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Original Research

The accuracy of undergraduate paramedic students in measuring blood pressure: A pilot study

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ABSTRACT

Introduction

Measurement of a blood pressure (BP) in the prehospital setting is one of many basic skills required of a paramedic. Assessment of BP is also one of several clinical measures that determines the patient's treatment and possibly the receiving hospital. To date there have been no studies of undergraduate paramedic students and their accuracy in BP measurements. The objective of this study was to determine the accuracy of undergraduate paramedic students in taking a BP in a non-clinical setting.

Methods

This was a prospective observational study using the Laerdal VitalSim mannequin with the BP volume and strength set at mid range values to test the accuracy of BP measurement. There were 62 third year Monash University paramedic students available for the study. We used three different BP ranges, a low, normal and high BP. Each student was randomly assigned the first and second BP by using a random number table. Each student was permitted one practice BP prior to the study data collection commencing. Ethics approval was granted.

Results

A convenience sample of 26 (42%) third year undergraduate paramedic students participated. 69% were female, with 46% being between 21 and 25 years of age. Two students, nurses, had previous BP measurement experience. There were six, four and four students who accurately measured the high, normal and low BP respectively. There was a statistical significant difference between the actual and student measured BP for the high systolic BP ($p=0.004$), normal systolic BP ($p=0.023$), and low systolic ($p=0.019$) and diastolic ($p=0.004$) BP.

Conclusion

This pilot study has highlighted that third year Monash University paramedic student's lack BP measurement accuracy in a non-clinical setting. This pilot study has highlighted the need for a review of how the teaching of BP measurement is undertaken within the curriculum.

Keywords

Blood pressure, education, paramedic, emergency medical technician, student

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INTRODUCTION

Blood pressure (BP) measurement is one of the many basic skills required of a paramedic. A patient's BP can impact their triaging, clinical management, and potentially, even the hospital they are transported to. All these factors will impact patient outcomes, as well as determine efficient use of scarce health resources, for example, inappropriate transportation of a trauma patient to a Level 1 trauma centre when in fact they did not need that level of care (1).

The BP is a commonly used vital sign measure when triaging patients in hospital. Engum et al identified BP as the most accurate trauma triage criteria of major injury for paediatric patients in the prehospital setting (2). Cooper et al examined the triage decisions of nurses before and after taking vital sign measurements and found that when a triage decision was upgraded due to subsequent vital sign measurement, abnormal BP was most often cited as the determining factor (3). In the Cooper et al study, 5.5% of triage decisions were upgraded and 2.4% were downgraded following vital sign measurement, highlighting that inaccurate or unmeasured vital signs can impact triage decisions.

Incorrect or inappropriate triage decisions can lead to negative patient outcomes. In a study examining outcomes for patients who were triaged to an intensive care unit (ICU), mortality was 22-32% higher in patients who were not triaged to the ICU compared to those who were (4). Likewise the conclusions drawn from a Scandinavian study showed that under-triaging of patients with severe trauma by paramedics is a significant marker for those patients having an increased risk of mortality due to inappropriate treatment and trauma centre trauma team activation (5).

An example of how accurate triage can affect the patient's treatment and ultimately their destination hospital is the state-wide trauma bypass policy of the Victorian Government, Australia, where by patients fitting major trauma guidelines are transported to major trauma centres throughout Victoria (6). Evidence suggests that the timely delivery of seriously injured patients to major trauma facilities helps in achieving optimal outcomes (7). Therefore this further highlights the importance of obtaining an accurate assessment of a patient's injuries and physiological status, including the BP.

The skill of BP measurement is central to the effectiveness of the majority of healthcare practitioners, including paramedics. As such, previous authors have discussed the different confounding factors, grouping them into the categories of patient, technique, and equipment. One report has estimated that BP measurements can vary 15 mmHg or more from the actual BP due solely to technique (8). Numerous studies have detailed the specific technique errors which can confound results, such as rapid cuff deflation, inappropriate cuff size, excessive pressure on the head of the stethoscope, inappropriate interpretation of Korotkoff sounds (9), arm support and position, rounding preference (8), and talking during measurement (10). Likewise, studies have detailed the effects of patient related factors, which can influence BP measurement, such as their emotions, activity, bodily functions and environment (11). In addition, incorrect measurements due to equipment failure are also possible (12).

To date, there have been no studies examining the accuracy of undergraduate paramedic students in BP measurement in non-clinical situations. The objective of this study was to determine the accuracy of undergraduate paramedic students in taking a BP in a non-clinical setting.

METHODS

Design

This study was a prospective single-blinded observational pilot study that used a convenience sample of undergraduate paramedic students.

Definitions

By accurately or correctly measured the blood pressure value we mean that the student reported value was the same as the value set by the assessor in the mannequin control.

Participants

Students eligible to participate in the study were enrolled full-time in year three of the Bachelor of Emergency Health (Paramedic) degree offered through Monash University, Victoria, Australia. There were 62 third year students eligible to participate in the study. The students undertake BP measurement education in semester one of first year, and continue using the skill during clinical simulations for the remainder of the course.

Mannequins

Two Laerdal VitalSim Resusci Anne mannequins were used in this study. The pulse volume of each mannequin was set to five (maximum of nine) and the pulse rate was set to 80 beats per minute with the pulse strength of normal (maximum of strong). The stethoscopes used by students were the Heine Gamma 22. Two investigators (MB and BW) tested all equipment prior to data collection.

The pulse volume had to be increased to nine after the first two students as they both had difficulty hearing the generated pulse. Neither of the assessors had difficulty in hearing the generated pulse when the volume was set to five.

Procedures

The students were invited to participate at the end of a lecture with the study set at a time when there was no student participation required in lectures, tutorials or practical sessions.

Students were randomly assigned to one of two rooms containing a mannequin using a random numbers table. The students were then given an opportunity to practise measuring the BP of the mannequin by palpation and auscultation. The BP of the mannequin for each group was set to 120/80 mmHg for the practise run. The students were shown where to position the BP cuff, the brachial pulse, and the best position for the stethoscope head for optimal performance. Each student, if desired, had several attempts to get use to the mannequin and how the pulse sounds were presented. The BP was checked by two of the assessors prior to commencing the study and after changing the pulse volume.

Students were then required to measure the systolic and diastolic BP of the mannequin in three different BP settings, high, normal and low. The order of the BP setting was determined randomly using a random numbers table. The high values were 200/140, 205/160, or 210/150; normal values were 140/90, 135/85, or 125/90; and low values were 60/40, 75/55, or 80/50. The allocation of the high, normal and low values were randomly allocated using a random numbers table. There were no time restrictions on the BP measurement.

The demographic information of the participants, as well as their BP measurements was recorded on a data collection form. Student involvement in the study was voluntary and they were advised they could withdraw at any stage without question.

Data Analysis

The SPSS program (Statistical Package for the Social Sciences Version 19.0.0.1, IBM Corporation, Armonk, New York, U.S.A.) was used for data storage, tabulation, and the generation of descriptive and inferential statistics. Descriptive statistics, means and standard deviations, were used to summarise the demographic and some of the BP measurement data. Inferential statistics, t-tests and one-way analysis of variance (ANOVA), including post hoc tests, were used to compare the differences between age groups and gender. All test were two tailed with the results considered statistically significance if the p value is < 0.05.

Ethics

Ethics approval for the study was granted by the Monash University Human Research Ethics Committee.

RESULTS

Demographics

There were n=26 (42.0%) students that participated in the study with n=18 (69.0%) being female. Of the students, n=10 (38.5%) were under 21 years old with n=12 (46.2%) between 21 years and 25 years old, two (7.7%) between 26 years and 30 years of age, one (3.8%) between 36 years and 40 years of age, and one (3.8%) between 41 years and 45 years of age. Two students, both former nurses, had previous BP measurement experience.

For the gender and age groups no comparative statistical results were possible due to the small numbers in the respective variables and/or cells when performing the calculation.

High BP

In this situation six (23.1%) students correctly measured the systolic and diastolic values. When reviewing the individual components, 11 (42.3%) students correctly measured the systolic BP, and eight (30.8%) students correctly identified the diastolic BP. See Table 1 for additional results.

Normal BP

In this situation four (15.4%) students correctly measured the systolic and diastolic values. When reviewing the individual components, eight (30.8%) students correctly measured the systolic BP, and 13 (50.0%) students correctly identified the diastolic BP. See Table 1 for additional results.

Low BP

In this situation four (15.4%) students correctly measured the systolic and diastolic values. When reviewing the individual components, eight (30.8%) students correctly measured the systolic BP, and 13 (50.0%) students correctly identified the diastolic BP. See Table 1 for additional results.

DISCUSSION

The results of this study suggest that third year paramedic students at Monash University are not able to accurately measure various blood pressures in a non-clinical, non-pressure, situation on a medium fidelity mannequin. At best, only 50% of the students were able to accurately measure at least one of the blood pressure (BP) components, systolic or diastolic BP.

Of the three BP confounding factors – technique, patient, and equipment, only technique factors were not specifically controlled for in this study, therefore, it is possible that inappropriate technique was the main contributing factor in the student's inability to accurately measure a BP.

Simulated BP Level	Correct n=(%)	Reading Range Low to high	Significance between actual and student p value
High			
Systolic	11(42.3)	-25 to +30	0.004
Diastolic	8(30.8)	-40 to +25	0.884
Normal			
Systolic	8(30.8)	-40 to +25	0.023
Diastolic	13(50.0)	-40 to +20	0.680
Low			
Systolic	8(30.8)	-5 to +28	0.019
Diastolic	13(50.0)	-10 to +20	0.004

Table 1: Accuracy of blood pressure readings

This may indicate that the quality or quantity of the instruction that the student's received was inadequate, including inadequate theoretical explanation, emphasis of the importance of BP as a vital sign measure, or supervised practice time.

At the time of this study, the students had not been required to display their BP measurement skills in an examination setting as part of their course, though they regularly undertook BP measurements during simulation sessions. Whilst these BP measurements were undertaken on various mannequins during their simulation time some were not capable of generating a pulse, therefore the students went through the process and were given the BP by the facilitator.

While the quality, quantity, and the date of instruction that each individual student had received in measuring BP varied and was not specifically measured, the syllabus for the third year students in question included approximately 3 hours of theory and instruction in the measurement of BPs in the first year of the course. When this current group of third year students were undertaking supervised BP measurement in first year there were no two-headed stethoscopes in which the facilitator could check the student's findings concurrently.

The results of this study indicate that this level of instruction may be inadequate in educating students to accurately measure a BP. It may also suggest that students require more targeted learning while on their clinical placements, which may be difficult to achieve. Future studies may attempt to control for these variables, by either accurately measuring past education or including a complete educational session before BP measurement testing.

Equipment confounding factors were controlled for in this study, as each participant used the same equipment, which was individually tested by practicing paramedics before the study. Likewise, patient factors were controlled for through the use of the medium fidelity mannequin. These two factors do however demonstrate that BP measurement contains more variables in a clinical setting than in a simulation setting with this study finding that students were unable to accurately measure a BP with these factors controlled for. Although it is extremely likely they will experience considerably more difficulty when having to apply this skill in a clinical setting on real patients.

Another explanation for the results is that the students were unable to accurately interpret the Korotkoff sounds. Of note, we did notice some students listening to portable music devices prior to enrolling in the study. The issue of students having hearing deficiencies needs to be investigated further as this may have further ramifications when they become novice paramedics. Good hearing is required to determine manual BP measurement and when listening to lung sounds, both which may determine the patient's management and hospital destination.

We were unable to accurately identify the differences in the accuracy of the systolic and diastolic measurement by students for the different levels of each BP. The issue may be multifactorial, involving the student's hearing ability, their understanding of where the sound should be measured, and the way in which the mannequin produces the systolic and diastolic sounds. This may be an issue that is addressed in further studies.

A prehospital based study investigating paediatric triage found the accuracy of BP measurement to be 86% (2). The result from the Engum et al study in a clinical setting is of concern, even though it was with paediatric trauma patients. The issue with this study was that such a small number of students accurately measured the various BPs in a non-clinical, non-pressure, situation. This inaccuracy in a non-clinical, non-pressure, setting does not bode well for the students in a pressurised clinical situation, as novice paramedics their clinical supervisors will need to check their assessments to ensure it is an accurate representation of what the patient is presenting with.

The findings of this study suggest there is a need to review the teaching strategies and curricula alignment of BP education, including the quality and quantity of theory and in the simulation setting. There is also a need for students to have regular assessments of their skills, especially BP measurement using two-headed stethoscopes, to ensure they are work ready when employed as novice paramedics. This study also points to a need for students who become novice paramedics to be adequately and closely supervised, in the early months, to ensure they are competent in measuring a BP in a clinical setting.

This study is potentially limited by a lack of realism in the use of the mannequins; however the use of living people does carry the added complication of controlling for variations of their BP between students, as well as other confounding patient factors, such as the 'white coat effect' (13). In addition, the small sample size and convenience sampling may lack validity when applied across other populations. Further research may also assess accuracy across the years of the course for participants, in an attempt to determine the quality and quantity of education and experience that is required to become proficient in BP measurement.

CONCLUSION

The results of this pilot study have demonstrated that third year Monash University paramedic students are not able to accurately measure a BP. These pilot results have important implications for teaching and learning approaches, and suggest that alternative or improved BP measurement practices are implemented within the paramedic curriculum.

CONFLICT OF INTEREST

The authors declare they have no conflicts of interest and that this study received no financial support.

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