Effect of listening to Nellie the Elephant during CPR training on performance of chest compressions by lay people: randomised crossover trial

Rawlins, L. , Woollard, M. , Williams, J. and Hallam, P.

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RESEARCH

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Effect of listening to *Nellie the Elephant* during CPR training on performance of chest compressions by lay people: randomised crossover trial

L Rawlins, medical student,[1] M Woollard, professor in prehospital and emergency care,[2] J Williams, principal lecturer,[3] P Hallam, research paramedic[4]

[1]Birmingham University School of Medicine, Edgbaston, Birmingham B15 2TT

[2]Pre-hospital, Emergency and Cardiovascular Care Applied Research Group, Coventry University, Coventry CV1 5FB

[3]School of Health and Emergency Professions, University of Hertfordshire, Hatfield AL10 9AB

[4]West Midlands Ambulance Service NHS Trust, Waterfront Business Park, Brierley Hill, West Midlands DY5 1LX

Correspondence to: M Woollard
Malcolm.woollard@coventry.ac.uk

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ABSTRACT

Objectives To determine whether listening to music during cardiopulmonary resuscitation (CPR) training increases the proportion of lay people delivering chest compressions of 100 per minute.

Design Prospective randomised crossover trial.

Setting Large UK university.

Participants 130 volunteers (81 men) recruited on an opportunistic basis. Exclusion criteria included age under 18, trained health professionals, and cardiopulmonary resuscitation (CPR) training within the past three months.

Interventions Volunteers performed three sequences of one minute of continuous chest compressions on a skill meter resuscitation manikin accompanied by no music, repeated choruses of *Nellie the Elephant* (Nellie), and *That's the Way (I like it)* (TTW) according to a pre-randomised order.

Main outcome measures Rate of chest compressions delivered (primary outcome), depth of compressions, proportion of incorrect compressions, and type of error.

Results Median (interquartile range) compression rates were 110 (93-119) with no music, 105 (98-107) with Nellie, and 109 (103-110) with TTW. There were significant differences within groups between Nellie *v* no music and Nellie *v* TTW (P<0.001) but not no music *v* TTW (P=0.055). A compression rate of between 95 and 105 was achieved with no music, Nellie, and TTW for 15/130 (12%), 42/130 (32%), and 12/130 (9%) attempts, respectively. Differences in proportions were significant for Nellie *v* no music and Nellie *v* TTW (P<0.001) but not for no music *v* TTW (P=0.55). Relative risk for a compression rate between 95 and 105 was 2.8 (95% confidence interval 1.66 to 4.80) for Nellie *v* no music, 0.8 (0.40 to 1.62) for TTW *v* no music, and 3.5 (1.97 to 6.33) for Nellie *v* TTW. The number needed to treat for listening to Nellie *v* no music was 5 (4 to 10)—that is, the number of cardiac arrests required during which lay responders listen to Nellie to facilitate one patient receiving compressions at the correct rate (*v* no music) would be between four and 10. A greater proportion of compressions were too shallow when participants listened to Nellie *v* no music (56% *v* 47%, P=0.022).

Conclusions Listening to *Nellie the Elephant* significantly increased the proportion of lay people delivering compression rates at close to 100 per minute. Unfortunately it also increased the proportion of compressions delivered at an inadequate depth. As current resuscitation guidelines give equal emphasis to correct rate and depth, listening to *Nellie the Elephant* as a learning aid during CPR training should be discontinued. Further research is required to identify music that, when played during CPR training, increases the proportion of lay responders providing chest compressions at both the correct rate and depth.

INTRODUCTION

The incidence of out of hospital cardiac arrest in the United Kingdom is 123 per 100 000 per year.[1] Cardiopulmonary resuscitation (CPR) is an important life saving technique that can be effectively taught to most people.[2] Starting CPR as soon as possible after an out of hospital cardiac arrest significantly increases survival rates.[3] When initiated by a bystander one to two minutes before emergency services arrive it has been shown to double survival rates from 21% to 43%.[4] It is important that CPR skills are taught well so that bystanders feel confident enough to use their skills. Several studies have examined methods of improving response rates in bystanders.[5] Resuscitation Council (UK) guidelines for adult basic life support recommend a compression rate of 100 per minute, with a repeating sequence of 30 compressions followed by two rescue breaths, and emphasise the importance of simplifying guidelines to aid acquisition and retention of life support skills, particularly for lay people.[6 7] It is important to maintain chest compression rates and reduce interruptions to compressions as failure to do so is associated with a reduced chance of survival.[8] Previous studies have found that after an initial training course CPR skills decline as early as two weeks later.[9 10] As few as 40% of learners are able to perform

effective compressions and ventilations on retesting.[9] Other studies have reported better results, including the public access defibrillation trial, in which 80% of lay responders remained competent in CPR skills for up to a year.[11] Measures to simplify the CPR sequence and training can improve skill retention,[12] including reducing the number of interventions from eight to four steps.[13]

Estimating a rate of 100 beats per minute (bpm) can be difficult. A pilot study involving listening to the song *Stayin' Alive* by the Bee Gees while performing CPR has suggested this helps health professionals maintain a compression rate of around 100 bpm.[14] Traditionally in the UK mentally "singing" the children's nursery tune *Nellie the Elephant* by Ralph Butler and Peter Hart has been suggested during CPR training to help learners maintain a rate of 100 compressions a minute because of its appropriate rhythm and tempo. Singing the chorus of the song twice, with one chest compression delivered on each beat of the tune, gives exactly 30 compressions as required in current international CPR guidelines. We carried out a randomised crossover trial to test whether listening to *Nellie the Elephant* during training really does help lay people to improve their performance of chest compressions during CPR compared with no music or a second tune with a similarly appropriate tempo.

METHODS

Hypothesis and objectives

Our hypothesis was that listening to the songs *Nellie the Elephant* or *That's the Way (I like it)* during CPR training would increase the likelihood of lay people performing chest compressions at the recommended rate, compared with the absence of music.

We determined the differences between interventions in average compression rates, the proportion of participants performing compressions at the correct rate, the proportion of correct compressions and the causes of errors, correlations between the rate of compressions and the proportion delivered at the correct depth, and relative risk and numbers needed to treat for correct compression rate.

Setting and participants

We invited staff or students aged over 18 at Coventry University to participate. We excluded healthcare students or professionals or those who had received CPR training within the previous three months. Participants were recruited on an opportunistic basis from individuals present around the university grounds in non-health related faculties.

Design

This community based prospective randomised crossover trial assessed performance of manikin based chest compression. All participants were given a brief demonstration on the use of a resuscitation manikin (Laerdal Recording Anne Manikin, Laerdal UK) and had one minute to practise while listening to a metronome, with feedback given on hand position, depth, and rate from an attached skill meter and verbally by the researcher.

Participants were then asked to perform three sequences of one minute of continuous chest compressions (ventilations were omitted for simplicity and in anticipation of potential changes in resuscitation guideline[15]) on the manikin, with a rest interval of one minute between each sequence. The three sequences were carried out without musical accompaniment, with repeated choruses of *Nellie the Elephant* (Nellie) by Little Bear (Little Acorns, Summerisle, 2001), or with *That's the Way (I like it)* (TTW) by KC and the Sunshine Band (*The Best of KC and The Sunshine Band*, E MI Records, 1990) via headphones in accordance with a pre-randomised order generated by the chief investigator using an Excel spreadsheet. This was concealed until recruitment started. The nature of the study meant it was impossible to blind participants and investigators.

Both songs were analysed with MixMeister BPM Analyser (MixMeister Technology LLC, Fort Lauderdale, Florida, USA) to verify the tempo of the songs (105 bpm for Nellie and 109 bpm for TTW) and were edited with WavePad Sound Editor (NCH Software, Greenwood Village, Colorado, USA) so that relevant portions were repeated for an appropriate interval.

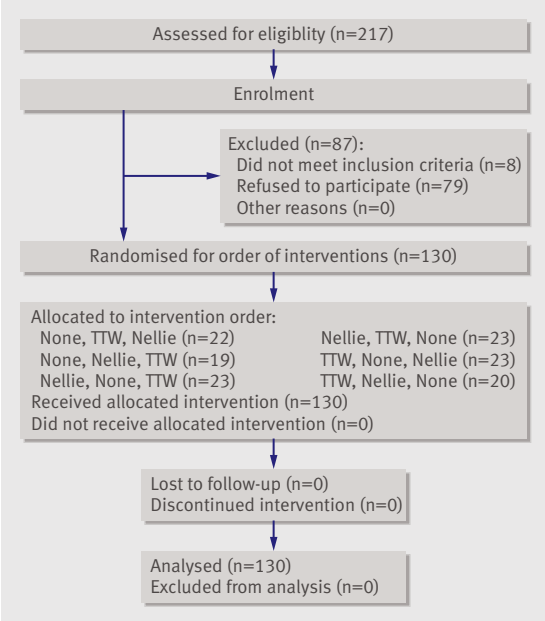
Outcome measures

Our primary outcome measure was the paired differences in average compression rates between interventions. Secondary outcome measures comprised paired difference between interventions in proportions of correct compressions, compressions too shallow, compressions too deep, compressions with incomplete hand release, compressions with incorrect hand position, compressions at the correct depth, participants delivering compression rates within the range 95-105 per minute, correlation between the rate of compressions and the proportion delivered at the correct depth, relative risk for compression rate of 95-105, and numbers needed to treat to achieve a compression rate of 95-100.

We collected demographic data on age, sex, occupation, and previous CPR training using an anonymised data collection sheet. Immediately after each one minute sequence researchers obtained quantitative data on chest compression performance from the manikin skill meter.

Sample size and statistical methods

Based on previous research that reported a standard deviation of 20.93 for a paired difference in mean compression rates,[16] we estimated that we needed 140 participants to detect a mean paired difference between any two interventions of five compressions per minute with a power of 0.80 and an α of 0.05. We used SPSS software (version 16.0.2, SPSS, Chicago, IL, USA) to calculate descriptive statistics and P values using Wilcoxon's rank sum test to compare differences in compression variables. We used StatsDirect software (version 2.7.2, StatsDirect, Altrincham, UK) to



Flow of participants through study

calculate P values and 95% confidence intervals for comparisons of the respective proportions of participants delivering compression rates within the range 95-105 per minute, Pearson's correlation coefficient for the rate of compressions in relation to the proportion delivered at the correct depth for each intervention, and relative risks and numbers needed to treat.

RESULTS

The figure shows the participant flow through the study. Of the 130 participants, 81 (62%) were men. The median age was 21 (interquartile range 20-25, range 18-72), and 94 (72%) had had no previous CPR training. Recruitment took place from 18 May to 5 June 2009.

All analysis was by intention to treat. Data on the quality of chest compressions and the causes of errors were missing for one participant in the *Nellie* intervention because of a technical problem with the skill meter device. Table 1 compares the performance of compression rate and depth with each intervention.

Differences between interventions in median compression rates were significant for Nellie *v* no music and Nellie *v* TTW (both P<0.001) but not for no music *v* TTW (P=0.055). Differences in the proportions of people delivering compressions at a rate of 95-105 were significant for Nellie *v* no music and Nellie *v* TTW (both P<0.001) but not for no music *v* TTW (P=0.55). Relative risk for a delivered compression rate of 95-105 was 2.8 (95% confidence interval 1.66 to 4.80) for Nellie *v* no music, 0.8 (0.40 to 1.62) for TTW *v* no music, and 3.5 (1.97 to 6.33) for Nellie *v* TTW. The number needed to treat for listening to Nellie *v* no music was 5 (4 to 10)—that is, the number of cardiac arrests required during which lay responders listen to Nellie to facilitate one patient receiving compressions at the correct rate (*v* no music) might be as many as 10 or as few as four.

There were no significant differences between interventions in the proportion of compressions given at the correct depth (no music *v* Nellie P=0.084; no music *v* TTW P=0.095; Nellie *v* TTW P=0.378). There was, however, a small but significant negative correlation between the rate of compressions and the proportion delivered at the correct depth for no music (Pearson's correlation coefficient −0.19, −0.35 to −0.02, P=0.03) and TTW (−0.18, −0.34 to −0.004, P=0.05), although this was not significant for Nellie (0.07, −0.11 to 0.24, P=0.44). These findings indicate that, with no music and TTW, as the compression rate increases the proportion of compressions delivered at the correct depth reduces.

Table 2 shows the proportion of compressions given correctly or incorrectly according to a number of factors for no music *v* Nellie, no music *v* TTW, and Nellie *v* TTW.

Table 2 shows that there were no significant differences between interventions for the proportion of chest compressions given correctly, the proportion given too deeply, or the proportion given with an incorrect hand position. There was a significantly greater proportion of compressions given to an inadequate depth when participants listened to Nellie compared with no music, but this difference was not significant for no music *v* TTW or Nellie *v* TTW. The proportion of compressions with incomplete hand release was significantly greater for both tunes compared with no music but not when both tunes were compared.

Inadequate depth of compressions was the most common form of error. In all interventions delivery of chest compressions at too great a depth, with incomplete hand release, or with incorrect hand position was infrequent. For all interventions the proportion of chest compressions given correctly was less than 25%.

DISCUSSION

Principal findings

There was a significant increase in the proportion of participants providing an appropriate compression rate while listening to *Nellie the Elephant* compared with no music or *That's the Way (I like it)* (TTW).

Table 1 | Comparison between interventions in performance of compression rate and depth

	No music	Nellie the Elephant	That's the Way (I like it)
Median compression rate (IQR, range)	110 (93-119, 43-146)	105 (98-107, 48-162)	109 (103-110, 53-157)
Proportion of subjects delivering compression rate 95-105/min (%, 95% CI)	15/130 (12%, 7% to 18%)	42/130 (32%, 24% to 41%)	12/130 (9%, 5% to 16%)
Median for proportion of compressions delivered at correct depth (IQR, range)	24% (0-62, 0-99)	14% (0-59, 0-97)	11% (0-65, 0-98)

Table 2 | Comparison between interventions in proportion of compressions given correctly or incorrectly. Figures are median percentages (interquartile range, range)

Compressions	No music (n=130)	*Nellie the Elephant* (n=129*)	*That's the Way (I like it* (n=130)	P value for difference: No music *v* Nellie	No music *v* TTW	Nellie *v* TTW
Correct	22 (0-61, 0-99)	14 (0-56, 0-97)	9 (0-53, 0-98)	0.07	0.07	0.41
Too shallow	47 (3-88, 0-100)	56 (6-97, 0-100)	57 (10-94, 0-100)	0.02	0.05	0.90
Too deep	0 (0-4, 0-98)	0 (0-3, 0-96)	0 (0-4, 0-98)	0.52	0.41	0.19
Incomplete hand release	0 (0-0, 0-60)	0 (0-0, 0-95)	0 (0-0, 0-87)	0.03	0.02	0.95
Incorrect hand position	0 (0-0, 0-76)	0 (0-1, 0-64)	0 (0-1, 0-89)	0.86	0.48	0.63

*Data missing for one participant.

Listening to TTW, however, showed no significant difference in the proportion achieving correct compression rates compared with no music. Disappointingly, for all three interventions the proportion of chest compressions given correctly was less than a quarter, with no significant difference between each. When participants listened to Nellie there was a significantly greater proportion of compressions delivered at an inadequate depth compared with no music or TTW. Although this did not seem to be correlated with compression rate for Nellie, there was a small but significant negative correlation for no music and TTW.

Strengths and weaknesses

The randomised crossover design of the study ensured that any differences between interventions were not due to the effects of the sequence in which they were performed or differences in the skills, amount of practice, or fatigue of participants. There were no losses to follow-up as the interventions were performed consecutively over 10 minutes. Opportunistic sampling could have led to responder bias. Those with previous knowledge of CPR might be more likely to participate, as might individuals with outgoing personalities. Selection bias could have occurred as recruitment was solely from university premises and the educational attainment and median age of participants of 21 years might not be representative of the population most likely to be required to perform CPR. We might also have unconsciously approached people we perceived as more likely to take part. The study was carried out in public areas, which might have deterred potential volunteers and resulted in distractions for participants, although the use of headphones should have reduced this.

Strengths and weaknesses in relation to other studies

A non-randomised observational pilot study previously investigated the effect of listening to *Stayin' Alive* by the Bee Gees on compression rates performed by healthcare professionals but had only 15 participants and has been published only as an abstract.[14] Our trial was on a larger scale, with 130 participants and a more robust randomised crossover design to limit the effects of bias and to provide comparators in the form of a control group (no music) and two tunes. Both studies reported a positive impact on the delivery of compressions at the correct rate when listening to music. The *Stayin' Alive* study reassessed participants' performance after five weeks with no music to test whether mental recall of the song improved skill retention. We did not evaluate this.

Previous research has reported poor performance of chest compressions. Before a basic life support course following the 2005 guidelines from the Resuscitation Council (UK) healthcare professionals (all with previous CPR training) delivered a median compression rate of 127 (interquartile range 93-133) and only one out of 32 participants delivered a rate of 95-105. After training, the median compression rate rose to 147 (135-161, P<0.001) but only one participant consistently compressed at an acceptable rate.[15] This suggests that, in this population, traditional instructor led training decreased the likelihood of participants compressing at the correct rate, whereas in the current trial listening to Nellie had some positive effect. A study that compared the proportion of participants providing the correct compression rate in a control group receiving traditional instructor led training with those trained with a manikin with voice prompts found that 9/30 (30%) and 13/33 (40%) performed compressions at rates in the range 90-110 a minute.[17] Although this shows similar benefits to listening to Nellie, the sample size was small and included student nurses, who might have had a greater degree of proficiency in CPR before the study. Furthermore, the acceptable range for the compression rate was wider than in our trial, and this might have increased the number of people meeting the required target. In a randomised controlled trial of CPR performance by untrained lay responders who received instructions from an ambulance dispatcher for compression only compared with standard CPR, 6/29 (21%) and 4/30 (13%) (P=0.343), respectively, gave compressions in the range 90-110.[18] Compressions were given too rapidly by 18/29 (62%) and 22/30 (73%) (P=0.291), implying that ambulance dispatchers might have been inadvertently coaching responders to compress at an inappropriately rapid rate. In our trial, the medians for compression rate were relatively close to 100, even with no music, despite the acceptable compression rate being set within narrower limits. Compression depth was inadequate in the dispatcher study in 21/29 (72%) and 24/30 (80%) (P=0.392), respectively, and the depth of compression was too shallow in a similarly high proportion of events in our trial. An observational study

WHAT IS ALREADY KNOWN ON THIS TOPIC

Mentally "singing" the song *Nellie the Elephant* is sometimes recommended during CPR training in the UK because of its appropriate tempo to help individuals keep a rate of 100 compressions per minute

WHAT THIS STUDY ADDS

Listening to *Nellie the Elephant* significantly increased the proportion of lay people achieving compression rates 95-105 a minute compared with no music

Unfortunately it also increased the proportion of compressions delivered at an inadequate depth

As current resuscitation guidelines give equal emphasis to correct compression rate and depth the use of *Nellie the Elephant* as a learning aid during CPR training cannot be recommended

evaluating CPR performance after training in lay volunteers in the Department of Health (England) National Defibrillator Programme found that the proportion of participants giving compressions at a rate in the range 90-110 increased from a baseline of 10/118 (9%) before the course to 24/112 (21%) after training (difference 13%, 3% to 23%, P=0.006).[19] When compared with participants who were tested immediately after the four hour class evaluated in that study, the proportion of our participants who listened to Nellie and compressed at the "correct" rate in the narrower range of 95-105 per minute was higher at 32%.

Meaning of study

The significant increase in the proportion of participants achieving compression rates of 95-105 per minute when listening to Nellie might be because of the simplicity and familiarity of the song, which has an easy beat to follow. Even though TTW has a similar tempo to Nellie, it resulted in no significant difference in the achievement of correct compression rates compared with no music. This might be because this song has a different style with more complex lyrics and percussion, which could make its beat harder to follow. The significantly greater proportion of compressions delivered at an inadequate depth when people listened to Nellie could be because of distraction from the task by the music, as several participants seemed amused by the song. The tune might also be a poor motivator for force and depth of compression, as it is a children's song. Although it could be theorised that increasing the rate of compressions might result in a decrease in the proportion delivered with adequate force and depth (because of increased fatigue), we found no significant correlation between these factors for Nellie, although this correlation was slightly negative for no music and TTW.

Implications for clinicians and policy makers

As current resuscitation guidelines give equal emphasis to the importance of performing chest compressions at both the correct rate and depth, we regretfully recommend that playing or imagining hearing *Nellie the Elephant* during CPR training should be discontinued. Our results also indicate that listening to *That's the Way (I like it)* is not a suitable alternative.

Unanswered questions and future research

Listening to Nellie resulted in only a third of participants delivering compressions at an acceptable rate, and the proportion of compressions that were too shallow exceeded 50%. Research is therefore urgently required to identify other tunes that could be played during CPR training to improve the proportion of participants giving compressions at the correct rate and to determine if songs with a greater musical emphasis on each beat could provide motivation to deliver more compressions at a greater (correct) depth. Potential tunes include *Another One Bites the Dust* (Queen, EMI Music Publishing), *Under Pressure* (Queen and David Bowie, EMI Music Publishing), *Quit Playing Games (With my Heart)* (Backstreet Boys, Universal Music Publishing Group), and *Achy Breaky Heart* (Billy Ray Cyrus, Mercury Records). Additional research in a more diverse population is warranted and could examine whether playing appropriate music during CPR training results in improvements in chest compression performance by health professionals.

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Contributors: MW had the idea for the study, supervised its design and conduct, analysed the quantitative data, edited and approved the submitted manuscript, and is guarantor. LR wrote the first draft of the study protocol, collected all data, wrote the first draft of the paper, and approved the submitted manuscript. JW contributed to the design of the study, edited the study protocol, and edited and approved the submitted manuscript. PH contributed to the design of the study and data collection and edited and approved the submitted manuscript.

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Ethical approval: The study was approved by Coventry University. All participants gave informed written consent before taking part.

Data sharing: Technical appendix, statistical code, and dataset available from the corresponding author at Malcolm.woollard@coventry.ac.uk.

1 Norris RM, UK Heart Attack Study (UKHAS) Collaborative Group. Circumstances of out of hospital cardiac arrest in patients with ischaemic heart disease. *Heart* 2005;91:1537-40.
2 Cummins RO, Eisenberg MS. Prehospital cardiopulmonary resuscitation. Is it effective? *JAMA* 1985;253:2408-12.
3 Larsen MP, Eisenberg MS, Cummins RO, Hallstrom AP. Predicting survival from out-of-hospital cardiac arrest: a graphic model. *Ann Intern Med* 1993;22:1652-8.
4 Thompson RG, Hallstrom AP, Cobbs LA. Bystander-initiated cardiopulmonary resuscitation in the management of ventricular fibrillation. *Ann Intern Med* 1979;30:737-40.
5 Vaillancourt C, Stiell IG, Wells GA. Understanding and improving low bystander CPR rates: a systematic review of the literature. *CJEM* 2008;10:51-65.
6 Resuscitation Council (UK). Adult basic life support guidelines. 2005. www.resus.org.uk/pages/bls.pdf.
7 International Liaison Committee on Resuscitation. International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. Part 2: Adult basic life support. *Resuscitation* 2005;67:187-201.
8 Eftestol T, Sunde K, Steen PA. Effects of interrupting precordial compressions on the calculated probability of defibrillation success during out-of-hospital cardiac arrest. *Circulation* 2002;105:2270-3.
9 Wilson E, Brooks W, Tweed W. CPR skills retention of lay basic rescuers. *Ann Emerg Med* 1983;12:482-4.

10 Berden HJ, Bierens JJ, Willems FF, Hendrick JM, Pijls NH, Knape JT. Resuscitation skills of lay public after recent training. *Ann Emerg Med* 1994;23:1003-8.
11 Christenson J, Nafziger S, Compton S, Vijayaraghavan K, Slater B, Ledingham R, et al. The effect of time on CPR and automated external defibrillator skills in the public access defibrillation trial. *Resuscitation* 2007;74:52-62.
12 Moser DK, Coleman S. Recommendations for improving cardiopulmonary resuscitation skills retention. *Heart Lung* 1992;21:372-80.
13 Handley J, Handley A. Four-step CPR—improving skill retention. *Resuscitation* 1998;36:3-8.
14 Matlock D, Hafner J Jr, Bockewitz E, Barker L, Dewar J. "Stayin' Alive": a pilot study to test the effectiveness of a novel mental metronome in maintaining appropriate compression rates in simulated cardiac arrest scenarios. *Ann Emerg Med* 2008;52:S67-8.
15 Sayre MR, Berg RA, Cave DM, Page RL, Potts J, White RD. Hands-only (compression-only) cardiopulmonary resuscitation: a call to action for bystander response to adults who experience out-of-hospital sudden cardiac arrest: a science advisory for the public from the American Heart Association Emergency Cardiovascular Care Committee. *Circulation* 2008;117:2162-7.
16 Mellor R, Woollard M. Skill acquisition by health care workers in the Resuscitation Council (UK) 2005 guidelines for adult basic life support. *Int Emerg Nurs* 2009;doi:10.1016/j.ienj.2009.08.003.
17 Woollard M, Smith A, McLean G, Chamberlain D. A randomised controlled trial comparing skill acquisition following standard CPR training or standard CPR training supplemented with a voice advisory manikin. *Ambulance UK* 2003;18:263-7.
18 Woollard M, Smith A, Whitfield R, Chamberlain D, West R, Newcombe R, et al. To blow or not to blow: a randomised controlled trial of compression-only and standard telephone CPR instructions in simulated cardiac arrest. *Resuscitation* 2003;59:123-31.
19 Woollard M, Whitfield R, Smith A, Colquhoun M, Newcombe RG, Vetteer N, et al. Skill acquisition and retention in automated external defibrillator (AED) use and CPR by lay responders: a prospective study. *Resuscitation* 2004;60:17-28.

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