

Paper

Factors Influencing Performance of Cardiopulmonary Resuscitation (CPR) by Foundation Year 1 Hospital Doctors

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Accepted 17 August 2011

ABSTRACT:

Background: Foundation Year One (FY1) doctors are often the first medical staff responders at in-hospital cardiac arrests. The study objectives were to assess the cardiopulmonary resuscitation (CPR) skills of FY1 doctors at a Belfast teaching hospital and to highlight factors that influence their performance.

Methods: A group of FY1 doctors working in a Belfast teaching hospital were asked to participate in this study. These junior doctors were regularly on-call for acute medical emergencies including cardiac arrest. Participants were instructed to perform two, 3 minute sessions of CPR on a skills reporter manikin. Each session was separated by a 5 minute rest period, one session using a compression-to-ventilation ratio of 15:2 and the other using a ratio of 30:2. Performance was gauged both objectively, by measuring the depth of chest compressions, and subjectively by a panel of 5 Advanced Life Support (ALS) instructors who reviewed the tracings of each CPR session.

Results: Overall, 85% of medical FY1's working in the hospital participated in the study. Objective results determined that males performed significantly better than their female counterparts using both the 15:2 and 30:2 ratios. The male FY1 doctors performed equally well using both 15:2 and 30:2 ratios, in comparison to female doctors who were noted to be better using the 15:2 ratio.

Individuals with a Body mass index (BMI) greater than the mean for the group, performed significantly better than those with a lower BMI when using the 30:2 ratio.

BMI was an important factor and correlated with chest compression depth. Females with a low BMI performed less well when using a ratio of 30:2. Overall, expert opinion significantly favoured the 15:2 ratio for the FY1 doctor group.

Conclusions: CPR performance can be influenced by factors such as gender and BMI, as such the individual rescuer should take these into account when determining which compression to ventilation ration to perform in order to maximise patient outcome.

This study showed that males and those females with a BMI of >24 performed satisfactory CPR when using the recommended Resuscitation Council guidelines. Females with a BMI <24 performed CPR more effectively when using the 15:2 ratio. FY1 doctors should be fully assessed prior to performing CPR at in-hospital cardiac arrests. Remedial teaching should be given to those less than satisfactory until they are shown to be competent.

INTRODUCTION

As FY1 doctors are often the first medical staff responders at in-hospital cardiac arrests, patient outcome is influenced by their ability to perform effective CPR. Inadequate CPR will not only compromise patient survival⁽¹⁾, but also, of the patients who do survive, the majority are likely to have poor neurological recovery, resulting in significant impairment in quality of life⁽²⁾.

In an effort to improve survival and post resuscitation quality of life, the European Resuscitation Council Guidelines 2005 placed greater emphasis on the rescuer's performance of chest compressions^(3,4). They recommend using 30 as opposed to 15 chest compressions per CPR cycle. However, studies suggest rescuer fatigue during the performance of 30 chest compressions^(5,6,7) may compromise overall CPR performance.

FY1 doctors are expected to be highly proficient in

resuscitation. These individuals are usually young, healthy adults who have received CPR instruction on several occasions during their undergraduate training and usually have undertaken a refresher training course before starting work as an FY1 doctor.

Unfortunately, survival figures following an in-hospital cardiac arrest are poor⁽⁸⁾. A variety of factors may be attributable to this including severity of pre-existing cardiac disease, co-morbidity and multiple drug therapy. It is essential however, that FY1 doctors are truly proficient in performing CPR at in-hospital arrests, should the patient have an optimal chance of survival.

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OBJECTIVE

The aim of this study was to subjectively and objectively assess the CPR performance of FY1 doctors and to identify factors which may influence the quality of this basic life support.

METHODS

All FY1 doctors employed, and actively working in a Belfast teaching hospital were invited to participate in this study. Each subject had received CPR training on at least 2 occasions as an undergraduate medical student and less than 3 months before the study and prior to employment at the hospital trust, had completed a compulsory CPR training course. As junior doctors they were expected to act as first medical responders at in-hospital acute medical emergencies including cardiac arrest.

Participants were given the same instructions and asked to perform CPR on a Laerdal Resusci-Anne Skills Reporter Manikin (Laerdal Medical, Norway). Subjects were randomly allocated to perform 3 minutes of CPR using a compression to ventilation ratio of either 15:2 or 30:2. Following a 5 minute rest, a further 3 minutes of CPR was performed using the other compression to ventilation ratio. Group A (18 FY1 doctors) used a ratio of 15:2 while Group B (16 FY1 doctors) used 30:2 for their initial 3 minute period of resuscitation.

A single investigator saved a complete tracing of each individual performance onto a laptop computer. Chest compression depths (mm) obtained from the tracings were measured and recorded by a second investigator who was blinded to the age, gender, BMI and study group to which the subjects belonged.

Using the Hills and Armitage method⁽⁹⁾ statistical analysis of the crossover trial was performed. The Mann Whitney U Test⁽¹⁰⁾ analysed the responses on chest compression depths when comparing subpopulations of different gender, BMI and ratios used. McNemara's Test⁽¹¹⁾ was used for analysis of the subjective data recorded by the 5 ALS instructors who viewed the individual session tracings. For all statistical analysis, a p value of <0.05 was taken as significant.

For the purpose of this study we assessed adequacy of CPR performance by the percentage of chest compressions of depth ≥ 38 mm as recommended in the resuscitation council guidelines. A 3 minute period of resuscitation was deemed effective when >80% of all compressions given were of a depth ≥ 38 mm. No upper level of chest compressions were considered. The body mass index figure of 24 was used as it was the mean BMI for the study population (Table 1).

The responses provided were statistically analysed to compare the following:-

1. male v female using ratio of 15:2
2. male v female using ratio of 30:2
3. 15:2 v 30:2 ratio for all FY1 doctors
4. 15:2 v 30:2 for male FY1 doctors
5. 15:2 v 30:2 for female FY1 doctors

6. BMI<24 v BMI >24 while using ratio of 15:2
7. BMI<24 compared with BMI >24 using ratio of 30:2
8. BMI<24 compared with BMI>24 using both compression ratios combined

TABLE 1:

Summary of study population characteristics & percentage of FY1 doctors achieving >80% of compression depths of >38mm.

	Male	Female	P value
Number	18	16	
Mean Age	24.9	23.9	
Mean BMI	25.3	22.6	
Ratio 15:2	88.9%	44%	0.008
Ratio 30:2	83.3%	25%	0.005
P value	0.51	0.12	

In addition to the objective study, all CPR tracings were inspected independently by 5 experienced ALS instructors who were asked to categorise each tracing as either 'effective' or 'ineffective' (based on whether or not the outcome was likely to result in neurologically intact patient survival).

The ALS instructors had no knowledge of the occupation, age, gender or BMI of those performing the CPR, nor the study group to which subjects belonged. As it was a possibility that borderline performance tracings could result in difference of opinion, it was decided that, for a period of resuscitation to be categorised as either 'effective' or 'ineffective', a minimum of 4 ALS instructors had to be in agreement.

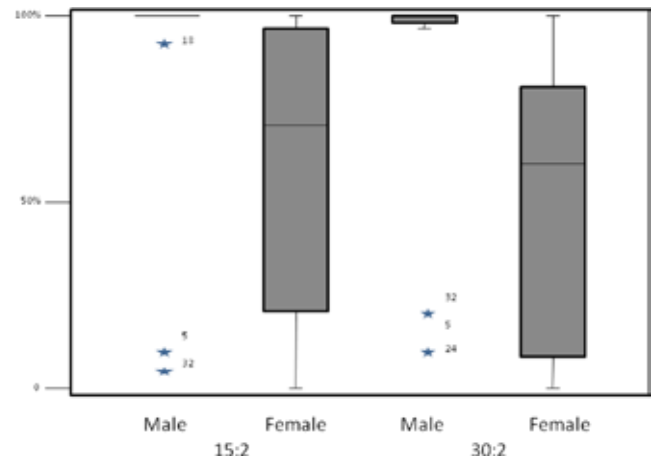


Fig 1. Boxplots of individual male and female FY1 doctors performance of CPR using 2 chest compression-to-ventilation ratios

RESULTS

Of the 40 FY1 doctors working in the hospital 34 (85%) agreed to participate in the study. 18 were male and 16 female, the age range was 23 – 35 years (mean 24yrs).

Less than 3 months prior to the study 7 FY1 doctors (21%)

had been involved in CPR as part of an in-hospital acute medical emergency.

TABLE 2:

Male & female F1 doctors using 2 different CPR ratios. Percentage achieving >80% of compressions of depths of $\geq 38\text{mm}$.

RATIO	Male	Female	P value
	N = 18	N = 16	
15:2	88.9%	44%	0.008*
30:2	83.3%	25%	0.005*
P value	0.51	0.12	

Gender:

When adopting the 15:2 ratio, 88.9% of males and 44% of females ($p = 0.008$) performed effective resuscitation. This gender difference was more marked when using the 30:2 ratio with 83.3% of males and only 25% of females ($p = 0.005$) being performing adequately (Table 1). Male performance was equal when using 15:2 or 30:2 ratio (88.9% & 83.3% respectively $p = 0.5$). Although the results for the female FY1 doctors did not reach statistical significance ($p = 0.12$) a greater number achieved >80% of compressions of depths >38mm using the 15:2 ratio rather than 30:2 (44% c.f. 25%). All but 3 males (when using 15:2) and all but 4 males (when using 30:2) achieved 100% of compressions $\geq 38\text{mm}$

When we compared males at the two ratios no statistical difference was observed (Table 1). 4 male FY1's performed better using the 15:2 ratio, 5 were better when using 30:2 and 9 showed no difference in performance. Of the 16 female doctors, 8 performed better using the 15:2 ratio, 5 were better using 30:2 and 3 were equally good at both ratios. The difference did not quite reach statistical significance ($p = 0.12$).

BMI:

82% of the junior doctors with a BMI>24 compared to 53% of doctors with a BMI<24 performed effective CPR using the 15:2 ratio. However this did not reach statistical significance ($p = 0.126$). Using the 30:2 ratio, subjects with a BMI>24 showed significantly better CPR performance than those with a lower BMI (76% c.f. 35% respectively $p = 0.045$). When comparing CPR performance overall (gender and ratio combined), BMI made a significant difference with 74% of

doctors with BMI>24 and only 44% of doctors with BMI<24 performing >80% of compressions $\geq 38\text{mm}$ ($p = 0.03$).

Subjective results:

As stated earlier, a CPR session could only be termed 'effective' or 'ineffective' if agreed by four or more ALS.

TABLE 3:

All F1 doctors. Comparison of those of BMI >24 with those of BMI<24. Percentage achieving >80% of compressions of depth $\geq 38\text{mm}$

RATIO	BMI>24	BMI<24	P value
	N = 17	N = 17	
15:2	82%	53%	0.126
30:2	76%	35%	0.045*
P value	ns	ns	

Gender:

Due to the small sample size of the subpopulations, levels of significance could not be achieved. However, clear differences were noted between male & female performance when using different compression-to-ventilation ratios. The majority of females were rated 'effective' when using 15:2 as opposed to 30:2. Taking the group as a whole, and using McNemara's test⁽¹¹⁾ on the mismatches (i.e. those subjects who were deemed to succeed under one and only one regime) the results showed 7 mismatched pairs. In every single case the 15:2 regime was considered effective and the 30:2 ratio ineffective. McNemara's test recorded a two-sided p value of 0.016 that is highly statistically significant with expert opinion favouring the 15:2 regime.

BMI:

The sample sizes of males and females of differing BMI were too small to achieve statistically significant results. However while the subjective results indicate that BMI has little influence on the CPR performance of male FY1s BMI may influence the performance of the group as a whole and female doctors, especially when using the 30:2 ratio (Table 5).

DISCUSSION

This study identified large variations in the quality of CPR performed by FY1 doctors, with respect to chest compression

TABLE 4

Number (%age) of CPR sessions rated either 'effective' or 'ineffective' by ≥ 4 of the 5 ALS instructors for male and female doctors

		Ratio 15:2		Ratio 30:2		
	Male N = 18	Female N = 16	Both N = 34	Male N = 18	Female N = 16	Both N = 34
Effective	15(83%)	7(43%)	21(62%)	13(72%)	2(13%)	15(44%)
Ineffective	2(11%)	8(50%)	10(29%)	3(17%)	9(56%)	13(38%)

TABLE 5

Number and percentage of CPR sessions rated 'effective' or 'ineffective' by ≥ 4 of the 5 ASL instructors for male and female doctors with a BMI above or below 24 (the mean BMI for the study population)

	Ratio 15:2						Ratio 30:2					
	BMI >24			BMI <24			BMI >24			BMI <24		
	□	□	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀
Effective	11	2	13	4	5	9	10	1	11	3	1	4
%age	92	40	77	66	46	53	83	20	65	50	9	24
Ineffective	0	3	3	2	5	7	0	3	3	3	7	10
%age	0	60	18	33	46	41	0	60	18	50	64	59

depth. CPR performance can be influenced by many factors, here we investigated the impact of gender, BMI and the ratio of chest compressions to ventilations used.

The objective results of this study clearly show that male FY1 doctors perform a greater number of adequate chest compressions in comparison to their female counterparts when using both the 15:2 and 30:2 ratios. There was no significant difference in CPR performance of the male group using either ratio, although female doctors tended to be more efficient using the 15:2 ratio.

There was no statistical difference in performance of doctors with regards to BMI when using the 15:2 ratio. However, with the 30:2 ratio doctors with BMI>24 performed better than their colleagues who had BMI<24. Males tend to be stronger than females and often have a greater BMI, they are less inclined to fatigue as quickly due to their increased muscle mass.

Although the sample sizes were small, the subjective results fully support our objective findings. They demonstrate that males achieve deeper chest compressions than females when using the current European Resuscitation Guidelines (30:2), females perform deeper chest compressions when using a ratio of 15:2 and females with a BMI < 24 deliver suboptimal compressions when using a ratio of 30:2.

Rescuer fatigue is more likely to be an issue when using 30:2 due to the increased number of compressions and absence of muscle recovery time available during the ventilation cycles. Previously, a study found that although the 30:2 ratio was more exhausting, the 30:2 technique delivered more chest compressions⁽⁷⁾. Interestingly, as with the combined doctors results of our study, the overall quality of compressions remained unchanged⁽⁷⁾. However the investigators failed to specifically assess the impact of gender on CPR performance. Sanders et al (2002) has suggested that an increased rate of chest compression is associated with better outcome. They compared the neurological outcome in pigs following induced cardiac arrest and found better neurological recovery at higher rates of compression and lower rates of ventilation⁽¹²⁾.

When FY1 doctors were assessed as a group, there was no statistical difference in the percentage of doctors performing chest compressions of ≥ 38 mm between 15:2 and 30:2. This mirrors the results of Conrad et al (2008) who found no statistical decline in chest compression depth and rate when

comparing 15:2, 30:2 or 50:2 ratios using male and female subjects⁽¹³⁾.

Whilst this study demonstrates that male gender and an increased BMI are associated with increased percentage of chest compressions ≥ 38 mm, previous studies have investigated the impact other factors have on chest compressions such as the position of the manikin⁽¹⁴⁾, whether or not a backboard for the patient is being used⁽¹⁵⁾ and the affect different mattresses have on chest compression depth⁽¹⁶⁾. With so many factors affecting the depth of chest compressions and therefore the quality of CPR, it is essential to optimise these variables to deliver better quality compressions.

CONCLUSION

This study shows that FY1 doctors perform effective CPR as determined by achieving a depth of chest compressions ≥ 38 mm. We demonstrated that both the gender and BMI of the FY1 doctor can influence the effectiveness of their CPR performance. A pattern which became most apparent on using the 30:2 ratio during the delivery of CPR.

Male FY1 doctors perform equally well using both 15:2 and 30:2 ratio, while females are more effective when using a ratio of 15:2. Our study found that junior doctors with a BMI greater than 24 are capable of more effective CPR, as judged by depth of chest compressions, when using a ratio of 30:2.

The authors have no conflict of interest.

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