Assessment of Sphygmomanometers: a Proposal for Excellence in Blood Pressure Measurement

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Introduction

Systemic hypertension is known to be a risk factor for cardiovascular events. Its high social burden accounts for approximately 40% of early retirements and work absenteism, and is a highly prevalent health problem in Brazil. Surveys conducted in some Brazilian cities show a 22.3% to 43.9% prevalence of hypertension (≥140/90 mm Hg)[1].

Diagnosis of hypertension is mandatory, since failure to treat hypertensive individuals is associated with increased cardiovascular morbidity and mortality, whereas antihypertensive treatment reduces the risks posed by hypertension[2].

Indirect measurement, first described by Riva Rocci[3], is the most frequently used technique for blood pressure (BP) measurement in the clinical practice; however, it depends on several factors in order to reflect the real behavior of this variable.

Despite the importance and standardization of techniques for BP measurement, studies show low health professional compliance to the systematization recommended[3]. Aspects related to the patients, health care professionals and conditions of the sphygmomanometers used – such as calibration, conditions and size of cuffs and inflatable bladders, conservation and functioning of bulbs, are fundamental for correct BP measurement[4].

In light of these considerations, we believe the assessment of calibration and functioning of the sphygmomanometers in use at Hospital das Clínicas da Faculdade de Medicina de Ribeirão Preto da Universidade de Sao Paulo (HCFMRPUSP) is necessary so that we can learn their current functioning conditions and further propose a continuous maintenance policy.

Objectives

To evaluate calibration and functioning of the sphygmomanometers in use at HCFMRPUSP.

Key Words

Measurement, Blood Pressure; Arterial Hypertension; Sphygmomanometers.

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Materials and Methods

First the Centro de Engenharia e Manutenção de Bioequipamentos – CEMB (Bioequipment Maintenance and Engineering Center) made an inventory of the total number of sphygmomanometers in use in HCFMRPUSP. Next, their components and functioning conditions were analyzed: calibration; state of preservation of inflation bulbs and valves; sizes and characteristics of cuffs and lining fabric of the inflatable bladders. The ideal standard for the characteristics and functioning of sphygmomanometers was based on the guidelines of the American Heart Association[5].

The assessment of calibration of the devices was made at CEMB, using a Y-tube against a K. Takaoka mercury-column manometer with scale from 0 to 300 mmHg. The assessment was made twice. Devices were considered out of calibration whenever a ≥ 3 mmHg difference was found when the technique described above was used.

Results

All 358 sphygmomanometers in use at HCFMRPUSP were mercury-column devices. Seven of them (2%) were out of calibration. As regards the cuff size, 345 (96.3%) were only adequate for normal adults, whereas only three (0.8%) were adequate for small adults and nine (2.5%) for large adults. A total of 114 (32%) inflatable bladders were perforated.

The fabric that encases the cuff was torn in 103 (29%) of the 358 devices assessed. A total of 114 (32%) inflation bladders had defects and required replacement. As regards the inflation bladder valves, 64 (18%) were not working properly and required repair or replacement. The characteristics and functioning conditions of the 358 sphygmomanometers assessed are shown in Table 1.

Discussion

This study demonstrates that the calibration and functioning conditions of the sphygmomanometers in use at HCFMRPUSP are worse than desired.

All sphygmomanometers used at HCFMRPUSP are mercury-column devices, and this is consistent with the literature that suggests that this type of device is less susceptible to decalibration. Likewise, decalibration is known to be more easily detected in them. Mion et al[6] evaluated 524 sphygmomanometers in use at Hospital das Clínicas da Faculdade de Medicina da Universidade de Sao Paulo (HCFMUSP) and in private medical offices in the city of Sao Paulo, and found 204 (49%) aneroid devices and 320 (51%) mercury-column devices. At HCFMUSP, of the 351 sphygmomanometers assessed, 315

Brief Comments

Table 1 - Characteristics and functioning conditions of the 358 sphygmomanometers in use at Hospital das Clinicas da Faculdade de Medicina de Ribeirão Preto da Universidade de Sao Paulo.

Type of device	Aneroid 0 (0%)	Mercury-column 358 (100%)	-
Calibrated	No 7 (2%)	Yes 351 (98%)	-
Cuff and inflatable bladder size*	Adult 346 (88%)	Large Adult 09 (2.5%)	Small Adult 03 (0.8%)
Inflatable bladders	Perforated 114 (32%)	Intact 244 (68%)	-
Inflation bulbs	Perforated 114 (32%)	Intact 244 (68%)	-
Cuff fabric	Torn 103 (29%)	Intact 255 (71%)	-
Valves	Not working properly 64 (18%)	Intact 294 (82%)	-

** The difference is represented by other types of cuff which are appropriate for other conditions such as use in newborns and blood pressure measurements in legs.*

Table 2 - Assessment form suggested for maintenance of the functioning conditions of sphygmomanometers in hospital medical care services.

Mercury-column Sphygmomanometer		
Mercury column is at zero (deflated)	**Y**	**N**
Column is fully filled when inflated	**Y**	**N**
Presence of dirt or oscillation in glass column	**Y**	**N**
Aneroid Sphygmomanometer		
Check against mercury column device. Measurements are equal or similar (difference ≤ 3mm)	**Y**	**N**
Cuff conditions		
Intact fabric	**Y**	**N**
Hooks or Velcro - OK	**Y**	**N**
Correct position of metal stand	**Y**	**N**
Inflatable bladder conditions		
Intact rubber bladder	**Y**	**N**
Intact fabric	**Y**	**N**
Inflation bulb and valve conditions		
Intact inflation bulb	**Y**	**N**
Intact valve	**Y**	**N**

Date of assessment: _____/_____/_____ Observer: _____
Next assessment: _____/_____/_____ Device Number: _____
Other observations: _____

were mercury-column devices. However, in private offices, of the 173 sphygmomanometers assessed, only five were mercury-column devices.

One aspect that should be pointed out in our study was the small number – only 2%, of devices out of calibration. In other studies, the percentage of sphygmomanometers out of calibration was higher, although almost all were aneroid devices[7,8].

In order to keep the equipment in perfect functioning conditions, after this assessment we created a calibration seal and routine assessment of the general conditions of the components, with established dates for the next calibration and assessment. Thus, a regular policy for calibration and assessment of the sphygmomanometers in use at HCFMRPUSP is now effective.

Concurrently, we created a policy for users' awareness of the importance of sending the devices for checks even before the pre-established deadline, if necessary, aiming to have 100% of the equipment in ideal functioning conditions. To achieve this goal efficiently, we elaborated an assessment form for each piece of equipment, describing all their components (Table 2).

The use of a cuff smaller than necessary for the patient examined results in blood pressure overestimation, whereas the opposite situation will lead to blood pressure readings lower than real[2]. In this study, the size of 345 (96.3%) cuffs was adequate for "normal adults" (arm circumference between 27 and 34 cm). Only nine (2.5%) were adequate for "large adults" (arm circumference between 35 and 45 cm) and three (0.8%) for "small adults" (arm circumference between 20 and 26 cm)[1]. Considering the importance of the size of the cuff used, we supplied all areas of the hospital with sets of three cuffs to be used in normal, large and small adults. Thus, we ensured that proper cuffs were available in all sectors of this institution.

Defects were found in 68 valves (18%), 114 (32%) inflatable bladders, and also in inflation bulbs; these rates are unacceptable and lead to inadmissible BP reading errors. Other authors[8,9] evaluated the functioning of sphygmomanometers in different situations and also found inadequate conditions. For this reason, assessment of calibration and functioning of these devices is mandatory.

None of the studies previously cited proposed the creation of systematic and continuing programs for the assessment and maintenance of these devices to ensure accurate BP measurements.

Our study encouraged and was used as a reference for the elaboration of the HCFMRPUSP's "Programa de Excelência em Medida da Pressão Arterial" - PEMEPA (Excellence in Blood Pressure Measurement Program), which we suggest be applied in other institutions, clinics and medical offices, with the following guidelines:

1. Determination of device characteristics

2. Continuing assessment of equipment calibration

3. Permanent assessment of functioning conditions of the sphygmomanometer components

4. Creation of an identification seal bearing the current and next assessment dates

5. Users' awareness for constant observation of the functioning of all components, regardless of the date scheduled for assessment.

6. Acquisition and use of cuffs with adequate characteristics for the arm size of the individual examined.

Equally important for blood pressure measurement are the procedures carried out by health care professionals. For this reason, as part of PEMEPA, regular updating courses on procedures for BP measurements were created.

In conclusion, this study demonstrated decalibration and other functioning problems in the sphygmomanometers in use at HCFMRPUSP, and this could lead to inaccurate BP measurements. These data were useful to find solutions for the defects identified, and also to create an excellence program for blood pressure measurement for HCFMRPUSP which could be further used as a reference for other health services in the country.

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Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This study is not associated with any post-graduation program.

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