Miscuffing: inappropriate blood pressure cuff application

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ABSTRACT For the accurate indirect measurement of blood pressure (BP), the American Heart Association (AHA) now recommends that cuff size should be based solely on limb circumference. We studied prevailing cuffing habits and compared them with newly revised AHA guidelines. Monitoring our staff’s cuff applications, we found that “miscuffing” occurred in 65 (32%) of 200 BP determinations on 167 unselected adult outpatients, including 61 (72%) of 85 readings taken on “nonstandard” size arms. Under cuffing large arms was the most frequent error, accounting for 84% of the miscuffings. Considering that miscuffing distorts BP readings by an average of 8.5 mm Hg systolic and 4.6 mm Hg diastolic, we can improve the accuracy of our BP determinations by remarking our cuffs and using the new AHA guidelines.


ESTIMATION of intra-arterial pressure by indirect means (i.e., sphygmomanometer) is predicated on a proper relation between the cuff size and the extremity. An undersized cuff causes falsely high readings and an oversized cuff causes falsely low readings.1–6

We studied the cuffing patterns of our staff at a teaching hospital outpatient clinic to determine the variance between prevailing cuffing habits and those recommended by the American Heart Association (AHA).7

Patients and methods

In a multispecialty outpatient clinic, the cuffing patterns of registered nurses and resident physicians were recorded during routine blood pressure (BP) measurements. Preamerasure of the patients’ midarm circumferences was done without the staff’s knowledge, so as not to alert them to the study’s specific intent. Standard and large adult cuffs were available at each examination site; thigh cuffs and small adult cuffs were available nearby.

To ascertain the magnitude of the BP error induced by miscuffing, we prospectively measured the BP of 60 patients whose arms would properly require a large-adult’s cuff (33 to 42 cm girth). They were chosen without regard to their prior BP status. Two measurements were taken on these individuals: one with a large adult cuff and one with a standard adult cuff.

The readings were separated by several minutes, during which time the patient was comfortably seated and the arm was supported. Both readings were taken by the same observer, who used the same mercury manometer and interchanged only the two cuffs. The onset of Korotkov phase V was used as the diastolic pressure. The sequence “standard cuff—large cuff” was used in 30 patients and the sequence “large cuff—standard cuff” was used in the other 30 patients.

Results

Distribution of arm sizes. The range of arm sizes encountered is shown in table 1, grouped by cuff size requirement. In the few cases when an individual’s right and left arm circumferences differed by more than 1 cm, an average of both arm sizes was used.

Cuffing patterns. Thirty of the 167 patients had a BP determination done by the physician in addition to the nurse’s routine measurement, and three entered the study twice on different days, for a total of 200 individual determinations. The proper cuff size was used in 69% of the 170 measurements by nurses and in 63% of 30 measurements by house staff physicians for an overall cuffing accuracy of 68% in 200 determinations. Figure 1 demonstrates the relationship between cuffing accuracy and the cuff size in this series of 200 cuffing events. Of note, in the 85 cuffings that required a nonstandard cuff, the proper cuff size was used in only 24 (28%). None of those requiring either a small-adult size or a thigh size were properly cuffed. Of the 64 cuffing errors, 54 were undercuffings and 10 were overcuffings. Fifty-two (96%) of the undercuffings were within the manufacturer’s range imprinted on the cuffs (figure 1).

Effect of undercuffing on BP measurement. With the BP obtained with the large-adult cuff as a reference, figure 2 demonstrates the difference in readings obtained with
a standard cuff in 60 large-armed patients (33 to 42 cm girth). The average error resulting from undercuffing was an increase of 8.5 mm Hg systolic and 4.6 mm Hg diastolic, with a wide individual variance. As expected, the 30 comparisons done with the standard cuff first had a higher difference (11.6/5.7 mm Hg) than did the 30 comparisons done with the large cuff first (5.5/3.5 mm Hg).

Legend: Each box represents an individual blood pressure determination.

- □ = properly cuffed
- U = undercuffed
- O = overcuffed

**FIGURE 1.** Cuff sizes used in 200 BP determinations.
Discussion

Using direct intra-arterial pressure measurement as a standard, several researchers have clearly demonstrated that an undersized cuff overestimates and an oversized cuff underestimates the true BP by as much as 10 to 30 mm Hg. Undercuffing can lead to the overtreatment of hypertension and overcuffing to its undertreatment.

Sequence of blood pressure measurements:
- standard cuff first, large cuff second
- large cuff first, standard cuff second

FIGURE 2. Range of systolic and diastolic differences (standard cuff reading minus large cuff reading) in 60 large-armed patients.
TABLE 1

Distribution of arm sizes, grouped by cuff size requirement

<table>
<thead>
<tr>
<th>Arm circumference (cm)</th>
<th>AHA cuff size</th>
<th>No. of patients</th>
<th>(% of total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;24</td>
<td>Small adult</td>
<td>5</td>
<td>(3%)</td>
</tr>
<tr>
<td>24-32</td>
<td>Standard adult</td>
<td>98</td>
<td>(59%)</td>
</tr>
<tr>
<td>33-42</td>
<td>Large adult</td>
<td>59</td>
<td>(35%)</td>
</tr>
<tr>
<td>&gt;42</td>
<td>Thigh</td>
<td>5</td>
<td>(3%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>167</td>
<td>(100%)</td>
</tr>
</tbody>
</table>

The 1980 revision of the AHA recommendations for cuff size clearly specifies the girth of arms that can be accommodated by each of the four adult cuff sizes with acceptable accuracy. In our study, 41% of the patients required a nonstandard cuff. Of that subgroup 72% were miscuffed. Clearly the AHA recommendations, now nearly 3 years old, have not yet influenced common practice.

To assess the magnitude of error induced by miscuffing, we focused on the most common misapplication — applying a standard cuff to a large arm. In comparing the standard and large cuff readings of 60 large-armed patients, we obtained 30 paired readings with the standard cuff first and the other 30 with the large cuff first. This was done to neutralize the recognized tendency for repeat BP readings to be lower than initial readings, as the subject relaxes and becomes accustomed to the procedure. Our finding, that the standard cuff overestimated the large-armed patients' BP readings by an average of 8.5/4.6 mm Hg, agrees with the extensive study of cuff comparison results of Maxwell et al.

The link between gross obesity and hypertension has been unquestionably established by studies using intraarterial measurements. However, because of cuff artifact, the association of obesity and hypertension observed in practice and in epidemiologic studies has probably been overemphasized. Since large-armed, relatively normotensive people have been overrepresented in "hypertensive" groups in epidemiologic studies, the mortality of the truly hypertensive population may have been distorted toward normality. Thus the presence of large-armed pseudohypertensive subjects in study groups may have weakened our appreciation of the extent to which hypertension and cardiovascular disease are linked.

In an effort to prevent miscuffing, most manufacturers have imprinted a "range" on the interior border of the cuff. These ranges, which vary widely among manufacturers, all differ significantly from the current AHA recommendations. Given that 96% of the undercuffings in our study were within the manufacturers' guidelines (as imprinted on the cuffs), it is imperative that all cuffs be remarked. This can easily be accomplished by making a line with an indelible marker on the interior surface of the cuff at a distance 32 cm from the left border in the standard cuff and at a distance 42 cm from the left border in the large adult cuff. This is a "built in" measurement of arm circumference that allows us to instantly determine whether the cuff is appropriate to the limb's girth.

In summary, the prevailing cuffing patterns differ radically from those recently recommended by the AHA. Considering the clinical and social implications of BP measurements, we would well serve our patients by proper cuffing. This can be accomplished by remarking our cuffs and having the proper cuff selection on hand.

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References

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