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The accuracy of manual blood pressures obtained by paramedic students in both quiet and simulated roadside environments

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Research

The accuracy of manual blood pressures obtained by paramedic students in both quiet and simulated roadside environments

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Abstract

Introduction

It is well recognised that ambient noise impacts on the accuracy of auscultation. Often, paramedics are required to manually obtain blood pressures on the side of the road where ambient traffic noise might impact on its accuracy. This study aimed to determine the level of agreement between manual blood pressure results obtained in a quiet and simulated roadside environment.

Methods

An experimental prospective study in the repeated measures design was utilised to determine whether paramedic students could accurately determine the manual blood pressure in a quiet and simulated roadside environment. A roadside environment was simulated by looping road traffic noise at constant volume. A cross-over control was employed. The accuracy of the blood pressure recorded in the quiet environment was contrasted to that obtained in the simulated roadside environment using the Bland-Altman plot.

Results

The data of 60 paramedic students (120 measurements) were analysed. The mean bias (95% CI; standard error) for the systolic blood pressures (SBPs) was -1.28 (-2.83; -2.64; 5.99) while the mean bias for the diastolic blood pressures (DBPs) was -1.2 (-3.12; 0.71; 7.39). The 95% limits of agreement are -13.02 to 10.46 and -15.68 to 13.28 for the SBPs and DBPs respectively.

Conclusions

This experimental study found that paramedic students are able to accurately obtain a manual blood pressure in a simulated roadside environment. However, a clinically significant discrepancy of 20-28 mmHg in SBP or DBP might still be appreciable in some cases. Further, more robust studies in a range of different pre-hospital settings are recommended to corroborate these findings.

Keywords:

emergency medical services, blood pressure determination

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Introduction

Pre-hospital hypotension has been found to have a significant impact on mortality in the trauma population (1) and blood pressure (BP) management forms a central part of the treatment goals in many patient populations (2-3). Yet obtaining a manual blood pressure in the pre-hospital setting might be particularly challenging because of ambient noise and vibration (4-5). A dated study (1994) found discrepancies of up to 47 mmHg ($p < 0.01$) in 485 manual BP measurements taken in a moving ambulance as compared to those obtained in a quiet environment (4). The authors suggested road traffic noise to be a causative factor in these discrepancies. The effects of ambient noise on the accuracy of BP measurements and the auscultation of lung sounds have also been well documented in other clinical contexts (6-7).

Unfortunately, merely using automated devices (that do not require auscultation) may not be the solution to this problem. Firstly, these devices might not always be available in resource limited settings (such as South Africa, where the current study was conducted). In addition, the accuracy of automated devices has been brought into question. A systematic review published in 2011 aimed at comparing the accuracy of manual and automated BP measurements (8). The authors concluded that automated devices might be suitable for general clinical use, but are increasingly inaccurate in trauma patients and patients with dysrhythmias and hypo- or hyper-tension (8). Unfortunately, these are often the patients seen in the pre-hospital environment. This study aimed to determine the level of agreement between manual BP results obtained in a quiet and simulated roadside environment.

Methods

Study design

An experimental prospective study in the repeated measures design was utilised.

Participants

A convenience sample of paramedic students from the University of Johannesburg in South Africa was selected as they all had the same training in obtaining a manual BP. Students are exposed to a master demonstration and given a standardised procedure check sheet, where after they practise on a BP simulator arm under instruction. When students feel competent in the skill, they are assessed as competent by way of Objective Structured Clinical Examination before they progress to BP measurement on real patients during clinical learning placements. This skill is acquired in the first year of study. Paramedic students were recruited by attending an information session on the study hosted by the principal investigator.

Procedure

Volunteer paramedic students were required to obtain a manual BP on a Laerdal blood pressure training arm (Model No. 375-40501, Laerdal Corp., Stavanger, Norway) in a quiet and a simulated roadside environment, both within a lecture classroom. The training arm and its manual sphygmometer

were calibrated as per the manufacturer's specifications. Each participant used the same sphygmometer and stethoscope (disinfected after each use) to exclude this as confounder. All students that participated in the study were previously found competent in this skill.

To minimise the safety risk to participants and to ensure identical inter-subject conditions, a simulated roadside environment was chosen, and was created by looping an audio recording of road traffic noise that was obtained from an open access internet source (9). The road traffic noise was looped continuously during the experiment at a constant volume using a standard sound system and amplifier (Laptop computer, Compaq nc6230, Hewlett Packard, Beijing, China; 400 watt Speakers with internal power amplifier, Wharfedale, Bradford, United Kingdom; 300 watt Amplifier, Soundcraft, Harman International Industries Ltd., London, United Kingdom). Unfortunately, we were unable to find a reliable reference range for road traffic noise volumes. The volume in this study was selected based on consensus between the researchers with extensive pre-hospital experience and deemed a valid reflection of typical road traffic noise.

To minimise variability, each participant functioned as his/her own control after a 4 day interval. On day one, all participants obtained the BP in a quiet environment, while on day four all participants obtained the BP in the simulated roadside environment. Participants were blinded to the actual BP value set on the training arm. The control BP was set at 114/84 mmHg.

Data analysis

The systolic and diastolic BPs reported by each subject were independently compared for the levels of agreement using a Bland-Altman (BA) Plot. The BA Plot was generated in Microsoft Excel 2010 (Microsoft Corp., Washington, United States) and a statistical software add on, XLStat 2013 (Addinsoft, New York, United States).

Ethics

All participants gave written informed consent prior to commencement of data collection. Ethics approval for the study was obtained from the Faculty of Health Sciences Research Ethics Committee of the University of Johannesburg.

Results

A total of 75 paramedic students volunteered and consented to take part in the study. However, 15 students did not arrive for the second day of data collection, yielding a 20% attrition rate. The data of 60 students (120 measurements) were therefore left eligible for analysis. Of these 66% ($n=40$) were male, 43% ($n=26$) were in the first year of study, 25% ($n=15$) in the second year, 18% ($n=11$) in the third year and 13% ($n=8$) were in the final year of study. Table 1 shows the descriptive data of the sample.

Table 1. Descriptive analysis of sample				
Variable (mmHg)	Minimum	Maximum	Mean	Standard deviation
Quiet SBP	100.0	118.0	110.3	2.7
Noisy SBP	90.0	120.0	109.0	4.7
Quiet DBP	70.0	90.0	81.7	3.8
Noisy DBP	45.0	90.0	80.5	7.5

SBP = systolic blood pressure, DBP = diastolic blood pressure

Bland-Altman plot

Figures 1 and 2 show the BA plots for the levels of agreement between the SBPs and DBPs obtained in the quiet and simulated roadside environments. The mean bias (95% CI;

standard error) for the SBPs was -1.28 (-2.83; 0.24; 0.77) while the mean bias for the DBPs was -1.2 (-3.12; 0.71; 7.39). The 95% limits of agreement are -13.02 to 10.46 and -15.68 to 13.28 for the SBPs and DBPs respectively.

Figure 1. Bland and Altman plot for systolic BPs in the different environments

Figure 2. Bland and Altman plot for diastolic BPs in the different environments

Discussion

The variance data of the sample (Table 1) shows a general discrepancy between the simulation set and obtained BPs in both the quiet and noisy environments. However, a consistently narrower SD around the mean is appreciable in the quiet BP measurements when compared to the noisy environment. This tends towards a larger and more haphazard measurement in the noisy environment, which brings the accuracy of the BP results obtained on the roadside into question. Yet, a larger variance is appreciable in the DBP measurements, and considering that SBPs are generally targeted as therapeutic goals in emergency care (2-3,10), the impact of inaccuracies may not be clinically important.

When considering the results of the Bland-Altman plots the mean bias for SBP (-1.28 mmHg) and DPB (-1.2 mmHg) are essentially negligible and do not indicate much clinical significance. Yet, wide limits of agreement are appreciable in both systolic (-13.02 to 10.46 mmHg) and diastolic (-15.68 to 13.28 mmHg) measurements. When considering these limits of agreement a discrepancy of as much as 28 mmHg might be expected when obtaining a BP manually in a

roadside environment as compared to a quiet environment. Notwithstanding the effect that the sample size might have had on the results (a larger sample size might yield a narrowed limits of agreement), the clinical impact of such large differences might be significant considering the narrow bands of therapeutic goals in certain patients (such as haemorrhagic shock and traumatic brain injuries) (2-3,10). A small mean bias and limits of agreement including zero, may lead to the conclusion that paramedic students are able to obtain a manual BP in a simulated roadside environment with similar accuracy than those obtained in a quiet environment. Yet, these results should be interpreted with caution as the limits of agreement are quite wide. This might be explained by a relatively small sample size.

Although not formally recorded, it was observed that subjects took generally longer and required between one and three attempts more to obtain a BP in the simulated roadside environment compared to the quiet environment. This might express a general increase in the difficulty of obtaining manual BPs in noisy (and roadside) environments when compared to those obtained in quiet environments and requires further investigation. Often, even in the time-critical pre-hospital environment, taking longer to determine the BP may not have an appreciable clinical implication.

Limitations of this study

An inherent bias may be appreciable as this study was conducted in a simulation-based setting and the simulated noise levels were not validated. Simulation bias is acceptable in this instance as confounders needed to be excluded (which may not be possible at the roadside) and the same amount of traffic noise was required in each subject to make datasets comparable. Using a constant BP value as control might have detracted from the clinical realism of the results. A further limitation is the relatively arbitrary selection of road traffic noise volume in the simulated environment. However, we believe that this improves the construct and ecological validity of the results as much variance exists within the road traffic noise experienced from one real-life accident scene to another. An attrition rate of 20% was appreciable, and the effect of attrition bias can therefore not be excluded. Having a limited sampled population detracts from the external validity and generalisability. A further limitation is that the time taken and attempts at determining the BP was not formally studied, but observed.

Conclusion

This experimental study found that paramedic students are able to accurately obtain a manual BP in a simulated roadside environment when compared to a quiet and controlled one. This is evidenced by a close to negligible mean bias between the two environments that is clinically unimportant. However, a clinically significant discrepancy of 20-28 mmHg in SBP or DBP might still be appreciable in many cases. This study was limited by its relatively small sample size and lack of generalisability. Further, more robust studies in a range of different pre-hospital settings are recommended.

Conflict of interest

The authors declare they have no competing interests. Each author of this paper has completed the ICMJE conflict of interest statement. The research was self-funded by the primary author.

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