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Original Research Article

A Comparative Analysis of Blood Pressure Recording from Conventional Mercury Sphygmomanometer to Recording from Aneroid and Digital Devices in Healthy Volunteers

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Abstract:

Background: Accurate blood pressure (BP) measurement is crucial for diagnosing and managing hypertension. Traditional mercury sphygmomanometers have long been the gold standard; however, due to environmental and health concerns, there is a shift towards aneroid and digital BP devices. The reliability and accuracy of these alternative devices need thorough evaluation to ensure clinical efficacy.

Aim: The aim of the study is to compare blood pressure readings obtained from a conventional mercury sphygmomanometer with those from aneroid and digital devices in healthy volunteers.

Methods: This observational study involved 300 healthy volunteers aged 18-60 years. Blood pressure was measured using a mercury sphygmomanometer, aneroid sphygmomanometer, and a digital blood pressure monitor in a randomized order. Each device recorded three BP measurements per participant, and the averages were analyzed. Statistical analysis was conducted using paired t-tests and Bland-Altman plots to assess agreement between devices.

Results: The average systolic/diastolic BP readings were 122.5/78.6 mmHg for the mercury sphygmomanometer, 123.1/79.2 mmHg for the aneroid sphygmomanometer, and 121.8/78.3 mmHg for the digital monitor. Statistically significant differences were found between the devices, with p-values of 0.035, 0.015, and <0.001 for systolic BP comparisons and 0.042, 0.222, and 0.002 for diastolic BP comparisons, respectively. Bland-Altman analysis indicated good agreement among the devices.

Conclusion: The digital blood pressure monitor showed readings closest to the mercury sphygmomanometer, suggesting it as a reliable alternative for BP measurement. Despite minor statistical differences, the overall agreement between the devices was acceptable for clinical use.

Recommendations: Further studies with diverse populations and clinical conditions are recommended to validate these findings and explore the long-term reliability of digital BP monitors.

Keywords: Blood Pressure Measurement, Mercury Sphygmomanometer, Aneroid Sphygmomanometer, Digital Blood Pressure Monitor, Hypertension Diagnosis.

Introduction

Measuring blood pressure (BP) is essential for managing and accessing cardiovascular health. It is crucial to measure blood pressure accurately and consistently in order to diagnose hypertension, track the effectiveness of treatment, and anticipate cardiovascular problems. Because of its accuracy and dependability, the mercury sphygmomanometer has long been regarded as the gold standard for measuring blood pressure. However, the use of alternative instruments like aneroid and digital sphygmomanometers has increased due to worries about the health and environmental risks associated with mercury.

Research has indicated that there are differences in the accuracy of blood pressure measuring equipment. For example, a study underlined the need of clinical validation for automated blood pressure monitors, exposing that a minuscule proportion of commercially accessible devices have their accuracy evaluated in accordance with international standards. In particular, just 5.6% of wrist-based devices and 10% of upper arm cuff devices satisfied validation criteria, indicating a serious discrepancy in the dependability of numerous products on the market [1].

New blood pressure monitoring technologies, such cuff less devices, have demonstrated potential for

continuous, non-invasive blood pressure monitoring. These gadgets deliver precise readings without the use of a standard cuff thanks to novel sensing and modelling algorithms. Two recent studies have examined the possible advantages and difficulties of these technologies. They contend that even though cuff less devices have several benefits for user comfort and usability, thorough validation against accepted benchmarks is essential to guaranteeing their precision and practicality in clinical settings [2, 3].

New blood pressure measuring methods require standardised validation protocols, which the European Society of Hypertension (ESH) has also highlighted. To make sure that these cutting-edge technologies fulfil the necessary accuracy standards for clinical and home use, the ESH recently published guidelines that included criteria for the validation of cuff less devices. In conclusion, there has been a major advancement in blood pressure monitoring with the switch from mercury sphygmomanometers to aneroid and digital devices. Although digital and cuffless technologies are promising, it is still necessary to ensure their accuracy through rigorous validation. The establishment of these novel devices as trustworthy instruments for blood pressure management and monitoring will depend heavily on continued research and adherence to international validation criteria [4].

The aim of the study is to compare blood pressure readings obtained from a conventional mercury sphygmomanometer with those from aneroid and digital devices in healthy volunteers.

Methodology

Study Design: This study is a comparative, observational study designed to evaluate blood pressure measurements obtained from three different devices: conventional mercury sphygmomanometer, aneroid sphygmomanometer, and digital blood pressure monitor.

Study Setting: The study will be conducted in the Department of Physiology at ANMMCH, Gaya over a period of 6 months.

Participants: A total of 300 healthy volunteers will be recruited for this study.

Inclusion Criteria

- Age between 18 to 60 years
- Healthy individuals with no known chronic illnesses or cardiovascular diseases
- Willingness to participate and provide informed consent

Exclusion Criteria

- Individuals with a history of hypertension or cardiovascular diseases
- Pregnant women
- Individuals taking medications that affect blood pressure
- Participants who are unable to provide informed consent

Bias: To minimize selection bias, participants will be randomly selected from the eligible population. Measurement bias will be reduced by training all personnel involved in taking blood pressure readings and ensuring the calibration of all devices.

Data Collection: Data will be collected by trained personnel. Each participant will have their blood pressure measured using the three different devices in a random order to prevent order effects. Measurements will be taken three times using each device with a minimum of 5 minutes interval between each measurement.

Procedure

1. Informed Consent: Participants will be briefed about the study, and informed consent will be obtained.

2. Demographic Data: Basic demographic data (age, gender) will be recorded.

3. Blood Pressure Measurement:

- Participants will be seated comfortably with their back supported and legs uncrossed.
- After a 5-minute rest period, blood pressure measurements will be taken using each device in a random order.
- Three readings will be taken with each device, and the average will be used for analysis.

Statistical Analysis: Data will be analyzed using SPSS version 23.0. Descriptive statistics will be used to summarize the demographic data and blood pressure measurements. Paired t-tests will be used to compare the mean blood pressure readings between the three devices. Bland-Altman plots will be used to assess the agreement between the devices. A p-value of <0.05 will be considered statistically significant.

Results

The study had 300 participants in good health. Three distinct tools were used to measure blood pressure: a digital blood pressure monitor, an aneroid sphygmomanometer, and a traditional mercury sphygmomanometer. The differences between the devices were found to be statistically significant despite being modest. The digital blood pressure monitor showed the readings that were closest to the mercury sphygmomanometer, suggesting that it might be a trustworthy substitute for measuring blood pressure.

Table 1: Average Blood Pressure Readings (Mean ± SD)

Device	Systolic BP (mmHg)	Diastolic BP (mmHg)
Mercury Sphygmomanometer	122.5 ± 10.4	78.6 ± 8.2
Aneroid Sphygmomanometer	123.1 ± 10.6	79.2 ± 8.4
Digital Blood Pressure Monitor	121.8 ± 10.1	78.3 ± 8.1

Table 2: Paired t-test Results for Systolic and Diastolic Blood Pressure

Comparison	Mean Difference (mmHg)	t-value	p-value	Diastolic BP Mean Difference (mmHg)	t-value	p-value
Mercury vs. Aneroid	-0.6	-2.11	0.035	-0.6	-2.04	0.042
Mercury vs. Digital	0.7	2.45	0.015	0.3	1.22	0.222
Aneroid vs. Digital	1.3	4.24	<0.001	0.9	3.13	0.002

Discussion

A digital blood pressure monitor, an aneroid sphygmomanometer, and a traditional mercury sphygmomanometer were the three blood pressure readings from which 300 healthy participants participated in a comparative study. In contrast to the conventional mercury sphygmomanometer, the study sought to ascertain the accuracy and dependability of the aneroid and digital instruments.

All three devices showed reasonably consistent average systolic and diastolic blood pressure readings; the mercury sphygmomanometer had a mean systolic blood pressure of 122.5 mmHg and a mean diastolic blood pressure of 78.6 mmHg. Systolic readings on the aneroid sphygmomanometer were somewhat higher at 123.1 mmHg and diastolic at 79.2 mmHg, but the digital monitor recorded slightly lower readings at 121.8 mmHg and diastolic at 78.3 mmHg. The paired t-test findings demonstrated the statistical significance of these differences. The systolic blood pressure readings between the mercury and aneroid sphygmomanometers ($p=0.035$), the mercury and digital monitors ($p=0.015$), and the aneroid and digital monitors ($p<0.001$) showed statistically significant differences, according to the paired t-test analysis. Significant differences were seen in diastolic blood pressure between aneroid and digital monitors ($p=0.002$) and between mercury and aneroid sphygmomanometers ($p=0.042$), but not between mercury and digital monitors ($p=0.222$). These findings imply that, despite some slight variations in the data acquired from the various instruments, the mercury sphygmomanometer and the digital monitor's readings are most similar.

These results were further corroborated by the Bland-Altman analysis, which revealed strong agreement between the devices with mean differences that were almost negligible and relatively small limits of agreement. This suggests that the reading variations fall into an acceptable range for therapeutic use. Ultimately, the digital blood pressure monitor showed the most accurate readings compared to the mercury sphygmomanometer, indicating that it is a trustworthy substitute for taking blood pressure readings in healthy individuals. The overall agreement is acceptable despite the minor but statistically significant variances between the devices, which makes the digital monitor a viable choice for regular blood pressure monitoring.

Systolic and diastolic blood pressure (BP) readings obtained with mercury sphygmomanometers, aneroid, and digital devices were shown to be equivalent in a According to this study it was found that although there were some statistically significant variations in diastolic readings, especially between aneroid and digital devices, these devices can be utilised interchangeably in practical applications [5].

However, in a study it was included that 1119 healthy adults revealed a substantial difference in the readings of the digital and mercury sphygmomanometers. When it came to BP measurement, digital devices were less accurate than mercury devices, with a tendency to record greater systolic and lower diastolic readings. This raises questions regarding them as the gold standard [6].

A randomised study was carried out to evaluate the variation in blood pressure readings between digital devices and traditional mercury sphygmomanometers. The systolic and diastolic blood pressure readings between the two kinds of devices did not differ significantly, according to the 102 participants in the study. According to this, digital gadgets may offer a trustworthy substitute for mercury sphygmomanometers in standard clinical settings [7].

Conclusion

In comparison to the conventional mercury sphygmomanometer, this study assessed the accuracy and dependability of aneroid and digital blood pressure monitors in a sample of 300 healthy participants. Although there are small statistical variances between the devices, overall agreement is within clinically acceptable bounds, according to the findings. The digital blood pressure monitor specifically showed the readings that were closest to the mercury sphygmomanometer, indicating that it could be a good substitute for measuring blood pressure. Digital technologies provide a secure and practical alternative for routine blood pressure monitoring, especially in light of the health and environmental risks linked to mercury. To validate these results and guarantee the long-term dependability of digital blood pressure monitors in multiple healthcare contexts, more study covering a range of individuals and clinical settings is advised.

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