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Investigating the Effect of Using Two Different Blood Pressure Measurement Methods (Standard Method in the Office and SPRINT Method) and Comparing the Numbers Obtained in These Two Methods

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Abstract

How to use different methods of blood pressure measurement and familiarity with these methods is necessary to control blood pressure diseases. The new guidelines emphasize the use of appropriate blood pressure measurement techniques. This study compares blood pressure measurement methods with mercury and digital devices and examines the effect of the SPRINT measurement method on blood pressure. In this study, the blood pressure of 87 patients was measured three times in a row at 5-minute intervals in a quiet room, and their average was considered as SPRINT blood pressure. Two of these measurements were done with a mercury device and the third time with a digital device. The resulting numbers were compared with the pressure measured by the digital device in the office and the blood pressure measured by the nurse during the same visit. The findings showed that the systolic blood pressure measured during the visit was about 8.4 mm Hg higher than the blood pressure measured by the SPRINT method ($p<0.001$). The diastolic blood pressure measured in the office was approximately 7.05 mm Hg higher than the pressure measured by the SPRINT method ($p<0.001$). According to the results obtained from the present study, the method of measuring blood pressure and the tools used have a significant effect on the numbers obtained and the diagnosis and treatment process. These results show the necessity of complete familiarity with these methods.

Keywords: SPRINT method, Standard method in the office, Blood pressure measurement, Digital device

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Introduction

According to the estimate of the World Health Organization in 2008, about 40% of people over 25 years of age (equivalent to 1 billion people) had hypertension. This figure is equal to 600 million people in 1980. Hypertension causes approximately 7.5 million deaths per year, which is more than 12.5% of all deaths and 57 million Disability Adjusted Life Years (DALYs). Hypertension causes at least 45% of deaths with Cardiac causes including about 17 million deaths per year and 51% of deaths from stroke [1-3]. The difference between blood pressure measured in the office and blood pressure measured outside the office is generally noteworthy [4-6]. People with hidden blood pressure have twice the risk of cardiovascular events than people with normal blood

pressure [6, 7]. Even in some studies, the risk of cardiovascular events of these people is equal to that of people with high blood pressure [8, 9].

There are different methods for measuring blood pressure. The standard method of measuring blood pressure in the office refers to a single measurement with a mercury sphygmomanometer by the doctor himself. Listening devices and oscillating devices Gauges are the two main types of pressure measuring devices. Digital oscilloscope devices have become the most common and widely used devices today and can be easily used in homes in addition to offices. The level of accuracy of digital devices in the correct diagnosis of hypertension and the follow-up of patients' treatment is still questionable [10, 11]. In addition, due to the effect of the white coat and to prevent underdiagnosis and overdiagnosis, the necessity of blood pressure measurement by the patient at home has been raised more than before. The results of a systematic review regarding the reasons for reducing accuracy in blood pressure measurement show that there are generally 27 important causes of error related to the measuring device, the method of measurement, and the measuring person. The effect of each of these causes can be very extensive [12-15]. The size and location of the cuff, the position of the arm, the size of the arm, the amount of rest before the measurement, the amount and method of filling the cuff, external sounds and the patient's speech during blood pressure measurement, the difference in hearing between those who measure the patient's blood pressure, rounding error (there is usually a tendency for numbers to end in 0 or 5), lack of repeated measurements, the distance between two measurements, uncalibrated device used, body position, muscle tone, quality of stethoscope, type The training of the person taking the measure and the effect of the white coat can each separately interfere with the accurate measurement of blood pressure [14, 16, 17].

European guidelines suggest that blood pressure should be measured more based on home pressure compared to white-coat pressure and that occult blood pressure should be obtained based on average daily and 24-hour nighttime blood pressures measured in ambulatory settings [13, 15]. In the American guideline, the average of three pressures is mentioned. This measurement paradigm is based on a randomized controlled study called SPRINT. In this regard, a group of patients with blood pressure was divided into two groups, and the systolic pressure control limit for one group was considered below 140 mm Hg standard and for the other group below 120 mm Hg (Intensive) [18, 19]. In this study, blood pressure was measured by first placing the patient in a quiet room for a few minutes. Then, his blood pressure was taken three times in a row, at intervals of several minutes, with an automatic device, and their average was considered as the final blood pressure [20-23]. According to the results of this study, the group whose blood pressure was intensively controlled had significantly fewer cardiovascular events and deaths than the standard group after about three years. Blood pressure measurement based on the American guidelines based on the SPRINT method causes differences compared to the standard pattern [24].

The main purpose of the present study is to compare the blood pressure of patients measured with a mercury sphygmomanometer and a digital sphygmomanometer. Also, in the present study, the blood pressure measured by the SPRINT method and the usual method of measuring it in the office are compared to investigate the relationship between the values obtained from these two methods. In addition, the effect of the white coat factor on the measured values of blood pressure is also investigated.

Materials and Methods

The samples of the present study were people over 18 years of age who were referred to one of the cardiologists of the heart clinic, and who were satisfied with multiple measurements of their blood pressure. Among these people, those whose right hand was paralyzed, had a shunt in their right hand, the cuff corresponding to the size of their arm circumference was not available in the clinic, and had special artemia, if they had eaten or smoked within 30 minutes before visiting, or did not cooperate to use the front surface of the arm were excluded from the study. Finally, 87 eligible patients were included in the study.

Experienced nurses measured people’s blood pressure once after taking an ECG in the waiting room using a Litman phone and Richter's mercury sphygmomanometer. Then, each patient entered a quiet room separately, and after 5 minutes of rest, his blood pressure was measured and recorded with a calibrated Canon M6 Comfort device. Once again, after 5 minutes, the patient's systolic pressure was estimated with a pulse using a calibrated Richter mercury sphygmomanometer. Then, with the same device, systolic and diastolic blood pressure was measured once using a Linumann class 2 phone and after 5 minutes, it was measured again with the same mercury sphygmomanometer, but this time with a Littmann 3200 digital phone. A final-year medical student measured all three blood pressures measured at this stage and their average was recorded as SPRINT pressure. Then the patients entered the cardiovascular room and their blood pressure was measured again by Omron device with the same model. The blood pressure of another group of patients was measured with the same method, but using a VMod BP80 digital device. In each visit, a patient's pressure was recorded by the attending. The blood pressure of 53 out of 87 patients was measured in the clinic with the Omron device and the other 34 with the Vmed station. The time interval between the first and last blood pressure measurement of each patient and the interval

between the patient's entry to the clinic and his visit by the attending was 20 minutes.

Blood pressure measurement based on the standards set by ALIA and in a sitting and leaning position, in a position where the patient's arm is at the level of his heart, the cuff is 2 cm above the open and closed cavity, and the stethoscope is not placed under the cuff, from the arm They were measured straight and after removing the sleeve. Before multiple blood pressure measurements, necessary explanations were given to the patient and his consent was obtained verbally.

The data collection form includes date and time, demographic characteristics (gender, age, and weight of underlying diseases), medications, abnormal paraclinical findings, heart rate, blood pressure measured by the nurse, blood pressure measured by a medical student, blood pressure measured by analog stethoscope and mercury sphygmomanometer, blood pressure measured by digital stethoscope and mercury sphygmomanometer, blood pressure measured by digital device by a medical student and blood pressure measured by a specialist with a digital device.

In this study, all personal information was kept confidential, and ethical considerations were observed. The obtained data were entered into SPSS software version 21. Descriptive information was shown as frequency and average. To analyze the data, Pearson correlation and independent t-tests were used. In all statistical analyses, a level of less than 5% was considered a significant level.

Results and Discussion

In this study, 87 eligible patients were examined. 56% of the patients were women and the rest were men. The age distribution of people was from 24 to 84 years and the average age was 56.02 ± 12.96 years. Approximately 37% of the patients had high blood pressure, 20% had diabetes, 25% had coronary artery disease, and 1% had valvular diseases. None of these patients had heart failure. 3% of people had had a nutritional stroke in the past. In the examination of the drugs used by these patients, it was seen that about 38% were using beta blockers and only 2% were using verapamil or diltiazem. In the measurements made by the nurse, the average systolic pressure was 132 ± 24.6 mm Hg. This value was equal to 132 ± 22.8 in the SPRINT method. The mean diastolic pressure measured by the nurse was 76.7 ± 13.5, but it was calculated by the SPRINT method to be 79.10 ± 75.75. Based on the above results, the difference between the systolic pressure measured by the nurse and the SPRINT method has a p-value greater than 0.05 and is therefore not statistically significant, but the diastolic pressure measured by these two methods has a significant difference **(Table 1)**.

Table 1. Average blood pressure is measured by the nurse and by the SPRINT method.

Variable	Type of measurement	Average	SD	p-value
SBP	Pressure measured by the nurse	132	24.67	0.60
	Pressure measured by SPRIN method	132.61	22.86	
DBP	Pressure measured by the nurse	76.79	13.50	0.01
	Pressure measured by SPRIN method	79.75	10.75	

Average systolic pressure measured by SPRINT method. It was 132.23 ± 7.89 and in the standard measurement in the office with a digital device, this number was 141.2 ± 26.39. As can be seen in **Table 2**, the difference between these two methods is significant in measuring systolic pressure. The diastolic pressure obtained by the SPRINT method was 90.85 ± 13.82 and in the standard measurement in the article with a digital calculator, it was 97.9 ± 15.19. In other words, the diastolic pressure with the SPRINT method is lower by 7.05 mmHg than the other method **(Table 2)**.

Table 2. Comparison of mean blood pressure measured by SPRINT method with pressure measured by digital device.

Variable	Type of measurement	Average	SD	p-value
SBP	Pressure measured by SPRINT method	132.78	23.89	< 0.001
	Pressure measured in the office with a digital device	141.26	26.39	
DBP	Pressure measured by SPRINT method	90.85	13.82	0.032
	Pressure measured in the office with a digital device	97.90	15.19	

Based on the comparison, the average pressures measured with a mercury device for systolic and diastolic pressure were 127.88 ± 19, and 82.79 ± 11.95, respectively, and with a digital device, they were 133.20 ± 09.15 and 83.88 ± 13.44, respectively. These differences were statistically significant for systolic pressure, but the difference in diastolic pressure was not significant (p-value = 0.425) **(Table 3)**.

Table 3. Average blood pressure was measured with a mercury sphygmomanometer and digital sphygmomanometer.

Variable	Type of measurement	Average	SD	p-value
SBP	Pressure measured by mercury sphygmomanometer	127.88	19	< 0.001
	Pressure measured in the office with a digital device	133.09	20.15	
DBP	Pressure measured by sphygmomanometer	82.79	11.95	0.425
	Pressure measured in the office with a digital device	83.88	13.44	

The results obtained from the present study show that blood pressure measurement using the SPRINT method can result in lower systolic and diastolic blood pressure measurements compared to the standard method of measurement in the office. The present study also showed that pressures measured by nurses are usually lower compared to pressures measured by doctors. This finding is similar to other studies. In a meta-analysis conducted by Clark *et al*. regarding the comparison of pressures measured by doctors and nurses in 15 studies, it showed that the systolic pressure measured by nurses was on average 7 mm Hg lower than the pressure measured by nurses [25]. This pressure difference for diastolic pressure was equal to 8.3 mm Hg. There was a significant concordance between the review studies. The new finding of this study is that there is no significant difference between the blood pressure measured by the nurse and the blood pressure measured by the SPRINT method by the doctor, but the diastolic pressure measured by the nurse is about 3 mm Hg lower than the measured pressure. Therefore, measuring blood pressure only once by a nurse can be a suitable alternative to the more complicated SPRINT method.

In the present study, the blood pressure measured by digital sphygmomanometer was similar to that measured by mercury devices. This finding is consistent with other studies. In a study that aimed to check the accuracy of the Omron M6 arm digital sphygmomanometer in 2006 in Turkey, the results indicated the high accuracy of this device in measuring blood pressure and the agreement of the numbers reported by it with the mercury device [26]. The results of the Omron 75017 device review in 2011 in Brazil showed that the systolic pressures obtained through the listening method are far higher than the pressures reported by the digital device. This situation was also true for diastolic pressure. However, when these numbers were compared using the Bland-Altman method, only 1% of the numbers were outside the range of two standard deviations [27].

A cross-sectional study was conducted in Victoria by Heinemann *et al*. during which the accuracy coefficient and the reliability of the Dinamap 8100 digital device were evaluated [28]. In this study, the blood pressure of 63 patients hospitalized in the general departments of a large hospital in this city, who were over 18 years old, and half of them were women, were measured. Two nurses measured the pressures of the patients with a standard and digital mercury device and the resulting numbers were measured with three different criteria: BHS, AAMI, Bland, and Altman. The results indicated that the devices agreed for systolic and diastolic pressure with the Bland and Altman criteria, only for the systolic pressure with the AAMI criteria, and none of the pressures were in agreement with the BHS criteria. The general conclusion of the research showed that this device can be used with a good degree of confidence to measure the systolic pressure of hospitalized patients, but more caution is needed to measure the diastolic pressure [28].

Myers *et al*. in Ontario, Canada, in which the accuracy of the digital BpTRU device was compared with standard mercury devices, conducted another study in 2008 [29]. Based on the results obtained, out of 238 residents of this city with the age range of 20 to 79 years were in good agreement with the numbers obtained from the mercury device. Mayer *et al*. also pointed out that at lower pressures, the numbers obtained from the mercury device were larger than the numbers from the digital device, but this difference decreased with increasing pressure [29]. In a study conducted by Landgraf *et al*. in California, two standard and digital mercury devices and a measuring cuff determined the blood pressure of 337 patients with an average age of 4.70 years during a routine doctor's visit [30]. The mercury device is significantly higher than the numbers obtained from the digital device. This difference was more significant in patients with an older age of more than 65 years. In addition, the presence of one or more cardiovascular disease risk factors increased this difference [30].

Conclusion

In general, it seems that different methods of measuring blood pressure have a significant effect on the measured blood pressure values of people, and therefore, when using the guidelines, one should pay attention to their intended method. Considering the ease of use and practicality of digital devices, as well as the possibility of using them at home and the importance of measuring blood pressure outside the treatment environment, to reduce the white coat effect, these devices can be used provided they are calibrated and reliable. He advised the patient to have sufficient knowledge about how to use them. It is also suggested to use a blood pressure measurement by a nurse instead of a SPRINT measurement.

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