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A novel CPR training method using a smartphone app

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ABSTRACT

The study aims to validate that a smartphone application can assist in the learning and skills retention for cardiopulmonary resuscitation training. This cardiopulmonary resuscitation feature of the Crowdsav platform is designed to record the chest compression performance as well as the rate of compressions of the trainee. Crowdsav is available for downloading in the public domain. The application, once downloaded can be utilised during training and be replayed by the trainee at his/her own will or via reminders from the training centre. The goal of using this application is to minimise the decay of the knowledge and compression skills and perhaps even reduce the resource for recertification, as skills and performance can be kept up, maintained and monitored remotely by a training centre using the application.

1. Introduction

Decay has known to occur in cardiopulmonary resuscitation (CPR) skills during the interval of 2 years between refresher and recertification training. This is especially for those who are non-practitioners. They may not have the opportunities to put these skills into use[1,2]. The skills required in basic CPR have been characterised as being difficult to teach, and once taught, difficult to retain[2–5]. The presence of bystander CPR as well as its quality can help improve the survival from cardiac arrest[1,2,5]. Today, there are various modalities and innovations which have come about to assist trainees with skills retention and sustainability of the knowledge and concept of CPR[5–10]. Development of tools such as feedback manikin or Pocket CPR by Zoll Medical as well as techniques, with the aim of improving the quality of CPR, has also made CPR training easier and more practical[8–10]. Moreover, portable CPR training tools on android and smartphones are free, readily available and accessible[6,7,9–11].

2. Objectives

The study aims to validate that a smartphone application can assist in the learning as well as skills retention for CPR. This CPR feature of the Crowdsav platform is designed to record the chest compression performance of the trainee. Crowdsav is available for downloading in the public domain. The application, once downloaded can be utilised during training and be replayed by the trainee at his/her own will or via reminders from the training centre. The goal of using this application is to minimise the decay of the knowledge and compression skills *i.e.* compression depth and rate and perhaps even reduce the resource for recertification, as skills and performance can be kept up, maintained and monitored remotely by a training centre using the application.

3. Methodology

Trainees coming for their CPR course were randomized into study and control groups. The former group was trained in CPR using the Crowdsav application with the feedback platform of smartphone, in addition to standard CPR training, before they

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were tested. The hand positions for the compression as well as the placement of the mobile device were clearly explained and demonstrated to the members recruited (Figures 1–3). The control group members were trained using the standard traditional method of instruction. Their passing rate and performance of the first attempt were then evaluated. This was repeated with a follow up session at 6 months post-training. The software application was downloadable for free. The study group participants were given instructions and a demonstration.

Figure 1. Hand position for CPR.

Figure 2. Placement of the smartphone with the Crowdsav application between the hands during CPR performance.

Figure 3. Side view of the smartphone between the hands.

After a trainee had successfully completed the CPR course, he will activate the application in its training mode to start recording. The student then began to achieve the recommended parameters set forth by the current CPR guidelines of compression depth, all the while holding phone as shown with the application running. The CPR performance would all be saved and be downloaded for analyses.

Every month, an email and/or short messaging service would then be sent to study group as a reminder to activate the application in the training feedback mode with the saved parameters, and follow the feedback from the application to refresh training on a dummy or any other simulated material.

The individual user would have access to their archived training readings to ensure that their skill competency was on par with current guidelines, otherwise, corrective action could be done with more refresher trainings, in-house or with a certified instructor, before expiry of their CPR certificate.

Also, the app would be a feature to locate nearby automated external defibrillators (AEDs) already in the existing database, or to geotag a new location of AED. Using the smartphone's built-in camera, a short text description of the location was entered and submitted into the database, with the GPS coordinates of the smartphone automatically submitted.

During an actual event, the user could activate the app in the real event mode to begin feedback for CPR with an option to locate the nearest AED for quick retrieval. The parameters from this actual event would be recorded in the app and uploaded into the database for evaluation or clinical research. Data from such events, especially from positive outcomes, would be valuable to determine whether the current CPR guidelines were adequate.

4. Results

A total of 138 trainees were recruited in study group and 171 were recruited in control group. The number of trainees during the 6th month post-basic cardiac life support training follow-up in the study group was 32 and for the control group, it was 37.

In measurements of the metric of rate, the target was set at 100 compressions/min. For measurements of depth of compressions, the target was set at 50 mm.

Any rate slower than 100/min or any depth less than 50 mm was considered as underperformance. Any rate faster than 100/min or any depth more than 50 mm was considered as overperformance.

The change of each subject between 30 s and 60 s CPR attempts was also recorded. If there was an improvement or deterioration of either compression rate or depth achieved, it was benchmarked to the target rate of 100/min for the former and 50 mm for the latter. An improvement for either metric is considered if the outcome of 60 s CPR attempt was closer to the target of the metric. For example, if a subject in 30 s attempt had a rate of 105/min, then in 60 s attempt had a rate of 98/min, he would be considered an improvement of (105 – 100) 5 – 2 (100 – 98) = 3/min. Conversely, if a subject in 30 s attempt had a depth of 48 mm, then in 60 s attempt had a depth of 55 mm, he would be considered deterioration of (55 – 50) 5 – 2 (50 – 48) = 3 mm.

4.1. Analysis of compression rate at 30 s without app and then at 60 s with app

In study group, 24 trainees overperformed in 30 s attempt (75% with an average of 116/min) with none achieving perfect rate of 100/min. Amongst those who overperformed, a greater number of them had compressions of 110/min and beyond *vs.* 100–109/min [15 (47% with an average of 122/min) in the former *vs.* 9 (28% with an average of 105/min) in the latter].

In subsequent 60 s attempt using the app, the number of subjects who overperformed and underperformed was each 14 (43% with an average of 108/min in the former and 106/min in the latter), with 4 (13%) achieved the target of 100/min. Also amongst those who overperformed here, there was now a lesser number of them with compressions 110/min and beyond *vs.* 100–109/min, 6 (19% with an average of 116/min) in the former *vs.* 8 (25% with an average of 103/min) in the latter. The number of subjects who had compression rates of 91–109/min increased from 13 (41%) in 30 s attempt without the app to 23 (72%) with the app.

There were more subjects overexerting above 100/min in 30 s attempt without app, and fewer subjects in 60 s attempt with app [24 (75%) *vs.* 14 (43%)]. And subjects who overperformed 110/min and beyond also dropped from 30 s attempt without app to 60 s with app [15 (40% with an average of 122/min) *vs.* 6 (19% with an average of 116/min)].

In the same subjects comparison between 30 s without app attempt and 60 s with app attempt, there were more subjects improving compared to the worsening, 26 (81% with an average of 12/min improvement) *vs.* 6 (19% with an average of 9/min deterioration).

4.2. Analysis of compression rate without app at 30 s and then 60 s

In control group, 32 subjects overperformed in 30 s attempt (86% with an average of 116/min) with none achieving perfect rate of 100/min. Amongst those who overperformed, a greater number of them had compression of 110/min and beyond *vs.* 100–109/min, 22 (59% with an average of 121/min) in the former *vs.* 10 (27% with an average of 105/min) in the latter, similar to the study group.

There were comparable distribution of subjects who overperformed and underperformed between 30 s and 60 s attempts [32 overperformed (86% with an average of 116/min) and 5 underperformed (13% with an average of 92/min) in the former *vs.* 30 overperformed (81% with an average of 115/min) and 5 underperformed (14% with an average of 92/min) with 2 achieving target rates of 100/min in the latter].

The number of subjects who had compression rates of 91–109/min remained almost the same from 14 (38%) in 30 s attempt to 15 (41%) in 60 s attempt.

In the same subjects comparison between 30 s and 60 s attempts, there were comparable subjects improving and worsening, 19 (51% with an average of 7/min for improvement) *vs.* 16 (43% with an average of 6/min for deterioration) with 2 subjects showing no change in performance.

4.3. Analysis of depth at 30 s without app, then 60 s with app

In study group, 20 subjects overperformed in 30 s attempt (62% with an average of 56 mm) with 16 subjects (50%) achieving close to target of 50 mm (54 mm), while 2 achieving perfect depth of 50 mm. All those who underperformed *i.e.* 10 subjects (31%) also almost achieved target depth of 50 mm (with an average of 46 mm).

In subsequent 60 s attempt using the app, more subjects underperformed than overperformed [22 (69% with an average of 43 mm) *vs.* 9 (28% with an average of 55 mm) with 1 achieving targets of 50 mm].

There was a slight dip in the number of subjects who achieved depths of between 41 and 59 mm [30 s without app attempt was 28 (88%) *vs.* 60 s with app attempt was 23 (72%)].

In the same subjects comparison between 30 s and 60 s attempts, there were comparable subjects improving and worsening, 14 (44% with an average of 3 mm for improvement) *vs.* 15 (47% with an average of 6 mm for deterioration) with 3 subjects showing no change in performance.

4.4. Analysis of depth without app at 30 s, then 60 s

In control group, 18 subjects overperformed in 30 s attempt (47% with an average of 57 mm) with 13 subjects (35%) achieving close to target of 50 mm (54 mm), while 4 achieving perfect depth of 50 mm. The majority of subjects who underperformed *i.e.* 15 (41% with an average of 44 mm) had achieved depth of average 46 mm *i.e.* 12 subjects (32%).

In subsequent 60 s attempt comparable subjects underperformed and overperformed, 16 (43% with an average of 45 mm) *vs.* 19 (51% with an average of 56 mm) with 2 achieving targets of 50 mm.

The number of subjects who achieved depths of between 41 and 59 mm was comparable between the two attempts: 30 s attempt was 29 (78%) *vs.* 60 s attempt was 30 (81%).

In the same subjects comparison between 30 s and 60 s attempts, there were comparable subjects improving and worsening, 19 (51% with an average of 6 mm for improvement) *vs.* 15 (41% with an average of 3 mm for deterioration) with 3 subjects showing no change in performance.

4.5. Behavioural observations

Those subjects who turned up at the 6th month follow-up practised at least once (38%) and without a single practice post-basic cardiac life support course (6%).

5. Summary of observations

About 75% of subjects overexerted themselves in compression rates above 100/min target initially without the app, but after using the app, this percentage dropped to 43%. The percentage and intensity of subjects who initially overexerted with compressions rates of 110/min and beyond also decreased by 47% with an average of 122/min *vs.* 19% with an average of 116/min. Using the app, the number of subjects with compression rates between 91 and 109/min increased from 41% to 72%. This also indicated that lesser number of subjects who used the app had compression rates slower than 90/min and faster than 110/min. Comparable percentage of subjects who had second attempts without the app achieved compression rates of 91–109/min *i.e.* from 38% to 41%. About 81% of the same subjects who subsequently used the app showed improvement from compression rates towards target 100/min, whereas those who attempted a second time without the app did not have the significant improvement *i.e.* 51%. Significantly, less number of the same subjects who used the app had deterioration of their compression rates compared to those who did not use the app, 19% *vs.* 43%. The proportion of the same subjects improving and worsening their depth using the app compared to without the app was comparable *i.e.* 44% *vs.* 51% for improvement, and 47% *vs.* 41% for deterioration. All improvements and deteriorations noted were less than 10 mm *i.e.* using app improved or worsened between 3 and 6 mm, whilst, the groups without app also improved or worsened between 3 and 6 mm.

6. Discussion

With innovation of technology, equipment and procedures are changing rapidly. Healthcare personnels need to adapt the changing and also reflect on how to utilize these new developments in the work that is to be carried out. Not all changes need to be implemented, but when we practice in the front line of care, we cannot run away from the fact that some transformations can indeed be an advantage for us, especially when it enables procedures to be done faster, more efficiently and effectively. The mobile device applications can provide feedback for the performance of CPR and thus have useful applications in practice. It is also readily useable and available to laypersons. Indeed, bystander and public CPR is an area where medical professionals need to work with trained laypersons and the community to enhance the rate of out of hospital cardiac arrest survival.

The subjects in this study used a variety of smart devices of different screen sizes, which most likely had different accelerometer component locations. The latter within the mobile devices can be so sensitive that some can even detect finger pressure on the screen of these smartphones[12]. This might explain the lack of clear benefit on depth outcomes.

Comparison of depth between study group and control group at 30 s without app attempts might show memory of depth among study subjects *i.e.* those who practised at home with app [10 (31% with an average of 46 mm) *vs.* 15 (41% with an average of 44 mm) achieve depth less than 50 mm 2 *vs.* 3 (8% with an average of 35 mm) achieved depth 40 mm or less].

A further interesting observation was noted during the course of the study. Subjects who practised on the Crowdsav app at least once (38%) was 6 times more responsive in coming back for the 6-month follow-up than subjects who did not practise at all (6%). Whether this could be postulated to mean that the typical regular Crowdsav app user is potentially 6 times more likely to respond to calls for help as a first responder, which is unclear. If this is indeed correlatable, by the Crowdsav platform in the trainings of CPR courses we may be able to determine who will be more likely to respond to public cardiac arrest cases. When we notify them via the Crowdsav app as a public volunteer service scheme and focus our resources on these better-trained volunteers, it will better serve to create a more successful volunteer scheme to greatly improve survival from sudden cardiac arrest in the community.

This was a pilot study to try out the app in CPR training, which was executed on a wider scale at our training centres. The numbers in the randomized cohorts were relatively small, thus some generic observations were made and the trends were noted.

7. Conclusion

CPR is an important, yet a complex set of skills. Communities are always looking for ways to better train volunteers and assist them with skills and knowledge retention, as this will have a bearing on the out of hospital cardiac arrest survival rate. Free app such as the Crowdsav one is freely and readily available in these days when smartphones are widely owned and utilized globally.

Conflict of interest statement

The authors report no conflict of interest.

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