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Does Dual Operator CPR help minimize interruptions in chest compressions?

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Abstract

Aims: Basic Life Support Guidelines 2005 emphasise the importance of reducing interruptions in chest compressions (no-flow duration) yet at the same time stopped recommending Dual operator CPR. Dual Operator CPR (where one rescuer does ventilations and one chest compressions) could potentially minimize no-flow duration compared to Single Operator CPR. This study aims to determine if Dual Operator CPR reduces no-flow duration compared to Single Operator CPR.

Methodology: This was a prospective randomized controlled crossover trial. Medical students were randomised into ‘Dual Operator’ or ‘Single Operator’ CPR groups. Both groups performed 4 minutes of CPR according to their group allocation on a resuscitation manikin before crossing over to perform the other technique one week later.

Results: Fifty participants were recruited. Dual Operator CPR achieved slightly lower no-flow durations than the Single Operator CPR (28.5%(S.D. = 3.7) versus 31.6%(S.D. = 3.6), P=<0.001). Dual Operator CPR was associated with slightly more rescue breaths per minute (4.9 (S.D. = 0.5) versus 4.5(S.D. = 0.5), P=0.009. There was no difference in compression depth, compression rate, duty cycle, rescue breath flow rate or rescue breath volume.

Conclusions: Dual Operator CPR with a compression to ventilation rate of 30: 2 provides marginal improvement in no-flow duration but CPR quality is otherwise equivalent to Single Operator CPR. There seems little advantage to adding teaching on Dual Operator CPR to lay / trained first responder CPR programs.

Introduction

Several factors may affect the quality of CPR. Performance of chest compressions is known to be tiring. It has been shown that rescuer fatigue occurs within 1 minute of chest compressions and that fatigue results in less efficacious chest compressions.[1-3] Hightower et al.[1] found that the percentage of adequate compressions decreased from 93% to 39% after 3 minutes and only 18% were satisfactory after 5 minutes. Performance of CPR by a single rescuer may also be affected by pauses between compressions (also known as the no-flow duration). Interruption in chest compressions reduce coronary perfusion pressure and the chance of successful defibrillation.

Guidelines 2005 increased the compression to ventilation ratio from 15:2 to 30:2 for dual operator CPR with the aim of reducing interruptions. In addition, if two rescuers are present, then the problems of fatigue and increased no-flow duration can be minimized. If the tiring compressions are shared between two or more rescuers then fatigue may be less of an issue. Furthermore, if one rescuer can perform chest compressions immediately after the other performs rescue breaths then it is possible to reduce the 'no-flow duration'. Although not the primary aim of a study in 2004, Handley and Handley suggested that 2 person CPR was more efficient than Single Operator CPR in avoiding long pauses for ventilation,[4] effectively resulting in a reduced 'no-flow duration'.

European Resuscitation Council (ERC) Guidelines in 2000[5] and 2005[6] offer different suggestions on how to approach the situation if 2 rescuers are present. The former ERC Guidelines 2000 suggest that when two or more trained rescuers are present they should perform Dual Operator CPR. This is when one rescuer performs chest compressions whilst the other performs rescue breaths, swapping if required (see Figure 1). ERC Guidelines 2005 recommend that when two or more rescuers are present Single Operator CPR should be performed, where one rescuer swaps with the other every 1-2 minutes. Both sets of guidelines stress that any changeover of rescuers should be undertaken with a minimum of delay. However, despite changing the guidelines between 2000 and 2005 there seems to have been no published research comparing the two methods. There have been studies examining how best to provide advanced resuscitation with multiple professional providers; in the pre-hospital setting[7] and the in-hospital advanced life support setting[8], but none of these have focused on the provision of basic life support alone or examined the effect on interruptions in chest compressions.

The aim of the present study was to determine if Dual Operator CPR, performed by a team of trained first responders reduces no-flow duration compared to Single Operator CPR with two rescuers.

Material and Methods

Setting

The study was carried out at the University of Birmingham Medical School, UK. We recruited 58 Basic Life Support (BLS) instructors that taught BLS on a peer-led BLS and Automated External Defibrillator (AED) course Ethical approval was granted by the South Birmingham Research Ethics Committee. Verbal consent was obtained from the candidates.

Study design

The present study was a randomised controlled crossover trial. All candidates were randomly allocated to work in pairs. The pairs were then randomised into a 'Single Operator' group (n=24) and a 'Dual Operator' group (n=26) using the random number generation feature of Microsoft® Excel.

The pairs allocated to the Single Operator group were instructed to complete 4 minutes of CPR by performing Single Operator CPR; swapping CPR provider after 2 minutes according to current guidelines. The pairs allocated to the Dual Operator group were instructed to perform 4 minutes of Dual Operator CPR (see Figure 1); where one BLS provider performs chest compressions only and the other BLS provider performs rescue breaths only, swapping roles every 2 minutes.

Before the session, the researcher instructed the candidates on how to perform Dual Operator or Single Operator CPR. Candidates were instructed to use current European Resuscitation Council BLS Guidelines to perform chest compressions and rescue breaths, i.e. a ratio of 30 chest compressions (at a rate of $100 min^{-1}$) to 2 rescue breaths (each delivered over 1 second).**Error! Bookmark not defined.** The instructions were consistent throughout the study, always asking the candidates to start with chest compressions. The only other input the researcher had was to begin and end the session.

The researcher did not indicate at any point during the 4 minutes how far through the session the candidates were.

After completing the initial CPR assessment, candidates returned 1 week later to perform the crossover part of the study. Upon their return candidates who were initially in the 'Dual Operator' group were asked to perform 4 minutes of Single Operator CPR and candidates initially in the 'Single Operator' group were asked to perform 4 minutes of Dual Operator CPR.

Data collection

CPR performance was assessed objectively using a Laerdal Skillmeter Manikin Resusci® Anne with PC Skillmeter VAM software which allows data variables about the quality of CPR to be downloaded to a laptop computer. The variables collected were: no-flow duration, number of compressions, number of correct compressions, compression rate, compression depth, duty cycle, number of rescue breaths, rescue breath volume, rescue breath flow rate and minute volume. The PC Skillmeter VAM software was programmed to take into account the ERC BLS Guidelines 2005 in order to count a 'correct' chest compression (depth 38-51 mm, correct hand position, complete release). During the assessment, both the candidate and researcher were blinded to the VAM software output.

Statistical methods

Using data from our previous study[9] we calculated that we would require 22 patients to detect a 10% difference in no-flow times with 90% power at a significance level of 0.05. We aimed to recruit 25 participants to allow for any loss to follow-up.

Data were analysed by SPSS 13 (SPSS Inc). Data were checked for normality using the Shapiro-Wilk Tests. Data were normally distributed and therefore analysed using paired t-tests. For all statistical testing a P-value <0.05 was considered statistically significant.

Results

58 candidates were assessed for eligibility and 8 were excluded before randomisation (n=8 due to personal commitments making them unable to attend CPR assessments). At initial CPR assessment there were 50 candidates (Dual Operator group n=26, Single Operator group n=24). At the crossover assessment 1 week after the initial assessment there were no candidates lost to follow up (Dual Operator group n=26, Single Operator group n=24). Figure 2 shows the flow of candidates through the study.

Participant characteristics

All participants were 2nd year medical students who had completed the ERC BLS/AED Instructor course in the preceding 3 months. All participants were involved in teaching on our peer led instructor programme at the time of the study.[10, 11] The initial Dual Operator group consisted of 18 women (69%) and 8 men (31%). The initial Single Operator group consisted of 15 women (63%) and 9 men (38%). The mean age (years) in the groups was very similar (20.5 in the Single Operator group versus 20.6 in the Dual Operator group).

CPR Performance

Data from the assessment of CPR performance are presented in Table 1. Dual Operator CPR achieved lower no-flow duration than Single Operator CPR. This improvement, although small, was statistically significant (28.5% (S.D. = 3.7) versus 31.6% (S.D. = 3.6), $P<0.001$). In absolute values, these percentages equate to 68 and 76 seconds without compressions for Dual and Single Operator CPR respectively, a difference of 8 seconds over the four-minute CPR session. To explore the impact of cohort averaging reducing the magnitude of difference between techniques the data on no flow proportions were dichotomised into two group – those where dual operator CPR increased no flow time and those where it reduced it. No flow duration for dual operator CPR decreased in 20 out of 25 of participants (32.3%(3.4) versus 27.8% (3.5), P=0.0001) and increased in five participants (28.9%(3.1) versus 31.2%(3.2), P=0.005).

There was no other difference in the performance of chest compressions. Specifically compression depth, compression rate, percentage of correct chest compressions and duty cycle were all very similar.

There were some small but statistically significant differences for the performance of rescue breaths. Dual Operator CPR achieved more rescue breaths per minute (4.9 (S.D. = 0.5) versus 4.5(S.D. = 0.5), P=0.009) and a higher minute volume (3730ml (S.D. = 490)versus 3387ml (S.D. = 414), P=0.006). There was no difference in rescue breath flow rate or rescue breath volume.

Discussion

The principal finding of this study was that compared to Single Operator CPR, Dual Operator CPR achieved a statistically significant reduction in no-flow duration when compared with Single Operator CPR (28.53% versus 31.62%, P=<0.001). However, the magnitude of the improvement (3%) was small and would be unlikely to have any major effect on patient outcome were they to be reproduced in an actual resuscitation attempt. There were no other clinically significant differences in CPR (rescue breath or chest compression) performance between techniques.

The quality of CPR is an important determinant of survival from cardiac arrest.[12-15] Studies have stressed the importance of minimising interruptions in chest compressions in order to maintain oronary perfusion pressure and improve the chance of successful defibrillation.[16] Observational studies in humans in cardiac arrest have reported prolonged interruptions in chest compression in clinical practice. Valenzuela et al. reported that chest compressions were not performed 57% of the time during pre-hospital resuscitation attempts.[17] Wik et al. showed in series of 176 out of hospital CPR attempts no chest compressions were performed 38% of the time even allowing for the time necessary for electrocardiographic analysis, pulse checks and defibrillation.[18] When two or more trained rescuers are present (e.g. a lifeguard team; community first responders), one strategy for minimizing interruptions in chest compressions is to undertake Dual Operator CPR, which theoretically would reduce interruptions in chest compressions as a result of the rescuer switching between ventilations and chest compressions.

The ERC Basic Life Support (BLS) guidelines from 2000 recommended Dual Operator CPR when 2 trained rescuers were present. However, this recommendation was withdrawn in the 2005 revision of the Guidelines. The decision to change the guidelines was taken on a pragmatic basis rather than as a result of new evidence specifically in this scenario. Underpinning the change in BLS guidelines between 2000 and 2005 was the idea of simplifying the algorithm to simplify teaching, in order to improve retention of skills[19]. However, another objective of Guidelines 2005 was to improve the quality of CPR and reduce interruptions in chest compressions. At the time of these changes, only one study had indirectly looked at the effect of Dual as opposed to Single Operator CPR. In a manikin study investigating the performance of CPR in confined spaces, Handley and Handley demonstrated a reduction in no-flow times (10 versus 6 seconds per CPR cycle) when Dual Operator CPR was performed. Therefore, it was possible that dropping Dual Operator CPR from the guidelines could have inadvertently led to a reduction in the quality of CPR.

The present study differs from the Handley and Handley study in that it was conducted in accordance with Guidelines 2005 which recommends a compression to ventilation ratio of 30:2 as opposed to 15:2. The change in compression to ventilation ratio has been associated with a significant reduction in no-flow duration.[20] We hypothesise that the difference in compression to ventilation ratio between the two studies explains why this study found that the improvement in no-flow duration was marginal with the two operator approach. The present study therefore supports the decision to drop Dual Operator CPR from the BLS curriculum as Dual Operator CPR increases the complexity of the guidelines without any meaningful benefits in terms of quality of CPR.

This study has several limitations. Firstly, the study set out to evaluate the impact of Dual Operator CPR used by a team of trained first responders. These findings and the recommendation that Dual Operator CPR should not be taught to first responders / lay persons applies only to this group of trainees. Dual Operator CPR should continue to form part of the training pathways for pre or in-hospital advanced life support resuscitation teams as these teams are tasked with multiple interventions (e.g. defibrillation, advanced airway management) in contrast to the first responder group in this study. Secondly, we used an "expert group" of BLS CPR providers (trained instructors). The quality of CPR in the study although better than has been seen in other clinical studies, still only yielded moderate compression performance (% correct compressions circa 40%) so these results may not necessarily extrapolate to clinical practice. Thirdly, the study period was relatively short at only 4 minutes and thus did not fully examine the impact of fatigue on performance. In many areas ambulance response times are in the region of 8 minutes. Whether any differences would have been seen over a longer duration of CPR was not investigated. Finally, it was not possible to blind candidates to the technique they were performing. Whilst we have no reason to suspect that this influenced the results, we cannot exclude this as a possibility.

Conclusion

Dual Operator CPR provides marginal improvement in minimising interruptions in chest compressions when compared to Single Operator CPR performed by BLS resuscitation teams. There are no other differences in the performance of CPR between Dual Operator and Single Operator CPR when 2 rescuers are present. There seems little advantage in adding teaching of Dual Operator CPR to trained first responder/BLS CPR programs in view of the added complexities.

Conflicts of interest

None declared.

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References

1. Hightower D, Thomas SH, Stone CK, Dunn K, March JA. Decay in quality of closed-chest compressions over time. AnnEmergMed 1995;26:300-3.
2. Perkins GD, Augre C, Rogers H, Allan M, Thickett DR. CPREzy: an evaluation during simulated cardiac arrest on a hospital bed. Resuscitation 2005;64:103-8.
3. Ochoa FJ, Ramalle-Gomara E, Lisa V, Saralegui I. The effect of rescuer fatigue on the quality of chest compressions. Resuscitation 1998;37:149-52.
4. Handley AJ, Handley JA. Performing chest compressions in a confined space. Resuscitation 2004;61:55-61.
5. Handley AJ, Monsieurs KG, Bossaert LL. European Resuscitation Council Guidelines 2000 for Adult Basic Life Support. A statement from the Basic Life Support and Automated External Defibrillation Working Group(1) and approved by the Executive Committee of the European Resuscitation Council. Resuscitation 2001;48:199-205.
6. Handley AJ, Koster R, Monsieurs K, Perkins GD, Davies S, Bossaert L. European Resuscitation Council guidelines for resuscitation 2005. Section 2. Adult basic life support and use of automated external defibrillators. Resuscitation 2005;67 Suppl 1:S7-23.
7. Hackman BB, Kellermann AL, Everitt P, Carpenter L. Three-rescuer CPR: the method of choice for firefighter CPR? Ann Emerg Med 1995;26:25-30.
8. Dunkley CJ, Thomas AN, Taylor RJ, Perkins RJ. A comparison of standard and a modified method of two resuscitator adult cardiopulmonary resuscitation: description of a new system for research into advanced life support skills. Resuscitation 1998;38:7-12.
9. Spooner BB, Fallaha JF, Kocierz L, Smith CM, Smith SC, Perkins GD. An evaluation of objective feedback in basic life support (BLS) training. Resuscitation 2007;73:417-24.
10. Perkins GD, Hulme J, Bion JF. Peer-led resuscitation training for healthcare students: a randomised controlled study. Intensive Care Med 2002;28:698-700.
11. Bucknall V, Sobic EM, Wood HL, Howlett SC, Taylor R, Perkins GD. Peer assessment of resuscitation skills. Resuscitation 2008;77:211-5.
12. Kramer-Johansen J, Edelson DP, Losert H, Kohler K, Abella BS. Uniform reporting of measured quality of cardiopulmonary resuscitation (CPR). Resuscitation 2007;74:406-17.
13. Edelson DP, Litzinger B, Arora V, et al. Resuscitation with actual performance integrated debriefing (RAPID) improves CPR quality and initial patient survival. Resuscitation Science Symposium 2008;A61:29.
14. Edelson DP, Abella BS, Kramer-Johansen J, et al. Effects of compression depth and pre-shock pauses predict defibrillation failure during cardiac arrest. Resuscitation 2006;71:137-45.
15. Leary M, Abella BS. The challenge of CPR quality: improvement in the real world. Resuscitation 2008;77:1-3.
16. 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.

17. Valenzuela TD, Kern KB, Clark LL, et al. Interruptions of chest compressions during emergency medical systems resuscitation. Circulation 2005;112:1259-65.

18. Wik L, Kramer-Johansen J, Myklebust H, et al. Quality of cardiopulmonary resuscitation during out-of-hospital cardiac arrest. JAMA: The Journal of the American Medical Association 2005;293:299-304.

19. Nolan J. European Resuscitation Council Guidelines for Resuscitation 2005: Section 1. Introduction. Resuscitation 2005;67:S3-S6.

20. Perkins GD, Boyle W, Bridgestock H, et al. Quality of CPR during advanced resuscitation training. Resuscitation 2008;77:69-74.