RESEARCH ARTICLE

A comparative study of automated versus manual measurement of blood pressure in a tertiary care hospital

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ABSTRACT

Background: Measurement of arterial blood pressure (BP) is one of the routine procedures performed both in outpatient and inpatient services of the hospital. Even though BP estimation is routinely done, its values are vital to assess the health status of the patients. Accurate recordings of BP can be estimated by adhering to all the precautions and instructions relating to the specific method employed for BP measurement. In recent years, many health-care setups are replacing the traditional manual BP apparatus with automated machines (digital) for BP estimation. Hence, there is a need to compare these two techniques in relation to their accuracy. Aims and Objectives: In a quest to replace manual mercury sphygmomanometers with automated machines, there is a need to see the reliability of automated machines of BP measurements especially which are currently available in India. Hence, the present study will help us to see the accuracy of automated machines by simultaneously comparing them with manual mercury sphygmomanometer. Materials and Methods: A total of around 224 patients which include 124 males and 100 females within the age group of 25–35 years are recruited for the study. Informed consent was taken from all the subjects. Institute ethical clearance was obtained before conducting the research study. Both manual and automated BP apparatus were used for BP recording. Results: The mean systolic BP (SBP) recorded in males using the mercury sphygmomanometer was found to be 113.19 ± 10.60 mmHg, 113.08 ± 10.08 mmHg, and 117.16 ± 11.14 mmHg, and the mean diastolic BP (DBP) was found to be 68.76 ± 8.34 mmHg, 70.50 ± 8.66 mmHg, and 72.69 ± 8.35 mmHg in sitting, standing, and recumbent postures, respectively. The mean SBP recorded using digital sphygmomanometer was found to be 113.90 ± 10.93 mmHg, 117.24 ± 10.23 mmHg, and 117.16 ± 11.14 mmHg and the mean DBP recorded was found to be 68.50±8.43 mmHg, 70.50 ± 8.66 mmHg, and 72.39±7.89 mmHg in sitting, standing, and recumbent postures, respectively. The difference between mean SBP and DBPs in males recorded using the two devices was found to be statistically insignificant. Similarly, the difference between mean SBP and DBP in females recorded using the two devices was not statistically significant. Conclusion: From the above results, it is concluded that there were no significant differences in recorded values of manual mercury sphygmomanometer and automated digital sphygmomanometer.

KEY WORDS: Systolic blood pressure; Diastolic blood pressure; Blood pressure; Digital; Automated

INTRODUCTION

Measurement of arterial blood pressure (BP) is one of the routine procedures performed both in outpatient and inpatient services of the hospital. Even though BP estimation is routinely done, its values are vital to assess the health status of the patients. Accurate recordings of BP can be estimated...
by adhering to all the precautions and instructions relating to the specific method employed for BP measurement. In recent years, many health-care setups are replacing the traditional manual BP apparatus with automated machines (digital) for BP estimation. BP estimation is one of the most frequently performed procedures on patients. For optimal treatment, outcome correct estimation of BP is important. It helps in finding out the cause of the diseases and also assessing the health status of the patients ranging from dehydration to fluid overload. Notably, BP recording helps us to find cardiovascular diseases (CAD) including acute cases who come to causality with presentation of chest pain. Accurate measurement of BP has tremendous importance in dealing with various conditions such as shock, cardiac failure, kidney failure, diarrhea, viral fevers, poisoning cases, burns, and road traffic accidents.

Sustained elevation of BP (hypertension [HTN]) independently or with other comorbidities has becoming prime cause for CAD, formation of atherosclerotic plaques inside the blood vessels, myocardial infarction, and heart failures. HTN if untreated or not managed correctly may lead to the development of kidney failure, stroke, and dementia. The incidence of HTN in our neighboring countries like Pakistan is around 10% in 1997. Diseases which are the result of ill-managed HTN are growing at unprecedented rate than before. According to the public health report published in the year 2008, 54% of strokes and 475 of heart diseases are related to HTN. Even it is estimated that, around 13% of all he deaths are attributable to HTN. Because of the abovementioned reasons, there is a need to monitor BP routinely in every patient who visits the hospital. Incorrect estimation of BP either it can be overestimation or underestimation can have serious implications on patients in various aspects. This may prone the patients to undergo unnecessary procedures, tests, and treatment which may not only affect the physical health of the individuals but also have consequences on mental health many times due to its financial implications. Hence, estimation of BP accurately has occupied paramount importance in health-care setups. It is known that generally three types of non-invasive procedure are used to monitor BP which includes manual sphygmomanometer (mercury), aneroid meter, and the automated oscillometric device. The mercury sphygmomanometer is generally used frequently and is believed to be the gold standard (training is required). Nowadays, there is a growing demand to replace manual mercury apparatus with automated oscillometric devices. As the manual mercury sphygmomanometer uses toxic substance called as mercury which is considered as an environmental hazardous substance, various countries across the globe, especially developed nations such as Sweden and the Netherlands are started banning the use of mercury containing sphygmomanometers. Considering the population of India and level of health-care system in India, it may not be immediately feasible or practicable to follow such trend but there is a need to slowly enrich our health-care system with new technological tools which may not only increase the precision but also has eco-friendly implications which indirectly contributes to promotion of the health care of the citizens and conservation of nature.

Many factors will play their part in deciding the accuracy of recording of manual BP estimation such as location of the position of cuff, dimensions of the cuff, kind of stethoscope, adherence to the instructions of use of the apparatus, physical activity of the person, age and sex of the patients, and white coat response. Even factors such as the level of attention and involvement of the examiner (doctor or nurse) will have implication on accuracy of BP recording. Environmental factors like background sound may definitely be able to alter the final outcome the manual procedure. Hence, in a quest to replace manual mercury sphygmomanometers with automated machines, there is need to see the reliability of automated machines of BP measurements especially which are currently available in India. Hence, the present study will help us to see the accuracy of automated machines by simultaneously comparing them with manual mercury sphygmomanometer.

MATERIALS AND METHODS

A total of around 224 patients which include 124 males and 100 females within the age group of 25–35 years are recruited for the study. Informed consent was taken from all the subjects. Institute ethical clearance was obtained before conducting the research study. Both manual and automated BP apparatus were used for BP recording. Study is a cross-sectional study. Questionnaires were provided to obtain demographic data from patients.

Inclusion Criteria

- Subjects with in the age group of 25–35 years
- Both males and females subjects.

Exclusion Criteria

- Subjects with a history of HTN, cardiac diseases, endocrine disorders, obesity, and renal diseases were excluded from the study
- Patients who are using psychotropic medications
- Patients with sleep disorders
- Patients who undergone surgery to their upper limbs
- Mentally ill.

Study Design

Study was conducted in the morning hours from 9 am to 11 am. Place of the study was the Department of Physiology, Vijayanagara Institute of Medical Sciences, Cantonment, Ballari, Karnataka. All the subjects were asked to take around
10 min rest before measuring the BP. Then, the subject is asked to sit comfortably in the chair by placing his arm in a relaxed state on a table which should be at the level of the heart. Only non-dominant hand should be used for recording the BP by both manual mercury sphygmomanometer (DIAMOND Deluxe BPMR 120) and digital sphygmomanometer (OMRAN Hem 711). Recording should be done sequentially in all positions such as sitting, standing, and in recumbent position. A minimum of 3 min time gap should be followed between each position for BP recording. Separately, means of systolic BP (SBP) and diastolic BP (DBP) are recorded both by manual and digital method. Finally, results are compared between the two techniques to find statistical significant variation if any.

**Statistical Analysis**

Data were analyzed using SPSS version 19 with $P \leq 0.05$ was considered as statistically significant.

**RESULTS**

In the present study, out of the 224 participants, males were 124, and females were 100. The mean SBP recorded in males using the mercury sphygmomanometer was found to be $113.19 \pm 10.60$ mmHg, $113.08 \pm 10.08$ mmHg, and $117.16 \pm 11.14$ mmHg, and the mean DBP was found to be $68.76 \pm 8.34$ mmHg, $70.50 \pm 8.66$ mmHg, and $72.69 \pm 8.35$ mmHg in sitting, standing, and recumbent postures, respectively.

The mean SBP recorded using digital sphygmomanometer was found to be $113.90 \pm 10.93$ mmHg, $117.24 \pm 10.23$ mmHg, and $117.16 \pm 11.14$ mmHg and the mean DBP recorded was found to be to be $68.50 \pm 8.43$ mmHg, $70.50 \pm 8.66$ mmHg, and $72.39 \pm 7.89$ mmHg in sitting, standing, and recumbent postures, respectively.

The difference between mean SBP and DBPs in males recorded using the two devices was found statistically insignificant [Table 1].

The mean SBP recorded in females using the mercury sphygmomanometer was $101.21 \pm 0.34$ mmHg, $102.12 \pm 9.12$ mmHg, and $109.08 \pm 10.12$ mmHg, and the mean diastolic BP recorded was found to be $63.59 \pm 9.34$ mmHg, $65.52 \pm 9.64$ mmHg, and $67.65 \pm 9.64$ mmHg. The mean SBP recorded using digital sphygmomanometer was found to be $98.10 \pm 9.12$ mmHg, $102.45 \pm 12.32$ mmHg, and $106.75 \pm 10.12$ mmHg and the mean DBP recorded with the digital sphygmomanometer was found to be $65.52 \pm 9.64$ mmHg, $68.10 \pm 8.61$ mmHg, and $68.34 \pm 9.21$ mmHg in sitting, standing, and recumbent posture, respectively. The difference between mean SBP and DBP in females recorded using the two devices was not statistically significant [Table 2].

<table>
<thead>
<tr>
<th>Posture</th>
<th>SBP (mmHg)</th>
<th>DBP (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting</td>
<td>Mercury</td>
<td>113.19</td>
</tr>
<tr>
<td></td>
<td>Digital</td>
<td>113.90</td>
</tr>
<tr>
<td>Standing</td>
<td>Mercury</td>
<td>117.24</td>
</tr>
<tr>
<td></td>
<td>Digital</td>
<td>117.16</td>
</tr>
<tr>
<td>Recumbent</td>
<td>Mercury</td>
<td>117.16</td>
</tr>
<tr>
<td></td>
<td>Digital</td>
<td>117.16</td>
</tr>
</tbody>
</table>

**Table 1:** Systolic blood pressure and diastolic blood pressure in sitting, standing, and in recumbent postures using manual and digital sphygmomanometers in males.

**Table 2:** Systolic blood pressure and diastolic blood pressure in sitting, standing, and in recumbent postures using manual and digital sphygmomanometers in females.
DISCUSSION

In the present study, no statistically significant difference was identified between the BP recording taken using the manual and automated sphygmomanometers. The manual BP recording technique with the help of mercury containing apparatus is a type of indirect method of BP assessment. The principle for the above-mentioned method is balancing air pressure (bag) against the pressure of the blood in the brachial artery. The air pressure is measured by means of mercury sphygmomanometer (BP machine). For automated recording, BP Omron Hem 711 model of digital sphygmomanometer was used. According to Jeyanthi et al., the principle of digital recording of BP is based on the oscillometric method.[9]

The present study findings are in line with the results of research done by Wadhwani et al. As per the results of Wadhwani et al. it is observed that the recorded values of automated and manual methods of blood pressure measurement are well comparable except that the SBP values are slightly higher with automated method than manual method.[9] In the present study, such significant differences were not found.

Various studies conducted on Canadian population relating to accuracy of BP measurement techniques have shown that well-manufactured digital BP apparatuses can be used instead of traditional manual mercury BP apparatuses.[10] The results of the study performed by Srinivasan et al. are quite contradictory to the present study results.[11] Even the results of Bhatt et al. are somewhat inconsistent with the present study outcome.[12] At the same time, the above aforementioned studies have recommended to use digital automatic apparatus sparingly and cautiously mainly in hospital setups. Differences in the results of the present study may be because of kinds of instruments used and dissimilarities in study settings.

Some of the findings of the present study are in agreement with some of the studies which concluded that there may be difference of the automated and mercury sphygmomanometer’s findings in SBP and DBPs which are still statistically significant.[13] Further, more research is required with large number of sample size and gender variations. More devices which are accurate but also cost effective are needed to be explored in future studies.

**Limitations of Study**

Only single type of digital apparatus is used for comparing it with manual mercury sphygmomanometer. Age group was restricted between 25 and 35 years. There is a need to compare the results in other age groups and diseased conditions.

**CONCLUSION**

From the above results depicting in Tables 1 and 2, it is concluded there is no significant variation in BP recordings.
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of both the techniques. As the values of both the manual and automated methods are comparable, SBP and DBP values can be used interchangeably in routine patient care. The advantages of digital automated method are non-invasive, training is not required to use, relatively safe to use, time conserving, portable, and ergonomic. Digital automated machines are mainly useful in rural areas where medical infrastructure is inadequate.

Examiner bias can be completely removed by automated method. At the same time, white coat HTN effect can be minimized by automated machine. From the observations of the present study and previous available related literature, it is recommended to continue using manual mercury sphygmomanometer as the main way of assessing BP. In parallel to conventional manual method, digital automated technique should be used mainly in the remote rural areas where skilled workforce is not available, in extreme cases of war and natural calamities and also for self-monitoring. Even though the results of the both the techniques are comparable, cautious attitude is needed to replace the conventional manual mercury method with digital automated method. It is desirable to conduct more research related to BP measurement for better understanding of the technicalities involved. This study leaves the scope for future studies like “comparison of different types of automated digital sphygmomanometers for finding out variation if any.”

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REFERENCES


