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# Medical and nursing students' knowledge of accurate blood pressure measurement procedure in University Malaysia Sarawak

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**ABSTRACT**

Blood pressure measurement is a basic, frequently-used clinical procedure. Nowadays with increasing use of automatic devices, blood pressure measurement procedure is the most inaccurately performed by the healthcare professionals. The medical and nursing students need good knowledge of accurate measurement procedure for correct diagnosis of hypertension. Our study assessed the knowledge of blood pressure measurement procedure among medical and nursing students in Faculty of Medicine and Health Science of University Malaysia Sarawak (UNIMAS). This was a quantitative, cross-sectional study. Data were collected from total 242 students (171 medical and 71 nursing programmes) with a pre-tested questionnaire including patient's position, application of instruments, and measurement technique and blood pressure reading. Of 16 items tested, correct answers for 9 items were less than 70%: proper patient's position (66.9%), choice of the arm (59.1%), appropriate cuff size(51.2%), chest piece (bell or diaphragm) of stethoscope used for listening of Korotkoff sound(11.6%), estimated inflation cuff pressure(66.1%), recommended deflation rate(65.3%), preference of last digit of blood pressure reading(60.7 %), awareness of the auscultatory gap (31.0 %), and habit of palpatory method (27.7%). 51.7% of total students (n= 242) had good knowledge scores. There was no significantly different between the medical and nursing students' mean knowledge scores (p value=0.099). Our study found that the students need subsequent learning and practices to improve their knowledge for accurate blood pressure result.

***Keywords:***
Blood pressure measurement procedure, knowledge, medical and nursing



## 1. Introduction

Arterial blood pressure, one of the "vital signs," is an important indicator of a person's state of health. Blood pressure (BP) measurement is always done to screen for hypertension which is a major

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modifiable risk factor for development of stroke, coronary heart disease, myocardial infarction, congestive heart failure, renal failure, and peripheral vascular disease [1]. There are several factors of error with significant practical consequences in measurement procedure. Therefore, accurate BP measurement is an important component to get correct diagnosis of hypertension [2-4].

In spite of the direct blood pressure measurement with an intra-arterial catheter is the gold standard; it is neither practical nor appropriate for repeated measurement in outpatient and for public health screening. The auscultatory method of indirect BP measurement with sphygmomanometer is the most widely used .This method is based on measuring the external pressure requires to compress the brachial artery via: an occluding cuff, stethoscope, and manometer [1]. It is a simple and easy procedure to be conducted, however it can present errors related to the environment, observer, patient and device itself [5]. The American Heart Association [6] recognizes three sources of error in the measurement of BP; observer bias, faculty equipment and, failure to standardize the technique of measurement. Campbell & McKay [7] reported that many studies have shown measurement errors frequently derived from problems with inadequate calibration of the instrument, invalidated devices; as much as from inappropriate procedures such as patients' position and improper cuff sizes. In a study by Perloff, et al.[1] it is found that nursing staffs obey by 40% of the recommended procedures while medical doctors follow by approximately 70%. As consequences of small measurement inaccuracies, errors of 5 to 10 mmHg can commonly occur as a result of improper BP measurement techniques [8].Vermillion [9] emphasized those factors: posture, cuff size, listening skills, operator errors and, environment which were causes of errors in blood pressure measurement.

Recently, there has been a shift towards automated devices in clinical practice because of repeatable standardized techniques and removal of observer bias. However, sphygmomanometer is still the most commonly used device in clinical practice [10]. American Heart Association (AHA) guidelines for in-clinic blood pressure measurement stated that "a patient seated comfortably with back supported, both feet flat on the ground with legs uncrossed is the standardized position. Patient's arm should be bared with supported at heart level, and should not talk during the procedure." BP should be measured in both arms at the first visit to identify coarctation of the aorta and upper-extremity arterial obstruction [11].

The ratio arm circumference/cuff width (AC/CW) must be around 0.40 and the cuff length must encircle AC from 80 to 100% to avoid over or under BP estimation [1]. The European Society of Hypertension Annual Meeting 2007 established guidelines [12] which recommended a standard bladder 12 -13 cm long, size appropriate to nearly 10-30 % of adults' arm circumference. The lower end of the cuff should be correctly placed 2-3 cm above antecubital fossa to allow space for placement of the chest piece (bell or diaphragm) of the stethoscope, and the midline of the bladder cuff should be positioned over the brachial artery in the antecubital fossa of the patient's upper arm [6].

Deflation rate of the mercury column should be at 2 to3 mm per second. The "Korotkoff sounds" is generated by the pulsatile blood flow in the partially compressed artery when the pressure in the bladder is reduced. There are five phases of Korotkoff sounds based on changes in quality and intensity. The first (phase I) and last (phase V) audible sounds should be recorded as systolic and diastolic blood pressure, respectively [13]. In blood pressure measurement, last digit of BP reading should be given to the nearest 2 mm Hg [11].In addition, an auscultatory gap, a period of abnormal silence interval in one of the Korotkoff sound phases can occur occasionally during BP measurement of a hypertensive patient. An unrecognized auscultatory gap might lead to serious underestimation of systolic pressure or overestimation of diastolic pressure. In order to correct for an auscultatory gap, the radial pulsation should be monitored by palpatory method before listening the korotkoff

sounds by auscultatory method [14]. There is evidence that auscultatory gaps are related to carotid atherosclerosis and to increased arterial stiffness in hypertensive patients [15].

Some studies have shown that there are deficient knowledge of blood pressure measurement skills noted in medical, nursing students and clinical nurses. In a study of clinical nurses' knowledge about blood pressure measurement technique at a metropolitan teaching hospital, Queensland, Australia in 2002 [16], the findings indicated that the knowledge was inadequate to perform blood pressure measurement in a standardized manner, and prevent introduced error. González-López JJ *et.al* in 2009 [17] studied on the level of knowledge about correct blood pressure measurement procedures among medical students at the Faculty of Medicine and nursing students at the Foundation Jimenez Diaz School of Nursing, Autonoma de Madrid (UAM) associate center . They reported that only 51.8% of all students knew how to measure blood pressure correctly. In a study of knowledge test of accurate blood pressure measurement skills in medical students at Palmer College of Chiropractice, Florida in 2013, it was found that the knowledge of blood pressure skills of a sample of students were deficient[18]. There were no studies of the assessment of knowledge and skill of the blood pressure measurement among the medical and nursing students in University Malaysia Sarawak. We have postulated that the medical and nursing students' knowledge of blood pressure measurement in our university would be no different from those of students in other medical universities.

Inadequate knowledge of blood pressure measurement may have huge impact on diagnosis of hypertension in clinical practice. Hypertension is increasingly becoming a public health concern in many countries. High prevalence are continuously being reported all over the globe [19].Therefore health professional have good knowledge and the best practices on accurate blood pressure measurement based on the proper guidelines in the students' training period. The present study was to assess how far the students' knowledge of blood pressure measurement with sphygmomanometer to get correct blood pressure result for accurate diagnosis of hypertension.

## 2. Materials and Method

### *2.1 Study Design*

A cross-sectional study carried out to assess the knowledge of blood pressure measurement procedure among the medical and nursing students in the Faculty of medicine and Health Sciences of University Malaysia Sarawak (UNIMAS) from September 2016- August 2017.

### *2.2. Study Population and Sampling Method*

Sample size was calculated by assuming 95% confidence level, 5% marginal error and 52% estimated success population percentage based on total students number of 510. A stratified squamous sampling method was used according to the distribution of the student population by academic year in each medical and nursing programme. A total of 242 students (71% of medical students (n = 171) from year - 2 to 4 and 29% of nursing students (n= 71) from year -1 to 3) were randomly selected in this study.

### *2.3 Data Collection Procedure and Instrument*

The data were collected by using self-administered questionnaires based on American Heart Association Guidelines (New AHA Recommendations for Blood Pressure Measurement) [11]. Questionnaire began with section A: including sociodemographic profile, educational level,

confidence level of students' knowledge about blood pressure measurement, and choice of instrument (i.e. mercury sphygmomanometer or aneroid or digital electronic device). In section B, there were 16 knowledge items concerned with the patient's position, proper application of instruments, and correct procedure and blood pressure reading. Criteria for correct answers are based on authoritative New AHA Recommendations guidelines, 2005 [11]. Questionnaire was piloted with two separate groups of 15 from yea- 3 medical and 15- from year- 3 nursing students. All dubious words and terms were changed to fit the understanding of the original questionnaires.

### *2.4 Data Analysis*

The data were analysed by descriptive quantitative analysis with SPSS statistic version 22. The correct answers were tabulated with distribution of percentage with 95 % confidence interval (CI). We tested differences in percentages of correct answers between the medical students and nursing students. Mean knowledge score of medical and nursing students was compared by using independent t-test. A p value less than 0.05 was considered significant.

### *2.5 Ethical Consideration*

Approval of Medical Ethic meeting at Faculty of Medicine and Health Sciences, University Malaysia Sarawak (UNIMAS) was obtained (UNIMAS/NC-21.02/03-02 Jld.2 (51). Written consent was taken from the participants.

## 3. Results and Discussion

In this study, 70.6 % of total students (n = 171) were confident about their knowledge of blood pressure measurement, however 29.3 % (n= 71) might have not enough knowledge. 80.9 % (n=196) chose mercury manometer as the most appropriate device rather than aneroid and automatic device (electronic or digital).

Detailed breakdown of knowledge items with correct responses were shown as distribution of percentage and the significance of each item was discussed.

In table 1, 66.9% (n= 162) acknowledged sitting position as a standardized position [1]. 23.6% chose supine and 9.5% used standing position. Supine position was an ideal position for hospitalized patient. Those two positions: sitting and standing would give different reading values [20]. Velthoven, Thien, Holewijn, Wilt and Deinum [21] found that sitting with the back unsupported and with the legs crossed would result in an erroneously high blood pressure. 59. 1% thought that both arms supposedly need to be measured at first visit of blood pressure measurement. In some studies [22], approximately 20% of patients would have differences of more than 10 mmHg between each side of the arm. If there was consistently different in blood pressure between the arms, the arm with higher pressure should be recorded subsequently. Because partial obstruction might cause blood pressure to be consistently lower in one arm.

86.8% of total students were aware of proper placement of the arm's position at the level of patient's heart. Placing the arm lower than the level of the heart would result in a higher blood pressure result, while placing it above the level of the heart would result in a lower result. Netea, Lenders, Smits and Thien [23] reported that for each 5 cm changes in arm position relative to the heart, there was a corresponding change in blood pressure by 3-4 mm Hg. 92.6% had knowledge that patient must sit quietly during blood pressure measurement. Activities like talking, having meal and drinking during measurement might cause some deviations in values [1]. 92.1% of total students had

known that the cuff should be applied on bared arm to get the most accurate result. Failure to remove clothes made increased arm circumference leading to further erroneous reading.

Moreover, only 51.2% of total students selected proper cuff size .Use of inappropriate cuff size that was common mistake made by the most of healthcare professionals [10]. Ignorance of appropriate cuff size was increasingly important as arm circumference was growing with the obesity epidemic [11]. 80.2 % gave correct answer about the proper placement of the centre of the cuff bladder (arrow marked on the cuff) which was over the brachial artery. Blood pressure measurement OSCE station guide [24] stated that "the arrow marked on the bladder cuff needed to put in line with the brachial artery when the cuff was wrapped around the patient's upper arm. Inflating bladder directly pressed over the brachial artery to make sure for getting enough pressure during inflation."

Regarding with the use of stethoscope, 11.6 % used the bell, 85.1 % chose the diaphragm, and only 3.3 % used both bell and diaphragm when listening to Korotkoff sound. The bell, low frequency filter of the microphone, permitted more accurate auscultation of the Korotkoff sounds than the diaphragm, especially at diastolic blood pressure [25]. However, most studies indicated that there was no significant difference when using the bell or diaphragm [26-27]. 92.1% clearly understood correct placement of chest piece of stethoscope over the brachial artery. Prineas and Jacobs [25] reported that the Korotkoff sounds were heard well with the bell of the stethoscope placed over the brachial arterial pulsation than other area over the antecubital fossa.

66.1% understood how far inflate the level of cuff pressure roughly. Perloff *et al.* [1] stated that "in order to determine the level of estimated inflation pressure to which the cuff should be inflated, while the radial pulse was palpating. The observer detected the point at which the pulse disappeared during inflation and re-appeared on deflation. After waiting for 30 seconds and re-inflated to a point 20-30 mmHg higher than the level noted in initial palpatory method." 65.3% knew recommended deflation rate of the cuff pressure. As mercury columns were calibrated in 2 mm division, cuff pressure should be deflated 2 mmHg per beat [11].Regarding preference of last digit of blood pressure reading on calibrated scale, only 60.7 % were aware of last digit of terminal reading. It should be recorded to the nearest 2 mmHg when using the mercury manometer to compensate for rapid and slow heart beats [6]. Remaining students did not understand how to read the last digit of blood pressure on calibrated scale.

97.1 % and 91.3% of total students gave correct answer for systolic blood pressure (SBP) and for diastolic blood pressure (DBP) recording respectively. Detection of the first repetitive tapping sound (Phase I Korotkoff sound) was accepted as SBP and last audible Korotkoff sounds (phase V) as DBP [11]. It showed that almost all students clearly understood the underlying principle of the systolic and diastolic blood pressure. Lastly, it was noticeable that only few of the students (31.0 %) had the knowledge about the auscultatory gap. 27.7 % were aware of the importance of palpatory method to avoid the auscultatory gap. Most of the students were unfamiliar with how to avoid an auscultatory gap and its clinical importance. An unrecognized auscultatory gap resulted in erroneous blood pressure reading: underestimation of SBP and overestimation of DBP [28].

Grading of knowledge scores was done depending upon numbers of correct answers given by using SPSS statistics. Total knowledge scores were 16. The mean score of all the students was 10.71. 12.4% of the total students (n= 30) had very poor, 36.0% (n= 87) had poor knowledge, and 51.7% (n= 125) had good knowledge scores [33.1% (n= 80) had good knowledge and 18.6 % (n=45) had very good knowledge score] shown in table 5.The findings were similar with those findings from other studies [16, 17, and 18]. It might be due to the increasing use of automatic devices, method of blood pressure measurement became more simplified. Therefore most students were not aware of the standardized procedure such as the proper position of the patient, the use of the correct cuff size based on recommended guidelines.

Of the 16 knowledge items of blood pressure measurement tested, there was significantly different ($p < 0.05$) between medical and nursing students' knowledge of following 9 items: the patients' position, side of arm chosen, barred arm or arm covered with clothes during measurement, correct cuff size, choice of bell or diaphragm of stethoscope and its proper placement on the arm, estimated inflation pressure, awareness of auscultatory gap and habit of placatory method to avoid the auscultatory gap. The higher percentage of medical students acknowledged some items such as estimated inflation pressure, silent gap in auscultatory method and clinical significance of palpatory method. In contrast, nursing students had known some knowledge items: proper sitting and arm position of the patient, and identification of Korotkoff sounds.

However, overall mean knowledge score of blood pressure measurement was not significantly different between the medical and nursing students shown in table 6 (p value=0.099). Because the medical students in our faculty had neither retrained period nor practice based on guidelines after learning how to measure blood pressure during the practical session in year-2, medical programme. The medical students might have a gap between knowledge and hand on practices. The nursing students had blood pressure measurement practical session in each year of nursing programme from year -1 to year -3.

## 4. Conclusion

We found that medical and nursing students had inadequate knowledge of blood pressure measurement procedure to perform accurately. Moreover, the level of knowledge score was not significantly different between medical and nursing students. Of 16 knowledge items, correct responses for 9 items were less than 70 % which was our concerned. Those students should have enough knowledge to avoid the common mistakes which were accidentally done during measurement procedure. They need to be aware standardized procedure based on guideline to correct blood pressure result. As blood pressure measurement is a basic crucial skill in physical examination of patient, students should have learned to be good enough knowledge and practical skills since preclinical year. Therefore, we concluded that there was a need for subsequent training and practices in our teaching program. Moreover, we hope that this study may improve the quality of learning in medical education to produce competent doctors and nurses in the future.

## Limitation of the Study

We need a larger sample size including all level of medical and nursing courses. Further research is needed that takes into account not only the knowledge test with questionnaires but also psychomotor skill by direct observation for more accurate conclusion.

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