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Educational intervention improves measurement of blood pressure skills in Iranian medical students

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Abstract

Background: The routine method of measuring blood pressure (BP) is subject to numerous pitfalls. We evaluated the impact of a guidelines-based educational intervention on improvement of BP determination by fourth-year Iranian medical students.

Methods: Using a consecutive sampling technique, 103 fourth-year medical students were recruited during their rotation in the Department of Community and Family Medicine at the Tabriz Medical School at the Tabriz University of Medical Sciences. All students attended a 3-hour training class covering accurate BP measurement. Using a valid checklist, sixteen elements of BP measurement skills were assessed among students before and after two weeks of training. McNemar's test, paired-sample *t* tests and Pearson's chi-square test were used to compare the data before and after training using SPSS version 23.

Results: The study showed that before the training class most of the elements of BP measurement skills were not performed by most of the students, and 9 of 16 BP measurement skills were only performed by <20% of the students. Following the training class, however, 14 of 16 BP measurement skills were performed by >70% of the students. Before training, mean/SD of correctly-performed-skills out of 16 skills was 4.76/2.03. After training, the mean/SD was 13.99/5.19 ($P<0.001$).

Conclusion: This study showed a significant improvement in medical students' BP measurement skills after a 3-hour course of training. Thus, it appears that periodic training sessions of accurate BP measurement for medical students may be of great benefit and equal importance in medical schools.

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Introduction

Around one-third of the world's adult population is afflicted with hypertension (HTN), resulting in a high burden of mortality and morbidity. HTN is the leading cause of coronary artery disease, stroke, and sudden death. Accurate diagnosis of HTN in the clinical setting is a high priority, as misdiagnosis imposes a heavy burden on the healthcare system due to increased morbidity and mortality, average insurance coverage costs, psychological effects of hypertensive stigmata, and unexplained extra visits.[1,2]

A well-trained practitioner is the single most crucial component of obtaining a correct BP measurement.[2] Thus, several standard skills are recommended to accurately measure BP in clinics. Poor adherence among medical professionals, including medical students, to the guidelines of BP measurement results in over/under diagnosis and treatment of BP in patients and disuse of hypertensive medications.[2-4] Patient positioning, prior exercise, prior caffeine use or smoking, patient pain or distress, and use of appropriately-sized BP cuffs all have been found to affect BP measurements.[1,5] For instance, it has been shown that when a patient is seated on the edge of the chair and has no back support, the measured diastolic pressure is about 6 mm Hg higher than normal BP with back support.[6]

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A study among American medical students showed that their blood pressure (BP) measurement performance is poor.[2] Another study performed at the University of Belgrade among 791 fourth-and sixth-year medical students found that only 13.5% of the fourth-year and 19.4% of the sixth-year students knew that the stethoscope membrane should not be positioned under the cuff.[7]

There are currently no studies in Iran on BP measurement performance among medical students. Our literature review showed there are no studies on the effects of a training course on improving the skills of medical students in Iran and other countries. A study in Greece showed that supplementary training courses for nursing students significantly improved their skills in taking accurate BP measurement.[8] As the first Iranian study, the purpose of our research is determining the BP measurement performance of fourth-year medical students and the effect of educational intervention on their performance.

Materials and Methods

General study characteristics

Using a pre/post educational interventional study design, 103 fourth-year medical students were recruited to assess the impact of training in BP measurement technique on medical students' skill and performance. The sample size was calculated according to the findings of a recent study on the skills of American medical students on the correct measurement of BP using the following sample size calculation formula for a total number of 95 for this study. The sample size was calculated as 95 using the formula to $(z)^2 p\ (1 - p) / d^2$ where Z is 1.96, P is 1 percent and d is 2 percent. We considered P 1 percent because according to American study only 1 percent of students measured BP completely correct. 1.96 is equal to a 95% confidence interval.

Using a consecutive sampling technique, the participants were chosen from those who took part in rotations at the Community and Family Medicine Department at the Tabriz University of Medical Sciences (TUMS), Iran, between September 2017 and January 2018. This study included three stages: measurement of skills before training, a 3-hour training class, and a measurement of skills post training. Students who missed the training class were excluded from this study. Written informed consent was obtained from the participants.

Data collection tool

A checklist of 16 characteristic skills was developed that reviews several guidelines around BP measurement, including Iranian National Guidelines,[9-11] and was confirmed by four cardiologists at the Heart Hospital of TUMS. Because Korotkoff sounds were subjective and it is not possible to measure this skill quantifiably, this item was omitted from the checklist. The items of the checklist included the following; (1) asking patient not to ingest caffeine or smoke nicotine within the past 60 min; (2) ascertaining if the patient had exercised within the past 30 minutes; (3) noting if the patient is in pain or very emotionally upset; (4) noting if the patient is back supported; (5) noting that legs are uncrossed; (6) instructing patients not to talk or use a mobile phone; (7) ascertaining that the patient has rested for five minutes before BP measurement; (8) ensuring the patient's upper arm is supported at heart level with palm facing upward; (9) ensuring that tight or restrictive clothing is removed from the arm and the measurement taken on the bare arm. (10) applying the cuff evenly and snugly one inch above the bend of the arm; (11) Applying cuff evenly and snugly where two fingers fit under cuff (a cuff is too tight if two fingers cannot fit under the lower edge of the cuff); (12) estimating systolic BP by pulsation, deflating cuff completely and rapidly and waiting 15-30 seconds before continuation; (13) inflating cuff to a pressure 20-30 mmHg higher than the estimated systolic pressure by pulse; (14) placing the diaphragm of the stethoscope over the brachial artery lightly (not tucking the stethoscope under the cuff); (15) Taking two readings. (16) Taking BP measurement in both arms.

Study design

Each month, 30 fourth-year medical students enter into the Community and Family Medicine Department of the TUMS for a rotation. Because the sample size was 95, this study was conducted over four months. Eight students could not participate in any training sessions and were excluded from this study. The training classes were offered as consistently as possible with similar conditions for the students over the four months. Each training session included three phases during the month. During the first phase, BP was measured by medical students without any additional training. In the second phase, students were trained to accurately measure BP based on the existing standard guidelines. The specific educational training session was three hours during which a family medicine specialty resident taught the most up-to-date theoretical guideline recommendations on BP measurement. The educational training sessions were offered in groups each month by one family medicine resident. Following the specific educational training session, the *New England Journal of Medicine* training video on BP measurement was presented. This English-language video explains BP determination skills comprehensively and the medical students were engaged in watching it. The video helped increase the students' understanding and demonstrated the importance of proper BP determination skills.

During the last phase, the students were asked to measure BP in simulated patients after two weeks of education. Students separately entered an identical simulated investigation room provided with a simulated patient seated on a chair with no arm or back support, and with his legs crossed. The simulated patient spoke

on their mobile phone during the procedure just before the BP measurement. The stethoscope and manual sphygmomanometer in the appropriate cuff size were provided for the students. Prior to the BP measurement session, the students were informed that the patient actor was a young man and had no history of previous disease, including HTN. The data collection methods were directly observed by the family medical resident and community medicine specialist. For reliable results and accurate data collection both before and after training, the observers filled out the questionnaires, which included 16 BP measurement skills. When each student entered the room, the observers indicated "yes" or "no" for each skill listed on the questionnaire. The collected data was analyzed using SPSS version 23. Students received a 1 if they did not accomplish the item on the check list and a 2 if they did accomplish it. The medical students participating in this study did not have comprehensive prior training of BP measurement skills based on guideline recommendations during their time in the medical school.

Statistical analyses

SPSS version 23 was used to perform all statistical analyses. The percentage of the students who accurately performed skills before and after training was reported. We used McNemar's test for comparing the percentage of the students who accurately performed skills before training with post training. We used chi square test to compare skills among male and female students. We used paired t-tests for comparing the mean number of correctly-performed skills before training with post training. Statistical significance was considered to be $P \leq 0.05$.

Results

A total of 103 students participated in this study over four months. The mean age of the students was 23 ± 1.4 years old. All students were in their fourth year of medical school and were planning to sit for their pre-internship exam in the winter of 2018. Analysis showed that 60.2% were female and 39.8 % were male. Table 1 shows the percentage of Iranian medical students performing BP measurement skills accurately and their mean performance score before training and after training.

As Table 1 shows, before the training course, most elements of BP measurement skills were not performed by most students: 9 of 16 BP measurement skills were only performed by <20% of the recruited students. No significant difference was found between male and female students. Performance of almost all 16 elements of BP measurement skills improved significantly after training ($P < 0.001$). After the training course, 14 of 16 BP measurement skills were performed correctly by >70 % of the students. Before training, mean/SD of correctly-performed skills was 4.76/2.03; following training, the mean/SD was 13.99/5.19 ($P < 0.001$).

Discussion

Our pre-training evaluation showed that guideline recommendations were implemented by only a small percentage of medical students and the average score of

Table 1. Percentages of BP measurement skills among Iranian medical students and mean performance scores before training and after training

BP measurement skills	Female (%)		Male (%)		Total (%)	
	Before training	After training	Before training	After training	Before training	After training
Asking the patient not to ingest caffeine or smoke nicotine within the past 60 minutes	45.2	85.5	58.5	97.6	50.5	90.3 ***
Asking the patient not to exercise within the past 30 minutes	17.7	77.4	22.0	70.7	19.4	74.8 ***
Note the patient is not in pain or very emotionally upset	12.9	45.2	14.6	46.3	13.6	46.6**
The patient back supported	3.2	85.5	9.8	80.5	5.8	83.5***
Legs uncrossed	3.2	88.7	14.6	90.2	7.8	91.3***
Instruct not to talk or use mobile phone[2]	90.3	98.4	85.4	100	88.3	99.0**
Resting the patient for 5 minutes before measurement	30.6	66.1	31.7	61.0	31.1	64.1***
Ensure upper arm is supported at heart level	72.6	95.2	70.7	85.4	71.8	91.3***
Bare arm.	82.3	100	90.2	100	85.4	100
Apply cuff evenly and snugly one inch above bend of arm	38.7	82.3	31.7	78.0	35.9	80.6***
Apply cuff evenly and snugly 2 fingers under cuff. A cuff is too tight if two fingers cannot fit under the lower edge of the cuff.	14.5	82.3	14.6	68.3	14.6	77.7***
Estimation of systolic BP by pulsation	6.5	96.8	4.9	90.2	5.8	94.2***
Inflate cuff to a pressure 20-30 mm Hg higher than the estimated SBP by pulse	12.9	93.5	9.8	92.7	11.7	92.2***
Place diaphragm of stethoscope over brachial artery lightly	1.6	85.5	00.0	80.5	1.00	83.5***
Take two readings	24.2	91.9	26.8	97.6	25.2	94.2***
Take BP measurement in both arms	6.5	74.2	7.3	68.3	6.8	71.8***
Mean performance score	-	-	-	-	4.75	13.99***

** $P < 0.01$, *** $P < 0.001$.

the students was found to be quite low. Demographic characteristics of the students and gender had no influence on their performance. Several studies have shown poor compliance with guideline recommendations by various health professionals.[7,12-16] A study evaluating the performance of 159 medical students in the United States showed that only one student showed all 11 of the required skills for accurate BP measurement, and the average score of the students was 4.1 of a total possible of 11.[2] This finding is very similar to our result: the mean performance score of students in our study was 4.75 out of 16 skills before training (see Table 1). A recent two-year cohort study that was conducted in Turkey showed poor compliance among medical students with guideline recommendations on BP measurement. This study also indicated that basic education of BP determination in medical schools is not adequate to attain satisfactory results, and students should be retrained and reevaluated through their clerkships.[15] Woolsey and colleagues assessed 123 primary care clinics for adherence to 2015 US Preventive Service Task Force (USPSTF) recommendations on BP measurement and found only 25.2% of primary clinics adhered to the recommendations.[17]

We found that training significantly improved students' adherence to guideline recommendations in proper BP measurement. Similarly, a study conducted among nursing students found that basic training programs yielded unsatisfactory results in the studied sample; however, a significant improvement was found in BP measuring techniques after supplementary training intervention, which was significant for all studied items.[8] Another study performed among pharmacy students revealed that simulation-based learning to teach BP assessment significantly improved students' clinical skills in BP measurement and their knowledge of pharmacotherapy of HTN.[18] Therefore, it appears that accurate BP measurement techniques should be taught to medical students on a schedule of every six months according to the recommendations of the guidelines to improve clinical skills and knowledge of HTN.[6,19]

Limitations. This study had several limitations. Because we used an auscultatory method to detect Korotkoff sounds, we were not able to assess students' ability to perform this specific skill. During the study an observer was be present in the examining room, which could have an impact on the way the students performed BP measurement. However, we did our best to diminish biases of student training by conducting the classes and sessions in similar conditions. The study also has the ordinary limitations of pre/post studies.

Conclusion

Our study demonstrated that skills of medical students in BP measurement are in need of additional training in Iran. There was a significant improvement in skills among fourth-year medical students' performance in BP measurement following a training course. Thus, it appears that skills of medical students should be evaluated frequently to check for the need for retraining or additional training. This in turn will reduce over/under diagnosis and treatment in clinical settings.

Ethical approval

This research is part of a family medicine specialty thesis which was approved by the Ethics Committee of Tabriz University. Ethical aspects were considered in all steps of the study and texts belonging to other authors that have been used in any part of this study have been fully referenced and cited. This study was approved by the Ethic Committee of the Medical Faculty of Tabriz (IR.TBZMED.REC.1397.032).

Competing interests

The authors declare that there is no conflict of interest.

Authors' contributions

MZP and SG offered the study. MZP designed the present research. MZP, SG and FM searched articles. MZP and FM extracted the data and summarized it. FM translated and MZP supervised; MZP reviewed the quality of the articles and revised it.

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