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EDUCATION

A pilot study to determine whether undergraduate paramedics are able to retain basic resuscitation and respiratory physiology knowledge

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Abstract

Introduction
While suboptimal bag ventilation has been well documented during cardiopulmonary resuscitation (CPR), we often do not consider how operator knowledge of ventilation guidelines may contribute to this outcome. The objective of this pilot study was to evaluate third year Monash University undergraduate paramedic students' knowledge of the International Liaison Committee on Resuscitation (ILCOR) ventilation guidelines and basic respiratory physiology.

Methods
A cross-sectional study was used to elicit responses about ventilation rate, tidal volume and knowledge of lower oesophageal sphincter pressure in normal and cardiac arrest states for third year undergraduate paramedic students at Monash University. Ethics approval was granted.

Results
There were 30 (41%) third year students who participated. Only 8 (27%) of the students who participated could identify the correct ventilation rate for an intubated patient in a cardiac arrest situation, with only 3 (10%) of students identifying the correct tidal volume. Overall, 27 (90%) of students had a poor knowledge of ventilation guidelines while 29 (97%) students were unable to recall basic lower oesophageal sphincter pressure values.

Conclusion
A greater emphasis on education of current ventilation guidelines, as well as the underpinning knowledge surrounding the guidelines, is needed to ensure students attain appropriate ventilation during CPR.

Keywords: *cardiopulmonary resuscitation; emergency medical services; hyperventilation; hypoventilation; pulmonary ventilation; tidal volume*

Introduction

There is sufficient scientific evidence to support the view that the delivery of ventilation using a self-inflating bag is erratic and uncontrolled by all disciplines.[1-6] The tendency to deviate away from evidence based resuscitation guidelines is also a notion that is well expressed within the scientific literature.[7] The factors of causation leading to suboptimal bag ventilation during CPR are yet to be thoroughly explored. While a number of authors have documented high ventilation rates, tidal volumes and airway pressures,[1,5, 6, 8, 9] few have taken the next step to explore what effect, operator knowledge of ventilation guidelines (and the underpinning concepts behind their changes) has on current reported 'hyperventilation crisis' in cardiac arrest. The objective of this study was to evaluate third year Monash University undergraduate paramedic students' knowledge of the International Liaison Committee on Resuscitation (ILCOR) ventilation guidelines and lower oesophageal sphincter pressure (LOSP).

METHODS

Study Design

A cross-sectional study using a survey form consisting of seven questions was used to assess student knowledge of current ventilation guidelines and LOSP understanding.

Population and Setting

Seventy three undergraduate paramedic students in the third year of a pre-employment course, Bachelor of Emergency Health (Paramedic) at Monash University, Victoria, Australia were eligible for inclusion in the study. At the time of the study, students had undertaken at least 28 months (or equivalent prior learning) of clinical education at Monash University. Each student had also undertaken at least 200 hours of in-field clinical practice. While students were in the process of completing their final year of study, the theory and practice relating to CPR were established in subjects during year one and year two of the course. Students were expected to understand and practice according to the ILCOR resuscitation guidelines. There were no specific exclusion criteria.

Process

The survey was administered to students who agreed to participate in the study after they had read an explanatory statement. The students were informed that participation was voluntary and anonymous prior to commencing the survey. Consent was implied by completion and return of the survey. It took participants on average five minutes to complete the survey.

There was an expectation that students had maintained knowledge of current CPR guidelines as well as the concepts relating to gas distribution across the lungs and stomach during resuscitation.

Students were given a scenario of a male patient in cardiac arrest, weighing approximately 80kgs, who had been intubated and they were required to ventilate the patient at the appropriate rate. Students were required to acknowledge in their responses that:

- A ventilation rate of between 8 and 10 is recommended in the cardiac arrest patient with an advanced airway.
- A tidal volume of 6-7ml/kg is guideline consistent in the cardiac arrest patient.

- A LOSP in a conscious healthy adult is likely to be in the range of 20-30cmH_2O.
- The LOSP is likely to fall during a cardiac arrest.

Analysis
Descriptive statistics were used to summarise the demographic and student response data. Data analysis was undertaken using SPSS (Statistical Package for the Social Sciences Version 17.0, SPSS Inc., Chicago, Illinois, U.S.A

Ethics
Ethics approval was granted by Monash University's Standing Committee on Ethics in Research involving Humans (SCERH).

RESULTS

There were thirty students (41% of the available students) who participated in the study. Just over half of the students (n=17, 56.7%) were aged between 21-25 years, while the next most common age group was 26-30 years with nine students. There were no students aged below 21 years or over 45 years. There was equal number of female and male students with 15 of each gender.

Almost half of all students (n=14) stated that 12-16 VPM was the correct ventilation rate, while only eight (27%) students accurately stating that a cardiac arrest patient with an advanced airway required a ventilation rate of 8-10 VPM (Figure 1).

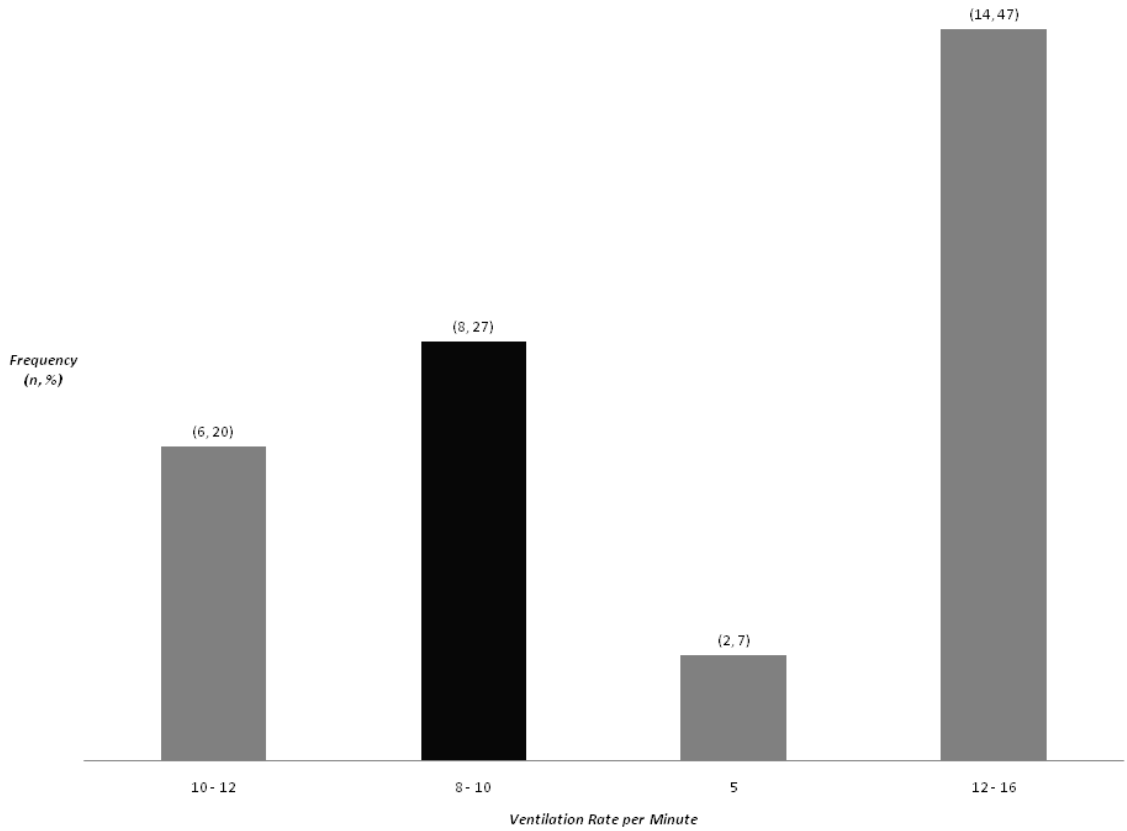

Figure 1: Assessing participant knowledge of ventilation rate.
Legend: Black is the correct ventilation rate per minute.

Just over half of all students (n=16) suggested that 10 ml/kg was the most appropriate ventilation tidal volume for the scenario patient. Other incorrect responses included 8-10 ml/kg (n=8, 27%) and 500 ml (n=3, 10%), while only 3 (10%) students could accurately state that the appropriate tidal volume for a cardiac arrest patient with or without an advanced airway is 6-7 ml/kg (Figure 2).

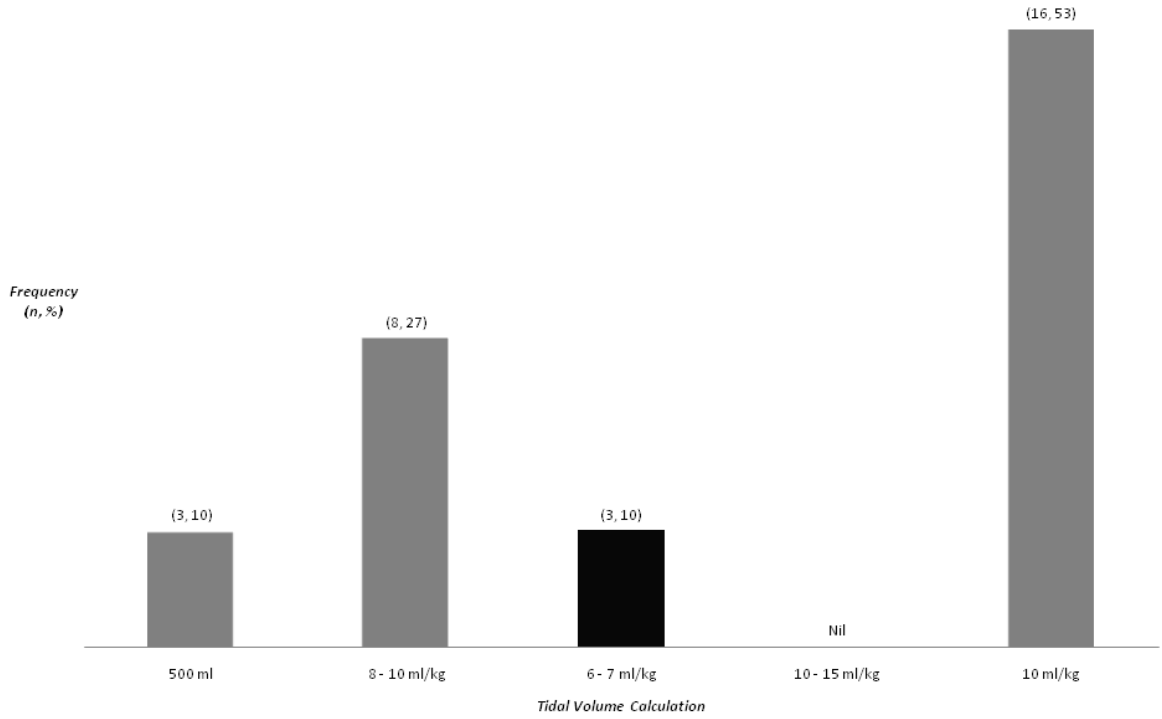

Figure 2: Assessing student knowledge of tidal volume.
Legend: Black is the correct response.

The assessment of LOSP both in normal and cardiac arrest states revealed significant shortfalls in student knowledge (Figure 3 & 4). The most common answers were 20mmH_2O (n=16), 30mmH_2O (n=10) and 5cmH_2O (n=2) in a conscious healthy adult. Only 2 students (7%) accurately determined that 20 - 30cmH_2O was likely to be the most appropriate answer in this setting. In addition, 25 students (83%) incorrectly determined that LOSPs in a cardiac arrest patient was likely to increase. Only five students could accurately conceptualise the likely LOSP changes in states of poor or absent circulation such as cardiac arrest.

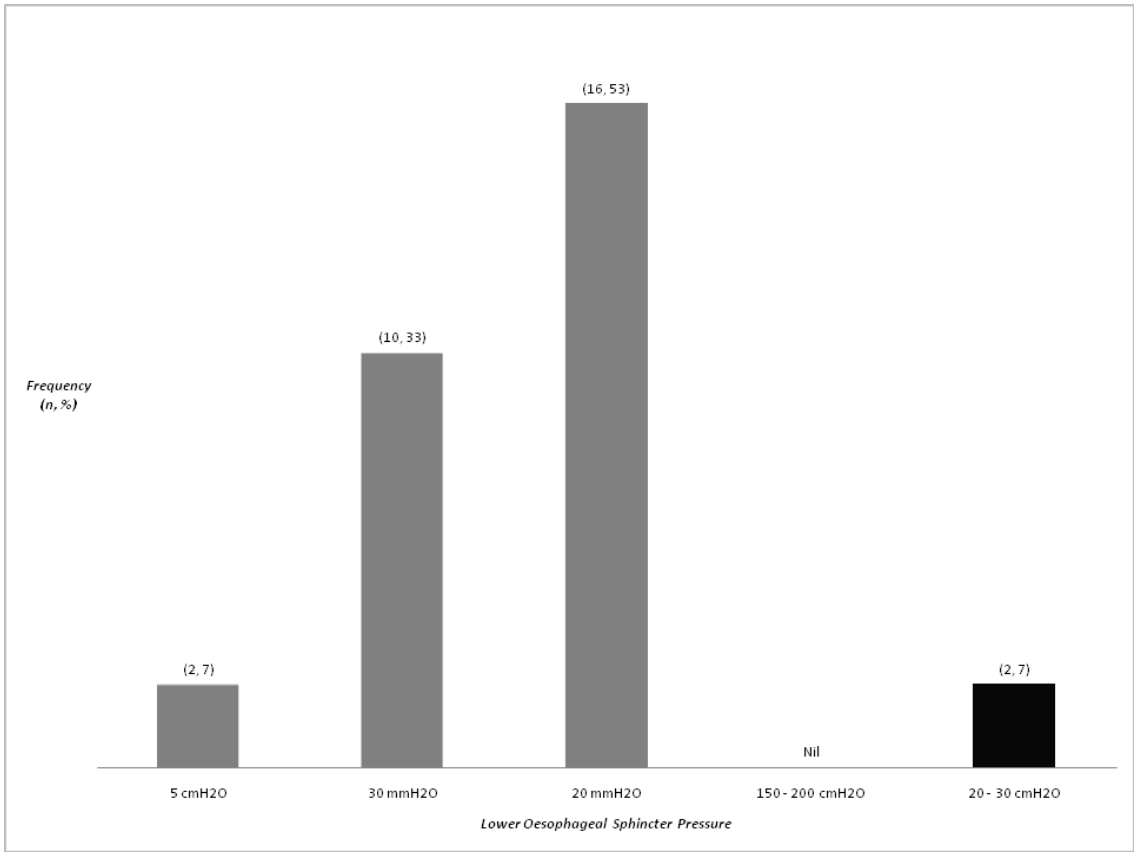

Figure 3: Assessing student understanding of normal LOSP.
Legend: Black is the correct response.

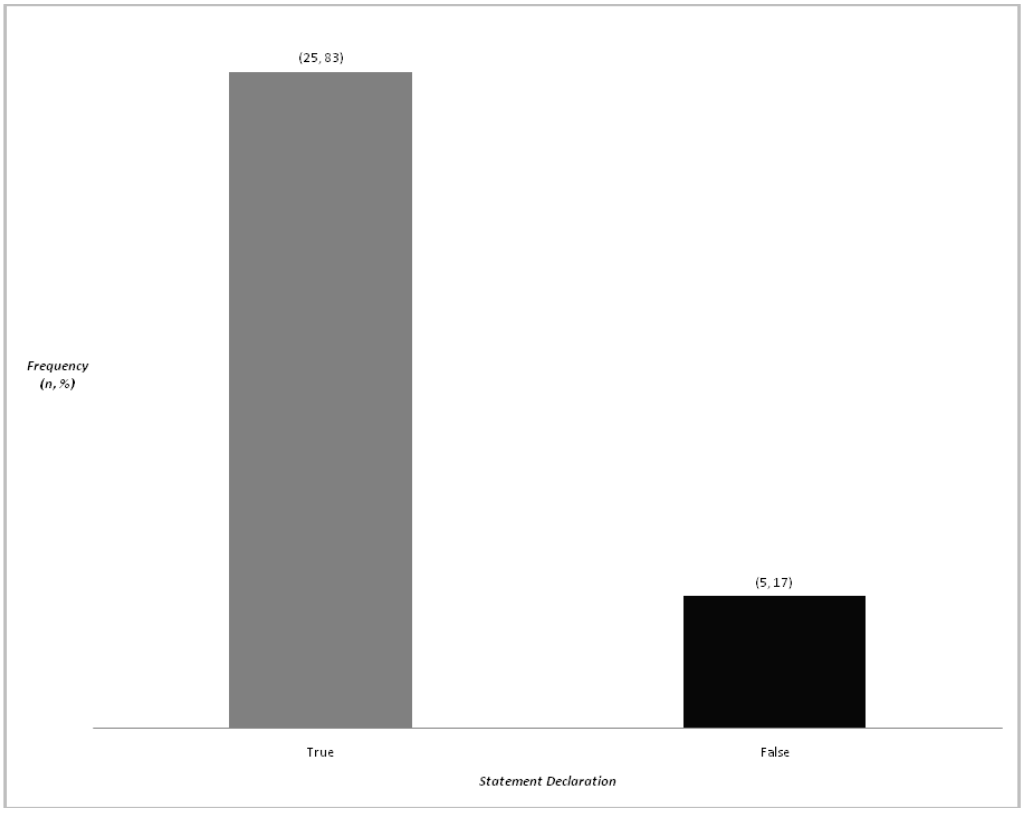

Figure 4: Assessing student understanding of LOSP change in cardiac arrest.
Legend: Black is the correct response.

DISCUSSION

The results of this study suggest that third year Monash University undergraduate paramedic students have a poor understanding of current international resuscitation ventilation guidelines and some components of respiratory physiology, especially LOSP.

In a study evaluating paramedic ventilation performance in cardiac arrest patients, Aufderheide and colleagues demonstrated that paramedics were likely to significantly reduce the incidence of hyperventilation with further education in resuscitation guidelines.[6] While the study did publish operator knowledge of resuscitation guidelines before and after training, it concluded that *"additional education of CPR providers is urgently needed to reduce these newly identified and deadly consequences of hyperventilation during CPR"*.[6] Studies of this nature are likely to have a substantial influence on future development of research, as well as complementing the design and determination of future resuscitation guidelines, education and clinical practice, and prehospital quality assurance.

The correlation between operator knowledge and operator performance is seemingly more evident from the findings of this study. Taking into consideration that the majority of the student sample were hoping to achieve a ventilation rate of 12-16 VPM and a tidal volume of 10ml/kg it is not difficult to see how such gross levels of suboptimal ventilations have been reported within medical literature. In a recent study, emergency department personnel were observed to have ventilated 80 cardiac arrest patients at a median rate of 18 VPM[5], while other authors have observed rates as high as 70 VPM by some emergency care providers.[1,9] With 53% of students recognising that 10ml/kg was the most appropriate tidal volume in the cardiac arrest patient (a practice that was changed in the 2000 ILCOR guidelines). This finding is further supported by medical literature that highlights some tidal volumes found to be as high as 1000ml during CPR.[8]

It is now well accepted that oxygenation can be maintained in the apnoeic patient with reasonable tidal volumes of 6-7ml/kg (approximately 400-600ml) with the use of supplemental oxygen.[10] Patients with an unprotected airway are particularly prone to developing life threatening complications associated with overzealous tidal volumes. Stomach inflation is a commonly encountered complication of ventilation in the unprotected airway, and is the catalyst for secondary life threatening complications such as regurgitation,[11,12] aspiration,[13] pneumonia[14] and death.[15] Excessive tidal volumes have also been associated with an increased risk of pulmonary barotrauma, particularly in the intubated patient, where ventilation volumes are usually restricted to lung capacity.[16]

In addition to assessing participant knowledge of ILCOR ventilation guidelines, it was also necessary to observe whether students had grasped the cascade of physiological events that lead to secondary complications such as gastric inflation. Two animal studies[17,18] have provided insight into the physiology of LOSP in human cardiac arrest with mechanical models highlighting significant levels of gastric insufflation under cardiac arrest simulations.[19] These concepts are further reinforced with the underpinning evidence that peak airway pressures in cardiac arrest often exceeds LOSPs, with one author reporting airway pressures as high as 100cmH_2O.[20] This study looked briefly at the concept of LOSP to assess student understanding of basic respiratory physiology (Figure 3 & 4). These results are concerning, as the frequency and extent of answers highlight a significant knowledge gap amongst the student sample. This study identified that 93% of students had a poor understanding of normal LOSPs in a conscious healthy adult, while 83% of students were unable to identify that LOSP were likely to fall in the setting of a cardiac arrest. With minimal

or no appreciation of these basic physiological concepts, it is not difficult to conceptualise the potential deleterious outcomes this may lead to during ventilation and/or CPR. These results highlight the need for a re-evaluation of the education process and content relating the physiology in a cardiac arrest patient.

These results revealed a clear knowledge deficit within the student sample. It is unknown whether knowledge gaps such as these were likely to affect ventilation performance. From a theoretical standpoint, these questions prove crucial in detailing the rationale behind recent changes to ILCOR resuscitation guidelines, and if at the very least, highlight the growing concern of hyperventilation in cardiac arrest. With further introspection, the cause of the knowledge deficit was likely to have been caused by a lack of education in this area rather than any external factor. Monash University Bachelor of Emergency Health (BEH) subject material suggests that the education of LOSP in the setting of cardiac arrest is not covered within the cardiovascular subject or anywhere within the course structure. In addition several other factors were hypothesised to have influenced participant answers:

- Student absenteeism may have affected the level of individual participation during lectures.
- Students in the BEH course do not undertake further ALS training until the subsequent teaching semester and therefore do not re-visit CPR guidelines in the patient with an advance airway for some time.
- Sessional clinical instructors (who were practicing ambulance paramedics) often undertook tutorials and lectures for students. It is unknown whether all sessional instructors were adequately assessed to be proficient in ILCOR resuscitation guidelines and not just those pertaining to their respective prehospital care organisation.
- Students were likely to have been influenced by industry expectations. Current clinical practice guidelines within Victoria, Australia continue to quote the use of a tidal volume of 10ml/kg within some guidelines.[21] This is likely to affect sessional instructors who are required to practice under these guidelines rather than an accepted international standard.

The results from this study have highlighted that there needs to be a review of the resuscitation content of the undergraduate paramedic course to ensure students are understand the current ILCOR guidelines and basic respiratory physiology. This review is in line with the Monash University Teaching Research Nexus, in which current teaching is informed and directed by quality scientific research within the relevant discipline.

This study is potentially limited by small sample size and hence the results lack external validity and should be interpreted with caution.

CONCLUSION

This pilot study suggests that third year undergraduate paramedic students at Monash University have a poor retention of ventilation resuscitation guidelines and LOSP values. These results provide a new dimension not previously explored by the literature in this area. The emphasis on ventilation education, training and reinforcement is paramount as each student prepares to undertake the role of a novice paramedic.

Acknowledgements

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