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The Frequency of Errors of Blood Pressure Measurement among Nurses in the Hospitals Affiliated to Shiraz University of Medical Sciences, 2014

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ABSTRACT

Background: The global prevalence of hypertension is one billion persons resulting in about 7.1 million deaths per year. In Iran, no statics of hypertension is available, but it has been reported that 40% of deaths are caused by cardiovascular diseases. Measuring blood pressure is one of the basic principles of medical examinations; however, the quality of the scientific standards of its technique is not highly observed.
Objectives: The present study aimed to evaluate the frequency of errors of measuring blood pressure among B.Sc. nurses working at in government hospitals of Shiraz, Iran.
Materials and Methods: This descriptive-analytical, cross-sectional study was conducted on 250 nurses selected from various wards. The study data were collected using the standard check list of blood pressure measurement, technique of American Heart Association (AHA guideline), and a questionnaire containing questions regarding knowledge about blood pressure measurement skills.
Results: This study showed that 54.0% and 78.0% of the participants obtained moderate scores (50 - 74.99) in the theoretical and practical tests, respectively. The results of Pearson's correlation coefficient demonstrated no significant relationship between the scores of theory and practice ($P > 0.05$). Most of the errors in measuring blood pressure in this research consisted of not measuring blood pressure at two stages, not observing its preparations and the proper time interval between the two stages, and not observing the measuring arrangements according to the checklist.
Conclusions: Considering the participants' theory and practice scores, it was concluded that evaluation of blood pressure measurement, which is an important basis in diagnosis and treatment, should be considered as an educational priority of health teams.

►*Implication for health policy/practice/research/medical education:*
Blood pressure measurement is an important basis to start and continue therapeutic care; therefore, it is implied that further education is required in order to increase nurses' knowledge regarding proper measurement of blood pressure.

1. Background

Hypertension (high blood pressure) is a disorder in which blood pressure is chronically higher than its normal value. Based on this definition, it refers to a systolic blood pressure at or above 140 mmHg, a diastolic blood pressure at or above 90 mmHg, or either of these two conditions (1). The worldwide prevalence of hypertension is more than 1 billion people, resulting in almost 7.1 million deaths each year (2, 3) to bring about 13% universal deaths (4). The information collected from the American National Health and Nutrition Examination Survey showed that 50 million or more Americans had high blood pressure and received different treatments (5, 6). Moreover, nearly 30% of adults are not aware of their high blood pressure and more than 40% of those with this disorder are not under treatment. Also, blood pressure of 2/3 of these patients is not under control. Hence, undiagnosed, untreated, and uncontrolled hypertension is an obvious burden imposed on healthcare systems (2).

Blood pressure measurement is one of the most common and the principal basis of medical examinations.

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Unfortunately, because of the failure to follow the standard scientific techniques in its measurement, it is of low quality and its value varies from person to person and from center to center. Thus, precise blood pressure measurement followed by the correct and early diagnosis of high blood pressure is absolutely vital. Most people consider blood pressure measurement a simple task insofar as in some medical centers, in order to reduce the time and the cost of hiring an expert, monitoring blood pressure is assigned to the receptionist or other untrained individuals who have no outlook on this valuable diagnostic method. It is surprising that these unspecialized individuals are also employed to control patients' blood pressure during cardiac stress test (exercise test), a test in which any changes in blood pressure is vital and has diagnostic value (7). By assessing health professionals' techniques of blood pressure measurement in Brazil, Viega et al. concluded that 40% of nurses and nurses' aides and 70% of doctors, assistants, medicine instructors, and nursing students performed blood pressure measurement procedure correctly (8).

Based on the importance of this issue and according to the guidelines published by American Heart Association regarding international standards for screening blood pressure, the complications and fatality resulting from hypertension can be reduced by correct diagnosis and early treatment. On the other hand, there are no statistical data regarding the right method for monitoring blood pressure and its sources of error in Iran.

2. Objectives

The present study aims to evaluate blood pressure measurement procedures and its rate of errors based on the standard techniques used among nurses at Shiraz educational hospitals in order to increase the quality of care and treatment of the patients with hypertension by identifying the flaws and defects.

3. Materials and Methods

This cross-sectional study was done at the educational hospitals affiliated to Shiraz University of Medical Sciences (Nemazi and Shahid Faghihi hospitals) in 2014. In this study, 250 nurses with B.Sc. degrees in nursing were randomly selected from different wards, except for intensive care units due to use of digital sphygmomanometer and pediatrics departments because of the specific situations there. The study sample size was determined considering P = 50% and d = 6.5% and using the following formula:

$$n=(Z_{(1-\alpha/2)})^2*P(1-p))/(d^2)$$

Data collection instruments included:

1) A checklist of standard techniques for monitoring blood pressure by American Heart Association in order to assess the way blood pressure is measured (9).

2) A questionnaire consisting of two parts: a) demographic characteristics and b) questions related to knowledge of the basic methods and preparation for blood pressure measurement and the conditions affecting its value.

In order to assess the reliability of the questionnaire, it was distributed among 50 eligible participating nurses. After 2 weeks, the questionnaires were redistributed among the same group of nurses and the correlation between the knowledge level in the two measurements was calculated using test-retest, revealing r = 0.8 which indicates the acceptable reliability of the questionnaire. In addition, the validity of the questionnaire was approved by faculty members of Fatemeh (P.B.U.H) School of Nursing and Midwifery.

After referring to various wards, the researcher introduced herself and explained the objectives of the study. Then, she asked the nurses who were willing to take part in the research to measure the blood pressure of their assistants and she completed the checklist throughout the experiment. Afterwards, the nurses were required to fill out the questionnaires they were given. It is worth mentioning that the nurses were evaluated based on their practical and theoretical scores calculated using the checklist and the questionnaire, respectively. After all, the data were entered into the SPSS statistical software, version 15 and were analyzed using Pearson's correlation coefficient.

4. Results

This study was conducted on 250 nurses with B.Sc. degrees working at the hospitals of Shiraz University of Medical Sciences. According to the results, the participants' age ranged from 23 to 53 years, with the mean age of 30.7 years. Besides, 86% of the examinees were female and 14% were male. In addition, 42% of the subjects were single and 58% were married. Moreover, 58%, 22%, 8%, and 12% of the participants had bellow 5, 5 - 9.9, 10 - 14.9, and more than 15 years of working experience, respectively.

Theoretical scores below 49.99, 50 - 74.99, and above 75 were achieved by 40%, 54%, and 6% of the nurses, respectively (Table 1). Also, practical scores below 49.99, 50 - 74.99, and above 75 were obtained by 5.6%, 78%, and 16.4% of the nurses, respectively (Table 2).

As Table 3 depicts, there was no significant relationship between the nurses' scores of theory and practice (r = 0.039, P value = 0.543). Therefore, it can be implied that proper performance of the procedure was not the reason for high theoretical knowledge about measuring blood pressure, and high theoretical scores could not guarantee appropriate performance in this regard.

Considering assessment of the knowledge about the preparatory steps of blood pressure measurement, the included issues were patient's rest before the measurement, steps to be taken to calm the patient down, paying attention to the factors that increase blood pressure, including

Table 1. Theoretical Test Scores of the B.Sc. Nurses at the Hospitals of Shiraz University of Medical Sciences

Theoretical Test Scores	Number	Percentage (%)
< 49.99	100	40
50 - 74.99	135	54
75 - 100	15	6
Total	250	100

Table 2. Practical Test Scores of the B.Sc. Nurses at the Hospitals of Shiraz University of Medical Sciences

Practical Test Scores	Number	Percentage (%)
< 49.99	14	5.6
50 - 74.99	195	78
75 - 100	41	16.4
Total	250	100

Table 3. The Relation between the Theoretical and Practical Scores of the B.Sc. Nurses at the Hospitals of Shiraz University of Medical Sciences

Practical Test Scores (Mean ± SD)	Theoretical Test Scores (Mean ± SD)	R	P
66.41 ± 12.76	51.82 ± 12.36	0.039	0.543

smoking, having pain, physical activity or exercise, emotional and breathing states, consumption of caffeine-containing beverages such as tea or coffee, changes in body temperature, and alcohol consumption, and taking into consideration the place of measurement in terms of presence of a catheter, lymphadenopathy, operation, wound, and burn. These preparatory steps were followed by 53.9% of the nurses in this study.

With respect to the knowledge of the accuracy of the sphygmomanometer, the included issues were the type of the used sphygmomanometer, calibration of the device, being sure about the intactness of the stethoscope and sphygmomanometer, and being sure about selection of appropriate cuff width. Overall, 42.57% of the nurses had sufficient knowledge in this regard.

Regarding the knowledge of unusual cases in blood pressure measurement, the questions were about the impossibility of measuring blood pressure from the arms, history of used medications, and whether the subject is suffering from positional vertigo and syncope. These were observed by 28.57% of the study participants.

Considering the knowledge of the right method of doing the procedure, the achieved score was 43.27% and the included issues were washing the hands before doing the procedure, having hand support and the position of the assistant's arm being at the same level as the sphygmomanometer and his/her heart, paying attention to the place of the cuff (2.5 cm above the elbow), finding the brachial artery, the way the cuff is deflated and inflated (inflating the cuff evenly and deflating it 2 - 3 mmHg per second), monitoring the blood pressure measurement in a 2 step-procedure (with first measuring the blood pressure using radial pulse followed by re-inflating the cuff to 30 mmHg above the value of the previous pulse pressure), and observing the least time interval needed between the two measurements (60 seconds) in case a second measurement is required (Figure 1).

5. Discussion

Blood pressure measurement is an important basis to start and continue the therapeutic care and healthcare professionals, including nurses, must be highly skilled in its measurement. However, the nurses in the present study showed average skills in the theoretical and practical tests (scores of 50 - 74.99% were obtained by 54% of the nurses in the theoretical test and 78% in the practical test). Therefore, it is implied that further education is required in order to increase their knowledge regarding proper measurement of blood pressure.

In a research entitled "Evaluation of the techniques used by healthcare workers for taking blood pressure" conducted by Villegas, Arias, and Botero at Columbia University in 1995, 172 of healthcare workers including 63 general practitioners, 50 nurses, 25 internists, and 25 surgeons participated in both practical and theoretical tests. In that study, the number of male and female participants was equal and their ages ranged from 20 to 65 years. In the practical part of the test, there was a maximum of 4 mmHg error in measuring systolic and diastolic blood pressures, with 63% of the participants measuring systolic pressure and 53% of them measuring diastolic pressure erroneously. In the theoretical part of the test which consisted of 10 multiple-choice questions with the passing score of 7 out 10, only

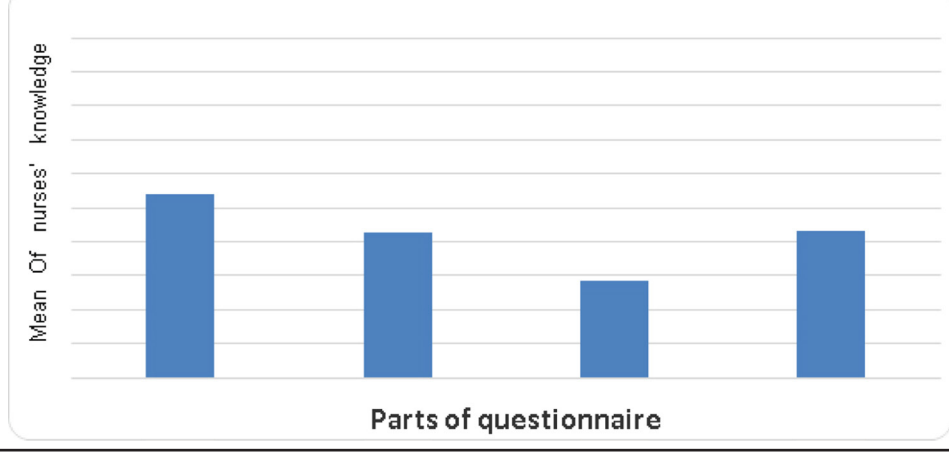

Figure 1. The Relationship between the Parts of the Questionnaire and the Mean Knowledge of the Nurses with B.Sc. Degrees at the Hospitals of Shiraz University of Medical Sciences

60% of the internists, 35% of the general practitioners, 12% of the surgeons, and 5% of the nurses managed to pass. The above results were obtained in circumstances where the participants had good academic and technical backgrounds and all were working in a major hospital (10). In another research done by Robin Armstrong in 2002 to evaluate the errors in blood pressure measurement among 78 nurses using a questionnaire containing questions on standards of blood pressure measurement, only 57% chose the right answer for cuff size, 29% chose the right answer for arm positions, and 62% got the speed of deflation correctly. According to Armstrong, nurses were only checked for their proper performance in measuring blood pressure and for following the standards of the procedure when they were in their student years, but there was no control on their performance in their workplaces (11).

Considering the similarity between the above-mentioned study and the present one, we also believe that the procedure for blood pressure measurement must be monitored and evaluated through ongoing education and training not only during student years but also throughout clinical practice. Besides, there must be more supervision in cases where measuring blood pressure is performed by paramedics and their assistants.

In the research by Joel and Perm, some errors in measurement of blood pressure included unsupported arm and back, wrong cuff size, too low cuff position on the upper arm, cuff over clothing, and not locating the monitor at the level of the observer's eyes (12).

In the current study, the sources of errors in measurement of blood pressure included:

- Not measuring blood pressure in two steps (by first taking the radial pulse and then using a stethoscope for brachial pulse),
- Not following the initial preparations for measuring blood pressure (preparing the patient before the measurement such a way that he/she has no pain and emotional stress, has not smoked or drunk tea/coffee 30 min prior to the procedure, etc),
- Not observing the right time interval required between the two measurements (if two measurements are needed), and
- Not following the order of each step of the procedure using the checklist (checking the pulse in order to measure the blood pressure, not paying attention to patient's position, lack of arm support, etc).

By the same token, Shahedi in his paper mentioned the sources of error in measuring blood pressure to be:

1) Measuring blood pressure once and only from one upper body part,
2) Not knowing the necessity of using a mercury sphygmomanometer as the standard device,
3) Not placing the sphygmomanometer cuff properly, and
4) Taking radial pulse before using a stethoscope.

That study indicated that in terms of the necessary skills for measuring blood pressure, healthcare professionals, regardless of their age, gender, and experience, had extremely low level of knowledge. In fact, most attentions were focused on new treatments and diagnostic methods for hypertension as opposed to measuring blood pressure properly (7).

Based on the fact that nursing students who are doing their apprenticeship are the only group being checked and evaluated for their proper performance of measuring blood pressure and there is no control on healthcare workers whatsoever (including nurses, paramedics, and their assistants), nurses' performance is recommended to be checked more often while they are in their higher levels of education. Besides, the standards of measuring blood pressure properly are suggested to be reviewed and the nurses' performance is recommended to be evaluated by holding educational workshops. Since there are several factors that influence blood pressure, it is important that medical professionals fallow the American Heart Association guidelines for blood pressure measurement to avoid misdiagnosis of hypertension and inappropriate prescription of anti-hypertension medications (13).

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Authors' Contribution

Roya Dokoohaki, Farahnaz Raeiskarimian: study design and data collection. All the authors have read and confirmed the final draft.

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Appendix. Recommended Technique for Measuring Blood Pressure

i. Measurements should be taken with a sphygmomanometer known to be accurate. A recently calibrated aneroid or a validated and recently calibrated electronic device can be used. Aneroid devices or mercury columns need to be clearly visible at eye level.

ii. Choose a cuff with an appropriate bladder size matched to the size of the arm. For measurements taken by auscultation, bladder width should be close to 40% of arm circumference and bladder length should cover 80% to 100% of arm circumference. When using an automated device, select the cuff size as recommended by its manufacturer.

iii. Place the cuff so that the lower edge is at least 1 in (2.5 cm) above the elbow crease and the bladder is centered over the brachial artery. The patient/client should be resting comfortably for 5 minutes in the seated position with back support. The arm should be bare and supported with the antecubital fossa at heart level because a lower position will result in erroneously higher systolic and

diastolic blood pressure measurements. There should be no talking, and patients' legs should not be crossed. At least two measurements should be taken in the same arm with the patient in the same position, and the mean should be recorded. Blood pressure also should be assessed after two minutes of standing (with arm supported) and at times when patients report symptoms suggestive of postural hypotension. Supine blood pressure measurements may also be helpful in the assessment of elderly and diabetic patients.

iv. Increase the pressure rapidly to 30 mm Hg above the level at which the radial pulse is extinguished (to exclude the possibility of a systolic auscultatory gap).

v. Place the bell or diaphragm of the stethoscope gently and steadily over the brachial artery.

vi. Open the control valve so that the rate of deflation of the cuff is approximately 2 mm Hg per heart beat (or per second if HR is less than 60 bpm). A cuff deflation rate of 2 mm Hg per beat is necessary for accurate systolic and diastolic estimation.

vii. Read the systolic level (the first appearance of a clear tapping sound [phase I Korotkoff]) and the diastolic level (the point at which the sounds disappear [phase V Korotkoff]). Continue to auscultate at least 10 mm Hg below phase V to exclude a diastolic auscultatory gap. Record the blood pressure to the closest 2 mm Hg on the manometer (or 1 mm Hg on electronic devices), as well as the arm used and whether the patient was supine, sitting, or standing. Avoid digit preference by not rounding up or down. Record the heart rate. The seated blood pressure is used to determine and monitor treatment decisions. The standing blood pressure is used to examine for postural hypotension, if present, which may modify the treatment.

viii. If Korotkoff sounds persist as the level approaches 0 mm Hg, then the point of muffling of the sound is used (phase IV) to indicate the diastolic pressure.

ix. In the case of arrhythmia, additional readings may be required to estimate the average systolic and diastolic pressure. Isolated extra beats should be ignored. Note the rhythm and pulse rate.

x. To avoid venous congestion, it is recommended that at least 1 minute should elapse between readings. Leaving the cuff partially inflated for too long will fill the venous system and make the sounds difficult to hear.

xi. Blood pressure should be taken in both arms on, at least, the first visit; if one arm has a consistently higher pressure, then that arm should be clearly noted and subsequently used for blood pressure measurement and interpretation.

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