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Accuracy of Sphygmomanometers Measurements in two Iranian Tertiary Educational Hospitals

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Background: Accurate blood pressure measurement has more importance in diagnosis, assessment of cardiovascular risk and efficacy of antihypertensive agents in hypertensive patients.
Objectives: Present study was designed for sphygmomanometers accuracy assessment in two study hospitals.
Materials and Methods: During the present cross sectional study, accuracy of 63 sphygmomanometers from two study hospitals was evaluated. Sphygmomanometer evaluation was performed according researcher prepared check list contains most of possible physical and functional defects. Accuracy detection in randomly selected sphygmomanometers was performed by comparison with one standard mercury sphygmomanometer. More than three mmhg pressure differences in two points or more than ten mmhg pressure difference in one point were considered as inaccurate sphygmomanometer.
Results: Among sphygmomanometers, 25 (39.6%) devices had excluded due to physical defects. Air leak (15.9%) was most cause of sphygmomanometers exclusion from the study. According study accuracy determination method, among 38 sphygmomanometers, 21 (55.27%) devices were inaccurate and 17 (44.82%) devices were accurate. All of three mercury sphygmomanometers were accurate. Mean of errors in included sphygmomanometers was 4.98 mmhg and 34.2% of included sphygmomanometers in one point accuracy determination had more than 10 mmhg differences with standard sphygmomanometer.
Conclusions: Current devices in our health care centers were inaccurate in most cases and might report wrong number as patients' blood pressure.

*Keywords:*Accuracy; Blood Pressure; Sphygmomanometers

1. Background

There are several therapeutic modalities such as life style modification and antihypertensive agents for hypertension management as an important and common public health problem. Inaccurate blood pressure measurement is a frequent problem that has impact on the hypertension management (1). According World Health Organization (WHO) report, ischemic heart diseases, cerebrovascular and cardiovascular disorders due to hypertension had higher rank among ten main mortality causes in Iranian population (2). Hypertensive patients had not any specific symptoms or signs related to hypertension and their disorders were diagnosed only by proper physical examination (3).

Accurate blood pressure measurement has more importance in diagnosis, assessment of cardiovascular risk and efficacy of antihypertensive agents in hypertensive patients. In some patient especially diabetic or renal failure patients, blood pressure measurement had more importance (4). Prescription of antihypertensive agents to normotensive persons can cause decline in their quality of life and even lead to some side effects (3). Although, there are some doubts in blood pressure measurement brachial artery, we had not suitable measurement method instead of brachial artery measurement method (5).

In developing countries such as Iran, we had some additive problems and limitation. There are some non-valid sphygmomanometers and inexpert health care workers. Present study was designed for sphygmomanometers accuracy assessment in two tertiary educational hospitals (Shohadaye Tajrish and Taleghani) of Shahid Beheshti University of Medical Sciences.

2. Objectives

Present cross sectional study was performed between January 2009 and May 2010 for determination of sphygmomanometers accuracy in two educational hospitals (Shohadaye Tajrish and Taleghani) of Shahid Beheshti University of medical sciences and health services.

3. Patients and Methods

Present study was approved in research ethical committee of Shahid Beheshti University of Medical sciences. Within the study, accuracy of 27 sphygmomanometers

from Shohadaye Tajrish and 37 sphygmomanometers from Taleghani hospital were evaluated. Study hospitals were located in Tehran, capital city of Iran and patients of Tehran city and other Iranian cities had been inferred with primary and complex disorders for diagnosis, management and follow-up of their disorders. Sphygmomanometers were randomly selected from study hospital wards including urgency department, internal medicine, cardiology, surgery, dermatology, neurology, gynecology, orthopedic, pediatrics and hospital outpatient's clinics including surgery, internal medicine, cardiology and gynecology. Sphygmomanometer evaluation was performed according researcher prepared check list contains most of possible physical and functional defects. Fraction or exhaustion in their pumps and their rubber tube; visible defects in air outlet or need to more force for its opening; defect or tarnish in their glass plates; tearing or other defects in their cuff were assessed as sphygmomanometers defects. We compared them with a new standard mercury sphygmomanometer.

Sphygmomanometers distended according American Heart Association (AHA) standards (4) until 250 mmhg and pay attention to decline in their pressure during next ten seconds. More than ten mmhg decline in pressure was considered as air leak defect. Same methods were repeated at 50 and 150 mmhg. All of defected sphygmomanometers were excluded and others randomly included into the study. Accuracy detection in randomly selected sphygmomanometers was performed by comparison with one standard mercury sphygmomanometer. Gradient plate of sphygmomanometers were removed and connected to the standard sphygmomanometer with one T shape rubber tube and one closed system was prepared. At five pressure points (50, 100,150,200 and 250 mmhg) sphygmomanometers were filled until noted points and other researcher detected pressure in gradient plate of study sphygmomanometers. More than three mmhg pressure differences in two points or more than ten mmhg pressure difference in one point were considered as inaccurate sphygmomanometer.

3.1. Statistical Analysis

Study data were included into the SPSS software 16.0 for data analysis. Qualitative variables were demonstrated with frequencies and percentage and quantitative variables were demonstrated with mean and standard deviation. All of p-values less than 0.05 were assumed as significant results.

4. Results

Finally 63 (three mercury and 60 pointer types) sphygmomanometers were included into the study. Among sphygmomanometers, 25 (39.6%) devices had excluded due to physical defects. Air leak (15.9%) was most cause of sphygmomanometers exclusion from the study. Details of physical defects were shown in Table 1.

Table 1. Frequency of Physical Defects among Included Sphygmomanometers

Physical Defects	No. (%)
Cuff defects	9 (14.2)
Bag defects	8 (12.7)
Pump defects	2 (3.2)
Rubber tube defects	8 (12.7)
Air outlet defects	7(11.1)
Glass defects	12(3.2)
Air leak	10(15.9)

According study accuracy determination method, among 38 sphygmomanometers, 21 (55.27%) devices were inaccurate and 17 (44.82%) devices were accurate. All of three mercury sphygmomanometers were accurate.

Table 2. Frequency of Sphygmomanometers with more than 3 Points Difference with Standard Sphygmomanometers

Test points	No. (%)
50	20 (52.6)
100	16 (42.1)
150	21 (55.3)
200	20 (52.6)
250	12 (31.6)

The frequencies of inaccurate sphygmomanometers according to points 100 and 150 are shown in Table 3. Mean of errors in included sphygmomanometers was 4.98 mmhg and 34.2% of included sphygmomanometers in one point accuracy determination had more than 10 mmhg differences with standard sphygmomanometer.

Table 3. Frequencies of Inaccurate Sphygmomanometers According to Points 100 and 150

	Deviation Amount												
	<-5	**-5**	**-4**	**-3**	**-2**	**-1**	**zero**	**+1**	**+2**	**+3**	**+4**	**+5**	**>+5**
Point 100	9	1	0	0	2	1	12	1	6	0	0	3	3
Point 150	11	1	1	0	1	2	9	1	4	1	1	1	5

5. Discussion

In the present study among 38 sphygmomanometers, only 17 sphygmomanometers was accurate and reliable and only three devices had no differences in measurement points with standard sphygmomanometers. Replacement of sliver with plate sphygmomanometers can reduce accuracy of blood pressure measurement in some clinical wards. Plate sphygmomanometers due to several mechanical parts had more prone to defects than other ones. In compare with previous studies, mechanical defects in study devices (39.6%) were more common than other papers. In two same studies in Brazil and England prevalence of physical defects was reported same with 17% and 12% respectively (6, 7). Measurement devices for blood pressure in our study had two or three times less accuracy the other studies. Lack of regular control and consideration system for blood pressure measurements and continue using old and defected devices might responsible for this high prevalence. Company catalog of measurements indicated that every plate and silver sphygmomanometers must be rechecked every 3-6 and 6-12 months respectively (8).

In one study on 36 devices in Brazil, 44% of devices plates were inaccurate (6). In present study rate of inaccuracy in devices plates was 33.3%. We think that in regular examination of blood pressure measurement devices, we pay more attention to accuracy of their plates and less attention to their physical defects. In the other hand calibrated plate devices with physical defects were not suitable devices. Most common physical defects in study devices was air leak and in most of them can be cover with replacement of rubber parts of devices. Oscillometric or automated devices for BP measurement operate via detection of the variation in pressure oscillations caused by arterial wall movement under the cuff, which enables a systolic, mean arterial and diastolic blood pressure to be measured (9). The perceived benefits of the electronic (oscillometric) devices are that they are more accurate, less time-consuming and labour intensive and require less concentration for use (9). In addition, they can be used in noisy surroundings and provide a reading when sounds are faint, such as with obese patients (10). Another advantage relates to their use in clinical settings, where use of oscillometric devices may result in greater 'within-subject' reliability than conventional readings, because of the absence of digit preference (11).

Present study had some limitations; firstly, we performed study only in two hospitals with limited number of sphygmomanometers. Next studies must perform with more devices. We assessed only palate and silver measurement types and next studies had to perform with other types such as electronic or automate blood pressure measurement devices. We did not measure with standard health care workers with same measurement methods. This matter might impact on our findings and overestimated measurement errors. Accurate blood pressure measurement more than expert health care workers need accurate and calibrate devices. Current devices in our health care centers were inaccurate in most cases and might report wrong number as patients' blood pressure. We think that one protocol must be design for regular control of blood pressure measurement devices.

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