BLOOD PRESSURE MEASUREMENT: ARM CIRCUMFERENCE AND CUFF SIZE AVAILABILITY

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To avoid inaccurate blood pressure (BP) readings, the American Heart Association (AHA) recommends cuff width (CW) encircling 40% of the arm circumference (AC) and cuff length at least 80-100%. This study aimed to identify inpatients´ AC, the corresponding cuff size and the cuff size availability. In total, 81 AC were measured in the right arm. The cuff sizes to fit them were calculated according to AHA AC/CW width 0.40 ratio. The AC varied from 17.5 to 40.5 cm and the corresponding cuff width from 6 to 16cm. The standard cuff 12 by 23 cm, the only size available in the clinics, was appropriate for only 17.3% of the subjects, whose AC varied between 32.5 and 34.3 cm. The lack of availability of different cuff sizes continues being a challenging problem to be faced. The standard cuff available, 12cm large, did not fit 82.7% of the identified AC, resulting in over or underestimated BP registers.

DESCRIPTORS: blood pressure determination; blood pressure; hypertension; nursing care

LA MEDICIÓN DE LA PRESIÓN ARTERIAL: CIRCUNFERENCIA DEL BRAZO Y DISPONIBILIDAD DE MANGUITOS

Para evitar medidas imprecisas de la presión arterial (PA), la American Heart Asociation (AHA) recomienda que el ancho del manguito (AM) circunde 40% de la circunferencia del brazo (CB) y el largo sea de 80-100%. El objetivo de este estudio fue identificar las CBs de pacientes internados, los manguitos correspondientes y los tamaños disponibles en las clínicas. Como método, 81 CBs fueron medidas en el brazo derecho. Los anchos fueron identificados según la razón CB/AM 040, propuesta por la AHA. Se obtuvo como resultado que las CBs variaron de 17,5 a 40,5 y los manguitos correspondientes de 6 a 16cm. El manguito estándar de 12x23cm, único disponible en las clínicas, fue apropiado para apenas 17,3% de los sujetos, cuyas CBs variaron entre 32,5 y 34,3cm. Se verifica que la falta de disponibilidad de diferentes tamaños de manguitos continúa siendo un desafío a ser enfrentado. Se concluye que el manguito estándar disponible no atiende a las CBs identificadas, resultando en registros sobre o subestimados de la PA.

DESCRIPTORES: determinación de la presión sanguínea; presión sanguínea; hipertensión; atención de enfermería

MEDIDA DA PRESSÃO ARTERIAL: CIRCUNFERÊNCIA BRAQUIAL E DISPONIBILIDADE DE MANGUITOS

Para evitar medidas imprecisas da pressão arterial (PA), a American Heart Association (AHA) recomenda que a largura do manguito (LM) circunde 40% da circunferência do braço (CB) e o comprimento de 80-100%. O objetivo deste estudo foi identificar as CBs de pacientes internados, os manguitos correspondentes e os tamanhos disponíveis nas clínicas. Como método, 81 CBs foram medidas no braço direito. As larguras foram identificadas segundo a razão CB/LM 040, proposta pela AHA. Obteve-se como resultados que as CBs variaram de 17,5 a 40,5 e os manguitos correspondentes de 6 a 16cm. O manguito padrão 12x23cm, único disponível nas clínicas, foi apropriado para apenas 17,3% dos sujeitos, cujas CBs variaram entre 32,5 e 34,3cm. Verifica-se que a falta de disponibilidade de diferentes tamanhos de manguitos continua sendo desafio a ser encarado. Conclui-se que o manguito padrão disponível não atende às CBs identificadas, resultando em registros super ou subestimados da PA.

DESCRITORES: determinação da pressão arterial; pressão arterial; hipertensão; cuidados de enfermagem

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INTRODUCTION

It is emphasized in the literature that different factors may influence blood pressure (BP) measurement accuracy. There are several errors that can be made by the observer (person who measures blood pressure)[1] due to poor BP measurement knowledge or lack of attention[2-4]. The main sources of inaccurate BP readings are related to the incorrect use of the equipment[5-6], the environment[7] and the increase of patient's alarm in front of his doctor (the "white coat effect" phenomenon)[8] . However, the use of a wrong cuff size to arm circumference (AC) is the most discussed cause of imprecise measurement.

To avoid over or under BP estimation, the ratio arm circumference/cuff width (AC/CW) must be around 0.40 and the cuff length must encircle AC from 80 to 100%[9-10] , as recommended by the American Heart Association[11]. The European Society of Hypertension Annual Meeting 2007 established guidelines[12] which recommended a standard bladder 12 -13 cm long, size appropriate to nearly 10-30 % of adults' arm circumference. In addition, a bigger bladder for fat arms (35cm) and a smaller one for thin arms were also recommended[12].

Narrow cuffs can overestimate BP values, as demonstrated in 1901[13]. The high readings result in excessive intake of anti-hypertensive drugs with severe consequences, such as dizziness and fainting. Conversely, larger cuffs may underestimate BP readings in lean subjects, resulting in misdiagnosis and mistreatment of hypertension[14]. In spite of these facts, health professionals currently use only one standard cuff to measure BP, with no distinction among different arm circumferences.

The possibility of poor BP evaluation is not a question of concern for many nurses or physicians. Although several guidelines have recommended the use of the correct cuff width since 1951[15], no consensus has been reached regarding the cuff sizes to be correctly used in children and adults. Moreover, we do not know whether health professionals would be able to select the proper cuff size and use it, if available in the market and medical units.

Many questions remain unanswered more than five decades since the American Heart Association attested that the proper cuff must be 20% larger than arm diameter to ensure precise BP readings. There are two aspects to be considered: the number of different cuff sizes to fit the entire arm circumference range of the world population and whether there would be differences among people from different countries, regions or inpatients in different clinics.

Several studies aimed to investigate the accuracy of sphygmomanometers and nurses' knowledge about the blood pressure measurement procedure, but to our knowledge few have been done to identify the arm circumference range of adult inpatients associated with the proper cuff size. The sample of a study recently developed in Brazil included only non hospitalized children and adolescents[16]. Many subjects included in hypertension studies are often affected by metabolic syndrome, diabetes, and obesity. These patients' arm circumference is usually bigger than 33 cm, demanding a cuff larger than the traditional standard one (12x23 cm). However, many subjects, such as young adults, women, slim or normal weight persons with an arm circumference smaller than 29 cm, need a narrower cuff than the standard one. The wrong choice of cuff for those patients can result not only in hypertension misdiagnosis and incorrect treatment, but also in an inaccurate analysis of any variable associated with BP, such as antihypertensive treatment control, obesity, physical exercise, smoking, physiological or emotional aspects, among others.

The discrepancies between the theoretical framework and cuff size recommendations for practice in the hypertension societies´ statements lead us to check what is happening in the wards where we practice nursing care education.

OBJECTIVES

To identify inpatients' arm circumference and the corresponding cuff size according to the traditional AHA AC/Cuff Width 0.40 ratio. To check in the wards the cuff sizes' availability to measure BP in these patients.

METHOD

A cross-sectional study was conducted in patients admitted to medical wards of different specialties of a general university hospital in the interior of Sao Paulo. The size of the sample was initially calculated to ensure 0.10 to be the maximum

error in estimate and ratio tests, with 0.90 probability: (n=2.69 x 0.25/0.01 yielded n= 67.2[17]. The 0.10 adjustment resulted in a calculated sample of 81 subjects. All invited patients complied with our study, so the maximum error decreased to 0.90. The 81 volunteers aged from17 to 60 years, 63% were male. They were admitted to clinical wards of several specialized units: Cardiology (35.8 %), Nephrology (12.3%), Endocrinology (12.3%), Hematology (12.3%), Gastroenterology (12.3%), Geriatric (8.7%) and to the General Clinic (6.2%). The sample included only patients with good mental health, able to understand the research procedure and to answer the researchers' questions. The study was carried out after the Ethics and Research Committee approval and the disclaimer patient signature.

Upper arm circumferences were measured by three cardiology specialized nurses, during routine blood pressure measurement, trained to avoid errors. As recommended in the 1993 American Heart Association Guidelines XX, the circumference was measured at the midpoint between the acromium and olecranon of the right arm, supported at heart level (fourth intercostal space), with the patient either sitting or lying down. In cases of discomfort due to brachial artery catheterization and special conditions, the left arm was used.

In order to estimate the correct cuff width for each patient, we adopted the American Heart Association arm circumference/cuff width 0.40 ratio. Although the 0.38 ratio represents exactly a cuff width 20% larger than upper arm diameter, we adopted 0.40 because it is universally accepted and used. The cuff length should encircle at least 80% the arm.

Cuff availability was checked when BP was measured. We also interviewed nurses and staff members responsible for the purchase of sphygmomanometers.

RESULTS

The results are presented in the following order: patient distribution according to clinical specialty, and gender (Table 1); body mass index distribution to gender (Table 2); body mass index distribution to age (Table 3), and Table 4 presents patients' arm circumference and corresponding cuff width. Regarding the analysis of the sample's demographic characteristics, from the 81 studied subjects, 51 (63%) were male, being the age average 55.4 years. The sample was composed of adolescents (4.9%), adults (54.3%), and elderly subjects (40.7%). Although diagnosis identification was not an objective of this study, Table 1 allows us to know the kind of clinic the patients were admitted to.

Table 1 – Gender distribution according to clinical specialty. Ribeirão Preto, 2002

Clinical Specialty	Gender				Total	
	Male		Female			
	n	%	n	%	N	%
Cardiology	22	27.1	7	8.7	29	35.8
Nephrology	6	7.4	4	4.9	10	12.3
Endocrinology	3	3.7	7	8.6	10	12.3
Pneumology	9	11.1	1	1,2	10	12.3
Gastroenterology	6	7.4	4	4.9	10	12.3
Medical Clinic	-	-	5	6.2	5	6.2
Geriatric	5	6.1	2	2.5	7	8.7
Total	51	63.0	30	37.0	81	100

The data from patients in cardiology and nephrology reach almost 50% of the sample. Note that 12.3% of the patients were admitted due to endocrinology problems. Many of them showed severe obesity. At data collection, 25% of the sample had systolic arterial pressure ≥ 140mmHg, and 23.4% diastolic ≥ 90mmHg. The majority of the patients received three or more diagnosis, reaching 11 diagnoses in two of them that suggest complexity in their evaluation and treatment.

Table 2 - Body mass index distribution as a function of gender. Ribeirão Preto, 2002

BMI* Kg/m²	Gender				Total	
	Male		Female			
	n	%	N	%	n	%
25 Under or normal weight	24	29.6	12	14.8	36	44.4
25 - 27,5 Overweight	9	11.1	1	1.2	10	12.3
27,5 - 29,9 Grade I obesity	3	3.7	5	6.1	8	9.9
30 - 39,9 Grade II obesity	6	7.4	7	8.6	13	16.0
Ignored	9	11.1	5	6.1	14	17.3
Total	51	63.0	30	37.0	81	100

*ILIB Rating (1994)

Data in Table 2 show the high rate of obese patients, reaching 38.2% of the sample. The association between body mass index and gender indicates a favorable male rate for under or normal

weight patients, twice as much as that observed in females. However, because many of the patients could not be weighted, it was not possible to obtain a precise evaluation of the studied sample with respect to body mass index classification.

Table 3 - Body mass index distribution according to age. Ribeirão Preto, 2002

	Age							
	17-25 yrs Adolescents		26-60 yrs Adults		> 60 yrs Elderly		Total	
	n	%	n	%	N	%	n	%
25 Under or normal weight	1	1.2	19	23.4	16	19.7	36	44.4
25 - 27,5 Overweight	1	1.2	5	6.1	4	4.9	10	12.3
27,5 - 29,9 Degree I obesity	-	-	7	8.6	1	1.2	8	9.9
30 - 39,9 Degree II obesity	1	1.2	10	12.3	2	2.5	13	16.0
Ignored	1	1.2	3	3.7	10	12.3	14	17.3
Total	4	4.9	44	54.3	33	40.8	81	100

Source: * ILIB Rating (1994)

Data regarding the association between body mass index and age reveal that, among three adolescents, two are under or normal weighted. Adult subjects also presented high values in this category. As far as the elderly subjects, favorable rates of obesity degrees I or II are indicated, although the number of ignored weight is greater than that of adults. This fact could have influenced the data, which revealed a lower frequency of underweight and normal patients in the elderly group.

Table 4 - Arm circumference and correspondent cuff width distribution obtained from patients. Ribeirão Preto, 2002

Correct cuff width (cm.)	Arm circumference (cm.)	n	%
7	17.5-19.4	5	6.2
8	20.0-22.3	10	12.3
9	22.5-24.2	6	7.4
10	25.0-27.2	16	19.7
11	27.5-29.9	12	14.8
12	30.0-32.0	14	17.3
13	32.5-34.3	6	7.4
14	35.0-37.0	8	10.0
15	38.0-38.6	3	3.7
16	40.5	1	1.2
Total		81	100

As observed in Table 4, the application of the arm circumference/correct cuff width 0.40 ratio revealed more than 50% of the subjects with an arm circumference smaller than 30 cm; thus, they needed a cuff width narrower than 12 cm. As far as the possibility of overestimation, arm circumference was bigger than 32cm in 22.3% of the sample. These patients need cuffs larger than 12 cm. Only 17.3% of the participants in the study have arm circumference in the range from 30 to 32 cm, for whom the standard cuff of 12 cm is adequate.

The use of the ratio 0.40 to calculate the proper cuff size to fit the studied arm circumferences resulted in a cuff width range from 6 to 16 cm.

Our observation that only the standard cuff size was available in the wards was reinforced by nurses and engineering technicians in charge, who confirmed that only this cuff was used in all patients. The personnel responsible for the purchase of such equipment had not been advised about the possibility of acquiring different cuff sizes, despite the narrow range of cuff sizes available in the market. The findings shown in table 4 indicating requirement of several cuff sizes reveal discrepancy between the theoretical framework and the cuff size applied to check blood pressure in hospitalized patients.

DISCUSSION

The demographic characteristics related to gender and age confirm the present reality in the health care system of many countries. Patients are admitted according to their diagnoses to overcrowded wards of a general hospital, where adolescents, adults, and elderly people remain all together in the same ward. The number of hypertensive subjects reaches more than 25% of the sample. However, many of these patients could be wrongly diagnosed due to the cuff availability problem.

According to the body mass index, a significant segment of the studied sample (44.4%) was classified as being under or normal weight. These findings are different from those gathered in the campus of the University of São Paulo in the 80s, where nearly 20% of the subjects were thin and 50% had normal weight[18]. Thus, the number of obese (30%) was lower than what has been found in the present study, in which 38.2% of the patients had a body mass index higher than 27.5.

Obesity rates are different from those estimated in Brazil some years ago: 40% are overweight and obese, reaching 15 to 20% among children and adolescents. In these two groups, obesity rates have doubled and tripled, respectively. Obesity prevalence is increasing worldwide and excess weight is associated with chronic-degenerative diseases, which results in poor quality of life and serious socioeconomic impact, a relevant public health concern. Solving this problem has been one of the greatest challenges in the health care area[19] at the beginning of this century.

Despite the possibility of bias when comparing the health status of two different populations, people in their work place versus inpatients subjects, our findings confirm the fact that obesity rates are increasing in Brazil. The association of obesity with hypertension, diabetes, cardiovascular and nephrology diseases, results in the elevated rates observed in the present sample. These rates draw special attention to blood pressure evaluation of obese subjects, particularly those under treatment in hospitals, because their arm circumferences higher than 33 cm need cuffs larger than the standard one. Many investigators, nurses, physicians, pharmacologists and others, do not know that the standard cuff size is ideal for arm circumferences from 30 to 33 cm. Moreover, they do not know how to correlate age, body mass index and arm circumference to cuff dimensions.

Data associating age and body mass index show that we can find any index value in children, adults or the elderly. This means that we need cuffs narrower than 12 cm to serve elderly people who are thin as well many subjects with normal size, weight and arm circumference, particularly women in Japan, Korean, Africa, Asia and France, as well as in other countries. Many have arm circumference lower than 30 cm, young lean women lower than 26 cm, different from obese subjects needing larger cuffs. As emphasized, only larger cuffs have been a question of concern in blood pressure measurement evaluation, as can be checked in the 2005 American Heart Association Guidelines for blood pressure measurement, where a cuff of 12 cm is recommended for an arm circumference of 22 to 26 cm[19].

Following a cohort of 530 subjects from the University of Sao Paulo[18] during the last 26 years, we have demonstrated that the use of the standard cuff (12 cm) in arms of 22-26 cm can result in hypertension misdiagnosis and mistreatment due to blood pressure underestimated readings. Cardiovascular and gestational complications, as well as heart failure, stroke, preeclampsia, eclampsia, and early placental displacement were common problems observed in the cohort of this longitudinal study[18].

Fortunately, the 2006 Brazilian recommendations for blood pressure measurement[20] maintained the decision made in the 1993 American Heart Association guidelines[10], which include a cuff 10 cm large. The 2007 European Society of Hypertension guidelines recommend a standard cuff 13x 34cm. As mentioned, they also recommend a bigger one for fat arms and a smaller one for thin arms[21].

The adults showed higher blood mass index levels than the elderly subjects, leading to the belief that the use of an “adult cuff” may jeopardize the results, since brachial circumferences do not always correspond to such denomination. The authors of the 1967 American Heart Association guidelines[9] recommended not labeling the standard cuff 12 cm large as “adult cuff”, because it does not always correspond to the appropriate width. Furthermore, high obesity indices cannot be indistinctly correlated to larger arms or larger cuffs, as showed in our findings. The application of the arm circumference/ correct cuff width 0.40 ratio revealed that more than 50% of the subjects needed a cuff width narrower than 12 cm, and 22.2% needed larger ones (arm/ circumference bigger than 32 cm). The cuff width range to comply with the studied arm circumference applying such ratio varies from 7 to 16 cm. However, in the units where the survey was carried out, only one cuff width was provided (12 cm), suitable for only 17.3% of the participating patients. The possibility of blood pressure readings being under or overestimated is a reality. As noted in Table 3, many patients should be receiving anti-hypertensive treatment, but precise evaluation and treatment are not easily obtained in such situation, as probably occurs in hospitals around the world.

The American Heart Association recommended an arm circumference/correct width ratio of 0.40 from 1951 to 2005[11,15]. In 2005, a ratio of 0.46 was also mentioned[11]. As shown in Table 5, applying a ratio of 0.40 in our sample resulted in the conclusion that a large cuff size range was needed not to have over or underestimation of blood pressure values. Because a single cuff size was available in the clinic where the study was conducted, it is likely

that many hypertensive patients are under poor blood pressure evaluation and wrong treatment.

Lack of availability of several cuff sizes is a serious market problem, faced not only by some clinicians or nurses, but also by blood pressure measurement researchers. After the cuff size error was observed in children, pregnant women and critical patients, the first author of this investigation raised an ethical concern about the registration of a wrong blood pressure value in a patient's record[5]. Brazilian nurses have been researching on blood pressure measurement and trying to attract specialists' attention to the serious public health problem of hypertension misdiagnosis and incorrect treatment[18]. It is bewildering why hypertensive societies find it so hard to solve the problems caused by inappropriate cuff size.

This study contributes to nurses' knowledge regarding the discrepancies between the theoretical framework of blood pressure measurement devices and the cuff size used in practice. Blood pressure measurement is the nursing procedure most performed in the world. The authors believe that efforts must be done to provide information to broaden nursing knowledge, focusing on the cuff size effect on blood pressure measurement. The matter could be discussed in continuous educational programs, raising nurses´ awareness on the need for a greater availability of appropriate measurement tools. This could improve quality of life and decrease costs in health area.

CONCLUSION

The study showed that different cuff sizes are needed to cover the entire arm circumference range demanded by adolescents, adults and the aged inpatients of a general hospital.

The results showed a large arm circumference range, requiring several cuff sizes to avoid blood pressure measurements errors. Our findings indicate discrepancies between the traditional American Heart Association theoretical framework for blood pressure measurement and clinical practice. Only the standard cuff size was available to be used in the entire study sample. The lack of different cuff sizes is not a local problem as reported in many other studies[3-5,7,18]. As shown in this research, only the standard cuff is commonly available in health care units. Unfortunately, many subjects continue to receive poor blood pressure evaluation and this often results in hypertension misdiagnosis, cardiovascular and gestational complications and deaths.

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