

Accuracy of Cuff-Measured Blood Pressure

Systematic Reviews and Meta-Analyses



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ABSTRACT

BACKGROUND Hypertension (HTN) is the single greatest cardiovascular risk factor worldwide. HTN management is usually guided by brachial cuff blood pressure (BP), but questions have been raised regarding accuracy.

OBJECTIVES This comprehensive analysis determined the accuracy of cuff BP and the consequent effect on BP classification compared with intra-arterial BP reference standards.

METHODS Three individual participant data meta-analyses were conducted among studies (from the 1950s to 2016) that measured intra-arterial aortic BP, intra-arterial brachial BP, and cuff BP.

RESULTS A total of 74 studies with 3,073 participants were included. Intra-arterial brachial systolic blood pressure (SBP) was higher than aortic values (8.0 mm Hg; 95% confidence interval [CI]: 5.9 to 10.1 mm Hg; $p < 0.0001$) and intra-arterial brachial diastolic BP was lower than aortic values (−1.0 mm Hg; 95% CI: −2.0 to −0.1 mm Hg; $p = 0.038$). Cuff BP underestimated intra-arterial brachial SBP (−5.7 mm Hg; 95% CI: −8.0 to −3.5 mm Hg; $p < 0.0001$) but overestimated intra-arterial diastolic BP (5.5 mm Hg; 95% CI: 3.5 to 7.5 mm Hg; $p < 0.0001$). Cuff and intra-arterial aortic SBP showed a small mean difference (0.3 mm Hg; 95% CI: −1.5 to 2.1 mm Hg; $p = 0.77$) but poor agreement (mean absolute difference 8.0 mm Hg; 95% CI: 7.1 to 8.9 mm Hg). Concordance between BP classification using the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure cuff BP (normal, pre-HTN, and HTN stages 1 and 2) compared with intra-arterial brachial BP was 60%, 50%, 53%, and 80%, and using intra-arterial aortic BP was 79%, 57%, 52%, and 76%, respectively. Using revised intra-arterial thresholds based on cuff BP percentile rank, concordance between BP classification using cuff BP compared with intra-arterial brachial BP was 71%, 66%, 52%, and 76%, and using intra-arterial aortic BP was 74%, 61%, 56%, and 65%, respectively.

CONCLUSIONS Cuff BP has variable accuracy for measuring either brachial or aortic intra-arterial BP, and this adversely influences correct BP classification. These findings indicate that stronger accuracy standards for BP devices may improve cardiovascular risk management. (J Am Coll Cardiol 2017;70:572–86) © 2017 by the American College of Cardiology Foundation.



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Cardiovascular disease is the number 1 cause of mortality worldwide, with elevated blood pressure (BP) as the single largest risk factor (1-3). Noninvasive brachial cuff BP is the principal method for hypertension (HTN) diagnosis and management; thus, accurate BP measurement is among the most important medical tests performed (4). Relatively small errors in cuff BP measurement can have major public health ramifications. An inaccuracy of 5 mm Hg is estimated to result in the misclassification of BP of 48 million people each year in the United States alone (21 million underestimated BP, 27 million overestimated BP) (5). BP underestimation leads to missed therapeutic potential and unnecessary elevation of cardiovascular risk (6). BP overestimation creates additional cost and exposure to the possible adverse effects of unnecessary treatment (5). The recognition of pre-hypertension as a nonbenign clinical presentation (7), and the benefit to some patient populations of achieving low BP targets (8), further emphasizes the need for accurate cuff BP across the range of BP classifications.

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Several lines of evidence question the accuracy of cuff BP. First, many small studies indicate a possible

bias for cuff BP to underestimate intra-arterial brachial systolic blood pressure (SBP) but overestimate intra-arterial brachial diastolic blood pressure (DBP), and thereby, underestimate intra-arterial pulse pressure (PP) (9-11). Second, cuff BP devices being tested for accuracy against other noninvasive measurements according to international validation protocols may perform to a “pass” standard even when clinically significant measurement errors occur among many patients (12). Third, there is large individual variability in intra-arterial BP between the aorta and brachial artery (9,13,14), and whether oscillometric or auscultatory cuff BP accurately measures either aortic or brachial BP has never been systematically determined. This question is important to resolve, given: 1) the possibility that aortic BP is more clinically relevant than brachial BP (13,15-17); and 2) the burgeoning of commercial devices purporting to measure aortic BP (18) to (theoretically) better assess cardiovascular risk (19). However, this is a controversial theory (20,21), with some investigators asserting that there is a lack of evidence to justify departing from standard cuff BP (20,22). Others suggest that brachial cuff BP may already accurately

ABBREVIATIONS AND ACRONYMS

BP = blood pressure

DBP = diastolic blood pressure

HTN = hypertension

JNC 7 = Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure

PP = pulse pressure

SBP = systolic blood pressure

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