ERRORS HAVE INCREASED, DUE TO HUMAN INTERVENTION."*
	"WE AKREADY USE A HUB + SPOKE SYSTEM FOR OUR DOSAGES AND ERRORS STILL OCCUR. ALSO THE CLINICAL CHECK IS MORE LABOROUS AND I THINK HAS MORE ROOM FOR ERROR AS A RESULT."
Increased time to dispense	*"Hub dispensing takes more time than dispensing in pharmacy. Currently have hub in place."*
Increased workload	*"INCREASED WORKLOAD IN DISPSENSARY."*
No time to provide services or for patients	*"PHARMACIST NOW STANDS ON PC CLINICALLY CHECKING OR FINAL CHECKING.NO TIME FOR PATIENTS / SERVICES."*

Small time saved	*"This has had a significant effect in changing how we operate. I believe accuracy has improved but the time saving has been small."*
Pharmacy closures and redundancies	*"Unfortunately, the savings will eventually result in pharmacy closures and redundancies. Work needs to be done to make it more environmentally friendly."*
	"I very doubt services + counselling patients will make pharmacies liable."
	"the responsible pharmacist must take responsibility for other people's mistakes (out of pharmacy)."
Prescription delivery issues	*"Transfer issues, in bad weather/ traffic issues."*
Processing multiple packages at different times	*"MULTIPLE PACKAGES ARE NOW AN ISSUE FOR PATIENT ALL AT DIFFERENT PROCESSING STAGES."*
Stock depletion	*"Pharmacy stock depletion. Emergency supplies will be hindered."*
System breakdown problems	*"Reduced knowledge of process when system down."*
	"Experienced both and both have gone wrong. Off-site turnaround. Plus I.T system sometimes crashes."
Takes longer for patients to get medication	*"Fears that hub-and-spoke will take longer for patients to get medication."*
	"HAS INCREASED THE WAIT TIME FOR PATIENTS – INSTEAD OF DISPENSED ON THE SAME DAY AS RX. PATIENT IS DELAYED BY 2 DAYS."

	"LONGER WAITING TIMES."
	If prescription at hub, then patient has to wait for whole process patient has to wait for whole process
	"Off-site turnaround. Plus I.T system sometimes crashes – leads to delays and then having to dispense in branch. Show causes delays in transit of meds."
Responsibility for other people's mistakes	*"The responsible pharmacist must take responsibility for other people's mistakes (out of pharmacy)."*
Won't work with MDS	*"We do well over 100 MDS trays, which change mid-month frequently, we have to collect + reblister – will never work with hub + spoke."*
Workload is shifted from one task to another	*"We currently use hub + spoke method of dispensing and find it shifts one workload from dispensing medications to matching prescriptions with items."*
	"More work to match up Rx with EPS."
	"Time wasted by duplication of tasks on and off-site Time wasted "matching" Pharmacists workload will remain under stress because the predicted void will be filled by other tasks. There will be no gain for the pharmacist!"
Effect on pharmacy staff	*"It will lead to job loss & dissatisfaction amongst staff & patient."*

Appendix 23- Study One: disadvantages of pharmacy automation

Theme	Comment
Mistake when filling robot	*"Mistakes in filling the robot."*
Beneficial to big multiples only	*"The 'Big Boys' will have a further market knowledge over independents. Worked in hospital with automated dispensing- numerous errors. Would have to be very high volume dispensing to be advantage."*
	"I think dispensary pharmacy automation would work better in bigger dispensaries or hospital dispensaries, but couldn't see it having where we do 8000 items a month."
Trust with errors	*"Automation does give errors? Need to check before giving to patient."*
Noise disturbance	*"In some cases – very noisy."*
Original package dispensing only	*"Have worked in Pharmacy with automation (hospital) + can only replace original pack dispensing."*
Pharmacists getting complacent about checking	*"Could still lead to mistakes where pharmacists get complacent & rely on robot & be more relaxed about checking."*
Return of investment isn't worth it	*"I don't think the return on investment is capable of funding from our existing remuneration package."*
Slows down dispensing process	*"But significantly slows down writing prescriptions."*
Technical problems	*"Pharmacy automation – robot kept breaking and engineers were based in Germany! Robot was sold as was inefficient & more often than not broken."*
	"But a few times it broke down it caused chaos."
	"Technical problems can still occur + high level of IT training required to administer."

	"I have worked in a pharmacy with a dispensing robot. It breaks down frequently, halting the dispensing process."
	"Plus it creates a huge amount of heat!"
Time consuming	*"Pharmacy automation 1) - more time consuming."*
Less staff	*"In any event as mentioned in your background statement at the department of health see automation being accompanied to funding reductions which then results in less staff."*
More workload for pharmacists	*I give more time to pharmacists for clinical services however in reality it my experience this technology has only increased workload due to all the issues associated with it*
	and therefore more workload for pharmacists.
Cannot dispense all types of medication i.e. fridge lines, CDs	*"All part pack, CD, fridge + other technical items still dispensed by hand."*
Lack of space	*All pharmacies will need twice the floor space in dispensing compared to shop floor.*

Appendix 24- Study One: Other comments of dispensing

Theme	Comment
General comments and experiences	*"I have worked in pharmacies with different prescription turn overs. One of the pharmacies had Pharmacy automation for about 10 years but the company decided to get rid it."*
	"I very doubt services + counselling patients will make pharmacies liable."
	"Its about saving money as opposed to better service for patients for better health outcomes."
	"I truly believe by having a robot, will encourage area managers to push more service targets which are highly unrealistic. Excuse will be "The robot is doing all checking", not understanding clinic checks and all other paperwork that go on in the back."
	"It's a good system. Reduce workload and cost with staff members/ However getting medication out on time or emergency with no work."
	"It needs sorting first, still not ready in practice -> causing a lot of complaints + potential for patients without medication." (Hub and spoke dispensing)
Funding issues	*"I believe that any gains in productivity will be balanced by staff losses, both dispensing and non dispensing, leaving no net gain. However, costs may decrease due to lower staff wages (both less staff and wage depreciation)."*
	"The main issue is pharmacy funding is being stripped. We must find ways to save money & hub & spoke is an option but would cut staff in branch and be a massive initial outlay for multiples. It's a sorry state of affairs."

Concern for time needed for patients to order Rxs	*"I am very concerned at how much longer in advance Rxs will need to be ordered by patients for regular repeats and how the bricks?"*
Concerns for types of prescriptions and medications with robotics	*"CDRx is going to dispense in hub and send to pharmacy? What happens to methadone, pallative care?"*
Concerns with having enough stock to dispense acute prescriptions	*"stocks they need to hold to still dispense acutes + walk ins."*
More information of experience is needed	*"Need more information/experience. Pilot to see how it works in practice."*
	"I need to known more information c̄ ref to above to make educated response."
Other suggestions	*"In house c- ACT checking."*
	"Focus on the prescription and not on the patient."
	"Hub + spoke preferred over automation."
Preferences	*"On site automation preference, hub and spoke too many variables."*
	"Automation and hub & spoke would probably work better than automation without hub and spoke. The high volume of dispensing envisaged for H&S would require automation to achieve."
	"Hub + spoke preferred over automation."
Patient record access concerns	*"If if hub and spoke, are patient meds record will be in pharm computer system to check for eligibility for advance services?"*
Robots cannot replace all tasks	*"We've lost a few patients to internet pharmacies but many have returned to us as I'm (+team) are much better at sorting out problems."*

	"I feel that it would mean job losses for dispensers and pharmacists. Wouldn't be as knowledge about each of our patient's prescription."
Further comments	*"Load of unnecessary rubbish."*

Appendix 25- Study Two: dispensing perceptions cross-tabulated with community pharmacy last visited

Independent variables		**Type of community pharmacy (%)**				
		Multiple (n=55)	**Supermarket (n=12)**	**Independent chain/independent (n=80)**	**Do not know (n=6)**	**Other (n=1)**
Enough time to speak to pharmacy staff[1]	Strongly agree/agree	80	58	88	67	100
	Neither agree nor disagree	16	42	8	17	0
	Strongly disagree/disagree	4	0	5	17	0
	P=	**0.127**				
Do pharmacists have enough time to provide healthcare advice to patients[2]		**Multiple (n=55)**	**Supermarket (n=12)**	**Independent chain/independent (n=81)**	**Do not know (n=6)**	**Other (n=1)**
	Strongly agree/agree	47	42	48	67	100
	Neither agree nor disagree	35	42	36	17	0
	Strongly disagree/disagree	18	17	16	17	0
	P=	**0.774**				

The extent to which respondents agree [1]they had enough time to speak to pharmacy staff (including the pharmacist) (median: multiple=1.00, supermarket=1.00, independent community chain=1.00); [2]pharmacists have enough time to give healthcare advice to patients (median: multiple=2.00, supermarket=2.00, independent community chain=2.00). Categories were recombined into: Strongly agree/agree, neither agree nor disagree or strongly disagree/disagree. Medians did not include other type of pharmacy or do not know.

[*]Kruskal-Wallis test was performed – *Do not know option was omitted from test*

Appendix 26- Study Two: hub and spoke perceptions cross-tabulated with employment status

Independent variables		Employment status (%)				
		Employed (n=52)	Self-employed (n=10)	Unemployed (job seeking/not job seeking) (n=2)	Student/Retired /Unable to work/Homemaker (n=89)	Other (n=3)
Trust & hub and spoke[1]	Strongly trust/trust	8	0	0	3	0
	Neither trust nor distrust	29	30	0	23	0
	Strongly distrust/distrust	63	70	100	74	100
	P=	0.269*				
Off-site and hub and spoke[2]		Employed (n=54)	Self-employed (n=10)	Unemployed (job seeking/not job seeking) (n=2)	Student/Retired /Unable to work/Homemaker (n=93)	Other (n=3)
	Strongly trust/trust	9	0	0	2	0
	Neither trust nor distrust	26	50	0	18	0
	Strongly distrust/distrust	65	50	100	80	100
	P=	0.028*				
Pharmacist time for healthcare services and hub and spoke[3]		Employed (n=59)	Self-employed (n=9)	Unemployed (job seeking/not job seeking) (n=1)	Student/Retired /Unable to work/Homemaker (n=89)	Other (n=2)
	Strongly agree/agree	7	0	0.0	1	0
	Neither agree nor disagree	39	33	0.0	30	50
	Strongly disagree/disagree	54	67	100	69	50
	P=	0.737*				

Table 11. The extent to which General Public respondents trust hub and spoke dispensing [1]replacing the manual labour of pharmacy staff in dispensing medication (median: employed=2.00, self-employed=2.00, student/retired/unable to work/homemaker=2.00, other=3.00) and [2]making up medication off-site (not in the pharmacy) using a robotic dispensing machine) (median: employed=2.00, self-employed=2.00, student/retired/unable to work/homemaker=2.00, other=3.00) The categories were recombined as: strongly trust/trust, neither trust nor distrust, strongly distrust/distrust) [3]The extent to which pharmacists agree hub and spoke dispensing will provide pharmacists more time to provide healthcare service (median: employed=2.00, self-employed=2.00, student/retired/unable to work/homemaker=2.00, other=2.00) (strongly agree/agree, neither agree nor disagree, strongly disagree/disagree) with the employment status of the respondent. Median excluded unemployed category.

*Kruskal-Wallis was performed

Appendix 27- Study Two: cross-tabulations and statistical tests of robotic dispensing perceptions with age

Independent variables		Age (years) (%)				
		18-25 (n=7)	**26-39 (n=12)**	**40-59 (n=44)**	**60 and over (n=100)**	**Prefer not to say (n=2)**
Trust robotic dispensing machine[1]	Strongly agree/agree	71	17	43	32	50
	Neither agree nor disagree	14	50	30	33	0
	Strongly disagree/disagree	14	33	27	35	50
	P=	**0.197***				
Robotic dispensing and productivity[2]		**18-25 (n=8)**	**26-39 (n=9)**	**40-59 (n=42)**	**60 and over (n=83)**	**Prefer not to say (n=2)**
	Strongly agree/agree	88	33	79	54	50
	Neither agree nor disagree	13	44	19	31	50
	Strongly disagree/disagree	0	22	2	15	0
	P=	**0.039***				
Robotic dispensing and hinderance to patients using pharmacy[3]		**18-25 (n=8)**	**26-39 (n=11)**	**40-59 (n=45)**	**60 and over (n=93)**	**Prefer not to say (n=2)**
	Strongly agree/agree	13	36	31	29	50
	Neither agree nor disagree	25	36	29	37	0
	Strongly disagree/disagree	63	27	40	34	50
	P=	**0.569***				

The extent to which respondents [1]trust the accuracy of a robot in dispensing medication (categories include: strongly trust/trust, neither trust nor distrust or strongly distrust/distrust) ;[2]agree robotic dispensing will increase productivity of dispensing prescriptions (categories include: significantly increase/increase, neither nor increase nor decrease or significantly decrease or decrease); [3]agree robotic dispensing will hinder patients from using the pharmacy (1=strongly agree, 2=agree, 3=neither agree nor disagree, 4=disagree and 5=strongly disagree, by respondents' age (years). Due to rounding percentages may not add up to 100%.

*Spearman's rho correlation was performed

Appendix 28- Study Two: cross-tabulations and statistical tests of robotic dispensing perceptions with pharmacy type last visited

Independent variables		**Type of Pharmacy (%)**			
		Multiple (n=47)	**Supermarket (n=12)**	**Independent/ independent chain (n=76)**	**Do not know/other (n=6)**
Trust robotic dispensing machine[1]	Strongly agree/agree	47	42	21	50
	Neither agree nor disagree	26	25	39	17
	Strongly disagree/disagree	28	33	39	33
	P=	**0.088**			
Robotic dispensing and productivity[2]		**Multiple (n=41)**	**Supermarket (n=9)**	**Independent/ independent chain (n=63)**	**Do not know/other (n=6)**
	Strongly agree/agree	66	67	59	67
	Neither agree nor disagree	24	22	30	17
	Strongly disagree/disagree	10	11	11	17
	P=	**0.909**			
Robotic dispensing and hinderance to patients using pharmacy[3]		**Multiple (n=46)**	**Supermarket (n=9)**	**Independent/ independent chain (n=72)**	**Do not know/other (n=5)**
	Strongly agree/agree	28	22	38	20
	Neither agree nor disagree	30	0	38	0
	Strongly disagree/disagree	41	78	25	80
	P=	**0.025**			

The extent to which respondents [1]trust the accuracy of a robot in dispensing medication (categories include: strongly trust/trust, neither trust nor distrust or strongly distrust/distrust) ;[2]agree robotic dispensing will increase productivity of dispensing prescriptions (categories include: significantly increase/increase, neither nor increase nor decrease or significantly decrease or decrease); [3]agree robotic dispensing will hinder patients from using the pharmacy (1=strongly agree, 2=agree, 3=neither agree nor disagree, 4=disagree and 5=strongly disagree, by the last type of pharmacy visited by the respondent. Due to rounding percentages may not add up to 100%.

Appendix 29- Study Two: other comments why pharmacists don’t have enough time to provide healthcare advice to patients

Theme	Comment
Don’t Know	*“Don’t know” x 3* *“I have no idea as I haven’t come across a problem in our area”* *“No idea”* *“Don’t know as I cant visit”*
Pharmacists have enough time	*“Pharmacists always seem to have time at our surgery”* *“Not in my experience”* *“It is not my impression that pharmacists have too little time”* *“Pharmacists is available at the chemist I used”* *“I haven’t noticed a problem with the pharmacy in my community”* *“Have not found that to be the case”* *“My pharmacist always makes time to take”* *“Our estate pharmacy is very helpful”*
Don’t agree with factors	*“I don t think any of these”* *“I don’t agree with research”* *“Don’t agree”* *“Not aware that this is the case”*
Other services	“Drug users that turn up jump que and scare the older customers” “Too much demanded from their role”
Regulatory constraints	*“Regulatory constraints”*
High Demand	*“High demand due to demographic changes”*
Other comments	*“I do not understand on what basis they might be able to find time to speak to me in detail, eg. Is it supposed to be in their "spare odd moments", or do they have effectivel a certain amount of time each week, for which they receive govt. funding to speal to individuals in details?”* *“A combination of all above”*

Appendix 30- Study Two: apart from GPs, where healthcare advice is obtained from

Theme	Comment
None	None of the above NONE
Colleagues/ Family/ Friends are healthcare professionals	*"Healthcare professionals in family"* *Im a nursing staff member, so colleagues of various job roles* *NHS employee with good medical knowledge/ understanding* *Family members*
Alternative medical treatment	Alternative medicine, treatment
Other services	Mental health services
Other comments	Non never ill I am fortunate not to require medical advice only if I need to visit my GP, which is not often Functional medicine doctor This is the only chemist available to sue in this village
Other resources	Books
Other healthcare professionals	Nurses at GP's

Appendix 31- Study Two: advantages of robotics

Theme	Comment
Reducing dispensing errors	*"HUB & SPOKE AND PHARMACY AUTOMATION BOTH STEM PRACTICAL MEASURES TO REDUCING DISPENSARY ERRORS"*
Frees up pharmacist's time	*"AND IN PROVIDING PHARMACISTS WITH MORE TIME TO PERFORM OTHER DUTIES,"* *"As a whole I think Hub & spoke dispensing and pharmacy automation will slightly benefit in pharmacies as the chemist can speak with patients about queries/problems whilst prescriptions are handled automatically by the robot machine."* *"HOWEVER Assuming automation allows pharmacists to give more time & attention to individuals then so be it."* *"and free the pharmacist for other necessary"* *"If automation is brought in perhaps they will have more time to give to patients as they now seem reluctant and often stand-offish when asked for advice."* *"(I think automation/use of robotics for dispensing will soon happen, that it will work/perhaps after initial and occassional mess-ups), and that in a sense it will definitely "save pharmacists' time which could then potentially be re-allocated for detailed talking with individuals.)"*
Ease of technology	*"I came across Robotic dispensing in Belgium, just surprised we do not have this form of ease technology here in the UK.* *It will be a brilliant idea if it actually comes to reality"*
Saves time	*"As far as I understand it, prescriptions will still be checked by a pharmacist whether 'hub & spoke' or 'automated' dispensing is done. Either method should save time."*
Improve accuracy of dispensing	*"Introduction of a degree of automation within the pharmacy can clearly help the accuracy of dispensing"*
More effective	*"I see it daily in my place of work. It works. Its more time affective and things get second checked anyway."*

Appendix 32- Study Two: disadvantages of robotics

Theme	*Comments*
Time will be reduced	*"I do not believe either automated service will benefit/increase the time for the Pharmacist staff."* *"Reason being that if it is proved to be successful, the staff members will be reduced to save money, hence no extra time available."*
Reduce number of pharmacists – insufficient time for advice	*"I would have no problem with robotic dispensing if it was really being used to improve services. I anticipate that it will actually be used to reduce the number of pharmacists, so they will still have insufficient time to give advice."* *"I do not believe either automated service will benefit/increase the time for the Pharmacist staff.* *Reason being that if it is proved to be successful, the staff members will be reduced to save money, hence no extra time available."* *"I would have no problem with robotic dispensing if it was really being used to improve services. I anticipate that it will actually be used to reduce the number of pharmacists, so they will still have insufficient time to give advice."*
System failures	*"I am nervous of any automation – problems when systems crash + people needing medication."*
Reduce staff	*"EXPECT BOTH SYSTEMS WILL BE EMPLOYED TO REDUCE STAFF NUMBER S INSTEAD OF THIS."*
Hinderance to the elderly	*"but my concern is how well the people are willing to receive this made of new dimension in the pharmacy world especially (the senior citizens)."* *"MOST USERS ARE OLD AND WON'T LIKE THE AUTOMATION PREFER FACE TO FACE CONTACT, BUT UNFORTUNATELY THIS IS THE WAY THE WORLD IS GOING."* "ALSO THERE ARE LOTS OF OLD PEOPLE ON MEDICATION AND THEY DONT LIKE CHANGE."

	"Hub and Spoke dispensing or Pharmacy automation System will have a devastating effect on the lives of elderly, mentally ill people"
Robotic errors	*"However if the chemist themselves can make errors with medication eg someonelses medication (in my family) given to me or given the wrong dose etc then surely robots can make the same mistake. Im having to check ALL my medication before leaving the pharmacy to ensure its correct. I cant be having rhe same conversation with a robot if things go wrong."* *"ROBOTS CAN'T READ SO WHAT IF THE WRONG MEDICATION GOES TO A PATIENT."* *"ESSENTIALLY SUSPICIOUS OF AUTOMATION, AS IF ERRORS OCCUR THEY TEND TO BE MORE OBVIOUS THAN 'HUMAN' ERRORS"* *"There would have to be major support in place to fix malfunctions of robotics. I can see the robotics being out of action for a long time, therefore being a total waste of money, if the fixing of problems is not efficient."*
Robotics not the answer	*"I can appreciate the cuts in funding will have a detrimental affect on current services but don't think that robotics is the answer."*
Replacing jobs	*"I don't like the idea of Robot's replacing people's jobs."* *"I do not agree with the use of an automated dispensing system because robots deprive human staff of needed jobs."*
Won't improve the system	*"Having spent many years studying, practising and teaching various methods of improving efficiency and effectiveness, including Kaizen techniques I would have to say in my considered opinion, the 'hub and spoke' and 'automated dispensing' methods as you describe will not*

	improve the system, but could actually have a negative effect.” *“For a system to be improved and made more effective with less faults, it is essential to eliminate as many of the parts of the process as possible. The system you describe has actually introduce d two more processes and increased the labour requirement by 200% in the guise of another pharmacist to check that the robot has performed correctly and another person to actually ‘feed’ the robot system. Every time you introduce another level of the process, the opportunity for mistakes to be made increases. The more complicated a system is the greater its vulnerability.”*
Other suggestions	*“I think more effort should be spent in checking each patients current need for prescribed repeat medicines which must waste millions of pounds every year when these un-needed medicines are discarded by the patients because they do not take them. Thank you.”*

Appendix 33- Study Two: other comments towards robotic dispensing

Theme	Comments
Environmental issues	*"Are there any transport increases, environmental issues?"*
Prescription transport	*"How will prescriptions be delivered, where collected etc?"*
Not enough knowledge to answer questions	*"I answered 'Do not know' to a number of questions as I felt I did not have the knowledge to make a fair judgement. I felt the questions should have been aimed at pharmacy staff and pharmacists to be able to then to give an accurate response from their experience. I felt therefore I did not have the relevant knowledge or experience to give any other answer."* *"CAN'T ANSWER THESE QUESTIONS BECAUSE IT HAS NOT BEEN TRIED YET."* *"I have no idea how efficient robots would be or if they make mistakes. If they were fool proof then the system could work but I no nothing about the effectiveness of robots and feel happier that I can walk into Pharmacy attached to my G.P. surgery and sort out any problems withe medications."* *"Until using all the new ways of dispensing it is difficult to decide which is best"* *"My responses are probably based on the fact I appreciate human contact! Many responses in the "neither trust nor distrust" are because I have had no experience of such dispensing method; I find I cannot imagine what this new method would be like + how it would effect me."*
Other comments	*Dear Sir/Madam* *I am very sorry, that can not help I am 75 years old. I do not interested in pharmacy automation or robotics survey.*
Prefer human contact	*"Never having given This specific question much thought I am drawing on my underlying feelings about various other services. I detest automatic tills in shops because they deprive people of employment Human contact is an important factor in making the day more meaningful/pleasant This could all be the end of the wedge; first slip down a slippery slope*

	leading to Robots in care homes or hospitals I positively love garages which fill your tank & pump up your tyres I love the internet but want to be in control"
Further knowledge	*I would like to know where hub + spoke dispensing or pharmacy automation are currently in use (apart from hospitals) in other countries?*
Pharmacist service experience	*"When collecting prescriptions at pharmacy it always seems to take a long time. The pharmacists do not seem to have a sense of urgency and often ignore customers who are waiting to be served."* *"My experience is that pharmacists are often unapproachable and have the air that they are superior and look upon customers disdainfully. Other friends and family agree with this statement."*

Appendix 34- Study Two: advantages of pharmacy automation

Theme	*Other comments*
Would be helpful	*"Pharmacy automation would be possible & helpful"*

Appendix 35- Study Two: disadvantages of pharmacy automation

Theme	*Other comments*
Delays and technical problems	*"If we are solely reliant on automation there will be huge problems + delays when there are technical problems."*
Won't save time	*"but would not save much time for the single pharmacist serving our community."*

Appendix 36- Study Two: other comments towards pharmacy automation

Theme	*Other comments*
Questions about the introduction of pharmacy automation	*"How would pharmacy automation be introduced and would independent pharmacies still be able to run viably?"*
Depends on programmer	*"As previously stated, pharmacy automation will only be as good as the person programming it."*

Appendix 37- Study Two: advantages of hub and spoke dispensing

Theme	*Other comments*
Reduce time	*"In as much as hub and spoke dispensing will reduce the time on waiting and queuing in the pharmacy,"*
Can see benefits	*"I can see the benefits of centralisation"* *"I FAVOUR THE HUB AND SPOKE DISPENSING"*
More time for pharmacists to provide healthcare advice to patients	*"Having worked for twenty five years in a pharmacy in a rural area. There was a lot of pressure put on the pharmacist & technicians. Hence the pharmacist had very little time to spend with customers who needed professional advice perhaps This proposed idea Hub & spoke dispensing will solve the problem."*

Appendix 38- Study Two: disadvantages of hub and spoke dispensing

Theme	*Other comments*
Loss of jobs	*"it will also lead to loss of job for the front desk dispenser."* *"It seems to me that a lot of people will love their jobs with Hub and Spoke dispensing and a lot of these people cant afford to lose their jobs."*
Loss of flexibility	*"It seems to me that he would lose this flexibility to use various supplies with the use of off-site centralised automation."*
More gain for multiples than independents	*but also the pitfalls. major nationwide pharmacists would probably stand to gain much more than independents.*
Delay urgent prescriptions	*"BUT ON OCCASIONS OF URGENT PRESCRIPTIONS GIVEN BY DOCTORS THAT CAN IMMEDIATELY BE TAKEN TO A PHARMACY AND DISPENSED I THINK THE DELAY OF OFF SITE HUBS WOULD DELAY THE PROCESS."*
Increase time taken to serve the patient	*"On the other hand use of a HUB will inevitable increase the time taken to serve the patient."*
Increased time to get prescriptions	*"HUB + SPOKE DISPENSING WILL INCREASE THE TIME IT TAKES TO RECEIVE THE PRESCRIPTION IN MY OPINION."*
Not beneficial outside large cities	*"Hub & spoke dispensing is not going to give timely dispensing of medicines outside large city regions."*
Unappealing process	*"Finally – Hub + Spoke arrangements – this seems to add unappealing layer of remoteness, probaly leading to more communications needed across that gap, and typically requiring an extra visit eg. When I'm given prescription by my Dr, as I'd have to go back after the meds had been physically transported there from the hub."*

Appendix 39- Study Two: other comments towards hub and spoke dispensing

Theme	Other comments
Proximity of hub to spoke	*"How close will hubs be to spokes?"*
Prescription delivery	*"How will prescriptions be delivered, where collected etc?"*
Environmental issues	*"Are there any transport increases, environmental issues?"*
Timescales of hub and spoke dispensing?	*"I wonder what timescales would be for receiving medication with a hub and spoke dispensing system?"*
Emergency on-site dispensing?	*"How would emergency or immediately required medication be made available if not dispensed on site?"* *"If you have "hub": a) How will it cope with emerging medication?"*
Hub to spoke ratio?	*"Where would the hub be - how many spokes would it serve?"*
No experience	*"As I had not previously heard of hub + spoke dispensing I could not contribute to a positive reply to many of the questions with regards to trust and confidence etc."* *"Having not experienced the hub-robotic method… I feel I am unable to compare."*
Pharmacist services	*"I am fortunate in dealing with an independent pharmacist. He has the flexibility to almost always manage to provide me with the full prescription requirements."*
Stock issues?	*"b) Will it lead to NO STOCK at pharmacies?"*
General comments	*"If you dont try hub and spoke dispensing you will not know if its beneficial neither will!"* *"In the case of rare, expensive and controversial medicine, The question of a hub scheme become more appropriate"*