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Examining physiotherapists' knowledge of and attitudes towards ankle-foot orthoses in the treatment of stroke survivors

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By

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Finally, …. Paul …. Helen

Abstract

After a stroke, many people will have impaired mobility. Physiotherapists are central to the rehabilitation of stroke survivors and have a number of options to assist in this rehabilitation, one of which is referral for ankle-foot orthoses. The evidence-base suggests that the use of ankle-foot orthoses on stroke survivor's gait is positive (NICE. 2012), and they are a valuable tool to assist with functional gait and consequently recovery. However, physiotherapists may be reluctant to refer stroke survivors for ankle-foot orthoses, and by not doing so, and failing to interpret guidelines correctly, may deny the patient a legitimate route of rehabilitation.

The aim of the thesis is to establish whether physiotherapists are hesitant to refer stoke survivors for ankle-foot orthoses, and, if there is a reluctance, whether this is a result of a lack of knowledge or other beliefs.

Three distinct research methods were used to investigate the knowledge and attitudes of physiotherapists. The use of questionnaires, semi-structured interviews and pre and post-training questionnaires with experiential training on ankle-foot orthoses allowed for the collection of wide ranging data. A combination of their knowledge and understanding as expressed in reports of practice and clinical decision making provided the data. The results from all three methods were then analysed in light of existing practice guidelines and to identify common themes.

The lack of knowledge and the beliefs of the physiotherapists combine to contribute to their reluctance to refer stroke survivors for ankle-foot orthoses. The results, from all three methods, show that knowledge is dominated by the importance of swing period gait deviations and not the functionally more debilitating stance period gait deviations. The experiential training was shown to improve their knowledge of when to use ankle-foot orthoses. They reported positive views to use of ankle-foot orthoses and no reluctance regarding biomechanical and neurophysiological factors, but transferred their reluctance to other issues that could not be challenged with the evidence-base.

Integrating orthotists, who are experienced in the use of ankle-foot orthoses, into the rehabilitation of those stroke survivors who have most to benefit from ankle-foot orthoses, could help ensure the option of this legitimate route of rehabilitation.

About the Author

The researcher is an orthotist registered with the Health and Care Professions Council.

One of his interests is evidence-based care, specifically the conflict between recommended practice and actual clinical practice. As a practicing orthotist he is also involved in the use of ankle-foot orthoses to assist with the rehabilitation of stroke survivors. This opportunity has allowed him study the overlap of these areas of interest.

Contents

Figures and Tables

1. Introduction

A stroke is a non-progressive lesion in the brain. People who have experienced a stroke are frequently termed 'stroke survivors' (Young and Forster 2007). The effect of a stroke on a personal level can be devastating for the person, their family and friends. There are estimates that 300,000 stroke survivors are living in England with a moderate to severe disability as a result of one or more strokes (Department of Health 2005).

There are three important guidelines in the area of management and rehabilitation of stroke survivors: *Management of patients with stroke: Rehabilitation, prevention and management of complications, and discharge planning*, Scottish Intercollegiate Guidelines Network (SIGN. 2010); *National clinical guidelines for stroke*, Royal College of Physicians (RCP. 2012); *Stroke Rehabilitation: Long term rehabilitation after stroke*, National Institute for Health and Care Excellence (NICE. 2013). As part of these guidelines the use of ankle-foot orthoses with stroke survivors is discussed and the evidence for their use is reviewed. The SIGN guidelines suggest the use of ankle-foot orthoses *"Where the aim of treatment is to have an immediate improvement on walking speed, efficiency or gait pattern or weight bearing during stance, patients should be assessed for suitability for an AFO by an appropriately qualified health professional"*(2010). The RCP guidelines address the implications for staffing *"All stroke services should have therapists who are knowledgeable about the use of aids and appliances to improve function after stroke, and have easy access to a well resourced wheelchair and orthotics service"* (2012). The NICE guidelines offer examples of the difficulties that stroke survivors may have with walking *"Consider ankle-foot orthoses for people who have difficulty with swing-phase foot clearance after stroke (for example, tripping and falling) and/or stance-phase control (for example, knee and ankle collapse or knee hyperextensions) that affect walking"* (2013). These guidelines recognise that ankle-foot orthoses are effective interventions in the management of stroke survivors and consequently, indications for the use of ankle-foot orthoses are given.

The rehabilitation goals that stroke survivors most frequently reported were improvements in their walking or 'gait' (Bohannon, Andrews and Smith 1988). Stroke survivors who are more functionally effected require the assistance of an ankle-foot orthosis more than those with less reduction of functional abilities (Teasell et al. 2001). Central to the use of ankle-

foot orthoses with stroke survivors is the 'appropriately qualified health professional' who will initiate the assessment or referral (SIGN. 2010). The referral of a stroke survivor to orthotic services for an assessment for an ankle-foot orthosis is made by physiotherapists. This relies on 'therapists who are knowledgeable' about the use of ankle-foot orthoses with stroke survivors (RCP. 2012).

There is evidence that indicates that physiotherapists are reluctant for stroke survivors to use ankle-foot orthoses (Raine, Meadown and Lynch-Ellerington 2009). There is the possibility that physiotherapists do not understand the function of ankle-foot orthoses which may contribute to their reluctance for stroke survivors to use them (Davidson and Waters 2000). There is also a suggestion that physiotherapists do not see that ankle-foot orthoses can facilitate the recovery of functional gait and muscle control (Sackley and Lincoln 1996). If the referral is not made, then the implication is that some stroke survivors will not benefit from an evidence-based intervention. It would be a missed opportunity for stroke survivors if the physiotherapists, who should refer them for assessment for an ankle-foot orthosis, do not.

The research aim is therefore:

> To explore physiotherapists' knowledge of and attitude towards ankle-foot orthoses in the treatment of stroke survivors

This thesis will explore which particular aspects of a stroke survivors gait will result in a referral and which do not. Also, what influences the physiotherapists in their decision to refer. The reasons behind the physiotherapists reluctance towards stroke survivors using ankle-foot orthoses will also be explored.

Figure 1 below shows the structure of this thesis. This highlights the parallel rather than sequential nature of the three methods of investigation.

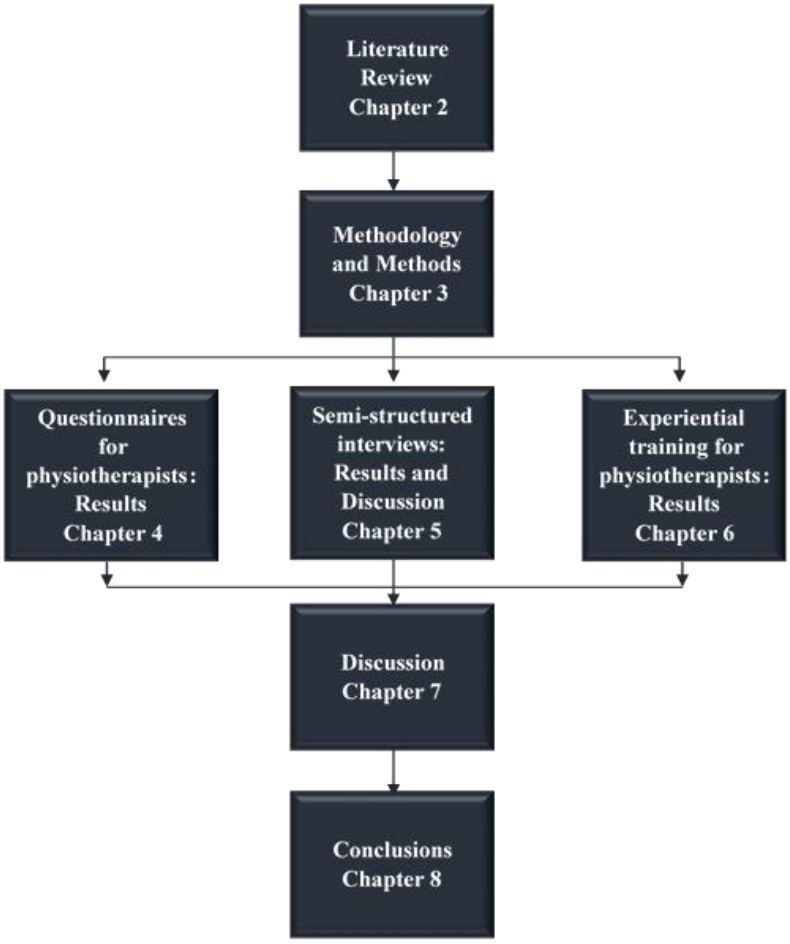


Figure 1 Thesis stucture

Chapter 2 offers a review of relevant literature and a discussion of key terms. This includes the effect of stroke on functional mobility. The importance of evidence-based care, and the resulting guidelines for care were then used to structure the review of how ankle-foot orthoses assist in the rehabilitation of stroke survivors. The final section of the literature review examines the published perceptions of physiotherapists to the use of ankle-foot orthoses with stroke survivors.

Chapter 3 presents the methods employed in examining physiotherapists knowledge of and attitudes towards ankle-foot orthoses in the rehabilitation of stroke survivors. Three different methods of investigation were employed: Questionnaires for physiotherapists, semi-structured Interviews, and Experiential Training with pre and post-training questionnaires.

The ethics, sampling and recruitment procedure, and the approach to data analysis are also discussed. The three methods seek to establish the knowledge base and attitudes of physiotherapists, and offer the possibility of triangulating the results. They were conducted concurrently with the results being sequentially presented in Chapters 4, 5, and 6.

Chapter 4 outlines the results of the questionnaires presented to three groups of physiotherapists prior to in-service training. The aim was to understand why physiotherapists refer some stroke survivors and not others for an ankle-foot orthosis, as well as why they are reluctant to refer.

Chapter 5 details the results of six semi-structured interviews conducted with physiotherapists. The interviews explored the physiotherapists understanding of ankle-foot orthoses, and their role in the rehabilitation of stroke survivors.

The results from the pre and post experiential training questionnaires are presented in Chapter 6. For the purposes of this thesis the change in responses between the pre and post-training questionnaires are of prime importance, rather than the experiential training itself.

The discussion of the three research methods and the results are synthesised in Chapter 7. This allows triangulation of the results across the three methods.

Finally, Chapter 8 presents the conclusions of this thesis and potential avenues for future research.

2. Literature review

The literature review aims to bring context to the areas of knowledge that inform this research project and is covered in the following 6 sections:

- Stroke and movement
- Evidence-based care
- The effects of stroke on gait
- The effects of ankle-foot orthoses on gait
- Evidence-based care and ankle-foot orthoses
- Perceptions of ankle-foot orthosis use

2.1. Stroke and movement

A stroke is a type of brain injury; a non-progressive lesion in the brain. The possible consequences of a stroke range in severity between recovery within 24 hours, termed a transient ischemic attack or 'mini stroke', to severe brain damage or death. The Department of Health states that stroke is the third biggest cause of death in the UK and the largest single cause of severe disability (Department of Health 2005). Financially the direct costs of care to the National Health Service is approximately £2.8 billion a year, with an additional estimated cost of £2.4 billion on the informal care costs, provided by family or care homes (Department of Health 2005).

The estimates of the incidence of stroke vary, some suggest that there are 110,000 people who experience a first stroke each year in England and a further 20,000 who experience a transient ischemic attack (Department of Health 2005). The prevalence is similarly difficult to estimate, some suggest there are 900,000 people living in England who have had a stroke and 300,000 of these are living with a moderate to severe disability (Department of Health 2005).

The initial interventions following a stroke are medical, to stabilise and prevent death. Longer term interventions are aimed at minimising the possible consequences of the stroke and rehabilitation becomes central. A consensus exists that rehabilitation aims "to limit the

impact of stroke related brain damage on daily life by using a mixture of therapeutic and problem solving approaches" (Young and Forster 2007).

The World Health Organisation has produced the 'International Classification of Function' that provides an organisational framework for healthcare (WHO 2001). The biopsychosocial model integrates the ideas that biological, psychological and social factors each play a part in human functioning.

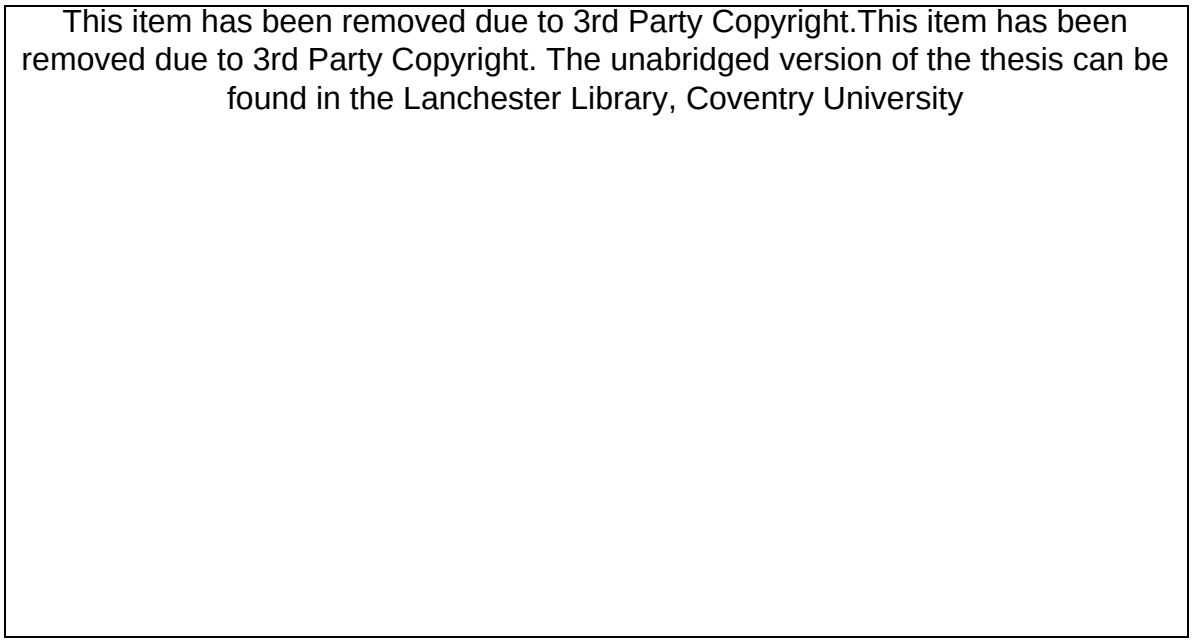


Figure 2 Diagrammatic representation of the International Classification of Function with stroke as the condition of interest (Levin, Kleim and Wolf 2009)

Figure 2 shows the structure of the International Classification of Function with stroke as the condition (World Health Organization 2001) conceptual parts of the model are: 'impairments', 'activities', and 'participation'. The definitions of the model can be summarised: impairment limitations include loss of body functions and structures, symptoms or signs; activity limitations reflect the functional task difficulties that stroke survivors' experience; participation restriction refers to the reintegration into their previous life. Rehabilitation interventions at the impairment level (ankle-foot orthosis) aim to improve body functions which can improve activities and thus facilitate increased participation, as can be understood from figure 2.

At the level of 'impairments' the immediate effects on the motor system following a stroke are of weakness or paresis (Shumway-Cook and Woollacott 2007). Paresis is defined as a decrease in the recruitment of the voluntary motor units to produce torque or movement (Gracies 2005a). During the initial weeks following a stroke the weakness may persist, but there may also be an emerging over activity of some muscles which may continue to increase over time, resulting in spasticity or increased muscle tone (Gracies 2005b, Yelnik et al. 1999, Yelnik et al. 2010). The weakness and increased muscle tone has a measurable effect at the impairment level and can impact on activity and consequently participation. Other consequences can be identified and described at the level of impairment, but paresis and increased muscle tone are the most debilitating for functional standing and walking. These are often identified as indications for an ankle-foot orthosis.

A comprehensive study that assessed the effect on walking soon after a stroke found that 51% of stroke survivors were not able to walk and 12% were only able to walk with assistance. Even after completing rehabilitation, 18% could not walk and 11% could only walk with assistance (Jørgensen et al. 1995a). The stroke survivors who are more severely affected by the stroke will stay longer in hospital and have most to be gained by rehabilitation and ankle-foot orthosis (Teasell et al. 2001). The majority of stroke survivors had achieved their best walking function within the first 11 weeks and further rehabilitation did not change walking function to a significant extent (Jørgensen et al. 1995a). However, further improvements in functional walking can be made, though these are less significant (Richards and Olney 1996). The importance of being able to stand and possibly walk should not be underestimated as this is the main determinant of discharge destination, if the stroke survivor cannot stand and step they will be discharged to a nursing home rather than to their own home (de Quervain et al. 1996).

Ankle-foot orthoses can help stroke survivors at the level of impairment (Tyson Sadeghi-Demneh and Nester 2013), which can assist with activities and participation for the stroke survivor.

2.2. Evidence-based care

The approach of evidence-based care is a dominant influence in the National Health Service and healthcare around the world. Evidence-based medicine has been described, to a certain

extent rhetorically, as a self-proclaimed Kuhnian paradigm (Howick 2011). Evidence-based medicine may not be a paradigm shift in science (Kuhn 2012), but the impact that evidence-based medicine has had, and is having, is momentous.

The original definition, which has change little over time, stresses the use of evidence to aid decision making *"Evidence-Based Medicine de-emphasises intuition, unsystematic clinical experience, and pathophysiological rational as sufficient grounds for clinical decision making and stresses the examination of evidence from clinical research"* (Evidence-Based Medicine Working Group 1992). Evidence-based care is often quoted as being *"the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients"* (Sackett et al 1997: 71). The importance of interventions being evidence-based in the National Health Service and consequently the importance of evidence-based practice cannot be underestimated (Gray 1997).

The approach of evidence-based care is employed to evaluate healthcare interventions and recommend and endorse interventions with a strong evidence-base. The way this is operationalised is broadly via quantitative research. Randomised controlled trials are the best research design to establish effectiveness of a clinical intervention (Jadad 1998). When there are more than one randomised controlled trial then combining the results in a systematic review is more powerful (Chalmers and Altman 1995). It is systematic reviews of randomised controlled trials that are at the heart of the recommendations of evidence-based practice (Dawes et al. 1999).

Evidence of the effectiveness of many interventions in stroke rehabilitation have been examined, including the use of ankle-foot orthoses. The National Institute for Health and Care Excellence (Section 13.10), the Royal College of Physicians (Section 6.8), and the Scottish Intercollegiate Guidelines Network (Section 4.2.6), have each conducted reviews into the management and rehabilitation of stroke survivors with specific sections on the use of ankle-foot orthoses (indicated in brackets) (NICE. 2013, RCP. 2012, SIGN. 2010). The guideline development followed the principles of evidence-based care. The pertinent conclusion was that ankle-foot orthoses are an evidence-based intervention. These guidelines should inform stroke rehabilitation with the indications given for the use of ankle-foot orthoses.

However, there is a concern that physiotherapists do not refer all stroke survivors who need orthotic services and ankle-foot orthoses. Thus, they may not be following these guidelines, possibly because of a knowledge gap or specific attitudes held.

2.3. The effects of stroke on gait

Walking is something most people take for granted, seldom questioning this ability until 'something goes wrong'. A persons gait is usually coordinated, efficient and symmetrical. When the symmetry of movement between the left and right sides of the body is lost, as can happen following a stroke, changes in gait can be very evident.

Clarity of terminology is important when discussing gait, the most common approach uses reciprocal floor contact and progression patterns (Perry and Burnfield 2010). Functional walking is comprised of repetitive sequences of limb motion. Each stride is divided into two periods, stance period and swing period, as shown in figure 3.

Figure 3 Divisions of the gait cycle (Perry and Burnfield 2010)

Stance period is when the foot of the leg of interest is in contact with the ground and swing period is when the foot of the leg of interest is not in contact with the ground, they are further subdivided into phases of gait as can be seen in figure 3. The approximate relationship

between stance and swing periods is 60% to 40% of the gait cycle. This does vary with the speed of walking.

Regaining walking ability is one of the most important rehabilitation goals for stroke survivors in hospital or at home (Bohannon, Andrews and Smith 1988, Mudge and Stott 2007). Functional walking is more challenging than sit to stand or quiet standing and explains why a high number of stroke survivors do not manage this independently (Jørgensen et al. 1995b). Many stroke survivors do not walk independently following a stroke or demonstrate gait patterns that are significantly altered, the degree of change can vary widely (Perry et al. 1995).

Gait problems for stroke survivors can present in many ways. Indications for an ankle-foot orthosis will be used as section headings below to discuss the gait of stroke survivors and are drawn from guidelines (SIGN. 2010). The four indications are:

- Walking speed
- Walking efficiency
- Gait pattern
- Weight bearing during stance

2.3.1. Walking speed

Walking speed for stroke survivors is reduced (Goldie, Matyas and Evans 1996, Hsu, Tang and Jan 2003, Mulroy et al. 2003), consequently the range of speeds available to stroke survivors is also reduced (Turnbull, Charteris and Wall 1995). Additionally, the stroke survivor is likely to fatigue quickly with a decline in their functional walking capacity over relatively short distances (Sibley et al. 2009). Walking speed has been shown to be valid, reliable and responsive to changes in walking performance and to be positively related to muscle strength and control (Richards, Malouin and Dean 1999), quality of gait (Wade et al. 1987) and inversely related to plantar-flexor spasticity or increased muscle tone (Lamontagne, Malouin and Richards 2001).

2.3.2. Walking efficiency

The disruption to muscle control has a major impact on stroke survivors functional gait, either paresis (de Quervain et al. 1996) or increased muscle tone (Mulroy et al. 2010). One notable effect of the paresis or increased muscle tone is the decrease in symmetry of movement and gait, this in turn reduces walking efficiency (Lamontagne, Malouin and Richards 2001).

2.3.3. Gait Pattern

Descriptions of impairment level changes to the kinematics of gait are common and frequently termed 'gait deviations' (Hsu, Tang and Jan 2003, Moore et al. 1993, Moseley et al. 1993, Olney and Richards 1996). These impairment level changes will have a detrimental effect on functional mobility (Taylor et al. 2006). During stance period there may be: decreased hip extension in late stance, knee hyperextension or increased knee flexion (Moseley et al. 1993). During swing period differences may include: decreased hip flexion, decreased knee flexion or decreased dorsiflexion (Moore et al. 1993). There are often many different ways of describing some of these gait deviations (Watelain et al. 2003). The documentation of impairment level changes does not lead to greater understanding of gait pattern, but can help provide a common language.

There have been approaches made to classify hemiperetic gait patterns, these have been based on observation of impairments or gait parameters (de Quervain et al. 1996, Knutsson and Richards 1979, Olney and Richards 1996, Shiavi, Bugle and Limbird 1987). When classifications are based solely on temporal-spatial stride characteristics the groups have similar velocities but very different kinematic values and electromyography patterns (Olney and Richards 1996). When classifications are based on electromyography patterns there is variability in stride characteristics and kinematics (Knutsson and Richards 1979, Shiavi, Bugle and Limbird 1987). An exploratory approach based on cluster analysis of different features of gait produced four sub-groups that were more homogeneous in regards to gait pattern, kinematics and velocity (Mulroy et al. 2003). This classification highlights the importance of the stance period for gait pattern and particularly stroke survivors gait.

Stance period

There are five parts to the stance period of gait, figure 4 is a visual representation of this.

Figure 4 The five phases of the stance period, with the associated tasks (Perry and Burnfield 2010)

The classification of stroke survivors' functional gait patterns highlights the importance of stance period for the two kinematic patterns identified, one of extension and of flexion (Mulroy et al. 2003). The extension pattern demonstrated plantar-flexion of the ankle and associated hyperextension of the knee and retraction of the hip. The flexion pattern demonstrated increased dorsiflexion of the ankle and associated increased flexion of the knee and lack of extension of the hip. The alignment of the tibia is directly influenced by either the increased tone or the paresis of the calf muscles. Stroke survivors who have more profound distal weakness have a more disrupted gait (Neckel et al. 2006). The alignment of the tibia in stance period is a key feature for stroke survivors gait and can be controlled by ankle-foot orthoses.

Swing period

There are three parts to the swing period of gait, figure 5 is a visual representation of this.

Figure 5 The three phases of the swing period (Perry and Burnfield 2010)

It should be noted that some of the more obvious gait deviations during swing period may not be the most detrimental to functional gait, an example is 'drop foot' (Mulroy et al. 2003). Isolated 'drop foot' in swing period is easier for stroke survivors to cope with than issues in stance period, either plantar-flexor weakness or plantar-flexor over activity (Lamontagne, Malouin and Richards 2001, Neckel et al. 2006). There is a causational relationship between the poor quality stance and the resultant quality of swing, which is not reciprocal. This again highlights the importance of stance period for functional gait.

2.3.4. Weight bearing during stance

Weight bearing during stance is fundamentally important for gait, it directly influences the stance period of gait. Furthermore, there is an assertion that weight bearing can beneficially influence abnormal muscle tone (Raine, Meadown and Lynch-Ellerington 2009), hence the importance of good quality weight bearing.

In summary the effects of stroke on gait can be significant: reduced walking speed, reduced walking efficiency, compromised gait pattern, and compromised weight bearing during stance. The gait deviations that are present during stance period are debilitating for functional gait of stroke survivors, but are clear indications for the use of ankle-foot orthoses which should help reduce the impairment level problems and improve the quality of a stroke survivors gait.

2.4. The effects of ankle-foot orthoses on gait

The definition of an orthosis as *"an externally applied device used to modify the structural and functional characteristics of the neuromuscular and skeletal systems"* (ISO. 8549-1 1989) is a broad definition and can encompass many devices. An ankle-foot orthosis is *"an orthosis which encompasses the ankle joint and the whole or part of the foot"* (ISO. 8549-3 1989); this is also quite a broad definition. The two main functions of ankle-foot orthoses for stroke survivors are biomechanical and neurophysiological. The biomechanical function involves, control of alignment, and neurophysiological function involves, managing weakness or increased muscle tone.

There are many designs of ankle-foot orthoses used to assist stroke survivors functional gait, both clinically and in research. The following designs of ankle-foot orthoses have been shown to produce an increase in velocity; rigid metal ankle-foot orthoses (Corcoran et al. 1970, Gök et al. 2003, Lehmann et al. 1987); plastic solid ankle-foot orthoses (Corcoran et al. 1970, Franceschini et al. 2003, Pavlik 2008, Sheffler et al. 2006); hinged ankle-foot orthoses (Pavlik 2008, Sheffler et al. 2006, Tyson and Thornton 2001); ready-made flexible plastic ankle-foot orthoses (de Wit et al. 2004).

Different designs of ankle-foot orthoses have different functional characteristics which can be matched to stroke survivors' functional deficits. Posterior leaf spring designs of ankle-foot orthoses are most commonly ready-made and provide swing period control, while solid ankle-foot orthoses are custom-made for each stroke survivor by an orthotist and provide stance period control and almost incidentally swing period control. Below is an attempt to begin to relate ankle-foot orthoses design to function, and ultimately to stroke survivors' needs:

Table 1 Summarised from (NHS Quality Improvement Scotland 2009). Attempts to link designs of ankle-foot orthosis to indications and the specific purpose of ankle-foot orthoses.

Matching the ankle-foot orthosis functional characteristics to the stroke survivors functional deficits is very important for optimal outcomes (Bregman et al. 2010). Conceptually there are three possible states: 'Over prescription'; 'Optimal prescription'; and 'Under prescription'.

'Over prescription' of control and resistance to movement can be an issue with ankle-foot orthoses. Initially the prescription can be optimal but then with some recovery of the stroke survivor the ankle-foot orthosis provides more control and resistance to movement than required. 'Optimal prescription' of control and resistance to movement of an ankle-foot orthosis is the ideal. This entails the matching of functional characteristics of the orthosis with the functional deficits of the stroke survivors. However, the changeable nature of stroke survivors' functional deficits can make this challenging. 'Under prescription' of control and resistance to movement of the ankle-foot orthosis is a significant problem, the ankle-foot orthosis is only partly beneficial. Frequently this under prescription will not be recognised by healthcare professionals.

The functional impact of an ankle-foot orthosis on a stroke survivors gait can be wide ranging. This next section adopts the indications for an ankle-foot orthosis (SIGN. 2010) as a structure to discuss the effects of ankle-foot orthoses on stroke survivors gait:

- Walking speed
- Walking efficiency
- Gait pattern
- Weight bearing during stance

2.4.1. Walking speed

Walking speed is an established outcome measure of the benefits of rehabilitation for stroke survivors (Dickstein 2008) and velocity is consistently used as an outcome measure in research on ankle-foot orthoses. Existing randomised trials and systematic reviews agree that ankle-foot orthoses increase the walking speed of stroke survivors (NICE. 2013, RCP. 2012, SIGN. 2010).

2.4.2. Walking efficiency

Walking efficiency is dependent on many aspects of gait, the link with symmetry of gait is clear, as symmetry of gait declines so walking efficiency also declines. The biomechanical effect of ankle-foot orthoses on the alignment of a stroke survivors leg, both statically and dynamically, are clearly observable and measurable. A systematic review concluded that there are immediate kinematic and temporal improvements in the gait patterns of stroke survivors with the use of ankle-foot orthoses (Leung and Moseley 2003).

2.4.3. Gait Pattern

Research conducted by Mulroy highlights more clearly than other research that the alignment of the stroke survivors leg during stance period is the primary determinant of poor gait rather than swing period issues (2003). Two primary gait patterns are clearly identified; one of excessive knee flexion during stance and one of excessive knee extension during stance (Mulroy et al. 2003).

The range of ankle-foot orthoses allow clinicians to attempt to match the different functional characteristics of ankle-foot orthoses with the functional needs of the stroke survivor. It is critical to differentiate the stroke survivors need for control between the stance and swing periods of gait. The stroke survivor who has gait deviations during stance period (and by implication swing period) has more mobility related disability because of their stroke than someone who has gait deviations only during swing period.

Stance period

Recovery of functional gait for stroke survivors will first require that they regain stance period control. An ankle-foot orthosis that controls a stroke survivors leg in stance period, either from excessive collapse into flexion or excessive hyperextension will also control any swing period gait deviations. Ankle-foot orthoses that control stance period will be more rigid at the ankle and forefoot and tend to be custom made by orthotists, and are recommended when stroke survivors gait is more compromised (Condie, Campbell and Martina 2004). The use of appropriately rigid and appropriately aligned ankle-foot orthoses for control of the stroke survivors foot and ankle during stance period are vital, to optimise the biomechanics at the hip and knee during gait (Bowers and Meadows 2007, Bowers and Ross 2010).

Swing period

'Posterior leaf spring' ankle-foot orthoses are advocated when there are only swing period gait deviations or issues of gait; this is typically a 'drop foot' gait pattern. The 'posterior leaf spring' can only adequately control the stroke survivors foot and leg for swing period and will not offer any control of stance (McHugh and Campbell 1987).

2.4.4. Weight bearing during stance

A recent systematic review concludes that the evidence suggests that ankle-foot orthoses can enhance weight bearing during stance (Tyson, Sadeghi-Demneh and Nester 2013). This ability to bear weight during stance in very important for balance, ankle-foot orthoses have been demonstrated to improve balance during gait and enhance functional activation of some paretic muscles (Hesse et al. 1999).

In summary the effects of ankle-foot orthoses on gait are positive, not only for walking speed, which is the most commonly reported research outcome, but also for walking efficiency, gait pattern and the ability to bear weight during stance. It is important for physiotherapists to understand that the different functional deficits of stroke survivors require ankle-foot orthoses with different functional characteristics to maximise benefits.

2.5. Evidence-based care and ankle-foot orthoses

Evidence-based care places great importance on the objectivity of randomised controlled trials (Jadad 1998), there are several randomised trials of ankle-foot orthoses with stroke survivors. Systematic reviews aim to synthesise objectively and transparently the results of randomised controlled trials (Chalmers and Altman 1995) again there are several systematic reviews of randomised trials of ankle-foot orthoses with stroke survivors.

There are 22 reported randomised trials of ankle-foot orthoses that have been cited by 7 different systematic reviews, 11 systematic reviews of the different editions are considered. All of the systematic reviews examine the evidence on ankle-foot orthoses effect on walking speed. Table 2 below shows which randomised trials were selected for inclusion in each systematic review. Of note is the trial by Alvin et al. (1988) and the trial by Mojica et al. (1988). These are actually the same trial but the references for Alvin et al. (1988) are wrongly attributed and cited in the two systematic reviews by Tyson and Kent (2007, 2013), the correct citation is Mojica et al. (1988).

Table 2 A summary of systematic reviews that report on ankle-foot orthosis use with stroke survivors with the outcome of walking speed. The crosses indicate the primary research trials selected by each systematic review. The shaded area indicates trials that were published after the systematic reviews, hence could not have been included

	RCP. 2000	SIGN. 2002	Leung and Mosley 2003	RCP. 2nd Edition 2004	Van Peppen et al. 2004	Tyson and Kent 2007 (withdrawn)	RCP. 3rd Edition 2008	SIGN. 2010	RCP. 4th Edition 2012	NICE. 2013	Tyson and Kent 2013	Number of times each article has been cited
Corcoron et al. 1970	X		X	X		X					X	5
Lehmann et al. 1987			X									1
Burdett et al. 1988			X			X					X	3
Alvin et al. 1988 ##						X					X	2
Mojica et al. 1988			X									1
Diamond et al. 1990			X									1
Beckerman et al. 1996	X	X		X	X					X		5
Hesse et al. 1996			X	X		X					X	4
Dieli et al. 1997			X									1
Chen et al. 1999				X							X	2
Hesse et al. 1999				X		X					X	3
Tyson and Thornton 2001			X	X		X		X		X	X	6
Gök et al. 2003						X					X	2
de Wit et al. 2004						X	X	X	X	X	X	6
Wang et al. 2005						X		X			X	3
Sheffler et al. 2006								X				1
Thijssen et al. 2007								X				1
Pohl et al. 2007							X	X	X		X	4
Wang et al. 2007								X				1
Bleyenheufe et al. 2008								X				1
Tyson and Rogerson 2009									X	X	X	3
Simons et al. 2009											X	1
Number of randomised trials selected for inclusion in each systematic review	**2**	**1**	**8**	**6**	**1**	**9**	**2**	**8**	**3**	**4**	**13**	

Incorrectly attributed article.

Table 2 presents the systematic reviews which are labelled across the top row and the randomised trials which are labelled down the first column. All systematic reviews report stroke survivor walking speed, which is found to increase with the use of ankle-foot orthoses. The table shows the inconsistency of selection of randomised trial for the systematic reviews, not an aspiration of evidence-based care. Of particular interest are the first three editions of the Royal College of Physicians guidelines and the effect of a changing inclusion criteria on primary research trials which is visually evident (RCP. 2000, RCP. 2004, RCP. 2008).

The one common element of all the systematic reviews is the reported beneficial effects of ankle-foot orthoses for walking speed (NICE. 2013, RCP. 2012, SIGN. 2010). These benefits maybe underestimations, because of the heterogeneous populations and under prescription of ankle-foot orthoses in the primary randomised trials. Two of the randomised controlled trials (Hesse et al. 1996, Tyson and Thornton 2001) have populations that are heterogeneous, highlighted by the standard deviations being more than twice the mean velocity, indicating the skewed nature of the population. The ankle-foot orthoses used in these studies were examples of 'under prescription' for some of the populations, both of these factors support the assertion that the functional benefits of ankle-foot orthoses are underestimated in these studies and likely others.

In summary the conclusions of the systematic reviews that ankle-foot orthoses increase stroke survivors walking speed is likely to be underestimated, along with the other associated benefits. However, there seems to be a continued reluctance in the face of this evidence on the part of physiotherapists for stroke survivors to use ankle-foot orthoses.

2.6. Perceptions of ankle-foot orthosis use

There is a view that ankle-foot orthoses are poorly tolerated by stroke survivors (Taylor et al. 1999). Five papers were identified that included stroke survivors' views or experiences of using ankle-foot orthoses (de Wit et al. 2004, Hesse et al. 1996, Pavlik 2008, Tyson and Thornton 2001, Tyson and Rogerson 2009). Three of the studies included randomised testing of the ankle-foot orthosis (de Wit et al. 2004, Tyson and Thornton 2001, Tyson and Rogerson 2009), the studies were of a design and quality to be included in national guidelines (NICE. 2013). The views of the stroke survivors expressed in different ways in each of the 5 studies were on the whole positive about ankle-foot orthosis use: 96% reported that their walking was better and that the ankle-foot orthosis was comfortable. 92% reporting that they were not concerned with the appearance of the ankle-foot orthosis (Tyson and Thornton 2001).

There is an apparent reluctance amongst physiotherapists to use ankle-foot orthoses during the rehabilitation process for stroke survivors (Edwards 1996, Raine, Meadown and Lynch-Ellerington 2009). Physiotherapists have traditionally discouraged the use of ankle-foot orthoses and justify this with the belief that the ankle-foot orthosis will prevent or delay recovery of 'normal' movement (Davidson and Waters 2000, Lennon and Ashburn 2000,

Sackley and Lincoln 1996) though the evidence-base does not support this belief. One study does suggest that the use of ankle-foot orthoses is increasingly widely accepted by physiotherapists (Lennon, Baxter and Ashburn 2001). However, studies of practice rather than perceptions of practice suggest that physiotherapists remain reluctant for stroke survivors to use ankle-foot orthoses (Tyson and Selley 2007).

The functional benefits of ankle-foot orthoses are consistently reported by various and successive guidelines (NICE. 2013, RCP. 2000, RCP. 2004, RCP. 2008, RCP. 2012, SIGN. 2002, SIGN. 2010). However, the wording associated with the use of ankle-foot orthoses in these guidelines may reflect a deeper reluctance that physiotherapists have: *"Nonetheless there are areas of controversy such as the use of walking aids and ankle-foot orthoses"* (RCP. 2000: 59); *"Evidence is conflicting with regard to the use of orthotics following a stroke"* (RCP. 2004: 66); *"Their use is, however, controversial"* (Tyson and Kent 2013); *"Many clinicians believe that wearing an AFO has a negative effect on the mechanics of walking that may outweigh the benefits"* (Shrivastava et al. 2014). The early proponents of evidence-based care demonstrated that change in practice can lag behind evidence by many years (Antman et al. 1992). The evidence-based guidelines maintain a reluctance to unreservedly recommend ankle-foot orthoses, the impact on clinical practice of this deeper reluctance needs to be explored.

A possible reason for reluctance that physiotherapists cite is that the ankle-foot orthosis is compensatory and will not facilitate stroke survivor recovery, leading to dependence on the ankle-foot orthosis. An example is one study that demonstrated that stroke survivors had better balance during gait and enhanced functional activation of some of the paretic muscles with an ankle-foot orthosis (Hesse et al. 1999), but expressed concerns that the ankle-foot orthosis would lead to dependence on it. Another study found significantly increased walking speeds of stroke survivors with an ankle-foot orthosis (Rao et al. 2008) but concluded that stroke survivors should stop using ankle-foot orthoses because of the risk of dependence on it. If this is informing physiotherapists actions and resulting in them not referring stroke survivors to orthotic services, then it is very paternalistic which has long been argued no longer has a place in healthcare (Coulter 2002). Furthermore, it fails to understand the possible duality of some interventions (Lehoux 2008) in this case ankle-foot orthoses.

The review of the literature suggests that physiotherapists are reluctant that stroke survivors use ankle-foot orthoses. This may be rooted in a lack of understanding of ankle-foot orthoses

or in professional beliefs. If the physiotherapists are reluctant to refer stroke survivors for ankle-foot orthoses then the grounds for this reluctance need to be examined and understood, this is the aim of the thesis.

2.7. Conclusions of the literature review

Stroke affects hundreds of thousands of people with an estimated 300,000 people in England living with a moderate to severe disability. An important goal for many stroke survivors is to regain the ability to walk.

Evidence-based care is a guiding force in modern healthcare and its principles are imbedded in policy decisions as they should be in clinical decisions. Evidence-based guidelines have been developed to assist clinicians in making well-informed judgements on individual patient care. These guidelines show the use of ankle-foot orthoses for stroke survivors to be an evidence-based intervention.

Following a stroke there are disruptions to the control of movement and thus changes to a stroke survivor's movements and gait, commonly a reduction in walking velocity. Perhaps the most debilitating aspect of this for the stroke survivor is the poor gait pattern during stance and the reduced ability to weight bear during stance.

Many different designs of ankle-foot orthoses have been used in research and more in clinical practice, providing a wide range of solutions with different effectiveness. Indications for an ankle-foot orthosis are needs based, it's important that clinicians identify the functional needs of a stroke survivor's gait and refer them for an ankle-foot orthosis.

Reviews of available literature has established the functional benefits of ankle-foot orthoses to stroke survivors' gait, most clearly with increases in walking speed. There are other benefits notable for walking efficiency, gait pattern, and weight bearing during stance.

That ankle-foot orthoses can assist a stroke survivor's gait and more specifically walking speed is clearly documented in systematic reviews. At the same time the existing literature suggest that physiotherapists remain reluctant to refer stroke survivors for ankle-foot orthoses. Therefore, research which examines knowledge and attitudes through reported

practice amongst physiotherapists is necessary because physiotherapists are the mediators of stroke survivors' access to orthotic services, for ankle-foot orthoses.

3. Methodology and Methods

The aim of the research is to understand if physiotherapists are 'appropriately knowledgeable' about the use of ankle-foot orthoses with stroke survivors. To achieve this, the knowledge and attitudes of physiotherapists need to be examined. This was done using the three methods reported on in the separate chapters.

3.1. Methodology

One recognised way to underpin qualitative research is the use of a 'methods based' approach, this reliance on a method without an overarching methodology has been proposed as an appropriate methodology in itself (Grbich 1999). What amounts to a 'methods based' approach has been used and advocated by Patton (1990), who focused on interviewing, observation and documentation as techniques for the gathering and representation of qualitative data. Emphasis on these rigorous procedures of data collection and analysis have also been advocated and used by Miles and Huberman (Miles and Huberman 1984), who take the view that reality surrounds the researcher and that a researcher can access and report on it fairly and objectively through careful application of appropriate methods. This use of complementary methods can permit between methods triangulation to act as a verification of the data gathered, results and conclusions (Flick 1992). Thus this research will employ a methods based methodology and rely on appropriate methods.

3.2. Methods and Research Design

Consideration was given to the selection of complementary research methods. Three distinct methods of investigation were chosen; they are not dependent on being conducted sequentially but importantly are complementary which can facilitate inter-method comparisons (Flick 1992). The first method is questionnaire based with three groups of physiotherapist. The second method involves semi-structured interviews with individual physiotherapists. The third method involves an experiential training session with pre and post-training questionnaires for a group of physiotherapists.

3.2.1. Questionnaires for physiotherapists

Open ended questions with written responses can be used to gain an insight into the views and perspectives of research participants (Abbott and Sapsford 1998, Bowling 1997). This can be an iterative process where question development can be directed by responses to the earlier questionnaires. This investigation was designed to elicit the knowledge and attitudes of physiotherapists and employed open ended questions, with brief written responses, and closed questions that participants answer on a visual analogue scale.

The core question was when the physiotherapist would refer a stroke survivor for an ankle-foot orthosis. This would run through the evolving versions of the questionnaire (Appendix 1, Appendix 2, and Appendix 3). This offered a good compromise between generating a volume of data and responding to themes raised by respondents.

3.2.2. Semi-structured Interviews with physiotherapists

Semistructured interviews are a recognised approach to gaining insight into respondent's knowledge and experience (Bowling 1997, Britten 1999). Patton has suggested questions on specific themes are most suitable for qualitative interviewing: behaviour or experience; opinion or belief; feelings; knowledge; sensory; background or demographic (1987). The perspective of physiotherapists on the use of ankle-foot orthoses are a mixture of 'behaviour or experience', 'opinion or belief' and 'knowledge'. Also semi-structured interviews are particularly suitable for examining 'subjective theories', which refers to the complex stock of knowledge and attitudes that participants have on the topic under study (Flick 1992, Flick 2002).

This method was employed as a check on the consistency of themes uncovered with the other methods, as well as possibly giving a more detailed and nuanced understanding of the themes. The semi-structured interview schedule is shown in Appendix 4. There were two parts to the interview: Part 1 included background questions, questions on ankle-foot orthoses and stroke rehabilitation, Part 2 included questions on a new design of ankle-foot orthoses (not reported on in this thesis).

3.2.3. Experiential training with pre and post-training questionnaires

This is a three stage method to evaluate the change in baseline reported knowledge and attitudes following a training intervention. Stages one and three are pre and post-training questionnaires respectively, with the second stage being experiential training. 'Experiential design' or 'design of experiences' has been used to convey experiences of different situations and surroundings, Nelly Ben-Hayoun created an experience that simulated the lift off of a Soyuz Rocket (Hayoun 2009). 'Aging suits' have been used by product designers to help gain insight into the challenges of advancing age (Singer 2011). This approach seemed to offer a novel way of conveying aspects of ankle-foot orthoses function to physiotherapists. Consequently, the method offered the opportunity to establish if there was a change in participant's reported knowledge and attitudes. The pre and post-training questionnaires are shown in Appendix 5 and Appendix 6, the outline of the presentation is shown in Appendix 7.

The approach that is new to teaching about ankle-foot orthosis function is the 'experiential training' which aims to simulate the effects of gait that some stroke survivors can experience and demonstrate. Some stroke survivors will develop contractures in the calf muscles of their leg and this will have specific biomechanical consequences for gait (Kinsella and Moran 2008). The training involved the fabrication of a walking cast on a volunteer physiotherapist, similar to a cast used for people who have a broken leg (below the knee). However, this cast was aligned with the ankle plantar-flexed simulating the alignment a stroke survivor may present with and consequently the resulting gait deviations.

The volunteer experiences the effect on their gait and the other training participants observe this. The volunteer attempts to stand and walk, the changes to their gait are significant, with a loss of symmetry and a significant decrease in walking speed (just like the gait of many stroke survivors). More importantly specific gait deviations are produced: a fully extended or hyperextended knee and tibia that cannot progress over the foot, this results in further complications proximally with retraction of the hip, and changes in the position of the trunk. The next part of the experiential training involves refining the alignment of the volunteers leg as an ankle-foot orthosis may.

Below in figure 6 there is a schematic representation of the methods and the data gathering stages of each method.

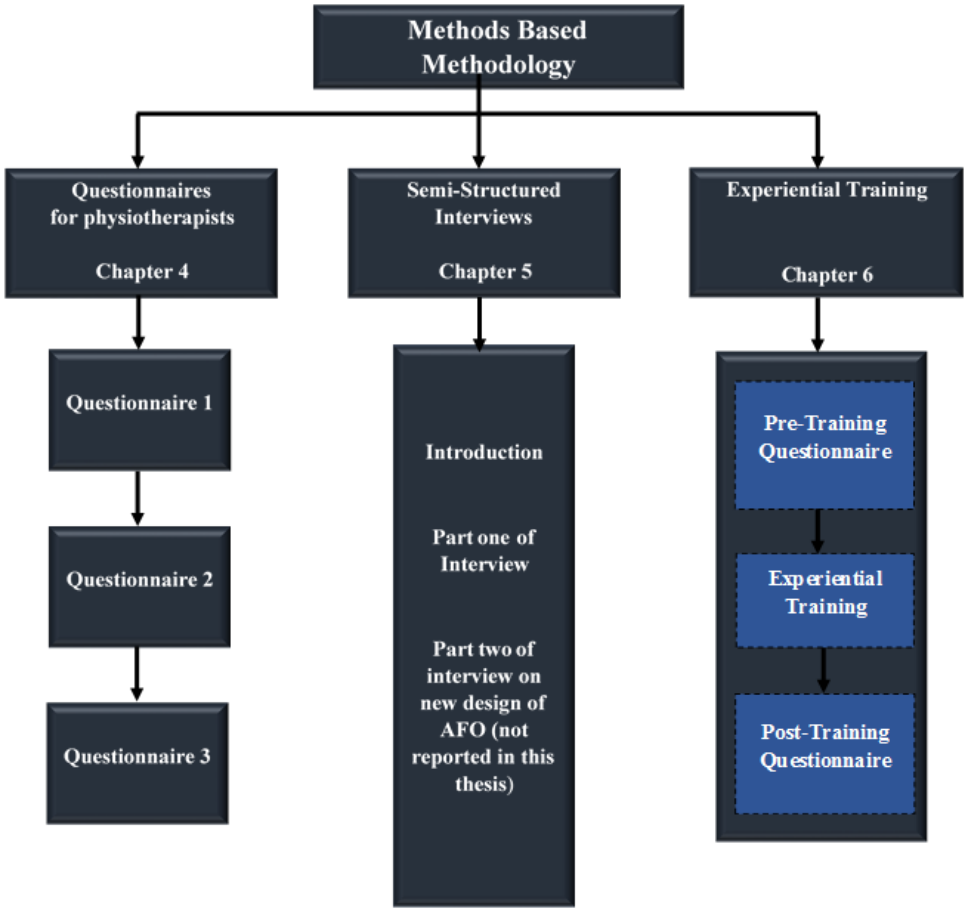


Figure 6 Schematic representation of the three complementary methods and data gathering stages

3.3. Ethics

Ethics approval was obtained following the Coventry University ethics approval procedure. Prior to submission consideration was given to minimise the impact of the study on participants. Ethics applications were submitted and approved; P11668, 07/03/2013 and P23211, 21/05/2014. Copies of the approval forms are shown in Appendix 8a.

The purpose of the research, to explore the understanding of physiotherapists of ankle-foot orthoses, was clearly stated to all participants for each method. There was a need to ensure that the data gathering was not confrontational or that the respondents would not feel

intimidated in any way. This was a risk given that the researcher was a practicing orthotist and had specific views on the use of ankle-foot orthoses with stroke survivors, this was minimised by the data gathering approaches.

Questionnaires were an approach that did not lead to confrontation, two methods used questionnaires, questionnaires for physiotherapists and experiential training for physiotherapists. The data was gathered from participants attending in-service training sessions. These training sessions resulted from opportunistic invitations to the researcher to participate in the training program, in-service training is conducted routinely in physiotherapy departments to help consolidate knowledge and meet the needs of continuing professional development. The purpose and nature of the study were explained to the participants. They were advised that participation was optional and that they could withdraw at any time (see example Participant Information Sheet in Appendix 8b and Consent Form in Appendix 8c).

There was no associated expectation of any benefits in participating aside from the in-service training that would follow the completion of the questionnaires, thus not raising expectations of benefits (Abbott and Sapsford 1998). The exception to this was for the semi-structured interviews, there was a £15 'high street' shopping voucher in recognition of time given for the interview but no further expectation of benefit.

For the experiential training, the ethical considerations differed in one specific aspect. A physiotherapist was asked to volunteer to have a cast applied to their foot and leg, and then walk in the cast. No harm would result from the application, use or removal of the cast for the demonstration. The notion of physiotherapists volunteering to demonstrate movement or anatomical features to their colleagues is not unfamiliar and all of the physiotherapists would have previous experience of this.

3.4. Participants and procedure

The participant selection is described in relation to the three methods, as is the procedure that is followed in their 'recruitment'.

3.4.1. Questionnaires for physiotherapists

The researcher was invited to present sessions of in-service training to physiotherapists who worked within different healthcare Trusts. The researcher linked the in-service training with data gathering for this thesis. This was done in accordance with Coventry University ethics guidance. The topic of the in-service presentation was 'Ankle-Foot Orthoses and Gait'.

The senior physiotherapists who made the invitation organised the date and time for the in-service training. They encouraged the attendance of their team of physiotherapists, all the physiotherapists were expected to attend irrespective of seniority and experience, thus helping to ensure a representative sample of a team rather than individuals. The teams and consequently the participating physiotherapists have a responsibility for treating stroke survivors.

The following procedure was adhered to at each of the three training sessions. Each session began with an introduction and overview of the training. The researcher also explained to the physiotherapists that the training was being used as part of a study looking at the issues surrounding ankle-foot orthosis use for stroke survivors. It was explicitly stated that they did not need to complete the questionnaires. The physiotherapists were assured that all data generated would be anonymised.

An individual paper copy of the questionnaire was then circulated to all participants, along with Participant Information Sheets and Consent Forms. Following the introduction, and immediately prior to the presentation, time was given for consent and completion of the questionnaire. A single request to complete the questionnaire was made. The questionnaires were completed individually, though some quiet exchanges between physiotherapists took place and may have related to the questions. Following the return of the questionnaires the in-service training began.

3.4.2. Semi-structured interviews

The physiotherapists were recruited through Coventry University and the Allied Health Professionals Research Network. These physiotherapists all had experience treating stroke survivors. They were all informed that the results would remain anonymous and that they

were free to withdraw from the interview at any time without consequences. They had the Participants Information Sheets and completed the Consent Forms prior to being interviewed.

The semi-structured interviews were conducted at the Health Design & Technology Institute. The interview followed the semi-structured interview schedule, Appendix 4.

3.4.3. Experiential training

The sampling and recruitment procedures were the same as those described in Section 3.4.1.

The differences relate to the pre and post-training questionnaire approach to data gathering. Following the completion of the consent form and pre-training questionnaire a walking cast was fabricated on the leg of a volunteer physiotherapist. The presentation followed and was the same as for Section 3.4.1, the key difference was that the volunteer then walked in the cast, replicating the gait deviations of some stroke survivors. Discussions of alignment issues took place during this experiential training stage. Then the post-training questionnaires were completed.

3.5. Data analysis

The analysis of data was informed by three factors: firstly, a study examining the approaches to gait analysis adopted by different professionals (Watelain et al. 2003), secondly clinical guidelines informing the use of ankle-foot orthoses for stroke survivors (SIGN. 2010), thirdly the analysis method itself, the framework approach (Ritchie and Lewis 2003). Each of these factors is described in more detail below.

Studies of gait analysis strategies have found that physiotherapists were ‘essentially descriptive’ in their observations made on stroke survivors gait (Watelain et al. 2003). This research will ask physiotherapists to provide statements on stroke survivors gait and the use of ankle-foot orthoses, based on their knowledge and attitudes. It is anticipated that the answers to issues of gait will be essentially descriptive and be brief statements often simply statements describing gait deviations. These statements will be mapped to the constituent parts of stance and swing period of gait, as outlined in Section 2.3. See Appendix 9 for an example questionnaire completed as part of the study.

The clinical guidelines for stroke rehabilitation informed the data analysis, the guidelines give indications when to refer for an ankle-foot orthosis (SIGN. 2010): walking speed, walking efficiency, gait pattern, or weight bearing during stance. This offers a structure for parts of the data analysis. The responses from participants were coded and mapped to the indications for ankle-foot orthoses, with gait pattern being further classified by the constituent parts of stance and swing period of gait, as outlined in Section 2.3. The statements that do not map to the constituent parts of the gait cycle will be mapped to the other 3 indications for using an ankle-foot orthosis (SIGN. 2010). A further anticipated theme is statements that relate to biomechanical or neurophysiological factors for using an ankle-foot orthosis, possibly issues related to tone or alignment of the ankle-foot orthosis (Condie, Campbell and Martina 2004).

The approach to data analysis employed is the framework approach (Ritchie and Lewis 2003). This method was developed for, and is particularly suitable for applied or policy relevant qualitative research, where the objectives of the research are set in advance of the study and are shaped by the research requirements (Green and Thorogood 2009). The framework approach is *"heavily based in the original accounts and observations of the people studied"* (Pope and Mayes 1999). Thus this approach is both inductive, in that it is grounded in the original accounts i.e. the views and statements of the physiotherapists, and deductive, in that it is informed by the aims and objectives of the research i.e. to gain insight into what physiotherapists understand regarding the use of ankle-foot orthoses for stroke survivors. The approach to analysis is systematic and the analytic process may be reviewed and verified by researchers other than the primary analyst (Pope and Mayes 1999). The five steps in the data analysis are: 1) familiarisation, 2) identifying a thematic framework, 3) indexing, 4) charting and mapping and finally, 5) interpretation (Ritchie and Lewis 2003).

The data generated from the semi-structured interviews is analysed following the 5 steps of the framework approach. The data from the other two methods were brief statements or gait deviations that effectively were 'pre-indexed' and thus only the last two stages were followed.

The familiarisation process begins before any sifting or sorting of data, with the researcher becoming familiar with all the data gathered. Considering the comparatively small amount of data that is anticipated the researcher will transcribe the tape recorded interviews and the

written responses to an electronic format (Britten 1999), thus beginning the formal familiarisation process (Ritchie and Lewis 2003). This familiarisation process involves reading the transcriptions several times and becoming 'immersed' in the data. The second stage is the identification of a thematic framework or indexes, this began during the familiarisation process and involved making notes of recurrent themes and issues that emerged as important to the participants. When all the data were reviewed, the researcher returned to the notes and identified the key issues, concepts, and themes so that the data can be examined and referenced, setting up the thematic framework. The third stage, indexing, is the process whereby the thematic framework or indexes are systematically applied to the transcriptions. The index headings are decided upon and a brief definition was developed to elaborate the index heading. A textual system that is directly based on the index headings was used in the margins to index the transcriptions. Some passages of text may contain a number of different themes, each of which was referenced. The fourth stage involved charting the data, or rearranging extracts of the transcription according to the themes identified. This process involves abstraction and synthesis of data, and not simply cutting and pasting chunks of text. Separate charts were developed for each of the themes in the framework. The final stage of the framework analysis was the mapping and interpretation of data as a whole, identifying patterns of knowledge and beliefs in the data.

3.6. Data presentation

As stated in the previous section on data analysis the approach is informed by the indications for an ankle-foot orthosis (SIGN. 2010): walking speed, walking efficiency, gait pattern, or weight bearing during stance. These indications are related to the effects of stroke on gait.

The fourth stage of the framework analysis is the mapping of data (Ritchie and Lewis 2003), the response statements (gait deviations) are the data that was mapped to gait pattern (SIGN. 2010) this was done visually to relate the gait deviations to specific parts of the gait cycle. Visualisation of data can help communicate the results and themes (Börner 2010, Tufte 2001). The period of stance is composed of 5 phases, as described in Section 2.3.4, and is shown in table 3 below. The gait deviations that will be visible or present at parts of stance will be listed under the most appropriate phase of stance. The period of swing for the purposes of this research is only classified as 'general' and 'drop foot', which relates to

possible gait deviations. The final row of table 3 highlights the functional tasks of gait at these phases.

Table 3 Example of presentation of response statements linked to visual stage of gait, or more specifically gait deviations

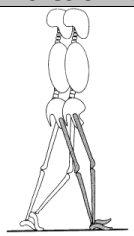
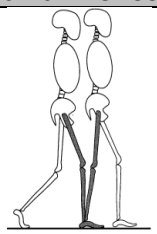
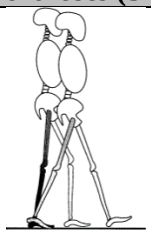
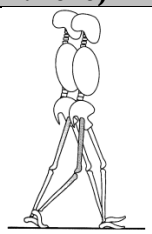
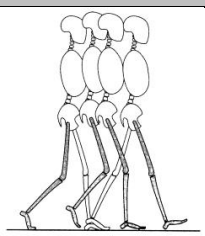
Gait pattern: indiction for an ankle-foot orthoses (SIGN. 2010)						
						
Initial Contact	**Loading Response**	**Mid Stance**	**Terminal Stance**	**Pre-Swing**	**Swing: general**	**Swing: 'drop foot'**
'No heel contact'		'Poor translation of tibia forward over foot in stance'	'Hyperextending knee in stance'		'No knee flexion during swing'	
Weight Acceptance		**Single Limb Support**		**Swing Limb Advancement**		

Table 3 is a data chart of response statements that offers insight into the knowledge of the physiotherapists and consequently the importance that they attach to different parts of the gait cycle. Other response statements that do not map to gait pattern are: walking speed, walking efficiency, or weight bearing during stance (SIGN. 2010) these will be tabulated or described in the text in a more familiar way to the reader.

Figure 7, is a schematic representation of the three methods and the questions asked during each investigation. This helps to illustrate the structure of the next three chapters, also this begins to show how the three methods are inter-related.

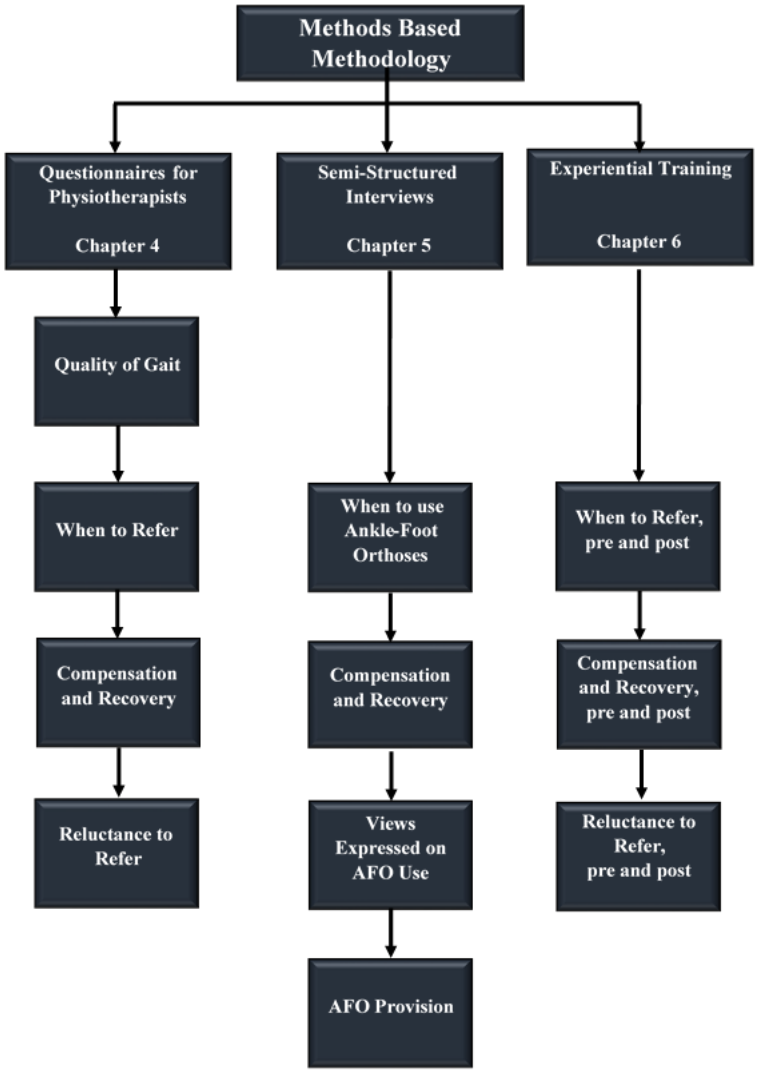


Figure 7 Overview of questions asked in the three research methods

4. Questionnaires for physiotherapists: Results

This chapter presents the results from three iterations of a questionnaire completed by three teams of physiotherapists. Importance was placed on participant recruitment to guarantee the majority of physiotherapists from each team completed the questionnaires, to ensure the results were representative. Questionnaire 1 (Appendix 1) was given to a team of 8 physiotherapists who worked in an acute setting who currently refer stroke survivors for ankle-foot orthoses, 7 of the 8 completed the questionnaire. Questionnaire 2 (Appendix 2) was given to a team of 22 physiotherapists of whom 19 completed the questionnaire. The team was composed of physiotherapists who worked in an acute setting and others who were community based. All would currently refer stroke survivors for ankle-foot orthoses. Questionnaire 3 (Appendix 3) was given to a team of 17 physiotherapists of whom 14 completed the questionnaire. Again some of the physiotherapists worked in an acute setting and some worked in the community. All would currently refer stroke survivors for ankle-foot orthoses. The results are presented in four sections:

- Quality of gait
- Reasons to refer
- Compensation and Recovery
- Reluctance to refer

4.1. Quality of gait

The aim of these two questions on quality of gait, good quality and poor quality, was to establish the participants working definitions of good and poor quality gait. This can help determine if there is consistency in participant's knowledge and attitudes regarding quality of gait and referral practice. The response statements (frequently gait deviations) to the two questions were coded as described in Section 3.5 and mapped and presented as described in Section 3.6. These are indications for the importance that the participants attach to different parts of gait. The indications for an ankle-foot orthosis are used to structure the results: gait pattern then followed by walking speed, walking efficiency and weight bearing during stance (SIGN. 2010). The two questions on quality of gait were only asked in Questionnaire 3, which 14 respondents completed.

4.1.1. Good quality gait

The question "When watching stroke survivors walk, which aspects of their gait pattern indicates a 'good quality' of gait?" was asked. The response statements to this question are termed 'good-quality-gait' statements in the text for clarity. A total of 37 good-quality-gait statements were generated, shown in full in Appendix 9.1. 18 of the 37 good-quality-gait statements were impairment level gait deviations which were coded and mapped to gait pattern, table 4. Of the remaining 19 statements, 17 were coded and mapped to other indications for an ankle-foot orthosis, table 5. Only 2 response statements were un-mapped (e.g. "*pain free*"). The good-quality-gait statements that were made first by each participant are indicated as 1st response.

Table 4 Frequency of coded good-quality-gait statements that mapped to gait pattern, '1st response' statements indicated.

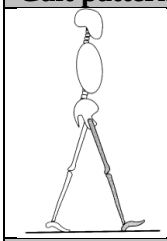
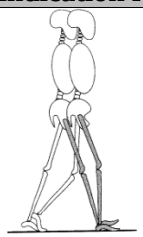
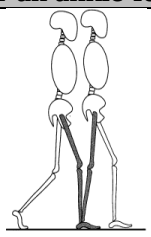
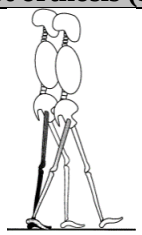
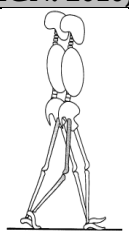
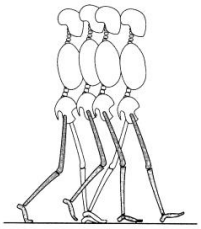
Gait pattern: indication for an ankle-foot orthosis (SIGN. 2010)						
						
Initial Contact	**Loading Response**	**Mid Stance**	**Terminal Stance**	**Pre-Swing**	**Swing: general**	**Swing: 'drop foot'**
					1st response	1st response
					1st response	
						1st response
						1st response
					1st response	
Weight Acceptance		**Single Limb Support**		**Swing Limb Advancement**		

Table 4 shows the 18 good-quality-gait statements mapped to gait pattern. 14 good-quality-gait statements related to swing period, 9 were general gait deviations, or the absence of these (e.g. "*No circumduction on affected side*") and 5 stated the absence of 'drop foot' (e.g. "*No foot drop*"). 2 of the good-quality-gait statements mapped to Initial Contact (e.g. "*Heel strike*

at initial stance"). Whereas only 1 good-quality-gait statement related to each of Mid Stance and Terminal Stance, the task of Single Limb Support.

These results indicate that good quality gait was broadly described by the absence of swing period gait deviations in general and specifically 'drop foot'. The good quality of the stance period is implicit and essential.

Table 5 Good-quality-gait statements that mapped to other indications for an ankle-foot orthosis

Other indications for an ankle-foot orthosis (SIGN. 2010)	
Walking speed	1 response statement
Walking efficiency	5 response statements (3 1st response)
Weight bearing during stance	11 response statements (5 1st response)

Table 5 shows that only 1 good-quality-gait statement was made for walking speed. 5 good-quality-gait statements mention symmetry of gait, indicating that some participants took a broad view of walking efficiency. There were 11 statements that related to weight bearing during stance, these were aspects of weight bearing with demonstrations of control of movement (e.g. "*Decreased postural sway*"), and dynamic balance (e.g. "*Dynamic balance/stability"*).

These results indicate the broad view of gait taken by some participants. While the 11 statements that refer to ability to weight bear during stance stress the demonstration of the fine control of this activity.

4.1.2. Poor quality gait

The question 'When watching stroke survivors walk which aspects of their gait pattern indicates a 'poor quality of gait'?' was asked. The response statements to this question are labelled as 'poor-quality-gait' for clarity. The 14 participants generated a total of 40 poor-quality-gait statements, shown in full in Appendix 9.2. There were 19 poor-quality-gait statements which were impairment level gait deviations that were coded and mapped to gait pattern, table 6. Of the remaining 21 poor-quality-gait statements 16 mapped to other indications for an ankle-foot orthosis, table 7. There were 5 response statements un-mapped (e.g. "*Shuffling gait*"). The poor-quality-gait statements that were made first by each participant are indicated as 1st response.

Table 6 Frequency of coded poor quality gait statements that mapped to gait pattern, '1st response' statements indicated.

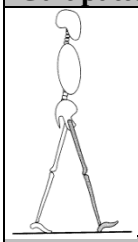
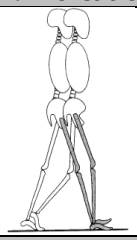
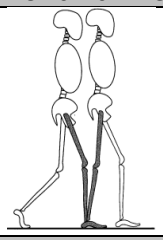
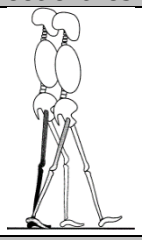
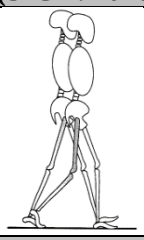
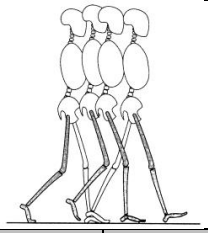
Gait pattern: indication for an ankle-foot orthosis (SIGN. 2010)						
						
Initial Contact	**Loading Response**	**Mid Stance**	**Terminal Stance**	**Pre-Swing**	**Swing: general**	**Swing: 'drop foot'**
			1st response			1st response
			1st response			
			1st response			
			1st response			
			1st response			
Weight Acceptance		**Single Limb Support**		**Swing Limb Advancement**		

Table 6 shows the 19 impairment level gait deviations that mapped to gait pattern. There were 7 poor-quality-gait statements that related to swing period, 4 general and 3 specifically 'drop foot' (e.g. "*Foot drop*"). 4 poor-quality-gait statements mapped to Initial Contact, which is the Weight Acceptance task of gait (e.g. "*Decreased dorsiflexion at initial stance*"). Of particular note are the 8 poor-quality-gait statements to the task of Single Limb Support, 3 Mid Stance (e.g. "*Decreased tibial translation during Mid/Terminal Stance*") and 5 Terminal Stance (e.g. "*Hyperextension of the knee in stance phase*"), all of these being 1st response statements.

These results indicate that poor quality gait was described by the presence of some swing period gait deviations and importantly the presence of more stance period gait deviations, specifically during the task of Single Limb Support. Indicating the effect of poor stance alignment and control on the quality of gait.

Table 7 Poor-quality-gait statements that mapped to other indications for an ankle-foot orthosis

Other indications for an ankle-foot orthosis (SIGN. 2010)	
Walking speed	No response statements
Walking efficiency	4 response statements
Weight bearing during stance	12 response statements (3 1st response)

Table 7 shows 4 poor-quality-gait statements refer to aspects of gait symmetry which relates to walking efficiency (e.g. "*Step symmetry*"). The 12 poor-quality-gait statements about weight bearing during stance highlight the inability to weight transfer during stance as an indication of poor quality gait (e.g. "*Inability to transfer weight to affected side/limb*"). There are 5 statements that do not map to any of the indications for ankle-foot orthoses (e.g. "*Compensations*") with 4 1st response statements in this group of 5. 1 respondent did not make any statements for the question on poor quality gait which explains why there are only 13 1st response statements.

These results show the 12 response statements that mapped to weight bearing during stance stress the inability of the stroke survivor to weight bear effectively during stance. This along with the stance period gait deviations in table 6 demonstrate the consequences of poor control and alignment of gait.

4.2. Reasons to refer

The question asked was "When watching a stroke survivor walk, what aspect of their gait would make you consider a referral for an ankle-foot orthosis?" The response statements to this question are labelled as 'reasons-to-refer'. This section presents the results from Questionnaires 1, 2, and 3 (Appendices 1, 2, and 3) a total of 40 participants, Questionnaire 1 was completed by 7 participants, Questionnaire 2 was completed by 19 participants, and Questionnaire 3 was completed by 14 participants. The number of statements per questionnaire are summarised in table 8. The response statements are shown in full in Appendices 9.3, 9.4, 9.5, and 9.6.

Table 8 Summary of the number of response statements per Questionnaire

	Questionnaire 1 7 Participants	**Questionnaire 2 19 Participants**	**Questionnaire 3 14 Participants**	**Total number of response statements**
Statements mapped to gait pattern	13	49	33	95
Statements mapped to other indications for an ankle-foot orthosis	13	9	6	28
Unmapped response statements	8	10	8	26
Total number of response statements per questionnaire	34	68	47	149

Table 8, indicates the spread of response statement with the majority being impairment level gait deviations that mapped to gait pattern (SIGN. 2010). Out of 149 response statements 123 were reported on.

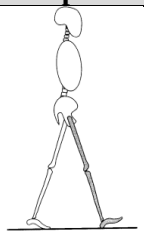
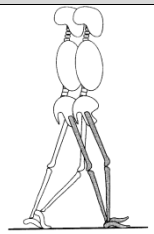
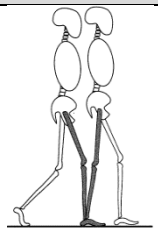
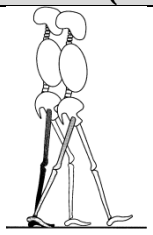
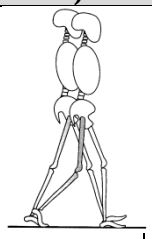
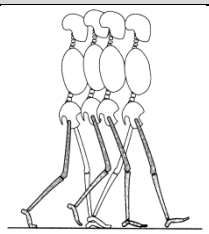
The next section will report in detail on the reasons-to-refer statements that were coded and mapped to gait pattern, the section following that will report on statements mapped to 'walking speed, walking efficiency, and weight bearing during stance' (SIGN. 2010).

4.2.1. Gait pattern

The reasons-to-refer that were impairment level gait deviations were coded and mapped to gait pattern, visually linking the reasons-to-refer to the part of gait referred to (as described in Sections 3.6). The table below reports the frequency of reasons-to-refer statements, a single square represents a single reasons-to-refer statements. These are indicators of which

parts of the gait cycle are perceived as important and should result in a referral for an ankle-foot orthosis. The reasons-to-refer that were made first by each participant are indicated with an '*' in table 9.

Table 9 Frequency of reasons-to-refer from Questionnaires 1 (dark grey), Questionnaire 2 (mid grey), and Questionnaire 3 (unshaded) that mapped to gait pattern. '1st response' marked with an '*'

Gait pattern: indication for an ankle-foot orthosis (SIGN. 2010)																															
																															
Initial Contact				**Loading Response**				**Mid Stance**				**Terminal Stance**				**Pre-Swing**				**Swing: general**				**Swing: 'drop foot'**							
*			*												*										*	*	*					
		*											*											*	*	*	*					
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Weight Acceptance								**Single Limb Support**								**Swing Limb Advancement**															

Table 9, shows the 95 reasons-to-refer coded and mapped to gait pattern. 47 reasons-to-refer mapped to Swing Limb Advancement, 37 of these specifically to 'drop foot' (e.g. "*Footdrop not responding to treatment*" and "*Footdrop*"). Suggesting that this, the most frequent reason-to-refer for an ankle-foot orthosis is the most important for participants. Furthermore, the majority of participants, 35 out of the total 40, report 'drop foot' as a reason-to-refer and of these 32 made 'drop foot' their 1st response statement, an indication of their knowledge

and attitudes to stroke survivors gait and when to use ankle-foot orthoses. The task of Weight Acceptance had 27 reasons-to-refer mapped to it. With 20 to Loading Response and the issue of ankle instability (e.g. "*Foot inverting*" and "*Decreased ankle stability*"). Not an issue that was highlighted by the questions on 'quality of gait' or more broadly in the literature. The Single Limb Support task had 21 reasons-to-refer mapped to it, 8 to Mid Stance (e.g. "*Poor translation of the tibia forward over the foot in stance*" and "*Knee stability*") and 13 to Terminal Stance (e.g. "*Knee hyperextension*").

The results show that participants report swing period difficulties as the reason to refer for an ankle-foot orthosis much more than either of the tasks of Weight Acceptance or Single Limb Support. This demonstrates clearly the limited appreciation the participants demonstrate of the importance of ankle-foot orthoses for stance period and gait of stroke survivors. This suggests limited knowledge on the function of ankle-foot orthoses.

4.2.2. Walking speed, walking efficiency, weight bearing during stance

The 28 reasons-to-refer (table 8) that mapped to other indications for an ankle-foot orthosis are summarised below in table 10. The full statements are shown in Appendix 9.6.

Table 10 Frequency of reasons-to-refer that mapped to: walking speed, walking efficiency, weight bearing during stance, or Neurophysiological factors.

Other indications for an ankle-foot orthosis (SIGN. 2010)			
	Questionnaire 1	**Questionnaire 2**	**Questionnaire 3**
Walking speed			
Walking efficiency	2		
Weight bearing during stance	7 (2 1st response)	2	5
Neurophysiological factors	4	7	1

There were no reasons-to-refer statements on walking speed being an indication for referral for an ankle-foot orthosis. There were 14 reasons-to-refer related to aspects of weight bearing

during stance (e.g. "*weight distribution*" and "*Decreased hip control*"). The 12 response statements that were coded as neurophysiological factors are specific impairment level symptoms that stroke survivors may present with and only their effects would be visible, rather than the actual impairment (e.g. "*Decreased range of movement*" and "*Tightness of plantar-flexors, decreased length*"). The unmapped reasons-to-refer were frequently related to factors that on their own would not warrant the provision of an ankle-foot orthosis (e.g. "*Low arch/no arch*" and "*Flexed toes*").

In summary the low number of response statements, 28 from 3 questionnaires, that mapped to other indications for an ankle-foot orthosis does not warrant detailed analysis. However, the results indicate limited awareness of the importance of weight bearing during stance, a limited appreciation that increased muscle tone is an indication for an ankle-foot orthosis and finally a compromised understanding of more detailed indications for an ankle-foot orthosis.

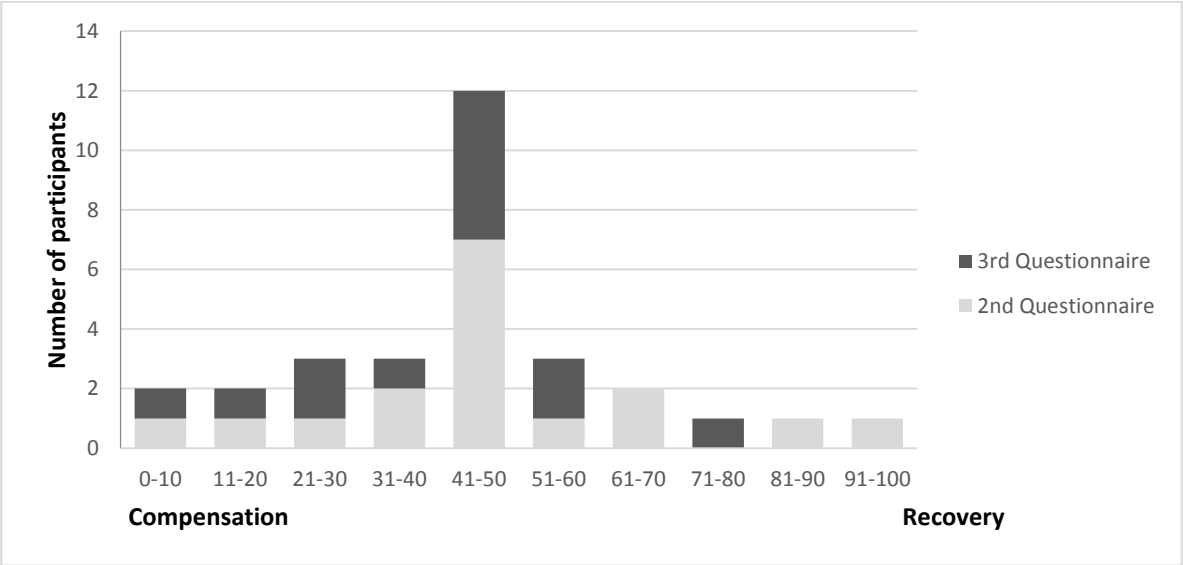
4.3. Compensation and Recovery

This section reports on results from Questionnaire 2 and 3, there were 33 participants. The question was:

> When a stroke survivor is referred for an **ankle-foot orthosis** where would you place the use of the **ankle-foot orthosis** on this continuum?
>
> Compensation _____ Recovery
>
> Comment if you wish.

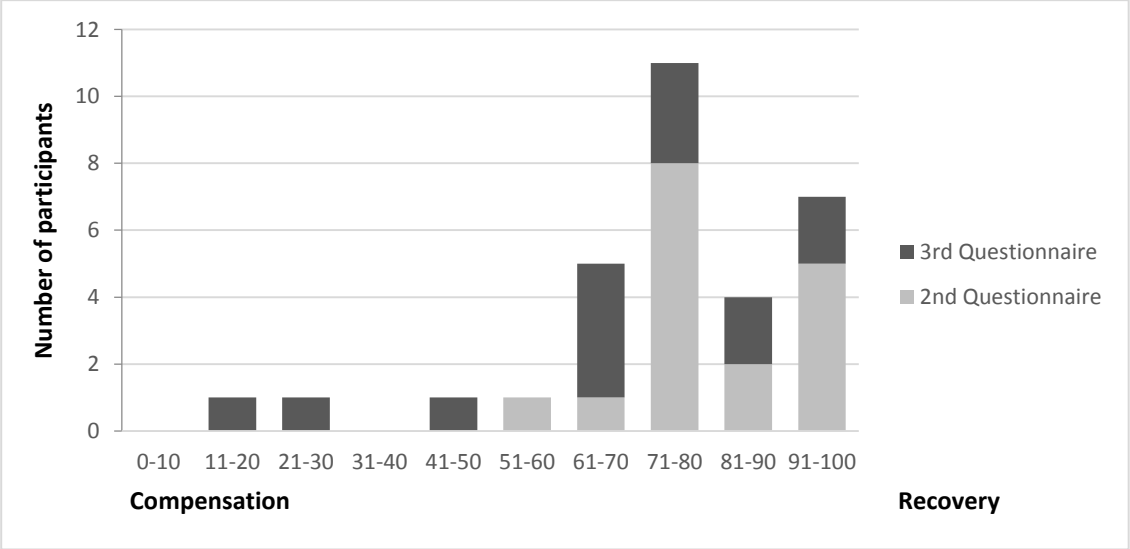
'Compensation' here is defined as 'performing the old movement in a new manner' and 'recovery' is defined as 'restoring the ability to perform a movement in the same manner as it was performed before injury'. Compensation is anchored at the left of the scale and recovery is anchored at the right of the scale. The mark that the individual physiotherapist recorded on the line were measured from the compensation end of the 100mm line and the results are presented in table 11 below.

Table 11 'Do you consider the use of an ankle-foot orthoses as compensation or recovery', frequency and location of responses



The frequency and location of responses are concentrated centrally between the two concepts but tend towards compensation. This suggests that the physiotherapists perceive ankle-foot orthoses to be more compensatory than facilitating recovery. The same question was asked with the use of functional electrical stimulation replacing the use of ankle-foot orthoses.

Table 12 'Do you consider the use of functional electrical stimulation as compensation or recovery', frequency and location of responses



The results indicate that respondents strongly identified functional electrical stimulation as facilitating recovery. There is a marked difference in the responses between table 11 and table 12. With participants believing ankle-foot orthoses are more compensatory and functional electrical stimulation facilitating recovery.

4.3.1. Are ankle-foot orthoses therapeutic?

Questionnaire 3 asked a supplementary question to interrogate the dichotomy of 'compensation' and 'recovery' thus only 14 participants answered this question. The idea of 'facilitating recovery' and something being 'therapeutic' are very close and are arguably interchangeable. This questions aims to identify whether participants are consistent in their understanding of the effect of an ankle-foot orthosis.

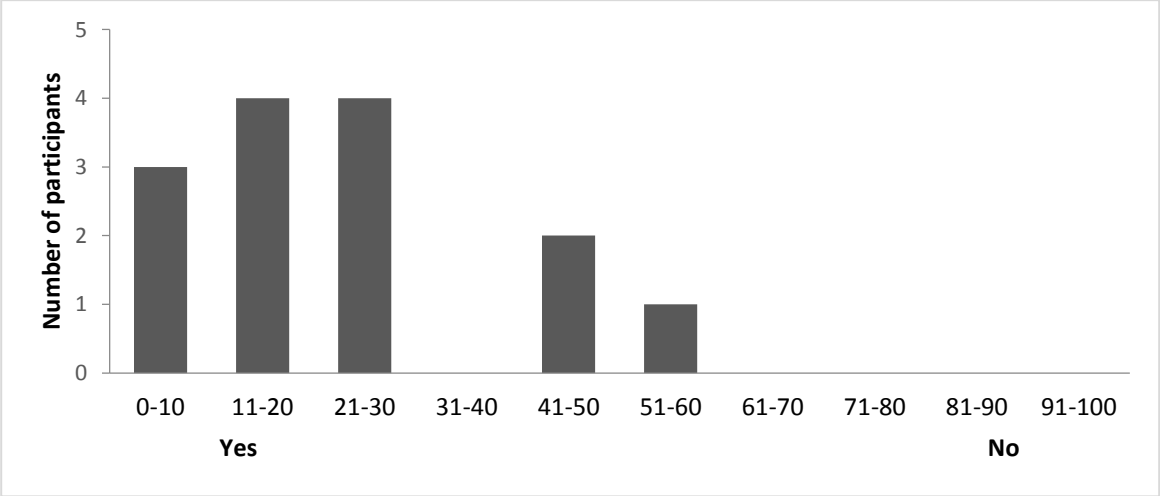
8. When a stroke survivor is referred for an **ankle-foot orthosis** do you consider the use of the **ankle-foot orthosis** as 'therapeutic'? Place a mark on this line.

Yes _____ No

Comment if you wish.

The marks that the physiotherapists put on the line were measured and are summarised below, with zero representing 'yes' and 100 representing 'no'.

Table 13 'Do you consider the use of ankle-foot orthoses as therapeutic', frequency and location of responses



The figure above shows that all but one of the 14 respondents thought ankle-foot orthoses were to some extent therapeutic. In summary the implications of these results are that participants view ankle-foot orthoses and functional electrical stimulation as having very different impacts on recovery of the stroke survivor. Significantly, the participants were inconsistent in their views that ankle-foot orthoses were compensatory while being therapeutic.

6 additional comments were made by respondents when answering this question, they are listed below:

> *AFO may improve quality of sit to stand to become more therapeutic, AFO can cause increased activity in proximal muscle groups*
>
> *They may allow improved gait, to then practice*
>
> *Can assist in increasing function and hence assisting with therapy and activity goals*
>
> *Enables better gait for function, to use as part of therapy but also address therapy out of AFO too. Aiming to progress to not needing the AFO*
>
> *To increase proprioceptive awareness*

Sometimes need for permanent problem, sometimes to help in therapy

These statements show awareness of the therapeutic contribution of ankle-foot orthoses amongst respondents but this knowledge is patchy. If these 6 positive statements had been made by one physiotherapist they would demonstrate an informed understanding. However, the statements came from 6 different physiotherapists and indicate rather that they have different pockets of awareness rather than an informed knowledge of ankle-foot orthosis use.

4.4. Reluctance to refer

This section reports on the results from Questionnaire 2 and 3. This question asked 'If you have any reservations about referring a stroke survivor for an ankle-foot orthosis tell us why?' A total of 33 physiotherapists completed Questionnaires 2 and 3. Analysis of the responses identified three themes: Views, positive and negative; Biomechanical and Neurophysiological factors; and Skin Integrity and other considerations. 34 response statements for acute stroke survivors, 22 response statements for chronic stroke survivors, response statements are shown in full in Appendix 9.7, 9.8, and 9.9.

The respondents were directed to comment on both acute and chronic stroke survivors, as their reservations may be different for each group. The question was left broad so respondents were not restricted to gait issues, as the physiotherapists may have other reservations. The question tended to elicit negative responses, however, several positive responses were generated so it does not limit or exclude these. The results for this question are presented separately for acute and chronic stroke survivors.

4.4.1. Acute stroke survivors

The reported views of participants show there were 16 negative views and 4 positive views. The negative response statements are wide ranging and include a perception that ankle-foot othoses use will limit and delay recovery (e.g. "*Still in recovery phase*"). The response statements also indicate that there is a reluctance to refer for an ankle-foot orthosis too early in the period of most recovery. The positive views show that a small number of

physiotherapists are not reluctant to make a referral for an ankle-foot orthosis (e.g. "*No reservations – keen for assistance*").

The theme of biomechanical and neurophysiological factors was subdivided into three sub-headings related to the function of, and indications for ankle-foot orthoses (See Appendix 9.8), a total of 5 response statements mapped to these factors. The responses demonstrate a lack of understanding of basic biomechanics of ankle-foot orthoses.

The theme of skin integrity and other considerations were mapped to by 9 response statements. These were mostly concerns with the risk of skin damage from the ankle-foot orthoses, and cognitive problems causing difficulty putting the ankle-foot orthosis on correctly (e.g. "*Difficulty fitting orthotic*").

4.4.2. Chronic stroke survivors

The results are summarised under the same three themes as for acute stroke survivors. Regarding the views of the participants the responses for chronic stroke survivors were similar in range to the acute stroke survivor responses, but with interesting differences in frequency. There were only 4 negative views and 6 positive views (e.g. "*Use regularly so not reluctant*"). Suggesting less reluctance on the part of respondents to consider ankle-foot orthoses when the stroke survivor was less likely to recover further, rather than using to enhance further recovery.

The theme of biomechanical and neurophysiological factors again was subdivided into the same sub-headings related to the function of and indications for ankle-foot orthoses. A total of 7 response statements mapped to these factors regarding chronic stroke survivors. These response statements demonstrate the lack of understanding of basic biomechanics of ankle-foot orthoses or increased muscle tone being an indication for ankle-foot orthoses.

The theme of skin integrity and other considerations received 11 response statements, again similar to those for the acute stroke survivor, including skin integrity, and the reluctance of the stroke survivor to use an ankle-foot orthosis.

Because of the small numbers of response statements relative to the number of participants, it is unwise to draw further conclusions. However, these results will be triangulated with other results.

4.5. Summary of results from questionnaires for physiotherapists

These questionnaires sought to explore the knowledge and attitudes of 3 teams of physiotherapists to the use of ankle-foot orthoses for stroke survivors.

There are limited details on the amount of experience each participant has. However, when considering participants as a team who were all encouraged to attend the training it is anticipated that the results generated will be representative of other teams treating stroke survivors rather than individuals within the team.

Good quality gait was broadly defined with statements describing the absence of swing period gait deviations as well as the fine control of weight bearing during stance. Poor quality gait was broadly defined with statements describing the presence of stance period gait deviations as well as the inability to bear weight during stance.

The question on gait and when the physiotherapists would refer a stroke survivor for an ankle-foot orthosis demonstrated clearly that they were very focused on ‘drop foot’. They reported most frequently that this gait deviation required management by the use of an ankle-foot orthosis. They had limited appreciation of the importance of stance period, specifically the importance of the task ‘Single Limb Support’ when ankle-foot orthoses can offer so much control and benefit to stroke survivors.

Regarding compensation and recovery, the physiotherapists view ankle-foot orthoses as compensatory and functional electrical stimulation facilitates recovery. Their views of ankle-foot orthoses being therapeutic are at odds with their views that ankle-foot orthoses were compensatory.

The question on participant’s reluctance to refer stroke survivors for an ankle-foot orthosis identified three main themes. The first, showed that participants broadly held negative views on the use of ankle-foot orthoses, believing that they limit or delay the recovery of stroke

survivors. The second theme, biomechanical and neurophysiological factors, highlighted the limited understanding the participants had on the broad functioning of ankle-foot orthoses or that increased muscle tone was an indication for ankle-foot orthoses. Finally, they had concerns about the risk of skin damage to the stroke survivor from the ankle-foot orthoses.

There are several sections of the results that raise concerns that physiotherapists are not appropriately knowledgeable about the use of ankle-foot orthoses with stroke survivors. The results from this chapter will be discussed in Chapter 7.

5. Semi-Structured Interviews: Results and Discussion

This chapter presents the results and initial discussions from the semi-structured interviews. The interviews were conducted with 6 participants, as summarised:

- Participant 1. Qualified for 27 years, with 14 years clinical experience in NHS including neurological rehabilitation specialism.
- Participant 2. Qualified for 39 years, with 35 years clinical experience in the NHS including stroke rehabilitation.
- Participant 3. Qualified for 42 years, with 28 years clinical experience.
- Participant 4. Qualified for 31 years, with 20 years clinical experience specialising in neurology and stroke rehabilitation.
- Participant 5. Qualified for 19 years, practicing in rehabilitation and experience in stroke units.
- Participant 6. Qualified for 8 years with some stroke specialism.

The participants reported many years of experience treating stroke survivors and experience of gait from various courses attended.

The results from the transcribed interviews, subsequent data analyses (as described in Section 3.5) and discussions are presented in the following 4 sections:

- When to use ankle-foot orthoses: gait pattern
- Compensation and Recovery
- Subjective theories regarding use of ankle-foot orthoses
- Ankle-foot orthoses provision

5.1. When to use Ankle-Foot Orthoses: Gait Pattern

The recommendations made in clinical guidelines for the use of ankle-foot orthoses stress the importance of stance period of gait (RCP. 2012, SIGN. 2010). However, the recurring

and most common theme among interviewees was ‘drop foot’ specifically and generally other swing period issues, illustrative quotations are used and are linked to participants:

5.1.1. Swing period gait deviations

When discussing gait deviations interviewees consistently and most frequently reported issues of ‘drop foot’:

> *“Well foot drop would probably be a **really common** one” Participant 1*
>
> *“I suppose the **most common** thing people think about is … and then when I’m thinking orthoses … people who’ve got … you know, they can’t lift their foot” Participant 2*
>
> *“During the swing phase there is **usually** a problem” Participant 3*
>
> *“**Typically** you’ll see foot drop, with low tone” Participant 4*
>
> *“The most difficult pattern is people can’t dorsiflex their ankle or can’t flex their knee, so on the swing phase of their gait they’re struggling to get their foot through” Participant 5*
>
> *“The **hugely typical** problem, I know kind of straight away, homing in on the foot and ankle, but, typically, it would be a lack of dorsiflexion during swing phase of gait” Participant 6*

Many examples were given by the participants of ‘drop foot’, they highlighted the frequency of this gait deviation: *“really common” “most common”; “usually”; “typically”*; and *“hugely typical”*. Other swing period gait deviations were referred to, but less frequently:

> *“High stepping circum-stepping gait, where the patient swings their leg to the side, because they can’t step through properly” Participant 4*
>
> *“Well they’ll swing their leg out to the side to swing their foot through” Participant 5*
>
> *“We call that circumduction they swing the hip out to the side” Participant 6*

The movements described are secondary to 'drop foot', they are examples of gait deviations that the stroke survivor is attempting to compensate for the primary gait deviation of 'drop foot'.

5.1.2. Stance period gait deviations

There were few mentions of the importance of stance period to the gait of stroke survivors. Interviewees made general statements regarding alignment during stance:

> *"Alignment's the main thing, isn't it, so that the rest of the body falls into place and then to help with mobility, to help foot clearance" Participant 1*

> *"A lot of us, we're trying to keep people as aligned as possible, trying to get people to walk as normally as you can because that's what you're designed for, so it helps your joints it helps the muscles fire off correctly" Participant 2*

There were the general statements made about keeping the stroke survivor aligned, but no detail to demonstrate an informed understanding of stance and stance period gait deviations. No mention was made of knee hyperextension during stance, which is surprising as this is a frequent gait deviation (Moseley et al. 1993, Mulroy et al. 2003). There were a few mentions of excessive knee flexion during stance, but these lacked sufficient detail to support a belief in a comprehensive knowledge or understanding of the participants:

> *"So typically you would see somebody with very low tone muscle weakness I suppose, and have problems in the lower limb, at the hip, knee and ankle, so lack of stability around the hip on stance, lack of stability around the hip and knee on stance, and then a problem with getting through stance and then into swing" Participant 4*

> *"They wouldn't be able to get extension when they were taking a stride with the opposite non affected leg and they wouldn't be able to clear their foot during swing phase and when they heel strike" Participant 3*

The first quotation, which is typical, fails to mention the ankle weakness specifically, which is a significant problem for some stroke survivors (Jonkers, Stewart and Spaepen 2003, Neckel et al. 2006). An ankle-foot orthosis can offer control of ankle alignment which in turn can offer optimised knee and hip alignment (Bowers and Meadows 2007). The second

quotation mentions the inability of stroke survivors to extend but gives no further detail and then again returns to the issues of gait deviations in swing period of gait.

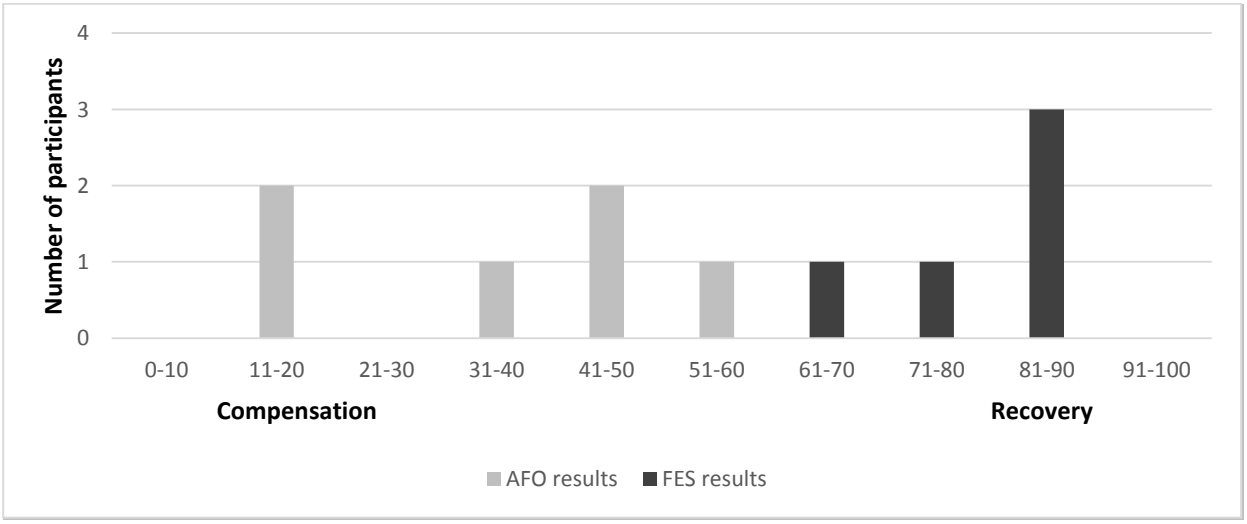
5.2. Compensation and Recovery

Two specific questions in the semi-structured interviews addressed compensation and recovery with regard to use of ankle-foot orthoses and functional electrical stimulation. The question on ankle-foot orthosis use was:

> When a stroke survivor is referred for an **ankle-foot orthosis** where would you place the use of the **ankle-foot orthosis** on this continuum?
>
> Compensation _____ Recovery
>
> Comment if you wish.

Respondents were informed that the definition of compensation was 'performing the old movement in a new manner' and recovery was defined as 'restoring the ability to perform a movement in the same manner as it was performed before injury'. The responses that the physiotherapists give to the above question on how they viewed ankle-foot orthoses and a subsequent question on functional electrical stimulation are given below in table 14. Participant 2 did not answer the question about functional electrical stimulation due to lack of familiarity.

Table 14 'Do you consider the use of a) ankle-foot orthoses b) functional electrical stimulation as compensation or recovery', frequency and location of responses



The responses demonstrate that the use of ankle-foot orthosis was reported as closer to a compensatory intervention, but a larger range of responses was recorded, suggesting less agreement between participants. The use of functional electrical stimulation was reported to be more likely to aid recovery and a smaller range of variation was recorded, indicating stronger agreement between participants. The participant's belief that functional electrical stimulation was therapeutic and facilitated recovery were not supported by the evidence (RCP. 2012). Interviews have the advantage over fixed questions of allowing a greater understanding of participants nuanced knowledge and attitudes, in this case into compensation and recovery:

> *"I suppose if you used AFOs with therapy and the aim was to maintain range of movement and alignment, then it would be more of a therapeutic effect. But just giving it to a patient, I would say it would be compensation." Participant 1*

The quote above, which is representative, indicates there is not a nuanced knowledge or informed understanding of the use of ankle-foot orthoses regarding compensation and recovery. Improved stance period alignment is therapeutic for muscle activation, afferent feedback and cortical activation (Miyai et al. 2002). With increased cortical activation there have been demonstrable treatment induced cortical reorganisation (Liepert et al. 2000) recovery in any other words.

5.3. Subjective theories regarding use of ankle-foot orthoses

The transcribed interview results have been examined to gain insight into the 'subjective theories' of the participants regarding the use of ankle-foot orthoses. The themes that emerged were 'evidence-base' and 'rational for clinical decisions'.

5.3.1. Subjective theory: evidence-base

Evidence-based care aspires to promote *"the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients"* (Sackett et al. 2007). The following response compares the use of ankle-foot orthoses with functional electrical stimulation (which does not offer any control of stance period alignment):

> *"So it's definitely a means to an end that the foot can clear the floor and put the lower leg in better alignment so that they can recruit muscle activity at the hip. So it would be a compensatory strategy. Whereas with FES, I mean there is evidence that there's a therapeutic effect with FES." Participant 1*

The above statement acknowledges the evidence of benefits to proximal muscle activation following realignment from an ankle-foot orthosis in stance period. But fails to understand the therapeutic limitations of functional electrical stimulation, the findings were contradictory (RCP. 2012).

5.3.2. Subjective theory: rational for clinical decisions

Evidence-based care seeks to *"de-emphasise intuition, unsystematic clinical experience, and pathophysiological rational as sufficient grounds for clinical decision making"* (Evidence-Based Medicine Working Group 1992). However, when there is no formal evidence-base then the rational for clinical decisions becomes important. Thus some clinical decisions will continue to be based on pathophysiological rational but this should be consistent and informed by appropriate research. Two issues raised by the interviewees were increased muscle tone and sensory feedback, both of these issues influence and are influenced by alignment. Firstly, increased tone in muscles can have a detrimental impact on stroke survivors' gait (Kinsella and Moran 2008, Mulroy et al. 2010):

> *"You've got the risk of contractures, so to maintain alignment and begin thinking about reducing spasticity first with something like Botulinum Toxin or physical measures, then I would think about using orthoses." Participant 4*

> *"But the tribe who are against it say that what you want to do is not wear that, the main problems is developing abnormal movement patterns, the main problem is developing spasticity through kind of abnormal movement pattern." Participant 5*

The implication from the first quotation is that problematic increased muscle tone is allowed to develop and consequent loss of range of movement before considering use of ankle-foot orthoses. This is contrary to results of research that has examined this, the use of ankle-foot orthoses has been shown to reduce the chances of stroke survivors developing problematic muscle tone and spasticity (de Sèze et al. 2011). The implication of the second quotation is that use of ankle-foot orthoses will cause the development of abnormal gait patterns and

subsequent increases in muscle tone rather than reduce them. Research indicates that this is not correct, it's been established that ankle-foot orthoses will normalise the biomechanics of gait of stroke survivors (Leung and Moseley 2003, Tyson, Sadeghi-Demneh and Nester 2013). The rational stated are contradictory and in inconsistent with research on these topics.

Regarding sensory feedback for rehabilitation of stroke survivors the interviewees demonstrated a poor understanding of the consequences of poor alignment in stance on sensory feedback:

> *"It's very much putting the foot in an abnormal … well not an abnormal … a normal position but the position hasn't got the normal sensory feedback and the normal adaptability of the foot that you would want." Participant 1*

This response highlights a failure to understand the importance of the alignment of the whole body. The use of ankle-foot orthoses will align the foot and ankle appropriately and allow optimised proximal alignment which will optimise afferent feedback (Miyai et al. 2002).

5.4. Ankle-foot orthosis provision

Different designs of ankle-foot orthoses have different functional characteristics. This range of functional characteristics is significant in the treatment of stroke survivors. RCP recommendations state that physiotherapists should be 'knowledgeable' on the use of ankle-foot orthoses to improve function after a stroke (2012), this is reliant on their knowledge and understanding of functional differences, not necessarily the range, of ankle-foot orthoses. Not that they necessarily provide the ankle-foot orthosis themselves but that the ankle-foot orthoses are provided by "*an appropriately qualified health professional*" (SIGN. 2010).

5.4.1. Provision by physiotherapists

The participants reported providing ankle-foot orthoses themselves. They reported having a stock of ankle-foot orthoses, described as 'posterior leaf spring' design which are only suitable for swing period control (NHS Quality Improvement Scotland 2009):

> *"…or with some patients you just want one to see if it works and if you've got a whole load of small, medium and large standard ones in the cupboard you can just try it out and try it for a week and see how it goes." Participant 1*

> *"I think most of us, certainly thinking about me in clinical practice, most of the time we would handle it ourselves, so we had a stock of ankle foot orthosis and very basic ones, and that's what we used to use." Participant 4*

> *"If you're just giving off the shelf AFOs, well you can just get a load of leaf spring AFOs from a supplier, have them in your cupboard and just give them out." Participant 5*

The ankle-foot orthoses to which physiotherapists have access are for swing period control, and cannot provide stance period control. If the physiotherapist has only this type of orthosis as a reference and for trial, then they should be aware of the functional limitations. However, there are no indications of this, there is no mention of an ankle-foot orthosis preventing collapse into excessive dorsiflexion at the ankle and consequently excessive flexion at the knee and hip. The participants demonstrate no understanding of the functional differences of ankle-foot orthoses they employ and the ones that can be provided by an orthotist suggesting that they are not *"an appropriately qualified health professional"* as recommended in the SIGN guidelines (2010).

5.4.2. Provision by orthotists

The interviewees did discuss when they would consider referring a stroke survivor to an orthotist for an

ankle-foot orthosis. Orthotists are appropriately qualified health professionals that can provide different designs of ankle-foot orthoses with different functional characteristics.

> *"I wouldn't refer to an orthotist unless I was really sure it was going to be something **useful**, just for the expense really and the hassle of it." Participant 1*

> *"For more, for better designed and more **effective** ankle foot orthosis, those would depend on the patient, and if they were going to make a very good recovery, then I would refer on to an orthotist." Participant 4*

There are no indications in the interviews that the participants understand what functional difference would make an ankle-foot orthosis more 'useful' or 'effective', this undermines their belief in their knowledge base. The respondents see themselves as mediators of access to Orthotic Services, which they are. Interviewees believe they have the knowledge and

understanding to assess when referral to an orthotist is appropriate. However, this is far from certain.

Some responses indicate that an orthotist should be involved in the provision of custom made ankle-foot orthoses, as is recommended in the clinical guidelines (RCP. 2012, SIGN. 2010). However, understanding of the different functional characteristics of other ankle-foot orthoses was not demonstrated in interviewee responses and this may suggest that their referral practices are not as well-informed as they hoped.

5.5. Summary of semi-structured interview results and initial discussions

Participants who took part in the semi-structured interviews had many years of clinical experience and specialisation in treating stroke survivors.

Their responses regarding indications for referral for an ankle-foot orthosis predominantly concerned 'drop foot'; this was the initial reason offered and was reiterated at many points during the interviews. There were few statements or examples of stance period issues that would result in the respondents making a referral for an ankle-foot orthosis. This is surprising given the extensive clinical experience of the participants.

The use of ankle-foot orthoses was very strongly perceived as being compensatory and the use of functional electrical stimulation as facilitating recovery.

The subjective theories concerning evidence-base and rational for clinical decisions was not current or well informed by research. The clinical decision making related to specific presentation or gait deviations of a stroke survivor were poorly rationalised and inconsistent. On the whole 'knowledgeable' use of ankle-foot orthoses was not illustrated by the clinical practice reported.

The majority of interviewees stated that they had a stock of 'posterior leaf spring' orthoses at their disposal. The respondents also stated that they would refer to an orthotist when required. The reasons given for referring to an orthotist were vague offering no specific clinical presentation of a stroke survivor to indicate knowledge of ankle-foot orthoses or the functional limitations of the 'posterior leaf spring' design.

Results from these interviews suggest that even physiotherapists with extensive clinical experience do not base their clinical decisions on knowledge gained from the current evidence used by guideline developers, relying instead on beliefs that are not supported in the broader published literature. These results and discussions will be discussed in greater length in Chapter 7.

6. Experiential Training for Physiotherapists: Results

This chapter presents the results from the pre and post experiential training questionnaires completed during a training event. The pre-training questionnaire is shown in Appendix 5 and the post-training questionnaire is shown in Appendix 6. The training was described in Section 3.2.3.

The study population was 21 physiotherapists who attended a training session on the use of ankle-foot orthoses for stroke survivors. They were acute and community based physiotherapists, part of a single team who had an interest and experience in treating stroke survivors. Some of the physiotherapists were recently qualified (with 2 years of experience) while others had almost 20 years of experience. The results only include the responses for the 17 physiotherapists who completed both the pre and post-training questionnaires. The results are presented in the following three sections:

- Reasons to refer
- Compensation and Recovery
- Reluctance to refer

6.1. Reasons to refer

The first question was "When watching a stroke survivor walking, what aspect of their gait would make you consider a referral for an ankle-foot orthosis?" The response statements to this question are labelled as 'reasons-to-refer'. The 17 physiotherapists generated 61 reasons-to-refer in the pre-training questionnaire and 65 reasons-to-refer in the post-training questionnaire, summarised in table 15.

Table 15 Number of reasons-to-refer for pre and post-training questionnaires

	Reasons-to-refer that mapped to gait pattern	Reasons-to-refer mapped to walking speed, walking efficiency and weight bearing during stance	Unmapped reasons-to-refer	Total number of reasons-to-refer
Pre-Training Questionnaire	43	8	10	61
Post-Training Questionnaire	51	13	1	65

The majority of reasons-to-refer in the pre and post-training questionnaire are impairment level gait deviations and are mapped to gait pattern (43 and 51 respectively). There is only one unmapped reasons-to-refer in the post-training questionnaire, demonstrating an increased focus on gait.

The reasons-to-refer that were gait deviations were mapped to parts of the gait pattern (swing and stance period) the other reasons-to-refer that matched the three other indications for using an ankle-foot orthosis (SIGN. 2010) were mapped to them. The results are reported in detail in the following three sub-sections:

- Gait pattern, swing period
- Gait pattern, stance period
- Walking speed, walking efficiency, and weight bearing during stance

The tables in the following three sub-sections present slightly abridged reasons-to-refer. The reasons-to-refer that each participant made first are highlighted in a darker colour as these are more likely to be the most strongly felt or held.

6.1.1. Gait pattern, swing period

Abridged reasons-to-refer from the pre and post-training questionnaires that mapped to the swing period of gait are presented below.

Table 16 Reasons-to-refer mapped to gait pattern, swing period: pre and post-training questionnaires, 1st responses are highlighted in the darker colour

Gait pattern: indication for an ankle-foot orthosis (SIGN. 2010)		
Pre-Training Questionnaire	**Visual representation of swing**	**Post-Training Questionnaire**
Hip hitching/circumduction Circumduction of whole leg Circumduction Dragging leg Circumduction of hip	Swing Period: general	Increased flexion at leg swing Decreased hip flexion on swing Hip circumduction Decreased knee flexion Hip hiking, in swing phase Hip hitching Hip hitching/circumduction

Foot drop Foot drop Foot drop Drop foot Drop foot – low tone Difficulty with foot clearance Inability to DF Decreased dorsiflexion in swing Abnormal gait, foot drop Drop foot Toe catching Foot drop Foot drop swing phase Foot drop Drop foot Weakness of dorsiflexors Foot catching	Swing Period: 'drop foot'	Foot Drop/dorsiflexion Decreased dorsiflexion Poor dorsiflexion swing Weak dorsiflexors Decreased foot clearance Ankle, poor dorsiflexion Foot drop Decreased dorsiflexion

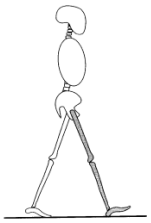
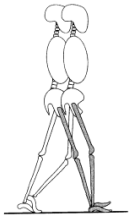
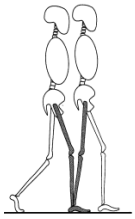
As table 16 above shows, pre-training there were 22 reasons-to-refer that mapped to swing period, 5 general reasons-to-refer and 17 specifically 'drop foot'. The 17 'drop foot' reasons-to-refer were made by 15 participants and 14 of these participants made 'drop foot' their 1st responses, suggesting that the participants prioritise this as the most important reasons-to-refer a stroke survivor for an ankle-foot orthosis. Post-training there were a total of 15 reasons-to-refer that mapped to swing period. 7 of these were general reasons-to-refer and 8 specifically 'drop foot' with only 3 of these being 1st responses.

These results demonstrate a large change in the frequency of reasons-to-refer a stroke survivor for an ankle-foot orthosis. Suggesting that swing period gait deviations are no longer believed to be such important indications for an ankle-foot orthosis. Especially highlighted by the decrease in number of reasons-to-refer that mapped specifically to 'drop foot'.

6.1.2. Gait pattern, stance period

The reasons-to-refer from the pre and post-training questionnaires that mapped to the stance period of gait are presented below.

Table 17 Reasons-to-refer mapped to gait pattern stance period: pre and post-training questionnaires, 1st responses are highlighted in a darker colour.

Gait pattern: indications for an ankle-foot orthosis (SIGN. 2010)		
Pre-Training Questionnaire	**Visual representation of stance**	**Post-Training Questionnaire**
No heel contact Poor foot placing Inability to 'heel strike' Poor foot contact No heel strike	 Initial Contact	No heel strike Increased knee flexion Heel strike Problems with heel strike Heel strike
Ankle instability Ankle instability Foot inverting Unstable ankle Inverting Ankle instability Twisting ankle Unstable ankle Foot inverting Ankle inversion	 Loading Response	Unstable ankle Instability during movement Altered gait due to foot position Altered foot positioning Instability of ankle Decreased ankle stability Foot and Ankle position
Poor translation of tibia Poor hip extension in stance Instability of stance	 Mid Stance	Increased hip retraction Increased dorsiflexion on stance Poor movement of tibia forward Poor hip extension in stance Biomechanics of hip Biomechanics of knee Poor biomechanics at hip/knee Decreased weight bearing Decreased stance phase Stance phase Unstable stance Decreased stance stability Reduced knee stability Weakness, around ankle, knee Instability in the lower limb Poor stability in stance

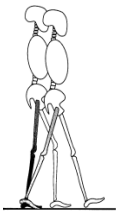
Hyperextending knee in stance Knee hyperextension Hyperextension of knee	 Terminal Stance	Hyperextension of knee Overextension of knee Knee hyperextension in stance Hyperextending knee, stance Knee Hyperextension Hyperextending of knee Hyperextension of knee Increased knee flexion in stance
	 Pre-Swing	

Table 17 above shows that pre-training 15 of the 21 reasons-to-refer (gait deviations) mapped to Initial Contact and Loading Response with some aspect of ankle instability being most commonly stated, arguable not the most critical gait deviation. Only 6 reasons-to-refer mapped to Mid Stance and Terminal Stance. After the training 12 reasons-to-refer mapped to Initial Contact and Loading Response and the remaining 24 mapped to Mid Stance and Terminal Stance (the task of Single Limb Support), a marked increase from the 6 reasons-to-refer pre-training. The reasons-to-refer demonstrate a range of ideas: *"Decreased ability to take weight through the paretic leg"*; *"Poor translation of the tibia"*; *"Poor biomechanics of the hip and knee"*; *"Hyperextension of the knee"*; *"Collapse of the leg and knee into excessive flexion"*. These display a much more knowledgeable and nuanced understanding of the importance of stance as an indication for an ankle-foot orthosis.

In summary the post-training questionnaires show there is a significant decrease in the importance that the physiotherapists attach to the swing period of gait as an indication for an ankle-foot orthosis. Furthermore, there is an increase in reasons-to-refer that map to Mid Stance and Terminal Stance which indicates an increase of the reported importance of stance period, both in the total number of reasons-to-refer and the number of 1st responses. This

shows that participants now attach greater importance to stance period gait deviations as an indication for an ankle-foot orthosis.

6.1.3. Walking speed, walking efficiency, weight bearing during stance

The reasons-to-refer from the pre and post-training questionnaires that mapped to the other indications for an ankle-foot orthosis (SIGN. 2010) are presented below.

Table 18 Reasons-to-refer that mapped to: walking speed, walking efficiency, weight bearing during stance, or Neurophysiological factors, pre and post-training

Other indications for an ankle-foot orthosis (SIGN. 2010)		
Pre-Training Questionnaire		**Post-Training Questionnaire**
	Walking Speed	
	Walking Efficiency	Step to gait Step to gait Step to gait
Reduced weight bearing Decreased lateral stability	Weight bearing during stance	No quads activity Hip movement decrease Maintain alignment of lower limb Abnormal ground reaction force
Unable to achieve plantar-grade Some spasticity in plantar-flexors Increased tone around the ankle Increase tone leading to PF High tone Increased tone in plantar-flexors	Neurophysiological factors	Increased tone plantar-flexors Ankle weakness Poor ankle control, tone Weakness foot/ankle High tone calf/foot Increased tone in plantar-flexors

No reasons-to-refer were made regarding walking speed being an indication for use of an ankle-foot orthosis. In the post-training questionnaire there are a 5 more reasons-to-refer, as can be seen from the table 18 above. The total numbers of reasons-to-refer are small and they show comparatively little change, it is inappropriate to draw further conclusions.

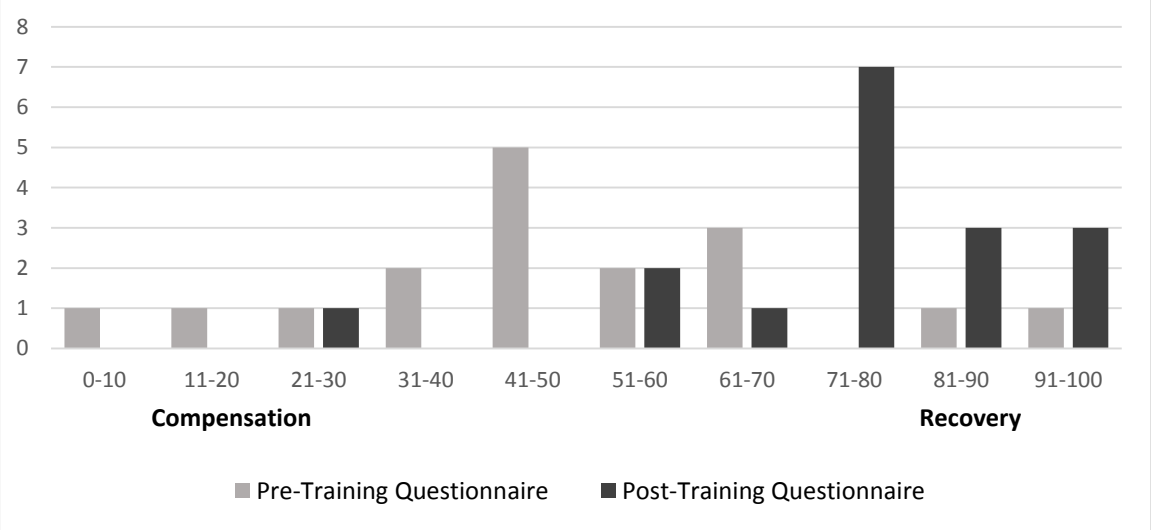
6.2. Compensation and Recovery

The pre and post-training questionnaires asked about compensation and recovery with regard to use of ankle-foot orthoses. In both questionnaires the question was:

> When a stroke survivor is referred for an **ankle-foot orthosis** where would you place the use of the **ankle-foot orthosis** on this continuum?
>
> Compensation _____ Recovery
>
> Comment if you wish.

'Compensation' here is defined as 'performing the old movement in a new manner' and 'recovery' is defined as 'restoring the ability to perform a movement in the same manner as it was performed before injury'. This is ostensibly a comparison of the pre and post-training results. The results shown below in table 19 are for the pre and post-training questionnaires

Table 19 Compensation and Recovery: pre and post-training questionnaires



The results from the pre-training questionnaire (light grey) show the mode is between 41 and 50, with some lean towards compensation. The majority of physiotherapists, 10 out of the 17, placed the use of ankle-foot orthoses closer to compensation than recovery. The results from post-training questionnaire (dark grey) show the mode is between 71 and 80. The change in reported views was distinct, 16 of the 17 participants reported a move towards

ankle-foot orthoses being seen as less compensation and more an intervention that facilitates recovery. The change in frequency and location are clearly visible in table 19.

The implication of these results is that following experiential training on the topic of ankle-foot orthoses use with stroke survivors, participants display a change in reported attitude. An increased awareness of how ankle-foot orthosis use can facilitate stroke survivor recovery.

6.3. Reluctance to refer

The pre and post-training questionnaires asked 'If you have any reservations about referring a stroke survivor for an ankle-foot orthosis tell us why?' Responses concerning treatment of both 'acute and chronic stroke survivors' were sought. The question was left broad so participants were not restricted to gait issues.

In the pre-training questionnaire 18 response statements were made about acute stroke survivors and 15 about chronic stroke survivors. The post-training questionnaire elicited 20 response statements concerning acute stroke survivors and 20 that related to chronic stroke survivors. Given that 17 physiotherapists completed the pre and post-training questionnaires there are comparatively few response statements. The results were analysed and three main themes emerged and are reported for acute stroke survivors and chronic stroke survivors. Some of the response statements have been made more concise and the response statements made first are shown in a darker colour. The three themes are:

- Views, positive and negative
- Biomechanical and Neurophysiological factors
- Skin integrity and other considerations

6.3.1. Acute stroke survivors

The response statements classified as positive or negative views on the use of ankle-foot orthoses with acute stroke survivors are presented in the table 20 below.

Table 20 Response statements mapped to: Views, positive and negative

Views, positive and negative - Acute Stroke Survivors		
Pre-Training Questionnaire		**Post-Training Questionnaire**
Too early Too early Limits active recovery Delay recovery Too early Other therapists opinion	Negative Statements	Too early?
Would refer	Positive Statements	Aware now AFO can prevent problems Don't work in acute, would refer Not reluctant I wouldn't be reluctant now I'm much less reluctant to refer now

The pre-training questionnaire elicited 6 negative statements (5 1st response statements) and only one positive statement. This contrasts with the post-training questionnaire with only one negative statement and 5 positive 1st response statements. This dramatic change in reported views is conveyed visually in table 20, additionally the use of the word "*now*" in the post-training questionnaire by 3 of the physiotherapists suggests the training had an immediate impact on their views.

The response statements considered 'biomechanical or neurophysiological factors' are presented below. Biomechanical factors are related to ankle-foot orthoses rigidity. Neurophysiological factors are impairment level symptoms, increased muscle tone, and the consequences of this, is lost range of movement.

Table 21 Response statements mapped to: Biomechanical and Neurophysiological factors

Biomechanical and Neurophysiological factors – Acute Stroke Survivors		
Pre-Training Questionnaire		**Post-Training Questionnaire**
Prevent movement Prevent movement	Rigidity of the AFO	
Increased spasticity Increased weakness	Tone	

Decreased range of movement at ankle	Range of Movement	

There are 5 statements that mapped to the biomechanical and neurophysiological factors in the pre-training questionnaire. These statements all demonstrate a reluctance to use ankle-foot orthoses and poor knowledge of ankle-foot orthosis function. There are no response statements that mapped to these themes in the post-training questionnaire which suggests a greater understanding of these factors that are considerations in the design of ankle-foot orthoses and indications for ankle-foot orthoses.

The response statements that were classified and mapped to 'skin integrity and other considerations' are presented in table 22.

Table 22 Response statements mapped to: Skin integrity and other considerations

Skin integrity and other considerations – Acute Stroke Survivors		
Pre-Training Questionnaire		**Post-Training Questionnaire**
Sensory input Risk of pressure sores Pressure problems Poor sensation	Skin integrity	Problems with skin Skin integrity Poor circulation Sensory deficit Poor sensation Poor skin condition
Cognitive problems Difficult to put on	Cognition	Cognitive problems Cognitive issues Cognitive problems
	Consent	Patient not consenting Consent issues
	Choice	Patient preference Patient choice
	Compliance	Compliance

There were 6 response statements in the pre-training questionnaire that indicated reluctance to refer for an ankle-foot orthosis. In the post-training questionnaire there were 14 response

statements that indicated reluctance, with more than three times the number of 1st response statements. The new themes of reluctance to refer were: Consent, Choice, and Compliance.

In summary, the results regarding acute stroke survivors from the post-training questionnaires demonstrate that the participants were no longer reluctant to refer stroke survivors for ankle-foot orthoses on account of their views or biomechanical and neurophysiological factors. However, in stark contrast was the participants increased reluctance regarding skin integrity and more significantly for the other considerations.

6.3.2. Chronic stroke survivors

The response statements classified as positive or negative views on the use of ankle-foot orthoses with chronic stroke survivors are presented in table 23, below.

Table 23 Response statements mapped to: Views, positive and negative

Views, positive and negative - Chronic Stroke Survivors		
Pre-Training Questionnaire		**Post-Training Questionnaire**
Poor access to service	Negative Statements	
Would refer Not reluctant	Positive Statements	Increase patient confidence Wouldn't be reluctant Would refer Not reluctant I wouldn't be reluctant now Now feel more confident to refer

The pre-training questionnaire has only three mapped statements, one negative and two positive 1st response statements. The post-training questionnaire contrasts with 6 positive response statements all of which are 1st response statements. In the post-training questionnaire 2 of the physiotherapists use the word "*now*" suggesting the immediate impact of the training.

The response statements considered 'biomechanical or neurophysiological factors' are presented below.

Table 24 Response statements mapped to: Biomechanical and Neurophysiological factors

Biomechanical and Neurophysiological factors – Chronic Stroke Survivors		
Pre-Training Questionnaire		**Post-Training Questionnaire**
Rigid, 'leads to' decreased movement for patient AFOs are quite stiff	Rigidity of the AFO	
Increased spasticity Tone	Tone	
Lack of range of movement to fit AFO Contractures	Range of Movement	Lack of range of movement, muscle shortening

In the pre-training questionnaire there were 6 statements that mapped to the three themes. 5 of these are 1st response statements. In the post-training questionnaire there is 1 statement that mapped to range of movement, indication of a persistent misunderstanding? There is a notable shift in responses and a more robust understanding of these themes are displayed.

The response statements coded and mapped to 'skin integrity and other considerations' are presented in the table below.

Table 25 Response statements mapped to: Skin integrity and other considerations

Skin integrity and other considerations – Chronic Stroke Survivors		
Pre-Training Questionnaire		**Post-Training Questionnaire**
Risk of pressure sores Pressure Poor skin condition Fluctuating oedema Concerns of skin care	Skin integrity	Problems with skin Pressure problems Skin pressure areas Poor circulation Sensory deficit Poor skin condition
Able to put orthosis on	Cognition	Cognitive problems
	Consent	Patient not consenting Consent issues
	Choice	Patient preference
	Compliance	Decreased compliance Compliance

		Lack of compliance

The response statements for chronic stroke survivors are consistent with those for the acute stroke survivors. From the pre-training questionnaire to the post-training questionnaire there are more than twice the number of response statements and almost three times the number of 1st choice statements that demonstrate an increased reluctance to use ankle-foot orthoses.

In summary all of the physiotherapists views and understanding of biomechanical and neurophysiological reason for the use of ankle-foot orthoses shows a marked change, with almost no reluctance to the use ankle-foot orthoses. However, their reluctance finds another form and that is themes that are less open to objective discussion and resolution, the themes of: skin integrity, cognition, consent, choice, and compliance which are considerations in the provision of ankle-foot orthoses and not contraindications.

6.4. Summary of experiential training results

The experiential training results are presented question by question, with the pre and post-training results shown alongside each other. The change in the response statements is an indication of the change in knowledge and attitudes and suggests a gap between baseline pre-training and post-training.

Asking the physiotherapists when they would refer a stroke survivor for an ankle-foot orthosis showed dramatic changes from pre to post-training questionnaire results. There was a marked decrease in the number of response statements that identified ‘drop foot’ as a reason to refer and a marked increase in the response statements that mapped to Mid Stance and Terminal Stance.

There was a marked change in perceptions of ankle-foot orthoses with regard to compensation. Post-training, the respondents were more likely to suggest that ankle-foot orthoses facilitate recovery rather than simply providing compensation for a loss of function.

The issues of reluctance to refer also showed an interesting and revealing change. There was an almost total reduction in the post-training questionnaire of negative views of ankle-foot orthoses and a marked increase in positive views. There was an almost total reduction in the

post-training reluctance to refer for an ankle-foot orthosis for biomechanical or neurophysiological reasons. However, the most revealing change was the increase in reluctance to refer in other areas: risk of skin damage, issues of cognition, consent, choice and compliance. These issues are less open to challenge by experiential training or any other form of training, and may be an expression of deeply rooted beliefs not based in evidence or a well-informed rational for clinical practice.

These results suggest that physiotherapists are not appropriately knowledgeable about the use of ankle-foot orthoses with stroke survivors.

7. Discussion

Referral for an ankle-foot orthosis is needs based, dependent on the knowledge and attitudes of the physiotherapist and the presentation of the stroke survivor. The three investigations aimed to determine if physiotherapists are knowledgeable about the use of ankle-foot orthoses with stroke survivors. This chapter will discuss critically the results presented in Chapters 4, 5 and 6 and will also explore the triangulation of results:

- The Three Methods
- Quality of gait
- Reasons to refer for an ankle-foot orthosis
- Compensations and Recovery
- Reluctance to refer for an ankle-foot orthosis
- Ankle-foot orthosis provision

Figure 8 Schematic representation of the triangulation of results from the different methods and discussions under each Section

7.1. The Three Methods

The three methods aimed to establish two things. Firstly, if physiotherapists have a well-informed understanding of the possible function of ankle-foot orthoses for stroke survivors. Secondly, if there is a shared set of criteria for the use of ankle-foot orthoses between the developers of guidelines, and the physiotherapists who implement the guidelines. If their referral practice is not congruent with practice guidelines they are demonstrating one of two things: that they are not 'appropriately knowledgeable' or that they do not adhere to evidence-based practice guidelines.

7.1.1. Questionnaires for physiotherapists

There were three groups of physiotherapists who completed questionnaires prior to in-service training. A total of 47 physiotherapists attended the training sessions and 40 of these completed the questionnaires. This is a high completion rate and can possibly be explained as they were effectively a 'captive audience'. There were no written marginalia to suggest that the physiotherapists had difficulties with the questions. In retrospect it may have been beneficial to gather detail on each participant. However, efforts were made to ensure the majority of team members attended the in-service training, helping to ensure that the teams were representative of teams in general.

7.1.2. Semi-Structured Interviews

The semi-structured interviews aimed to gain a more nuanced insight into the knowledge and 'subjective theories' of 6 physiotherapists. There was a second purpose, gaining feedback on a new design of ankle-foot orthoses, which is not reported on in this thesis. This may have assisted the physiotherapists in talking more freely about ankle-foot orthoses and their current clinical practice.

The physiotherapists who participated in the interviews had extensive experience in general and specifically in the rehabilitation of stroke survivors. This was both in an acute setting and a community setting for longer term rehabilitation. The data gathered offered an insight into of their knowledge and attitudes.

7.1.3. Experiential Training

There were two variables with this method: the effect of experiential training as opposed to more standard approaches to training, and the measurement of change between pre and post-training questionnaires.

The experiential training clearly simulated (on the volunteer), poor ankle alignment and poor biomechanical and neurophysiological factors which can cause stroke survivors increased difficulties with their gait. This experience for the volunteer and the other participants was marked and illustrated the truth that you cannot have 'normal movement' without 'normal alignment'. Thus presenting, visually, a very strong argument for the normalisation of alignment with the use of ankle-foot orthoses. This may help to explain some of the large response changes that were reported. The approach of experiential training seemed to increase knowledge of ankle-foot orthoses function and improved many physiotherapists views of ankle-foot orthoses. However, the longer term retention and assimilation of this knowledge is unknown.

There were 21 people who attended the training and 17 completed the pre and post-training questionnaires. More details regarding clinical experience could have been asked at the time of training. However, it would have been increasingly possible to identify respondents and it was considered that this would limit the willingness of the physiotherapists to complete the questionnaires.

7.1.4. Approach to analysis and presentation

Given that the questions were focused on the gait of stroke survivors and ankle-foot orthoses it was reasonable to have some prior thoughts on the approach to analysis. The structure to assist with analysis was informed by the Scottish Intercollegiate Guidelines Network on rehabilitation after stroke (SIGN. 2010). This structure offered four indications for the use of ankle-foot orthoses: walking speed, walking efficiency, gait patterns, and weight bearing during stance. Most of the focus of participants was on gait pattern. These were classified into stance and swing and then sub-classified into the different phases of stance (Perry and Burnfield 2010). This was beneficial in highlighting the participants focus on swing period

gait deviations, and more generally helpful in visually linking statements of gait deviations to the part of gait where the gait deviation would be seen.

The analysis of the data followed the framework approach (Ritchie and Lewis 2003). This was structured and well suited to the focus and purpose of the research. The framework approach places importance on 'charting and mapping', usually extracts of transcribed text as in the semi-structured interviews. The other two methods charted and mapped data relating to gait deviations and other impairment level gait issues. This approach was appropriate and the summarised data offered an insight to physiotherapists' knowledge and attitudes. Importantly the framework approach and the SIGN indications for ankle-foot orthoses (2010) offered a clear structure for the researcher to report objectively on the data analysis and conclusions drawn, and also facilitated the triangulation of the results.

7.2. Quality of gait

Good quality gait was broadly defined in two ways. Firstly, with statements on the absence of swing period gait deviations. Secondly with the stroke survivor demonstrating good control of weight bearing during stance. In contrast poor quality gait was described with many more stance period gait deviations. This was corroborated with statements on the inability of the stroke survivors to weight bear during stance on the paretic leg.

Stance period gait deviations are consistently identified by research as indicators of gait problems more often than swing period deviations (Mulroy et al. 2003). The results from this study demonstrate an understanding at some level of the different consequences of swing period and stance period gait deviations. The implication is that the physiotherapists identified gait deviations associated with 'poor quality gait' but they would not use these identifiers with the same frequency to refer a stroke survivor for assessment for an ankle-foot orthosis. This highlights the failure to fully understand how pervasive the effects of poor stance period or weight bearing can be on a stroke survivors gait. Furthermore, this may highlight weakness in the clinical reasoning for the referral of stroke survivors for an ankle-foot orthosis, arguably detrimental to the stroke survivor.

7.3. Reasons to refer for an Ankle-foot orthosis

There are guidelines for the referral of stroke survivors for an ankle-foot orthosis (SIGN. 2010). However, it appears that the physiotherapists do not share the same priorities as the guideline developers. The pertinent discussions are presented in the following sub-sections:

- Gait pattern, swing period
- Gait pattern, stance period
- Walking speed, walking efficiency and weight bearing during stance

7.3.1. Gait pattern, swing period

The most common reason given to refer was ‘drop foot’, this is consistent across the three methods (Section 4.2, 5.1, and 6.1 pre-training questionnaire). This may reflect the comparative ease of seeing ‘drop foot’ when a stroke survivor is walking. Semi-structured interviews can often permit a more nuanced understanding of knowledge and views, however, the interviews show that the physiotherapists understanding was not nuanced. Their understanding was poor and demonstrated with the high frequency of ‘foot drop’ and the very low frequency of stance issues as reasons to refer.

Some mention was made of secondary swing period gait deviations across the three methods. Such as circumduction which is often the stroke survivors active attempt to reduce the risk of tripping because of a ‘drop foot’. This suggests a group of stroke survivors less effected, rather than those that would have most to gain from an ankle-foot orthosis (Teasell et al. 2001).

The results from the post experiential training questionnaire are starkly different to the questionnaires for physiotherapists, the semi structured interviews and the pre-training questionnaire. They show the decrease in number of statements mapped to swing period and specifically to ‘drop foot’, highlighting a very clear change in knowledge and attitudes. Thus putting the results from the other two methods and pre-training statements into context, suggesting that the knowledge base of all groups of physiotherapists was lacking.

7.3.2. Gait pattern, stance period

An interesting aspect of stance is the issue of ankle instability. There was no mention of ankle instability in the statements that describe 'good quality gait' or 'poor quality gait'. This is consistent with reports on the determinants of poor gait (Mulroy et al. 2003) and patterns of gait (de Quervain et al. 1996). However, participants report a high number of statements on ankle inversion and ankle instability as reasons to refer for an ankle-foot orthosis, Section 4.2 and 6.1. This contrasts with the published literature and suggests a possibly poor interpretation of gait deviations or a poor rational for clinical decisions.

The reported importance of stance across the three methods (Section 4.2, 5.1 and 6.1 pre-training questionnaire) was low. The participants in the first method, questionnaires for physiotherapists, did not appreciate the importance of stance period as an indicator for referral for an ankle-foot orthosis. The semi-structured interview participants did not demonstrate an understanding of the importance of stance period, and what descriptions were offered were generic and lacked detail. The pre-training questionnaire results were consistent with the results from the other two methods. Taken together these demonstrate a failure to: understand the multitude of stance issues for stroke survivors (Moseley et al. 1993), appreciate the increased objectivity required to optimise stance (Mulroy et al 2013) or comprehend the importance of stance as an indicator for an ankle-foot orthosis (SIGN. 2010).

Participants made little mention of weakness of plantar-flexors or stance stability, this is in stark contrast to the extensive attention given to weakness of dorsiflexors during swing leading to 'drop foot'. This is in contradiction to published research into the causative factors of gait deviations, which are mostly due to plantar-flexor weakness (de Quervain et al. 1996, Neckel et al. 2006). The physiotherapists that took part in the semi-structured interviews seemed less aware of the impact of muscle weakness on stance period, despite their many years of experience. Furthermore, participants made little mention of the problem of increased muscle tone, which is in contrast with the difficulties stroke survivors can experience (Kinsella and Moran 2008, Mulroy et al. 2010). However, the results from the post-training questionnaire contrast sharply. The physiotherapists demonstrate a marked increase in their awareness of the importance of stance, and the effect of weakness or increased muscle tone especially on Single Limb Support. This is consistent with the difficulties that stroke survivors experience during gait (Mulroy et al. 2003), the emphasis

on optimising biomechanics and function of ankle-foot orthoses (Bowers and Meadows 2007, Bowers and Ross 2010), and the importance attached to stance by guideline developers (SIGN. 2010). However, the duration of this demonstrated change is unknown.

7.3.3. Walking speed, walking efficiency and weight bearing during stance

Walking speed, walking efficiency and weight bearing during stance are the three other indications for a referral for an ankle-foot orthosis (SIGN. 2010). There was only one response statement that mapped to walking speed from the investigations in Chapter 4 and 6, suggesting that physiotherapists did not place the same importance on walking speed as guideline developers as a reason to refer for an ankle-foot orthosis.

The post-training questionnaire showed an increased awareness of walking efficiency and weight bearing during stance as indications for an ankle-foot orthosis, but the numbers were small.

7.3.4. Summary of reasons to refer for an ankle-foot orthosis

Physiotherapists report gait deviations during gait pattern more so than walking speed, walking efficiency and weight bearing during stance as indications for ankle-foot orthoses. The results for gait pattern suggest that the physiotherapists who participated in the research were not appropriately knowledgeable about the use of ankle-foot orthoses with stroke survivors. They focussed on swing period gait deviations, mostly ‘drop foot’ with little demonstrable understanding of the importance of stance period.

Comparing the statements made when answering questions about the quality of gait, with when to refer for an ankle-foot orthosis is insightful. The physiotherapists understood that stance period issues were related to poor quality gait. However, this understanding of poor quality gait did not result in these gait deviations being given as a reason to refer stroke survivors for an ankle-foot orthosis.

It has been suggested that different professionals see things that their professional interventions could improve (Watelain et al. 2003). An interesting suggestion as stance period issues can be less responsive to many non-orthotic rehabilitation interventions.

Therefore, physiotherapists need to be aware that ankle-foot orthoses can influence gait and consequently rehabilitation of stroke survivors who demonstrate stance weakness or increased muscle tone.

7.4. Compensation and Recovery

One of the reasons physiotherapists are reluctant for stroke survivors to use ankle-foot orthoses is a belief that it is purely 'compensation' and will not facilitate 'recovery' of lost function (Shumway-Cook and Woollacott 2007). This position was explored with a question in each of the three research methods.

The results show clearly that most of the respondents perceive ankle-foot orthosis use as being more compensation than assisting with recovery (Sections 4.3, 5.2 and 6.2 pre-training questionnaire). This contrasts with their perceptions that the use of functional electrical stimulation facilitates recovery. There are two issues, firstly examining the definitions of 'compensation' and 'recovery' (Levin et al. 2009) there is no difference in the actual degree of compensation or recovery for the two interventions. Secondly, evidence-based guidelines state that the findings for therapeutic use of functional electrical stimulation were not as the physiotherapists believed 'established' but were contradictory (RCP. 2012).

The views of the physiotherapists on the use of ankle-foot orthoses being compensatory is contradicted by their views of ankle-foot orthoses being 'therapeutic' (Section 4.3.1). The perception of ankle-foot orthoses being 'therapeutic' does imply some changeability of the stroke survivor's presentation from the use of ankle-foot orthoses, specifically improvements in their function, in any other words 'recovery'.

The experiential training method showed a significant change in responses between the pre and post-training questionnaires. Firstly, there was a visible move of response frequency towards recovery (Section 6.2). Secondly, all but one of the physiotherapist responses moved towards ankle-foot orthoses facilitating recovery. Suggesting the benefits of ankle-foot orthoses are often resisted (unacknowledged and/or unrecognised) by physiotherapists.

In summary the results for the post-training questionnaire contrast starkly with the other results. This change in response raises questions about the baseline knowledge of the physiotherapists and their objectivity regarding different rehabilitation interventions for

stroke survivors, such as ankle-foot orthoses and suggest that specific training my help inform these views.

7.5. Reluctance to refer for an ankle-foot orthosis

There is an evidence-base to support the use of ankle-foot orthoses by stroke survivors (NICE. 2013, RCP. 2012, SIGN. 2010). However, there seems to be a continued reluctance from physiotherapists for stoke survivors to use ankle-foot orthoses. The question on this topic does tend to stimulate/request negative responses but several positive responses were generated so it does not limit or exclude these. The discussions are presented in the following three sections:

- Views, positive and negative
- Biomechanical and Neurophysiological factors
- Skin integrity and other considerations

7.5.1. Views, positive and negative

The views concerning reluctance to refer of the physiotherapists were captured by the three different research methods (Section 4.4, 5.3.1 and 6.3).

The questionnaires for physiotherapists indicated more reluctance to use ankle-foot orthoses with acute stroke survivors than chronic stroke survivors. This may reflect the changeability of stroke survivors in the first 6 months following a stroke (Jørgensen et al. 1995b), as some alluded to when suggesting it was ‘too early’ or that they were ‘waiting for recovery’. However, predictors of recovery exist and unsupported hope should not limit the use of beneficial interventions.

The physiotherapists subjective theory of evidence-base (Section 5.3.1) offers an insight into their reluctance to use ankle-foot orthoses. Their attitudes are not informed by the lack of evidence-base on the therapeutic benefits of functional electrical stimulation, or the actual evidence-base of benefits of ankle-foot orthoses.

The approach of experiential training highlights the changeability in response statements of the physiotherapists and thus questions their baseline knowledge, both those who attended

the experiential training and consequently the baseline knowledge of the physiotherapists who contributed to the other two methods.

7.5.2. Biomechanical and Neurophysiological factors

The physiotherapists knowledge of biomechanical and neurophysiological factors was captured by the three methods (section 4.4, 5.3.2 and 6.3). Statements made under the headings of 'tone' and 'range of movement', leading to a reluctance to use ankle-foot orthoses, demonstrate a lack of understanding of ankle-foot orthoses. Increased or decreased muscle tone are indications for the use of ankle-foot orthoses, (Section 4.2 and 6.1) and is stated more widely in published research (de Sèze et al. 2011, Mulroy et al. 2010). Regarding 'range of movement' ankle-foot orthoses can accommodate loss of range at the ankle readily while continuing to optimise proximal kinematics and muscle activity (Kinsella and Moran 2008, Mulroy et al. 2010).

The physiotherapists subjective theory of rational for clinical decisions (Section 5.3.2) offered insight into the knowledge and attitudes of the physiotherapists who were interviewed, the results indicate two contradictory beliefs. Firstly, that they believe ankle-foot orthoses are used after other interventions in the management of increased muscle tone. Secondly, that ankle-foot orthoses cause increased muscle tone. These points are contradicted by the evidence. Results from a recent randomised controlled trial found that the use of ankle-foot orthoses improved gait, as would have been expected, and resulted in the need for less medical management of increased tone (de Sèze et al. 2011).

The pre-training questionnaire raised similar issues as the questionnaires for physiotherapists did. However, the post-training questionnaires offered a contrasting view. There were no concerns raised by the physiotherapists about the rigidity of ankle-foot orthoses, this is now consistent with the evidence (Bowers and Meadows 2007, Bowers and Ross 2010). There were no concerns raised about increased muscle tone being a reservation for the use of ankle-foot orthoses, this is now consistent with the evidence (de Sèze et al. 2011). There was only one statement of concern about loss of range of movement of the stroke survivor's ankle causing a reluctance to use an ankle-foot orthosis. This indicated that one of the messages of the presentation was not universally understood; that loss of range of movement can easily be accommodated in custom made ankle-foot orthoses (Mulroy et al. 2010).

In summary, across the three methods, there seemed to be a poor baseline knowledge of biomechanical and neurophysiological factors for ankle-foot orthoses use. The experiential training seemed to increase knowledge and resolve issues from poorly informed views.

7.5.3. Skin integrity and other considerations

Skin integrity and other considerations are specifically that and should not result in referring clinicians being inappropriately reluctant to refer. However, the results from the questionnaires for physiotherapists and the pre-training questionnaire (Section 4.4 and 6.3) show a large number of response statements on the risk of skin damage caused by ankle-foot orthoses. This will always be a consideration and not a contraindication for use of an ankle-foot orthosis. There is a risk of pressure from an ankle-foot orthosis and this is complicated by stroke survivors possible neuropathy. However, the parallel is the use of casts for people who have foot ulceration because of lost range of movement and neuropathy due to diabetes, casts are the 'gold standard' intervention to heal ulcers (Sinacore et al. 1987). The other considerations raised was cognition of the stroke survivors, specifically related to putting on an ankle-foot orthosis. This is disingenuous, any cognitive and physical dexterity problems that limit donning an ankle-foot orthosis will certainly limit their ability to put on socks and shoes and consequently they will have support for these tasks.

The post-training questionnaire showed significant change in response statements for skin integrity and other considerations. The response statements more than doubled in number and expanded in range. This could suggest that when physiotherapist are reassured regarding concerns of biomechanical and neurophysiological factors the importance of skin integrity and other concerns increases and demonstrate a fundamental reluctance to refer for ankle-foot orthoses.

7.5.4. Summary of Reluctance to refer

The change in reported knowledge and attitudes has been highlighted with the experiential training and suggest that physiotherapists baseline knowledge regarding the use of ankle-foot orthoses with stroke survivors falls short of what is expected and 'appropriate'.

Following the experiential training, the physiotherapists reluctance relating to functional aspects of ankle-foot orthoses decreased, and their views became more positive. But their reluctance relating to skin integrity and other considerations increased, these are areas that are difficult to question objectively and have assumed a much greater importance. It would be a missed opportunity if the physiotherapists focus on skin integrity and other considerations resulted in them not advocating ankle-foot orthoses for stroke survivors with stance period gait difficulties.

7.6. Ankle-foot orthosis provision

The physiotherapists who took part in the semi-structured interviews did not demonstrate a good understanding of ankle-foot orthoses design and function. They continue the theme of 'drop foot' in swing period which they treat with a range of ready-made orthoses. The results provide no confidence that they are differentiating between 'drop foot' and more serious stance period issues or that they can differentiate between the functional characteristics of different ankle-foot orthoses. *"Physiotherapy intervention requires that the movement problems be identified in terms that are amenable to interventions"* (Moseley et al. 1993: 259). These physiotherapists fail to understand the movement problems associated with stance period of gait and fail to provide appropriate interventions, directly and indirectly by failing to refer to an orthotist.

8. Conclusions

In practice it is physiotherapists who refer stroke survivors to orthotists for ankle-foot orthoses. However, the literature suggests that physiotherapists can be reluctant to refer stroke survivors for ankle-foot orthoses, and by not doing so may deny the stroke survivor a route of rehabilitation. Therefore, it was appropriate to examine physiotherapists knowledge and attitudes towards ankle-foot orthoses in the treatment of stroke survivors. The research explored the physiotherapists reported practice and clinical reasoning to establish if it was consistent and concordant with recommended clinical practice (NICE. 2013, RCP. 2012, SIGN. 2010).

The three complementary research methods permitted between method triangulation, which helped with the verification of the data gathered, the results and the conclusions. The three methods examined the knowledge and attitudes of individuals and teams of physiotherapists. The physiotherapists had a range of experiences and worked across acute and community healthcare. The framework approach to analysis was followed (Ritchie and Lewis 2003), and found to complement the purposes of the research. The structure of the results and analysis were informed by the SIGN recommendations for ankle-foot orthoses (2010) which were invaluable.

The physiotherapists were asked why they would refer stroke survivors for an ankle-foot orthosis. The initial results focussed on the gait pattern of stroke survivors with the physiotherapists predominantly reporting swing period gait deviations, they failed to prioritise stance period issues as has been done in practice guidelines (SIGN. 2010). Across the methods the physiotherapists lacked understanding of how pervasive the effects of stance period gait deviations actually are. The experiential training demonstrates a marked change in response statements confirming that prior to training they are not ‘appropriately knowledgeable’. However, the effect both short term and longer term of the experiential training cannot be guaranteed. It is likely that to maintain long term changes physiotherapist would need to be supported by further training or mentoring from an orthotist.

The three other SIGN recommendations were also considered in the research (2010), walking speed, walking efficiency and weight bearing during stance. The outcome most used in ankle-foot orthosis research is walking speed. However, physiotherapists do not report

walking speed as a reason to refer. Physiotherapists did not often report walking efficiency as a reason to refer, possibly this concept is not a priority in clinical practice? The importance of a stroke survivor being able to weight bear during stance is selectively understood, the physiotherapists understood that not being able to weight bear well during stance is an indicator of poor gait and was infrequently given as a reason to refer. In the wider context, guideline developers may need to consider physiotherapists clinical priorities and their understanding when producing practice guidelines. This is essential if guidelines are to become embedded into everyday clinical practice.

Compensation and recovery superficially seemed clear, the physiotherapists broadly viewed ankle-foot orthoses as compensatory. However, when they were asked about the therapeutic effects of ankle-foot orthoses their previous dichotomous convictions were less certain. The issues of compensation and dependence on ankle-foot orthoses is difficult, but it is unlikely that a stroke survivor will continue using an ankle-foot orthosis unless they find a benefit. The paternalistic position of not referring for an ankle-foot orthosis because of the risk of dependence is difficult to support or maintain.

The experiential training resolved the negative views held by the physiotherapists, and also resolved their stated reluctance to use ankle-foot orthoses for biomechanical or neurophysiological reasons. However, it seems that some physiotherapists increased their stated reluctance to use ankle-foot orthoses with stroke survivors and will try and justify this reluctance with reasoning that is not based in evidence or well-informed pathophysiological rational (skin integrity and other considerations).

The physiotherapists demonstrated no understanding of the functional differences of ankle-foot orthoses. They fail to understand that ankle-foot orthoses can provide stance period control and that this is important for the rehabilitation and recovery of the more severely affected stroke survivors.

In summary there are evidence-based guidelines with indications for a referral for an ankle-foot orthoses (SIGN. 2010). The physiotherapists reported clinical practice does not follow these clinical guidelines. Evidence-based practice has had a significant impact on healthcare over the past three decades, however *"It does beg the question, What went before?"* (Parsons

2009). Is *"What went before?"* still influencing physiotherapists in the use of ankle-foot orthoses for stroke survivors and their rehabilitation?

8.1. Recommendations

The research has led to the following recommendations.

Within the constraints of time allocated for undergraduate physiotherapy gait training, there should be a review, to ensure that the emphasis on complexity of gait is correct. Specifically, sufficient focus given to stance period of gait. This could help ensure that following qualification, physiotherapists can identify a range of gait deviations. This would enable them to focus on those gait deviations most detrimental to function, rather than focusing on those deviations that are most visible.

Physiotherapists working in the area of stroke rehabilitation may benefit from experiential training on the use of ankle-foot orthoses specifically for stroke survivors. But this does not guarantee a change of clinical practice, which is important. Further work could be conducted with teams of physiotherapists to see if change in knowledge was retained and applied regarding the use of ankle-foot orthoses with stroke survivors.

The pre and post-training questionnaires show a change in knowledge, indicating the value of the experiential training approach. However, the results also show that some physiotherapists seem stubbornly reluctant to consider the use of ankle-foot orthoses with stroke survivors. The solution may be for closer working practices between physiotherapists and orthotists, with orthotists being regular members of the rehabilitation team (in-patient and out-patient), especially for the group of stroke survivors who most need assistance with their rehabilitation and recovery. This may require that these stroke survivor's rehabilitation be jointly supported for longer, so that longer term outcomes be monitored and be reflected on by physiotherapists and orthotists.

Finally, the guideline developers may wish to refine the guidance, to make the recommendations more clinically relevant. Reducing the emphasis on walking speed and efficiency, but focussing on more detailed recommendations regarding gait, specifically the stance period of gait.

Future work could include: Detailed observational research on the retention and application of knowledge by the physiotherapists on the use of ankle-foot orthoses with stroke survivors in clinical practice.

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Appendices

Appendix 1, Questionnaire 1

In-service Training

Ankle-Foot Orthoses and Gait

5th October 2011

The purpose of the research question is to explore the understanding of physiotherapists on the use of ankle-foot orthoses.

You do not have to complete the questionnaire if you do not wish to, there will be no adverse consequences if you do not complete the questionnaire.

When watching a stroke survivor walk what aspect of their gait would make you consider a referral for an ankle-foot orthosis?
• • • • •

Appendix 1a,

Reflections on questionnaire development

The first questionnaire asked a single question. ‘When watching a stroke survivor walk, what aspect of their gait would make you consider a referral for an ankle-foot orthosis?’ Some of the response statements highlighted a reluctance on the part of physiotherapists to refer both acute and chronic stroke survivors, it was decided to pursue this theme. Other response statements raised issues of compensation and dependence, it was decided to pursue this theme. In addition, some physiotherapists mentioned Functional Electrical Stimulation as an alternative option to ankle-foot orthoses a comparison questions was included in subsequent questionnaires. The second iteration of the questionnaire is attached in Appendix 2.

Appendix 2, Questionnaire 2

In-service Training

Ankle-Foot Orthoses and Gait

12th April 2012

When watching a stroke survivor walk what aspect of their gait would make you consider a referral for an ankle-foot orthosis?
• • • • •

When watching a stroke survivor walk what aspect of their gait would make you consider a referral for functional electrical stimulation?
• • • • •

Use of ankle-foot orthoses for stroke survivors, exploring Compensation and Recovery.

When a stroke survivor is referred for an ankle-foot orthosis where would you place the use of the ankle-foot orthosis on this continuum?

Compensation _____ Recovery

When a stroke survivor is referred for Functional Electrical Stimulation where would you place the use of the functional electrical stimulation on this continuum?

Compensation _____ Recovery

If you have any reservations about referring a stroke survivor for an ankle-foot orthosis tell us why?

Acute stroke survivor	Chronic stroke survivor
•	•
•	•
•	•
•	•
•	•

If you have any reservations about referring a stroke survivor for functional electrical stimulation tell us why?

Acute stroke survivor	Chronic stroke survivor
•	•
•	•
•	•
•	•

What presentation of an **ACUTE** stroke survivor would make you refer for an assessment for interventions? And would the time since the stroke influence this decision?

What presentation would make you consider an ankle-foot orthosis? And when would you consider this?				
Presentation	**Yes or No**	**Link**	**Weeks since stroke**	**Comments**
Bed rest only			2	
Immobile, tilt table				
Immobile, STS			4	
Immobile, Standing				
Walking, Ass 2			8	
Walking, Ass 1 constant				
Walking, Ass 1 light			12	
Walking, 1 near				
Walking, Ass for stairs			16	
Independent				

What presentation would make you consider a 'soft and scotch cast'? And when would you consider this?				
Presentation	**Yes or No**	**Link**	**Weeks since stroke**	**Comments**
Resting bed or chair only			2	
Immobile, tilt table				
Immobile, STS			4	
Immobile, Standing				
Walking, Ass 2			8	
Walking, Ass 1 constant				
Walking, Ass 1 light			12	
Walking, 1 near				
Walking, Ass for stairs			16	
Independent				

Appendix 2a,

Some questions in the second questionnaire resulted in a high number of response statements while others did not. The questions on Functional Electrical Stimulation were often not answered, and did not warrant being asked in the third questionnaire. For the third questionnaire it was decided to ask about the quality of gait, and how the physiotherapists would define this, as this may gain further insight into their other responses. The third iteration of the questionnaire is attached in Appendix 3

Appendix 3, Questionnaire 3

In-service Training

Ankle-Foot Orthoses and Gait

18th October 2012

Thank you for taking time to complete this questionnaire. If you have any questions or concerns about the wording of the questions then please note that beside the question.

About You:

1. How many years have you been qualified?					
Student	0-5	6-10	11-15	16-20	21 or more

2. Have you been on specialist neurological training courses focusing largely on walking and gait, for example Bobath, Motor Relearning, Soft and Scotch casting, Functional Electrical Stimulation? Please list and indicate number of days spent on the pertinent courses:

3. Please excuse the false dichotomy. Is your practice and approach to neurological rehabilitation more **influenced** by the Bobath approach or Motor Relearning approach? Place a line on this continuum.
Bobath _____ Motor relearning

About Gait

4. When watching stroke survivors walk which aspects of their gait pattern indicates a **'good quality of gait'**? It may help to consider swing phase and stance phase of gait.

5. When watching stroke survivors walk which aspects of their gait pattern indicates a **'poor quality of gait'**? It may help to consider swing phase and stance phase of gait.

About AFOs and Gait

6. If you have any reservations about referring a stroke survivor for an **ankle-foot orthosis** tell us why?	
Acute stroke survivor	**Chronic stroke survivor**

7. When watching a stroke survivor walk what aspect of their gait would make you consider a referral for an **ankle-foot orthosis?**
• • • •

8. When a stroke survivor is referred for an **Ankle-foot orthosis** do you consider the use of the **ankle-foot orthosis** as 'therapeutic'? Place a mark on this line.

Yes _____ No

Comment if you wish.

Use of assistive devices for stroke survivors: exploring Compensation and Recovery.

- **Compensation** is defined as performing the old movement in a new manner
- **Recovery** is defined as restoring the ability to perform a movement in the same manner as it was performed before injury

9. When a stroke survivor is referred for an **ankle-foot orthosis** where would you place the use of the **ankle-foot orthosis** on this continuum?

Compensation _____ Recovery

Comment if you wish.

10. When a stroke survivor is referred for **Functional Electrical Stimulation** where would you place the use of the **Functional Electrical Stimulation** on this continuum?

Compensation _____ Recovery

Comment if you wish.

Appendix 4, Semi-Structured Interview schedule

Investigation into Physiotherapists views and experiences of using ankle-foot orthoses with stroke survivors.

The overarching purpose of this interview is to inform work being carried out on the design of ankle-foot orthoses for stroke survivors.

Use of orthoses in stroke rehabilitation remains variable and controversial to some. There appears to be a lack of clarity as to what stroke survivors may gain from the use of lower limb orthoses. Most referrals to Orthotic Departments are made by Physiotherapists, therefore it would be useful to identify how and why Physiotherapists come to a decision to use orthoses for stroke survivors.

Part 1 of the interview

Questions about you:

1. How many years have you been qualified?

2. How many years have you specialised in treating neurological conditions?

3. Have you been on specialist neurological training courses focusing largely on walking and gait, for example Bobath, Motor Relearning, Soft and Scotch casting, Functional Electrical Stimulation?

Questions on your views:

1. When watching stroke survivors walk, what aspects of their gait would make you consider a referral for an **ankle-foot orthosis**?

2. What are your views on the use of **ankle-foot orthoses** with stroke survivors?

3. We wish to understand your 'willingness or reluctance' to use **ankle-foot orthoses** with stroke survivors. If you are reluctant to refer for an **ankle-foot orthosis** tell us why?

Questions on your perceptions of interventions:

The next two questions aim to explore your views on **Compensation** and **Recovery**:

- **Compensation** is defined as performing the old movement in a new manner.
- **Recovery** is defined as restoring the ability to perform a movement in the same manner as it was performed before injury.

1. When a stroke survivor is referred for an **ankle-foot orthosis** where would you place the use of the **ankle-foot orthosis** on this continuum?

Compensation _____ Recovery

2. When a stroke survivor is referred for **Functional Electrical Stimulation** where would you place the use of the **Functional Electrical Stimulation** on this continuum?

Compensation _____ Recovery

Part 2 of the interview

This section focuses of a new design of Ankle-foot orthosis (adjustable by clinician, stroke survivor or family). We wish to understand your views regarding this design and its utility in clinical practice:

1. Adjustable plantar-flexion resistance
2. Adjustable dorsiflexion resistance
3. Controlled movement at the ankle, the movement will not be free (as in a joint) or locked (as in solid ankle)
4. Adjustable resistance to movement of the sole of the Ankle-foot orthosis

Appendix 5, Pre Experiential Training Questionnaire

Training

Ankle-Foot Orthoses and Gait

Question 1.

Significance of gait deviations and symptoms (acute or chronic).

When watching a stroke survivor walk what aspect of their gait would make you consider a referral for an ankle-foot orthosis?
• • • •

Question 2.

Use of ankle-foot orthoses for stroke survivors, exploring Compensation and Restoration.

When a stroke survivor is referred for an ankle-foot orthosis where would you place the use of the Ankle-foot orthosis on this continuum?

Compensation _____ Recovery

When a stroke survivor is referred for Functional Electrical Stimulation where would you place the use of the Functional Electrical Stimulation on this continuum?

Compensation _____ Recovery

Question 3.

If you are: Why are you / would you be reluctant to refer for an Ankle-foot orthosis?	
Acute stroke survivor	**Chronic stroke survivor**
•	•
•	•
•	•
•	•
•	•

Appendix 6, Post Experiential Training Questionnaire

Evaluation

Could we ask you to take a short time to answer some of the initial questions from this morning; we are wondering if the course will have had an impact on your thoughts and possibly subsequent practice?

When watching a stroke survivor walk what aspect of their gait would make you consider a referral for an ankle-foot orthosis?
• • • •

When a stroke survivor is referred for an ankle-foot orthosis where would you place the use of the ankle-foot orthosis on this continuum?

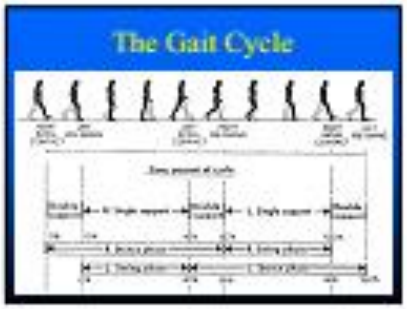
Compensation Recovery

If you are: Why are you / would you be reluctant to refer for an ankle-foot orthosis?	
Acute stroke survivor	**Chronic stroke survivor**
•	•
•	•
•	•
•	•
•	•

Any other comments on the course or ankle-foot orthosis?

Appendix 7, PowerPoint presentation and handout

Barney White



1

Barney White

Gait Patterns

Admission
- Velocity (“percentage of Normal”)
- Knee Flexion in Mid Stance
- Ankle Dorsiflexion in Mid Swing

Six months post stroke
- Velocity (“percentage of Normal”)
- Knee Flexion in Terminal Stance
- Knee Flexion Pre-Swing

Gait Deviations: Stance

- Decreased peak hip extension in late stance
- Decreased peak lateral pelvic displacement
- Increased peak lateral pelvic displacement
- Decreased knee flexion (hyperextension)
- Increased knee flexion
- Decreased ankle plantar flexion at toe-off

Gait Deviations: Swing

- Decreased peak hip flexion
- Decreased peak knee flexion in early swing
- Decreased knee extension prior to heel strike
- Decreased dorsiflexion

AFOs

- AFOs are use to control alignment and thus impairments
- AFOs are used to assist mobility and thus activities
- The two main functions of AFOs are: biomechanical and neurophysiological
- Immediate kinematic and temporal improvements in the gait patterns of adults with hemiplegia
- However, there continues to be opposition to the use of AFOs for people following a stroke
- Report of a consensus conference on the orthotic management of stroke patients

AFOs: Evidence

- Increased walking speed
- Increased step length
- Improved symmetry
- Improved weightbearing
- Decreased knee hyperextension

AFOs: Evidence

- Increased velocity
  - Condie et al (2004)
  - NHS Quality Improvement Scotland (2009)
  - Leung and Moseley (2003)
  - Tyson and Kent (2004)
  - NICE (2012?)

Appendix 8, Ethics

Appendix 8a, Approval Forms

REGISTRY RESEARCH UNIT
ETHICS REVIEW FEEDBACK FORM
(Review feedback should be completed within 10 working days)

Name of applicant: Gillian Ward

Faculty/School/Department: [Faculty of Health and Life Sciences] Occupational Therapy

Research project title: Ankle-foot orthosis design evaluation

Comments by the reviewer

1. **Evaluation of the ethics of the proposal:**
2. **Evaluation of the participant information sheet and consent form:**
3. **Recommendation:** (Please indicate as appropriate and advise on any conditions. If there any conditions, the applicant will be required to resubmit his/her application and this will be sent to the same reviewer). ☐ Approved - no conditions attached ☐ Approved with minor conditions (no need to re-submit) ☐ Conditional upon the following – please use additional sheets if necessary (please re-submit application) ☐ Rejected for the following reason(s) – please use other side if necessary ☒ Not required

Name of reviewer: Anonymous

Date: 07/03/2013

REGISTRY RESEARCH UNIT

ETHICS REVIEW FEEDBACK FORM

(Review feedback should be completed within 10 working days)

Name of applicant: Ronald White.....

Faculty/School/Department: [School of Art and Design] Design Ergonomics

Research project title: Steps toward stroke survivor walking improvement: The advanced adjustable Ankle-Foot Orthosis

Comments by the reviewer

1. Evaluation of the ethics of the proposal:
2. Evaluation of the participant information sheet and consent form:
3. Recommendation: **(Please indicate as appropriate and advise on any conditions. If there any conditions, the applicant will be required to resubmit his/her application and this will be sent to the same reviewer).** [X] Approved - no conditions attached [ ] Approved with minor conditions (no need to re-submit) [ ] Conditional upon the following – please use additional sheets if necessary (please re-submit application) [ ] Rejected for the following reason(s) – please use other side if necessary [ ] Not required

Name of reviewer: Anonymous.....

Date: 21/05/2014.....

Appendix 8b, Participation Information Sheet

Coventry University

Participant Information Sheet

Study Title: Examining physiotherapists' knowledge of and attitudes towards ankle-foot orthoses in the treatment of stroke survivors

Researcher: Barney White

You are being invited to take part in the above study. Before you decide to take part it is important for you to understand why the research is being done and what it will involve.

Please take time to read the following information carefully and discuss it with the researchers if you wish. Please ask if there is anything that is unclear or if you would like additional information. Take time to decide whether or not you wish to take part.

What is the purpose of the study?
The aim of the study is to examine physiotherapists' knowledge of and attitudes towards ankle-foot orthoses, specifically in the treatment of stroke survivors.

Why have I been chosen to participate?
You have been chosen to participate as you may play a role in the rehabilitation of stroke survivors. You will have first-hand experience of the rehabilitation options for stroke survivors including the potential of using Ankle Foot Orthosis.

Do I have to participate?
No, your participation is voluntary. You can withdraw at any point during the study or up to two weeks following participation without giving a reason and without consequence. If you do wish to withdraw after the data collection please contact the researcher, the details are given below.

What will happen in the study?
The study will gather data using three different methods. You will be asked to participate in one of these methods which are described below:

Method One: You will be asked to complete a simple questionnaire prior to some in-house training.

Method Two: You will take part in semi-structured interviews with the researcher, these should last no longer than 45 minutes.

Method Three: You will be asked to complete two questionnaires, the first will be completed prior to some experiential training. The second questionnaire will be completed after the training. There may be a requirement for one or more of the participants to be fitted with a cast to assist in illustrating different walking patterns.

What are then potential disadvantages of participation?
I do not foresee any disadvantages or risks to taking part. However, the study may seem repetitious.

What are the possible benefits of taking part?
By taking part in this study you have a chance to be involved in original research, which may be published in a peer- reviewed journal or presented at an academic conference. It is hoped that the information we get from this study and others like it, will lead to recommendations concerning the use a referral of Ankle Foot Orthosis.

What if something goes wrong?
It is not anticipated that anything will go wrong, however if you feel uncomfortable the study can be ended at any time without penalty or consequence to you.

Will my participation/performance be confidential?
Yes, all results will remain anonymous. Results will be entered onto a password protected computer and hard copies stored in a locked box. These results will only be identifiable by a participant number, which is assigned to you on your consent form. The consent form is the only place where the participant number will correlate with your name and these will be stored in a separate locked box. Only myself and my supervisory team will have access to the raw data. Once analysed no individual results will be identifiable. All information will be archived for 5 years following the completion of the study, after which it will be destroyed as confidential waste. This is in accordance with the 1998 Data Protection Act.

What will happen to the results of the experiment?
The experimental results will be added to those given by other participants who have taken part. The results will be written up as part of my PhD thesis and may be published in a peer-reviewed academic journal or presented at an academic conference.

Who is organising and funding the research?
The research is organised by Barney White. It is funded by Coventry University.

Who has reviewed the study?
This study has been reviewed and approved by Coventry University Peer Review Ethics board.

If you would like further information please contact me at whiter19@coventry.ac.uk

If you wish to make a complaint about this study or your participation please contact my director of studies, Dr James Shippen at aa0388@coventry.ac.uk

Thank you for taking the time to read this 'Participant Information Sheet' and for considering participating in this study

Appendix 8c, Consent Form

Consent form v 1.0

Coventry University

Centre Number:

Study Number:

Participant number:

CONSENT FORM

Title of Project: Examining physiotherapists' knowledge of and attitudes towards ankle-foot orthoses in the treatment of stroke survivors

Researchers: Barney White

	Please initial box
I confirm that I have read and understood the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily.	☐
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected.	☐
I understand that the interview may be video recorded	☐
I agree to take part in the above study.	☐

Name of participant	Signature of participant	Date
Name of researcher	Signature of researcher	Date

Appendix 9, Data

9.1. Quality of Gait, good quality

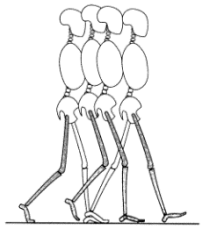
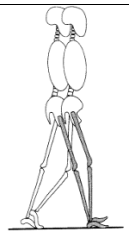
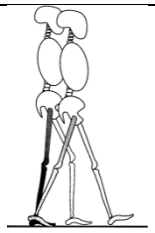
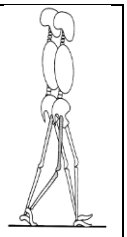
						
Swing: general	**Swing: 'drop foot'**	**Initial Contact**	**Loading Response**	**Mid Stance**	**Terminal Stance**	**Pre-Swing**
2.3 Step length and height 3.1 Circumduction to avoid foot dragging 4.1 Ankle and knee flexion/extension 5.3 Adequate extension to allow for swing phase 6.2 Good clearance, hip flex, no lateral pelvic tilt, no compensations, even stance 8.2 Control of hip and knee flexion in swing 9.4 Swing initiated from hip flexors 10.2 No circumduction of affected side 11.1 Quality, speed and clearing the floor	5.2 Adequate dorsiflexion for swing phase hence decreased risk of tripping 7.1 Effective swing through and foot clearance 8.3 No foot drop 12.1 Swing phase, able to keep foot from scuffing the floor 13.1 Foot clearance	1.2 Heel strike 9.5 Heel strike at initial stance		7.5 Good hip and knee control in stance, forward translation	9.3 Stable knee, no hyperextension	

Table 26 Good quality gait, response statements that mapped to gait pattern

Walking speed	Walking efficiency
12.2 Speed of walking	2.4 Step symmetry 7.4 Rhythmical and efficient 8.1 Fluid movements 6.1 Symmetry, stability, reciprocal, heel strike to toe off 10.1 Stance phase is equal on both legs (adequate weight transfer)
Unmapped response statements	**Weight bearing during stance**
9.4 No associated reactions 7.3 Pain free	1.3 Able to weight bare through affected side 5.1 Equal weightbearing in stance phase bilaterallyie not antalgic gait 14.1 Stance phase initial loading, weight transference, pre-swing 1.1 Control of trunk so that hip extension and flexion is possible 2.2 Control at core, hip, knee and ankle 7.2 Decreased postural sway 10.3 Adequate motor control to achieve heelstrike and toe off 11.2 Control around hip on stance leg and selective hip and knee flexion in swing followed by knee extension and dorsiflexion on contact 2.1 Dynamic balance/stability 9.1 Stability quality stance phase 14.2 Stance phase, throughout

Table 27 Good quality gait, all other response statements

9.2. Quality of Gait, poor quality

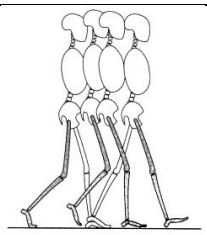
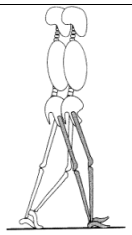
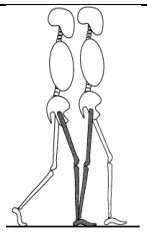
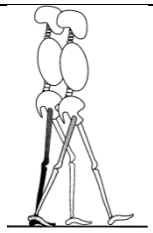
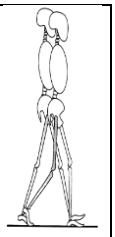
						
Swing: general	**Swing: 'drop foot'**	**Initial contact**	**Loading Response**	**Mid Stance**	**Terminal Stance**	**Pre-Swing**
7.4 Hip hitching to initiate swing 9.2 Circumduction to initiate swing 10.2 Circumduction of affected side 11.3 Increased flexed hip and knee to compensate for lack of dorsiflexion	5.1 Inability to dorsiflex hence poor swing phase 7.2 Foot drop 12.2 Foot drop	1.4 Heel strike 6.2 Poor foot placement, internal rotation 6.3 Pelvic rotation, flat footed placement 9.4 Decreased dorsiflexion at initial stance		1.3 Knee control 4.2 Poor alignment 9.3 Decreased tibial translation during mid/terminal stance	3.1 Hyperextension of the knee in stance phase 6.1 Hyperextension, decreased knee control 7.1 Knee hyperextension in stance 9.1 Hyperextension of knee during mid/terminal stance 11.1 Hyperextended knee on stance	

Table 28 Poor quality gait, response statements that mapped to gait pattern

Walking speed	Walking efficiency
	2.3 Step length and height 2.4 Step symmetry 7.3 Unsymmetrical gait 8.2 Different length of time spent on good/bad leg
Unmapped response statements	**Weight bearing during stance**
4.1 Compensations 6.5 Associated reactions e.g. flexor withdrawal, asymmetry, one sided trunk shortening, step to, decreased speed 8.1 Shuffling 12.1 Shuffling gait 14.1 Any compensatory movements which will lead to secondary complications	1.1 Inability to transfer weight to affected side/limb 1.2 Inability to accept weight through that limb 2.1 Dynamic balance/stability 2.2 Control at core, hip, knee and ankle 4.3 Off balance 5.2 Poor muscle power in glutes/proximal hamstrings/quads/hip flexors for all aspects of gait 6.4 Small stride length and decreased extension, decreased lateral stability glut meds 7.5 Increased trunk sway 8.3 Side flexed to affected side at trunk 10.1 Stance phase is equal on both legs (adequate weight transfer) 10.3 Adequate motor control to achieve heelstrike and toe off 11.2 Increased trunk movement to compensate for hip and knee

Table 29 Poor quality gait, all other response statements

9.3. When to refer, Gait Pattern, Questionnaire 1

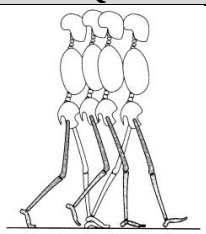
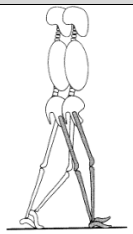
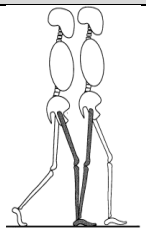
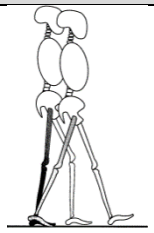
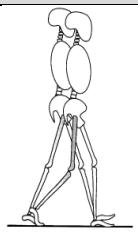
Data from Questionnaire 1 that mapped to Gait Pattern						
						
Swing: general	**Swing: 'drop foot'**	**Initial Contact**	**Loading Response**	**Mid Stance**	**Terminal Stance**	**Pre-Swing**
	1.3 Catch toes while walking and at risk of tripping and unable to use FES or not using it to walk with nurses but needs some support. 3.1 Persistent dorsiflexion weakness 4.1 Footdrop 5.1 Footdrop AFO 6.1 Footdrop (improvement in management in conjunction with other techniques) 7.1 Footdrop not responding to treatment		1.2 Ankle inverting on foot placement on stepping so at high risk of damaging lateral ligament and decreasing feedback through foot to extend 3.3 Ankle inversion, risk of damage particularly with nursing staff 7.3 Weight-bearing on lateral border	3.5 Poor stance phase	1.4 Patient walking but hyperextending knee in stance phase, to control excessive plantar-flexion in stance phase 6.2 Knee hyperextension multiple impairment reducing ability to mobilise 7.2 Knee hyperextension	

Table 30 When to refer, data from questionnaire 1 that mapped to gait pattern

9.4. When to refer, Gait Pattern, Questionnaire 2

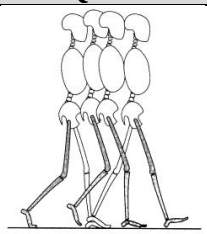
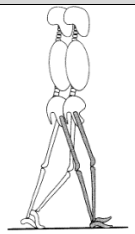
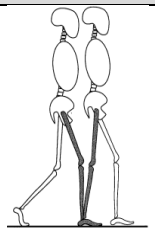
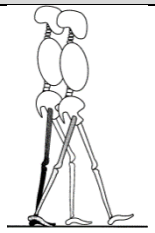
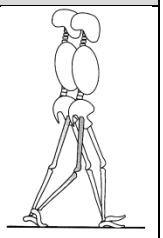
Data from Questionnaire 2 that mapped to Gait Pattern						
						
Swing: general	**Swing: 'drop foot'**	**Initial Contact**	**Loading Response**	**Mid Stance**	**Terminal Stance**	**Pre-Swing**
7.2 Hip hitching/circumduction 10.3 Circumduction of whole leg 12.2 Decreased hip flexion, circumduction 14.4 Dragging leg 17.4 Circumduction of hip	1.1 Foot drop 2.1 Foot drop 3.1 Foot drop 5.1 Drop foot 6.1 Drop foot – low tone 7.1 Difficulty with foot clearance 7.3 Inability to DF 8.4 Decreased dorsiflexion in swing 9.1 Abnormal gait, foot drop 10.1 Drop foot 10.2 Toe catching 11.1 Foot drop 12.1 Foot drop swing phase 13.1 Foot drop 14.1 Drop foot 15.1 Weakness of dorsiflexors 16.1 Dorsiflexion i.e. foot catching 18.1 Foot drop 19.1 Decreased dorsiflexion activity	4.1 No heel contact 4.2 Poor foot placing 13.3 Inability to 'heelstrike' 17.1 Poor foot contact 17.2 No heel strike	2.2 Ankle instability 5.2 Ankle instability 6.2 Foot inverting 6.4 Unstable ankle 10.4 Inverting 11.2 Ankle instability 14.3 Twisting ankle 15.2 Unstable ankle 15.3 Foot inverting 16.4 Ankle inversion tone/plantar-flexed 18.3 Decrease in stability of ankle 19.3 Inverted foot/ankle	8.2 Poor translstion of tibia forward over foot in stance 8.3 Poor hip extension in stance 17.5 Instability of stance 19.4 Decreased activity to extend hip/trunk over mal-aligned foot/ankle	8.1 Hyperextending knee in stance 9.2 Knee hyperextension 17.3 Hyperextension of knee 19.2 Knee hyperextension	

Table 31 When to refer, data from questionnaire 2 that mapped to gait pattern

9.5. When to refer, Gait Pattern, Questionnaire 3

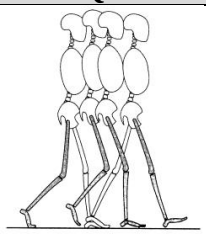
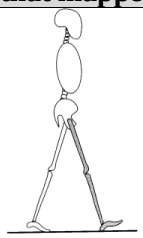
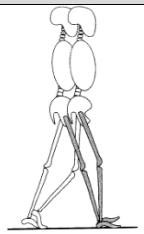
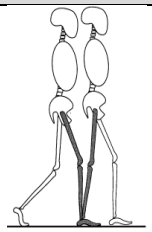
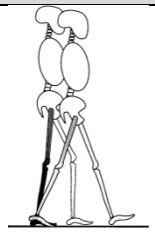
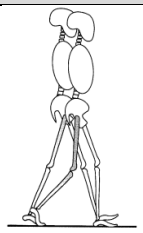
Data from Questionnaire 3 that mapped to Gait Pattern						
						
Swing: general	**Swing: 'drop foot'**	**Initial Contact**	**Loading Response**	**Mid Stance**	**Terminal Stance**	**Pre-Swing**
4.3 Increased hip flexion 4.4 Hip circumduction 10.3 Circumduction of hip due to poor dorsiflexion at ankle 12.4 Hip hitching 14.3 To facilitate better hip flexion and minimise circumduction	2.1 Foot drop 3.1 Foot drop, circumducting gait 4.1 Foot drop 5.1 Decreased ankle dorsiflexion/plantar-flexion 'foot drop' 6.1 Decreased active dorsiflexion 7.2 Foot drop 8.1 Drop foot 9.1 Foot drop/hip hitching to enable swing and floor clearance 10.1 Foot drop 12.1 Foot drop 13.1 Foot clearance 14.1 No/poor ground clearance	10.2 Inadequate heel strike/toe off 11.1 Lack heel strike	6.3 Decreased ankle joint stability 7.4 Decreased ankle stability 9.4 Decreased ankle stability 11.3 Problems with in/eversion 12.3 Ankle instability	2.2 Knee stability 7.5 Encourage forward translation of tibia in stance 9.3 Decreased hip extension in stance/hip external rotation/decreased hip stability	4.2 Knee hyperextension 5.2 Decreased control around knee, hyperextension 7.1 Decreased knee control, i.e. hyperextension 9.2 Hyperextension knee in stance 11.2 Problems controlling hyperextend knee 14.2 Knee hyperextension to facilitate full extension	

Table 32 When to refer, data from questionnaire 3 that mapped to gait pattern

9.6. When to refer, other indications, Questionnaire 1, 2 and 3

Unmapped response statements	Walking efficiency
1.2.3 Righting reactions 1.2.8 Decrease Proproception 1.2.9 Functional use 1.5.2 Resting splints (monitor need), pain, hygiene, resting, ROM 1.5.3 Braces, gait 1.5.4 Cast, prevention of complications 1.5.5 Facilitating ADLs/ gait 1.5.6 Safer walking/falls 2.1.2 Pes cavas (high arch) 2.1.3Low arch/no arch 2.1.4 Deformities 2.2.4 Skin condition 2.3.2 Excessive pronation 2.7.5 Compensations due to effort 2.9.3 Abnormal flexion of upper limb 2.12.3 Decreased toe extension 2.16.2 Skin integrity 2.16.3 Oedema 3.1.1 Good body awareness, relatively intact cognition, lower limb proprioception. Depending on the goals of the orthosis provision 3.1.2 Intact not-affected lower limb 3.1.3 A will to improve 3.1.4 Ability to swing phase in affected lower limb facilitated 3.8.2 Pronated foot 3.8.3 Flexed toes 3.12.2 Arch drop 3.14.5 To improve upper limb positioning during mobility	1.2.4 Gait pattern normalisation 1.3.4 Concept of 'walking early' to refine CPG and activity
Weight bearing during stance	**Neurophysiological factors**
1.1.1 To stabilise foot and knee in standing so that I can control the hip, if I can't hold it all myself then the patient can't control 1.2.1 Alignment (midline) 1.2.2 Muscle activity – balance 1.2.5 Balance 1.2.7 Stability 1.3.2 Requiring a lot of facilitation at ankle, hip and knee. Particularly for weight transfer 1.6.3 Weight distribution 2.2.3 Reduced weight bearing on affected side 2.8.5 Decreased lateral stability 3.1.5 Ability to weight bear through affected lower limb (facilitated) 3.4.5 Poor alternate weight bearing 3.6.4 Not normal knee, hip activity 3.7.3 Decreased hip control 3.14.4 To minimise trunk lateral flexion	1.2.6 Decrease tone 1.7.4 Unable to reach plantar-grade? Increased tone 1.6.4 Decreased ROM 1.6.5 Contractures 2.3.3 Unable to achieve plantar-grade 2.6.3 Some spasticity into plantar-flexion 2.7.4 Increased tone around the ankle 2.13.2 Increase tone leading to PF/inversion 2.14.2 High tone 2.15.4 Increased tone into plantar-flexors 2.18.2 Increased tone in calf (excessive pronation) 3.6.2 Tightness of plantar-flexors, decreased length

Table 33 Data from Questionnaire 1, 2 and 3 that mapped to Walking speed, Walking efficiency, Weight bearing during stance and Neurophysiological factors

9.7. Reluctance to refer: Views, Positive and Negative

Views, Positive and Negative	
Acute stroke survivor	**Chronic stroke survivor**
Negative views 2.7.1 Too early 2.11.1 Too early 2.12.1 Limits active recovery 2.16.1 Too early 2.17.1 Delay recovery 2.17.2 Other therapists opinion 3.1.1 I suppose patients might compensate or rely on their AFO and not work on the major problems that prevent 'good' mobility 3.3.1 foot drop 3.5.1 Still in recovery phase 3.6.1 If weakness ++ weight of orthotic 3.7.1 Optimum time for neuroplasticity (first 3/12) most change may occur in this period 3.8.2 Reliance on it long term 3.10.1 Potential to improve with physiotherapy 3.10.2 AFO may not be needed after several weeks 3.12.1 Possible contraindications 3.12.2 Possibility of improvements	Negative views 2.17.3 Poor access to service – delay in assessment and provision 3.1.1 If AFO is provided too late then period of major recovery can have past 3.8.1 'They've managed so far' patient reluctant to wear special shoes 3.13.1 Compensations
Positive views 2.8.1 Would refer but I don't work in acute, might be reluctant as will lose push off which can change biomechanics. Would refer but also work bare foot in physio 3.2.1 Not applicable 3.4.1 No 3.9.1 No reservations – Keen for assistance. Concern is delay in obtaining orthotic for community patient	Positive views 2.8.1 Would refer as before may also work barefoot in physio to give experience of heel strike and push off 2.17.1 Use regularly so not reluctant. 3.2.1 Not applicable 3.3.1 Improve gait pattern 3.4.1 No 3.9.1 No reservations – Keen for assistance

Table 34 Views, Positive and Negative

9.8. Reluctance to refer: Biomechanical and Neurophysiological factors

Biomechanical and Neurophysiological factors	
Acute stroke survivor	**Chronic stroke survivor**
Movement 2.5.1 Prevent movement 2.11.1 Prevent movement	Movement 2.5.1 Rigid, 'leads to' decreased movement for patient 2.11.1 AFOs are quite stiff
Symptoms 2.6.1 Increased spasticity 2.6.2 Increased weakness	Symptoms 2.6.1 Increased spasticity 2.14.1 Tone
Range of movement 2.6.3 Decreased range of movement at ankle	Range of movement 2.10.1 lack of range of movement to fit AFO 2.14.2 Contractures 3.7.1a AFO could provoke/cause pain especially if contractures/shortening have developed

Table 35 Biomechanical and Neurophysiological factors

9.9. Reluctance to refer: Skin integrity and other considerations

Skin integrity and other considerations	
Acute stroke survivor	**Chronic stroke survivor**
Skin 2.12.2 Sensory input 2.12.3 Risk of pressure sores 2.14.1 Pressure problems 2.15.3 Poor sensation 3.7.2 Swelling	Skin 2.12.1 Risk of pressure sores 2.13.1 Pressure 2.16.1 Poor skin condition 2.16.2 Fluctuating oedema 2.17.2 Concerns of skin care is not closely monitored 3.7.1b AFO could provoke/cause pain especially if contractures/shortening have developed
Cognition 2.15.1 Patient has cognitive problems 2.15.2 Difficult to put on 3.8.1 Difficulty fitting orthotic	Cognition 2.12.2 Able to put orthosis on 3.11.1 Difficulty putting AFO on in Department
Consent	Consent
Choice	Choice 3.11.2 Reluctance to wear them as ‘doesn’t look good’ if younger or self-conscious
Compliance 3.10.3 Non compliance	Compliance 3.10.1 Non compliance 3.12.1 Willingness of client to comply with AFO wearing

Table 36 Skin integrity and other considerations

Appendix 10, Semi-Structured Interviews: Data

Participant 1

"I've done the FES courses, I've trained with FES and I've done lots of gait courses. Nothing specific to AFOs, AFOs are part of gait training, aren't they? So nothing with a qualification to it."

"Well, foot drop would probably be a really common one. Spasticity maybe, so there would be a flaccid foot or a spastic foot which would have different sort of problems. Weakness down one side of the body, sensory loss down one side of the body. Weakness round the hip causing sort of different biomechanical problems. Upper limb problems, balance problems, then cognitive problems."

"So you would expect, starting at the bottom, you would expect people would catch their foot during the swing phase because they can't obviously flex. People that can't take their weight in stance phase so they don't want to transfer weight onto their affected leg."

"In a typical sort of hemiplegic patient, strengthening their extensors would be my main thing and sort of looking at the hip and strengthening the hip and improving their balance and their sort of proprioceptive control. Then more for mobility I would be thinking something to hold their foot, whether its FES, AFO or some sort of temporary bandage type thing, or even footwear, looking to help toe clearance in swing phase."

"It's very much putting the foot in an abnormal…well not an abnormal…a normal position but the position hasn't got the normal sensory feedback and the normal adaptability of the foot that you would want. So it's definitely a means to an end that the foot can clear the floor and put the lower leg in better alignment so that they can recruit muscle activity at the hip. So it would be a compensatory strategy. Whereas

with FES, I mean there is evidence that there's a therapeutic effect with FES. And I suppose if you used AFOs with therapy and the aim was to maintain range of movement and alignment, then it would be more of a therapeutic effect. But just giving it to a patient, I would say it would be compensation."

"I think with acute patients, who tend to be low tone … and if they're in hospital in the first few weeks, if you want to get them mobilising quickly you need to…I would say that the hip control is more of a problem than the foot. So if you can give them an AFO then, just so that you don't have to worry about the foot, and focus on the hip and then when the strength of the hip returns then you can focus more on therapy with the foot. So I would say early on. [...] With somebody that isn't mobile, to prevent contractures, you know, just strapping onto somebody who's maybe unconscious to prevent deformity. So you could use an orthosis for that. [...] And then in the early stages, to align… Alignment's the main thing, isn't it, so that the rest of the body falls into place and then to help with mobility, to help foot clearance."

"And then with more chronic patients, often they've got good strength in their leg but they trip up… So I think at all the stages you would use AFOs for different reasons."

"It depends on the hospital; it depends on the relationship between the therapist and the orthotist. If they're somebody that just comes in every Tuesday and has a clinic and you don't really know them, there'd probably be less communication. But in some places that I've worked the orthotists have worked with the physios in the department and it's been much more of a sort of a collaborative thing. But I would say with acute patients when…or with some patients you just want to one to see if it works and if you've got a whole load of small, medium and large standard ones in the cupboard you can just try it out and try it for a week and see how it goes. And if you think that it's going to be useful then that's how I would do it and I wouldn't refer them to an orthotist unless I was really sure it was going to be something useful, just for the expense really and the hassle of it."

“People have said to me that they can’t balance as well when they’ve got their AFO on because they can’t do their normal ankle balance reactions. [...] So that’s why a hinged one is sometimes better with the more able patients that are getting about and using public transport and that sort of thing. [...] I guess somebody like that would need to have a good relationship with their orthotist so they could adapt it to their need.”

“I would say ladies would be very conscious of the look of them and I’ve come across lots of lady patients that won’t wear them because they look spastic and disabled and it makes them look a bit awkward. With elderly patients, they are, I would say, are more accepting but with the younger MS patients, that’s the experience I’ve had. And I think FES is more disguisable.”

“Yeah. I guess in the early stages, quality is probably more important. But from a sort of psychological point of view it’s really important to be able to function. So you’re looking at being able to get around. I would say both are important for different reasons.... Well, quality is important to try and get the maximum potential out of them and if you’re just looking at quantity you could end up with a patient walking with a deformed foot and that becomes the normal for them and then it becomes really difficult to get out of that. So it’s really important to look at quality early on, but in a more chronic patient, you are looking at quality too because you want to try and get them as efficient as they possibly can be. So you would need…I would say a lazy therapist would just look at quantity, you need to look at both of them, definitely. And from the patient’s point of view. they’re probably more interested in quantity and you’ve got to take that into account as well. So I would say the decision you would make is different with every patient you treat, depending on what they want and what their goals are and what the potential is.”

“I think it’s a really good idea because it’s something that with some patients you do want it tight and it’s something that if you had one, you could adjust it yourself, couldn’t you, as you got better? As someone got better, you wouldn’t have to get a

new AFO, you could just adjust the one you'd got. So I think it's a really good idea. […] So if they were given an AFO in the early stages after stroke, they could keep the same AFO as they recovered so they could loosen it and loosen it and loosen it as they got better and got more flexibility. So that's where this would be special, I think, because there isn't an AFO that you can do that with. …Or if you've got MS, you could stiffen it and stiffen it the other way as you got worse. So I think in that way, a person could keep their own AFO for a long period of time so that would be the highlight of this."

"It is a bit fiddly."

"So somebody that's one handed and may be elderly, it would need to be something like that you slot in and just press and something much, much simpler than this. Otherwise they'd have to…Unless they go to their therapist to have it adjusted rather than doing it themselves."

"I would say that feels too…I would feel that that's too stiff. For the balance side of things, I would be wary of using this with somebody that was quite mobile. But that standard position I would feel is too stiff, there's no give at all there, it's really strong. But that might be good for some patients, say someone with spasticity, it would hold really firmly. So with some people I suppose that's good."

"I don't know what other people would think. I would think, as a therapist I would want a little bit of give and with patients that were more mobile I would want even more give than this because it seems to … Like with it off completely (the adjustment plates) you would think that was at its most flexible and there's still very little flexibility in it."

"I mean, I can't imagine anybody wanting something stiffer than that. It's really, really stiff."

“So that [would need] something additional, because people tend… their foot just tends to pronate with the…so it would stop that. So a little support, maybe increase the thickness on the medial side, possibly.”

“It doesn’t look that different to what’s around at the moment. It looks much the same.”

“I like the look in that there’s not much material in it and I think people would like that.”

“Black’s a bit…I don’t know, I think if it was me I would rather a white one or a cream coloured one.”

“It’s just the big, black band, I think, would put some people off I think. Perhaps a different colour, yeah. Or if that could be a bit smaller maybe, because it’s quite a thick band, isn’t it?”

“Because I don’t think it’s anything…I don’t want to be really negative but I don’t think it’s that much different to what’s around already. It looks as though it would be good and I would use it, I think I would use it. The carbon fibre ones around at the moment are like this but they’re better because in that they’re really strong and they’re the same shape so they’re quite minimal but they’re really lightweight. But if that was much cheaper, then that would be a reason for…Because that’s…I would say the shape of that is as good as the carbon fibre but it’s heavier and bulkier but if that was a lot cheaper then that would be…yeah.”

Participant 2

“I suppose the most common thing people think about is ... and then when I’m thinking orthoses ... people who’ve got ... you know, they can’t lift their foot.”

“What people would call a dropped foot and that sort of thing and that ... or really being able to control their ankle ... like when they put weight on it being able to control the position of their ankle, so they might be able to lift their foot adequately in some way or other, but then they can’t control their ankle.”

“The end result for the person ... I suppose it’s that thing that you get secondary effects in, so you end up with ... you can’t control your leg possibly, so, yes, falls risk. You can’t ... it might cause all sorts of joint problems, so then it hurts, so you don’t want to do it and then you’re not going to do it, so it’s going to get worse. I’m trying to think apart from balance, falling, pain, not doing it. Maybe not wanting to be seen walking like that, so you might not want people to ... yes, that reveals that there’s something wrong with you.”

“A lot of us we’re trying to keep people as aligned as possible, trying to get people to walk as normally as you can because that’s what you’re designed for, so it helps your joints, it helps the muscles fire off correctly - but obviously there comes a point sometimes where that isn’t possible, so you want them to be able to walk and it might be a bit messy, but if you didn’t think they’re going to get that recovery or nobody’s going to be able to give them the therapy they need to get that recovery ... because a lot of it’s that too. There isn’t therapy available to get the recovery that they might be able to get, so you go for just being able to walk.”

“So if you see an orthosis can enable that to happen that they can walk more independently so we can do more, then you’re going to want that.”

“You’ll talk to some people who are in a fabulous service and they get everything and they’ve got people who know how to get what people need and it’ll be another world and if you go to private rehab centres they ... it’s another world, or specialist ones where they see post-head injury, so younger population, you get all sorts of things like you can get everything you need and that’s where the technologies get developed in those sort of services.”

“Well you would refer, but they would come to you, so there wouldn’t be a big palaver and it wouldn’t use too much of anybody’s time ... well the orthotist, but it would be quite accessible, so that was great, made it very easy, you could be there with the patient. Very bad where you just refer and you can’t be there. That always ends badly.”

“Finding a way that they can get their shoe on and do the straps up and all of that and do the strap ... and working all of that out. Yes. And that can be a reason why you’re not sure whether they’re going to be able to use something, so you’ve got a piece of kit, it helps them, but you’re not sure they can use it because have they got the help available to get it on, if they can’t get it on themselves?”

”People don’t really want something on their foot. It’s a bit of a nuisance, but you’re selling it. You know, we’re so busy selling the things that we think might be useful, sometimes we don’t think about whether somebody would like it or not. Because they might not like it, because they don’t know what it is. [...] I mean obviously that’s where you want to have access to things in a reasonable way so that you can try things out. You say, “Just give it a go. Let’s have a look,” so that’s your biggest selling point is to see if it makes any difference.”

“If you use a good orthotic you might be able to do both. You’d be hoping for that. Yeah, well, no, definitely hoping that the quality will enable the quantity.”

“Oh I think that’s useful, yeah, absolutely. If you think they’re going to change their level of ability, yeah, if you think there’s potential there for that. It’s meant to be able to replace the therapist, so that they can do more of something because what you want to do is make yourself redundant really. You don’t want to be ... people can only do stuff when they’re with you, that’s really awful.”

“That’s inversion at the ankle – that movement there. There’s a few other things going on, but that’s principally what’s happening.”

“The best ones like this are fitted for you personally. […] It’s quite soft. I can’t really tell.”

“I mean the material’s quite nice when you touch it. From afar it just looked like metal, but actually it’s a bit nicer to touch and warmer.”

“I would think thinking about what shoes somebody’s going to be able to use was interesting as well.”

“There’s some ... older women I know it’s been very hard because their looks are everything and they will make all sorts of sacrifices in order to be ... to look alright according to their criteria and will maybe forsake all sorts of opportunities.”

“But it’s got less going on. It’s a bit less obtrusive than your regular standard ... bog standard plastic AFO, which, you know, can’t be revealed to anybody. It’s horrible. But this still looks like quite a thing.”

“It feels better than just a ... ordinary standard thing definitely. There’s more potential here than in ... it’s just can you hit that price? That’s the reason they’ve got all these horrible ones is because they’re dead cheap and they can just throw out, you know, some factory.”

Participant 3

“I’ve done some CPD courses on gait management, particularly related to functional electrical stim with individuals with spinal cord injury.”

“A poor quality gait would mean that they weren’t able to get a rhythmic gait for a start, so there would be a loss of rhythm between the two legs; they wouldn’t be able to get extension when they were taking a stride with the opposite non affected leg

and they wouldn't be able to clear their foot during the swing phase and when they heel strike. That would be most common I would think."

"Primarily, if they are up and mobile and we are teaching them gait, then the problems usually arise from raising the foot off the ground, giving a heel strike and clearing the toe on the swing phase. Then during the swing phase there is usually a problem and spasticity can interrupt any of those movements, so it rather depends on that."

"In stroke, rehab using orthosis is probably quite common. It is in other areas as well."

"Initially if they have very poor dorsiflexion, which is pulling the toe up, then you would have using an orthosis in order that they would be safe while they were walking but you would stimulate the muscles that they would need to train to do without the orthosis. But there are times when an orthosis is required where the muscle isn't going to recover that much and so you want to maintain the range of movements so an orthosis can be effectively used."

"One has to make these decisions fairly early really. Yes, it's when you're trying to get them up on their feet and walking, you make a decision then whether you need an orthosis, yes."

"The other thing – I don't know if you will get to this, but the other thing that has to be considered with injuries or with a stroke is the fact that a stroke can also impact the sensation, the skin sensation, and the skin quality and safety. So that's the other thing that we would consider when using an orthosis; if the skin was particularly frail or fragile or they did have serious sensory losses, then you would certainly go to an orthotist to make sure it was fitted well – an off the shelf one would cause more skin problems than you would be able to tolerate. […] This is nice because there's no – it isn't curving round the foot, which could cause blisters and it's well clear of the malleoli, it would just be this being safer on the skin if they've lost sensation."

“I think because they [patients] do see the purpose of them and they do help them get up and walk, it certainly contributes to their ability to be much more mobile and walk. I think they’re well accepted. I think they need to be as less intrusive as possible, so the smaller they are, the neater they are, the more acceptable they are.”

“If I’m recommending an orthosis for permanent, it’s very functional; one needs it to be functional. The problem with answering that question is that there are other factors involved in endurance, quality of walking, not just the orthosis – that only addresses the ankles so everything else is affected in strokes. So I would say that orthosis contributes to the individual being functionally able to walk as far as they want to or are able to, but there are other factors that would impact on either the quality of the walking or the length they could do, the endurance quality. ”

“FES is less likely to be used by the patient permanently; you know we would be using it more as a technique as rehab therapy, short term, to aid recovery.”

“It depends on how long term you think they’re going to use it; they’re only going to see the therapist for maybe six weeks and then possibly come back – so this is if they are going to have to use this in a permanent way, I doubt very much if they would bother; the therapist would put it at a resistance and perhaps if they saw the therapist again she might assess it and change it, but I’m not sure if the patient would be that bothered. It would be a fairly exceptional patient that got down to alter a resistance.”

“I don’t see that one being very useful, no. No, I don’t. I mean if the person has no movement in the foot, then that becomes more problematic and certainly to be safe they would need –this might be sufficient but they’d probably need to wear very secure shoes as well.”

“I think the side bar makes sense to me, it would be interesting to know biomechanically if going into the arch area makes a difference.”

“I would make this as minimalistic as possible; obviously it has to be sufficient that it’s not – because it needs to distribute the stresses on the leg, but I would make this as minimal as possible.”

“It’s light, I like that, it’s light – that’s always a factor and the lighter they can make it the better. With the new materials they’ve got, if this was slightly – if this cuff was a bit less and obviously this is a bit clunky because it’s a prototype, but the less clunky looking it can be and the lighter it is that would encourage people to suggest they use it, for sure.”

“Replacement of Velcro straps too, if they’re going to use it for any length of time […]; they get furry – this bit gets really furry and it stops sticking and then that’s dangerous, so that would be an issue as a therapist I would be keen to know if it is easy to replace that and is not too expensive.”

“Often patients find themselves just using one or two pairs of shoes with them and they’re rather clunky looking shoes you know. So I think it’s always worth trying to think whether or not we could make this so that it would be easy to use with other styles of shoes.”

“Well, you’ve got to put trousers over them, it’s that sort of real life stuff; if they’re difficult to get trousers over or they look awful if you are wearing a skirt, then people don’t like them. I mean, I wouldn’t either.”

Participant 4

“The majority of it was on the job. I did have training in gait analysis, and in gait rehabilitation in relation to stroke, but that was when I was clinical so that was a little while ago.”

“Well, it depends I suppose in what problems that they’ve got with regards to their impairments, so typically you would see somebody with very low tone muscle weakness I suppose, and have problems in the lower limb, at the hip, knee and ankle, so lack of stability around the hip on stance, lack of stability around the hip and knee on stance, and then a problem with getting through stance and then into swing phase...”

“Typically you’ll see foot drop, with low tone, and so you may get a high stepping gait, high stepping circum-stepping gait, where the patient swings their leg out to the side, because they can’t step through properly.”

“I always say if I have a stroke, God forbid, I want to walk normally, so I want to look normal. Not all patients feel like that, I think a poor quality gait is where you can see there are impairments and see that the patient isn’t able to get the right gait cycle, and isn’t able to get the components of that gait cycle. And, it could also, poor quality gait, I suppose it depends what the patient feels themselves. Often it takes a lot of effort, it’ s hard work, they use a lot of energy, so they get very fatigued with their gait as well.”

“I think in the past we tended to be much more hands on and like you’ve just said, people are tending to use more and more things now, to think okay what do we need to make this patient independent. They may not be able to achieve what you want them to achieve, so what can we use to make them more functional, to make them more independent.”

“I think, people tend to have preferred approaches. Certainly 10 years ago; people would definitely use this approach or this approach. I think now people are using much more mix and match and very much looking at what works for the patient, thinking about the patient problems and what could we do, rather than just thinking this is my approach, so I think it’s, yeah I think it’s changed over the last 10 years.”

“I think if, I think the biggest thing is if a patient has low tone, and they’re not able to use that limb, for example a wrist, and they’re to keep in better alignment, so that they don’t get, if they’re, you know they don’t get muscle shortening, and it’s helping a better alignment, so that you can perhaps get better function, certainly in those secondary complications following that.”

“You’ve got the risk of contractures, so to maintain alignment, and again thinking about reducing spasticity first with something like Botulinum Toxin or physical measures, then I would think about using orthosis, again once I reduced that tone to maintain alignment. So, maintain alignment is a big one, and also to help in functional activities, so thinking about gait, using an ankle or foot orthosis to try and maintain alignment, but also to enable the patient to get the right gait cycle, to be able to get heel strike or at least be able to get foot flat and not their toes hitting the ground first. So, thinking about then using orthosis to improve functional ability, does that make sense?”

“Yeah, yeah absolutely because if you think about lying in bed, your feet automatically drop down, yeah so your calf muscles will very soon get short. You get that, when that patient is in a position where they can stand, their heels may not be able to touch the ground because they’ve got shorter muscles, so right from day one I would be thinking about, okay we need to use something, to keep that foot at 90 degrees, what we call ‘plantigrade’ so that when they do recover, when they stand, they’ll be able to get their foot at, at least 90 degrees so that they’ll... So, right from day one, depending on the patient, obviously all patients are different, I would be thinking, what do we need, what are the problems here and some problems it might be thinking about orthosis from day one.”

“I wouldn’t use this sort of orthosis from day one; it would be a different type of orthosis. This wouldn’t be appropriate and if I’m thinking about using something at day one, it’s not to put into a function, it’s to maintain alignment while the patient is immobile. [...] This to me is something very much, somebody’s who’s up and

walking and yes, you're maintaining alignment, but you are also looking to try and improve function, try and improve movement, so this wouldn't be appropriate for yeah, that first example."

"I think most of us, certainly thinking about me in clinical practice, most of the time we would handle it ourselves, so we had a stock of ankle foot orthosis and very basic ones, and that's what we used to use. For more, for better designed and more effective ankle foot orthosis, those would depend on the patient, and if they were going to make a very good recovery, then I would refer on to an orthotist."

"If they're hypersensitive, whether they have pain, whether they've got poor skin condition... whether they have a lot of increased tone because sometimes certainly the kind of splint will make that worse, so it really depends on the patient as to when and if you would use one."

"I think I would focus on quality first; I think probably quantity comes after that. I think for patients often it is quantity that they're interested in. I think it comes from all different types of people. I think the younger patients are much more aware of what they look like and their quality and they want to get back to how they were before, and they're much more considered about the quality of movement. I think, older patients perhaps aren't, and they just want to be able to function, they want to be independent and it doesn't necessarily matter."

"No, I mean the carbon fibre ones that are available, I'm not aware that they are adjustable, yeah."

"Personally, I think that would be for, for a medical, a therapist to say, let's adjust this, you're progressing well; however, I can think of patients who wear ankle foot orthosis that will be perfectly capable of changing, thinking having a go and they know what they feel like, so I'm a little bit protective of my role if you like, and patients and don't always give them responsibility that I should, but I can think of some certainly that would be able to do that themselves."

“I think, the detrimental effects would be that they, if the difference was significant, that effectively they (the patient) may make the device ineffective, if they’re changing around with the settings.”

“That is quite rigid. Yeah... I mean that is very rigid, there’s not much give in there. [...] (when asked if it should be more flexible)Yes, to allow, yes I think to allow a little bit of movement, but I think if you’re making this as rigid as it is, I’m not quite sure what the additional resistance will do, because for me it feels fairly rigid as it is.”

“I mean, I can see if you had somebody who had an issue with tone, you put them into something like this (the cuff), and often their foot will still turn... so this probably wouldn't be appropriate for them, but if you had something like this that could bring them more in alignment and give them a better stretch, that might be a possibility. I quite like the idea of this actually.”

“I know that some of the new carbon fibre and I know this is a prototype, I accept that, but it does feel quite heavy. It’s prototype, they’re quite rough edges and all of that. I think that it looks a lot less cumbersome than some of the older plainer type of orthosis, but yeah... I suppose once you start putting these on, you know does it get heavier, so I think the lighter it is, the better for patients.”

“I think that there is a lot more choice out there but a lot of that choice is costly, with what’s going on in the NHS at the moment, ‘we can’t give you that, because it’s too expensive, you can have this one’ , but often the cheaper one isn’t the best.

Participant 5

“No, I don’t have any formal qualifications in any of that.”

“The most difficult pattern is people can’t dorsiflex their ankle or can’t flex their knee, so on the swing phase of their gait they’re struggling to get their foot through. [...] You know, the exact nature of that is difficult to say, but it would vary from patient to patient. I would say that’s probably the most typical characteristic.”

“Well they’ll swing their leg out to the side to swing their foot through. If they don’t have an AFO they’ll swing their foot out to the side, or they don’t have an FES machine to help them dorsiflex their ankle. [...] They swing their leg out to the side to get their foot through and that’s probably the most typical.”

“The way you would decide what you were doing with them would be to assess them and say, ‘OK, well this particular patient ... which joints move? Which don’t move? Why don’t they move? Where are they weak? Where are they not? Where are they stiff? Where are they not? Where can’t they control, you know, this synergy of their whole limb so it moves in ... I suppose an efficient way?’”

“So the acute setting people are more focused rightly on modifying people’s impairments and so people are sometimes reluctant to put an AFO on people because they say by putting an AFO on somebody then it’s stopping them having the opportunity to actually dorsiflex their ankle actively, so people are against that, so there’s whole tribes of physios who are against it ... so the argument for putting an AFO on is you can get up, you’re not going to trip, you can walk if you walk with the nurses, you’re not going to lose range at your ankle because the AFO will hold it and you can keep all the other muscles strong, apart from the ones around the ankle by walking around more quickly. But the tribe who are against it say that what you want to do is not wear that, the main problem is developing abnormal movement patterns, the main problem is developing spasticity through kind of abnormal movement pattern, so we don’t want to get them up walking earlier, we want to let them sit down, work on this, when this starts to come back then we’ll start to get them up walking. [...] Myself, I would give someone an AFO because I believe the benefits of wearing one and getting up and moving quickly outweigh the ... you

know, any sort of negative ... but that would vary from place to place. There's little consensus on it."

"The provision of orthotics is very patchy and so it's very common for people to come with one that's not adequate, it doesn't really control their foot position properly, so we'd have to provide them with a better one."

"If you're just giving off the shelf AFOs, well you can just get a load of leaf spring AFOs from a supplier, have them in your cupboard and just give them out, but if you're giving someone a bespoke AFO then you have to have someone who's skilled to do it and so we ... on the ward where I am then we have an orthotist who comes once a week who can plaster someone's leg, make a mould, take it away, OK, it's not quite right, fiddle with it, modify it and ... do you know what I mean? And it's right. And you can do it there because we have the provision, but not everywhere would have that. [...] Some places don't even have access to an orthotist at all and they're not being provided with anything that's sensible."

"Most people don't like using them. They find them uncomfortable, don't like them, or heavy, they're hard to get on."

"People who need to have the thick one to control their ankle don't like it because they find it hard to get a shoe that'll fit round it. You have to modify the shoe, take the insole out or get different sizes, that kind of stuff, so they don't like ... and particularly women don't like them because they can't wear fashionable shoes with them."

"What I'd be going for is efficiency, where efficiency is speed with as few errors as possible; that's what I'd be going for and so if you've had a significant injury, you're never going to walk normally, it's just not ... it's never going to happen and virtually nobody's ... you know, with significant injury, virtually nobody gets anywhere near walking normally, so I suppose for me I'm going for speed and distance because it

helps people actually do something." [Participant, who sees patients at the more chronic stage]

"I think it's nice to control the stiffness in terms of controlling the knee, so that's a nice touch. […] there's a lot of off the shelf ones you can get. The only ones we've provided off the shelf are the leaf spring ones which are very thin and as I say they're OK if your ankle's floppy, but if it's not it's not. But I could see this confers some advantage over the ones that we provide. "

"I like that. Yeah, that's good. Yeah, I think it's a neat idea being able to adjust it."

"It'll be nicer if you could control the angle a bit more."

"This seems pretty stiff. No. I can hardly bend it. I mean if it was thin I suppose you could ... you know, then thicken it up, but I don't see that as a big issue myself."

"Our patients who need a rigid one like this ... are not only doing this, they're turning in and this is not going to control it. That's a big problem with that. It wouldn't control it because their forefoot's going to be turning over here past that." [Participant, visually demonstrating sideways movement at the ankle which he felt would not be supported]

"It would [fix the issue of lateral inversion]. I suppose it would, but then if you were needing that you'd just go and get a bespoke plastic one. It's the same. It seems like a faff. It seems like a bit of a faff just to doing ... using two things to do the job that one thing would do. But maybe ... I tell you where you could ... you might use this is as a kind of earlier on when people are changing. Do you know what I mean? When they're just in hospital and they're changing quite a lot you've got this kit and you can set them up with a kit until they get to the point where they're reasonably stable and you can provide them with something permanent."

"It's nice because it's not enclosing the foot and it's ... so it's nice and cool, people don't like the ones we give because they enclose the foot, so that's nice."

“I don’t think the plastic ones are that heavy. I mean it may be this is lighter, I don’t know. I find it hard to judge, but, you know, lighter the better.”

(about general orthoses) “It looks unsightly if you’re going out and in the summer and you don’t want to have it on show, so that’s a big issue.”

“A lot more patients would get this in their own shoe. They’re hard to get in – the other ones.”

“I suppose my impression is it depends how much it costs. ”

Participant 6

“Not formal qualifications. Various in-service training sessions and actually, external courses but none that have given me any qualifications, not like a certificated thing. [...] It comes into part of lots of courses that I’ve been on really.”

“The hugely typical problem, I know kind of straight away, homing in on the foot and ankle, but, typically, it would be a lack of dorsiflexion during the swing phase of gait and a lack of plantarflexion as well during push off, which is a part of stance phase of gait. So, they would be really typical problems.”

“We call that circumduction, they swing the hip out to the side. They might hip hitch, so just pull their leg up, or they might just drag their toe. They’re the main things specifically related to the lack of dorsiflexion, I’d say.”

“So that would be if there was a weakness that was leading to them, like I said before, having to compensate or alter their gait pattern or making them unsafe, then, of course, we consider an orthosis, as long as the disadvantages didn’t outweigh the advantages.”

"Communication is good. They let us know who they're reviewing. They've set aside a bit of time at a specific time of the week which happens to be a Monday, where they'll see stroke patients, they put all the stroke patients in and call it the stroke clinic. And every week they email us to let us know who is coming at what time. So, if any of us therapists want to go along and join the session we can and then we can discuss it between us. […] Sometimes anything more than a few days is too long in stroke rehabilitation. If you need something, you need it very quickly but it's been taking them a number of weeks, and sometimes we've missed the opportunity for decent rehab in that time and some people … or at least we haven't been able to maximise their potential. So I would say if we needed an ankle orthosis or any orthosis for a patient, I wouldn't ever really want to wait anything more than two weeks. But, we currently wait a lot longer than that."

"Sometimes, say for example with an ankle orthosis, it does actually, to an extent, restrict their movement. So, if the benefits that that's providing outweigh the disadvantages, then go for it. But, orthosis can alter the gait pattern in themselves. If you or I put an orthosis on, certainly one of the rigid ones, our gait would be altered for the worse, whereas with somebody who had quite a bad weakness in their dorsiflexor muscle group put it on, then it would probably be altered for the better rather than worse. It's simply a case of weighing that up."

"We often have to explain to them exactly why and what the benefits are. Often..., it's so obvious that they need it, but they often won't try to go without it, but they do express that they wish they didn't have to have it and they ask when will they not need to have it any more, that sort of thing. But some where the difference that it makes them is a bit more subtle, we might need to educate them a bit more. But, generally, they do comply generally."

"I would say quality and quantity, you can't really separate them. If you've got somebody with a better walking pattern, and more efficient walking, then they'd

generally be able to walk further for longer. So I'd say they'd come together quite closely, yeah, they go hand in hand."

"Them doing it themselves… they'd be pleased that they don't have to go out."

"Not a hundred percent sure, just thinking about it straight away, that they would necessarily be able to adjust it and judge that they need to adjust it. But we could, as physios. […] I can't imagine that if we got a patient to the point where they were still using it but they were still improving, usually we'd still be involved. But if they'd got to the point where they were still improving and we weren't involved, then I guess they could adjust it themselves. I'm not quite sure whether they'd be able to necessarily judge that and that kind of recovery, where you would actually change the AFO is quite significant recovery. And I think most of the time we wouldn't leave them on their own to carry that recovery on. If they're still making that significant change, we'd probably still be working with them."

"Okay, so that's really rigid at the moment, isn't it? I can't move it at all. [..] it doesn't seem very flexible, it seems really rigid. So, I don't think they'd be getting any more movement from that than a normal plastic rigid AFO. I could be wrong, maybe it's because I'm not weight-bearing fully on it but it feels really rigid. So, then I don't quite know the point of what the extra bars would be to make it even more rigid. [...] I would think that that would be the most rigid setting and then it would be much less rigid. So, as they weight-bear, they would be able to achieve more dorsiflexion and plantarflexion, it would be available to them, wouldn't it? But it would still give them a little bit support where they couldn't quite achieve that."

"We have focussed much more on talking about plantarflexion and dorsiflexion but the ankle can be unstable medially and laterally as well, after stroke. The shape of this one looks like another one that we do use that is appropriate for medial and lateral instability but it might not give enough in some patients if they were very unstable. [...] But, when I think about the other rigid AFOs where they have to put outside

edges on to stop medial lateral instability, that has a big impact on what shoes they can fit in because it widens it around here and that, perhaps, wouldn't do that."

"It'd probably be easier to get on and off as well if it was separate. And, it would mean that if they could manage without it in certain shoes or for a particular occasion and they could do without it, they weren't going to be walking around too much or something like that."

"Yeah, that's quite an interesting idea if it worked with the instability, if it wasn't too soft, but I think it perhaps wouldn't be. But the only thing is if you did need it too rigid, then it could become a not very nice thing to wear because there's quite a lot to it, it's sort of like a sock, isn't it? And, if it was much more rigid than that, I don't think it would be very comfortable and I don't think people would like wearing it. And it might get sweaty as well, that's the other thing, isn't it? But, yeah, that might work. I've not really seen anything like that at all that I can think of. I think it probably would work."

"This is quite big, so they won't like that. But, I mean, if there's a reason why … it's not terrible but it is definitely bigger. The plastic AFOs just have, it's much smaller, a bit like that, a tiny little strap just round the front and none of that bit at the front."

"Yeah, and the rest of it is much better because there's not an awful lot visible, is there? So, compared to some of them, there's not as much visible outside the shoe. I think it looks pretty good apart from that." [P6