Enhanced self-assessment of CPR by low-dose, high-frequency training

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Abstract

Purpose - The purpose was to investigate what effect an intervention of low-dose, high-frequency cardiopulmonary resuscitation (CPR) training with feedback for one month would have on professionals' subjective self-assessment skill of CPR.

Design/methodology/approach - This study had a quantitative approach. In total, 38 firefighters performed CPR for two minutes on a Resusci Anne QCPR. They then self-assessed their CPR through four multiple-choice questions regarding compression rate, depth, recoil, and ventilation volume. After one month of low-dose, high-frequency training with visual feedback, the firefighters once more performed CPR and self-assessed their CPR.

Findings - With one month of low-dose, high-frequency training with visual feedback, the level of self-assessment was; 87% (n=33) correct self-assessment of compression rate, 95% (n=36) correct self-assessment of compression depth, 68% (n=26) correct self-assessment of recoil and 87% (n=33) correct self-assessment of ventilations volume. The result shows a reduced number of firefighters who overestimate their ability to perform CPR.

Originality/value - With low-dose, high-frequency CPR training with visual feedback for a month, the firefighters develop a good ability to self-assess their CPR to be performed within the guidelines. By improving their ability to self-assess their CPR quality, firefighters can self-regulate their compression and ventilation quality.

Keywords Cardiopulmonary resuscitation; self-assessment; objective visual feedback; Low-dose- High frequency; manikin; firefighter

Introduction

Sudden cardiac arrests caused by ischemic heart disease are the most common causes of death in middle and upper-middle income countries (AHA, 2018; WHO, 2018). The survival rate for out-of-hospital cardiac arrest is approximately 10% in the US (Chan et al., 2014) and Europe (Hawkes et al., 2017; Herlitz, 2017) and 5-6% in South Korea (Hwang et al., 2016) and Japan (Okubo et al., 2017). With such a low percentage of patients surviving, there is considerable room to improve outcomes.

The survival rate from cardiac arrest can be improved with high-quality CPR and early defibrillation (Meaney et al., 2013; Song et al., 2016). Guidelines for CPR comprise of chest compressions performed at a depth of 5–6 cm with a rate of 100–120 compressions/min. Ventilation consists of 1-second inflation of the patient's chest every 6 seconds with air volumes of 400-700 ml. The chest compressions to ventilation ratio being 30:2 (Song et al., 2016; Monsieurs et al., 2015).

To establish or update guidelines for CPR, the International Liaison Committee on Resuscitation (ILCOR) guidelines are used as a scientific basis, integrated with corresponding country or region's specific medical, legal, and cultural properties (Hwang et al., 2016). The ILCOR updates internationally standardized CPR guidelines by applying new scientific evidence to the existing CPR guidelines with a 5-year interval. Both the American Heart Association and European Resuscitation Council have a key role as members of ILCOR (Hwang et al., 2016).

Previous research has shown the importance of prehospital CPR quality (Kleinman et al., 2015; Smart et al., 2015). Prehospital CPR is performed in an unknown and sometimes unsafe environment. Apart from paramedics, the prehospital rescuer can include firefighters, (Abelsson, 2019; Abelsson et al. 2019) mountain rescuers (high altitude) (Tomonobu et al. 2018), lifeguards (aquatic environment) (Barcala-Furelos et al., 2019) and police officers (Hasselqvist-Ax et al. 2017).

Swedish firefighters are a part of the prehospital emergency medical services (EMS). At prehospital medical emergencies, they are either dispatched as an additional assistant to the paramedics or as a substitute for the ambulance when there are no ambulances available. The firefighters have a basic emergency medical technician (B-EMT) education and are responsible

for providing immediate resuscitation, including cardiopulmonary resuscitation when required, at all scenes of accidents (Abelsson et al., 2019).

To increase the quality of CPR and the patient's chance of survival, CPR training needs to be efficient. The training also needs to be assessed, which can be done objectively by numerical measurement to ensure the participants' knowledge (Meaney et al., 2013; Monsieurs et al., 2015; Greif et al., 2015; Yang et al., 2016). A subjective assessment of CPR quality is performed visually either by an instructor, a peer, or the CPR performers themselves (Jones et al., 2015). The subjective assessment can be used as an evaluation of participants' outcomes and to support participants' learning (Reinholz, 2016). Assessment for learning, or formative (educational) assessment, is focusing on how to use the information of learning to modify the learning activities (Black et al., 2003).

Practicing participants' peer assessment skills can also improve their self-assessment skills (Black et al., 2003). The self-assessment gives the participant guidance and, thereby, the ability to adapt their actions to, for example, achieving the right compression depth during CPR (Panadero and Alonso-Tapia, 2013). For self-assessment to be successful, the participant needs to have a realistic expectation of the goal that can be achieved in relation to their actual knowledge. The participant can accurately assess the quality of the task performed and decrease the gap between actual and desired skills (Sadler, 1989).

Previous research has suggested that the subjective assessment of CPR quality is not always consistent with the corresponding objective measurement (Cheng et al., 2015). The aim of this study was, therefore, to investigate what effect an intervention of low-dose, high-frequency CPR training with objective feedback for one month would have on professionals' subjective self-assessment skill of CPR.

Method

This study had a quantitative approach. Before and after the simulation intervention consisting of one month of CPR training, the participants answered a questionnaire regarding subjective assessed CPR.

Participants

Participants consisted of 38 firefighters. Inclusion criteria were firefighters employed for emergency response. The age range was 23 to 64 years (mean 43). Time since the latest CPR training ranged from 6 months to 2 years (mean 6 months). Time since the last CPR performed

on patient; 53% (n=20) within the last 12 months, 32% (n=12) within the last 5 years, 15% (n=6) never performed CPR on a patient. All firefighters received information about the study and participated voluntarily.

Data collection

In the pre-test, the participants performed CPR in pairs for two minutes on a Laerdal Resusci Anne QCPR® (Stavanger Norway) without visual feedback. Each of the two firefighters either performed chest compressions or ventilations in accordance with European Resuscitation Council (ERC) Guidelines for Adult Basic Life Support (BLS) (Monsieurs et al., 2015). The spring required 45 kg chest compressions to achieve the correct compression depth. The firefighters then shifted tasks and repeated CPR performance. We collected objective CPR data during the pre-test using the SimPad Skill reporter®, while subjective data was collected using a participant questionnaire immediately after the test. The subjectively of their CPR performance was recorded through four multiple-choice questions regarding how they assessed their quality of: compression rate, depth, recoil, and ventilation volume.

During the intervention, the firefighters practiced low-dose, high-frequency CPR for one month. The low-dose, high-frequency training consisted of two minutes of training with objective visual feedback during one month with a mean of six practices per person. The manikin was placed in an easily accessible room at the fire station, where the participants themselves initiated two minutes of CPR training based on when it fitted into their schedule.

Post-test evaluations were performed at the end of the one-month CPR intervention. We replicated the pre-test evaluation procedure by asking participants to performed CPR in pairs without visual feedback while collecting objective data. Subjective data was once again collected immediately after the CPR test using the multiple-choice questionnaire. No feedback regarding the CPR quality was given to the participants in either the pre or post tests. All objective CPR results were recorded in a SimPad Skill reporter® during the pre-and post-test.

Data analysis

The descriptive and inferential analysis was conducted using Statistical Package for the Social Sciences (SPSS), version 24.0. Descriptive analysis (central tendency and distribution) were used to describe the data, whereas inferential statistics (paired t-test) compared potential

differences between the variables before and after the interventions. The level of significance used was set at α=0.05.

Ethical consideration

The study followed the ethical principals in accordance with the World Medical Association (2013) about anonymity, integrity, and maintaining public confidence. Ethical approval was obtained from the fire chief of the region. Informed consent was obtained from each participant.

Results

The result shows how the intervention of low-dose, high-frequency CPR training with objective feedback for one-month improves the subjective self-assessment of CPR (Table 1) (Figure 1). To obtain the results, the participants' subjective self-assessment was compared with their objective CPR results, including: compression rate, depth, recoil, and ventilation volume. The objective assessment measured on the CPR manikin, which was judged to be correct, was comprised of; compression rate 100–120 compressions/min, compression depth 5–6 cm, recoil 0 mm and ventilation volume 400-700 ml in accordance to guidelines (Monsieurs et al., 2015).

--please insert Table 1 here--

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Compression rate

In total 45% (n=17) of the participants assessed their compression rate correctly in the pre-test, while the remaining 55% (n=21) underestimated their abilities. In the post-test, the number of participants correctly assessing their compression rate increased by 42% (n=16). In total, 87% (n=33) of the participants assessed their compression rate correctly in the post-test, compared to 45% (n=17) in the pre-test (p=<0.001)

Compression depth

In the pre-test, 58% (n=22) of the participants assessed their compression depth correctly, while the remaining 42% (n=16) underestimated their ability. In the post-test evaluation, 95% (n=36) of the participants assessed their compression depth correctly, which is an increase of 37% (n=14) (p=<0.001).

Recoil

In the pre-test 42% (n=16) participants assessed their recoil correctly. The same number of

participants underestimated this ability 29% (n=11), as overestimate it 29% (n=11). At the post-test, the number of participants with correct assessment increased by 26% (n=10) (*p=<0.001*).

Ventilation volume

In the pre-test 45% (n=17) of the participants assessed their ventilation volume correctly, 34% (n=13) overestimated their ability while 21% (n=8) underestimated it. In the post-test the number of participants who correctly assessed their ventilation volume increased by 42% (n=33) (*p=<0.001*).

Discussion

In this study, the firefighters practiced low-dose high-frequency CPR training, consisting of multiple two minute CPR sessions with visual feedback. A mean value of 6 high frequency practices pre person was recorded during the CPR intervention month. Our hypothesis that the firefighters' ability of self-assessment would improve during this month was proven correct. By developing and improving their ability to self-assess their CPR quality, the firefighters can more accurately self-regulate their compression and ventilation quality. This results in CPR being performed with reflection and understanding of how compressions and ventilations are to be performed and what consequences the different adjustments will have. This is consistent with previous research (Hwang et al., 2016).

The ability of self-assessment enables the firefighters to continuously perform CPR within the recommended guidelines. This built-in self-assessment tool for CPR is also of value to police officers and other EMS staff who encounter people in need of CPR. Using firefighters and police officers as first responders during out-of-hospital cardiac arrest increases the chance of survival for the patient (Hasselqvist et al., 2017; Stein et al., 2017). But because professionals like firefighters, police officers, and paramedics perform CPR in all but a few well-defined cases, these professionals can experience mental stress as they want to successfully resuscitate the patient (Abelsson, 2019). Developing the ability of these professionals to self-assess and self-regulate their CPR quality, can ease the sense of responsibility they feel for another person's life during and after the resuscitation attempt.

Self-assessment may be more difficult than peer assessment as the assessor lacks the distance to themselves and their actions (Black et al., 2003). Previous studies describe how assessors generally overestimate their own abilities (Cheng et al., 2015; Dunning et al., 2004). The result showed how the number of firefighters who overestimated their ability on any part of CPR,

decreased by 21% (n=8) after the intervention, from 47% (n=18) in the pre-test evaluation to 26% (n=10) in the post-test. The result also showed significantly improved self-assessment of all four measured parts of the CPR. The firefighters' self-assessment of the compression rate and compression depth improved by 42% (n=16) and 37% (n=14) respectively. While their ability to self-assess of recoil improved by 26% (n=10) and ventilation volume improved by 42% (n=16).

In summary**,** with low-dose, high-frequency CPR training, including visual, objective feedback for a month, the firefighters developed the ability to self-assess their CPR performance. The mission for all rescuers; mountain, sea, austere territory, and police is public safety. This self-assessment skill is equally important for all other rescue professional, as the quality of their CPR is equally important. By developing all emergency responder's ability to self-assess CPR quality, the self-regulating of compression and ventilation may improve patients' chances of survival with a good neurological status.

Limitations

There are some limitations to this study. Firstly, the small number of participants could have influenced the result in any direction. Secondly, the participants of this study do not fully represent the general population of EMS since they were one profession enrolled in only one region. Neither do the participants represent the general population of health care providers since this cohort is performing CPR regularly.

Conclusion

With low-dose, high-frequency CPR training with visual feedback for a month, the firefighters enhanced their ability to self-assess their CPR. By improving their ability to self-assess their CPR quality, firefighters can self-regulate their compression and ventilation quality to be performed within the guidelines. This CPR training method could be used to improve the self-assessment skills of other emergency responders with the mission of public safety.

Conflicts of interest: none

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Table 1. Self-assessment of CPR skills by 38 firefighters, pre and post training.

Item	Pre-training self-assessment			Post-training self-assessment			p-value*	Difference pre/post
	Correct	Over Estimated	Under Estimated	Correct	Over Estimated	Under Estimated		
Compression Rate, n (%)	17 (45)	0	21 (55)	33 (87)	0	5 (13)	<0.001	16 (42)
Compression Depth, n (%)	22 (58)	0	16 (42)	36 (95)	1 (3)	1 (3)	<0.001	14 (37)
Recoil, n (%)	16 (42)	11 (29)	11 (29)	26 (68)	10 (26)	2 (5)	<0.001	10 (26)
Ventilation volume, n (%)	17 (45)	8 (21)	13 (34)	33 (87)	0	5 (13)	<0.001	16 (42)

*Paired t test

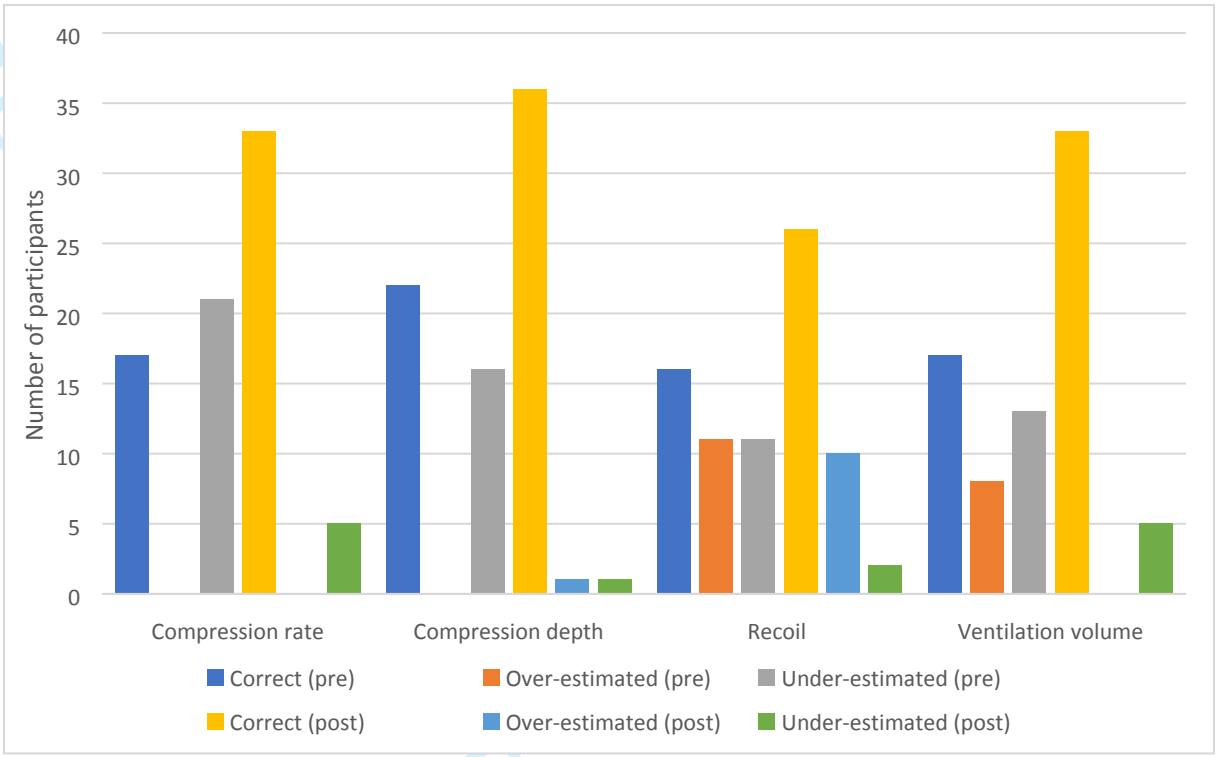

Figure 1. Participants self-assessing their CPR skills pre and post one-month CPR training.