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REVIEW

Central pressure should be used in clinical practice

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Abstract The original purpose for recording brachial blood pressure (BP) more than 100 years ago was to estimate central (aortic) BP. While high brachial BP is an important cardiovascular risk factor, it is clear that major differences in central systolic BP (SBP; e.g. >30 mmHg) can occur among people with similar brachial SBP. It is also proven that central SBP responses to antihypertensive therapy can differ substantially from brachial SBP responses, such that true treatment effects cannot be gauged from conventional brachial BP. Importantly, assessment of central BP results in: 1) improved predictive accuracy of future cardiovascular events beyond brachial BP and other cardiovascular risk factors; 2) superior diagnostic accuracy over brachial BP and; 3) different patient management than usual care guided by brachial BP. Collectively, the above illustrates that central BP is a better cardiovascular risk biomarker than brachial BP. As with all medical advances there are areas of research need and international consensus is required on issues such as standardization of techniques. However, central BP can now be accurately estimated (with appropriate waveform calibration) using brachial cuff methods in an approach that is familiar to clinicians, acceptable to patients and amenable to widespread use. In other words, this modern BP technique can finally satisfy the original purpose for measuring central aortic BP as intended more than 100 years ago. Although the tipping point towards routine use is yet to be reached, the body of evidence continues to favour the view that central BP should be used in clinical practice.

Contents

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Since inception of the method to measure blood pressure (BP) by cuff at the arm in the 19th century, the purpose has been to gain an appreciation of central aortic pressure on the understanding that this would be the most clinically relevant measure of pressure exposure to the heart. The original 1896 reports from Riva-Rocci on the operation of the cuff sphygmomanometer described the technique as measuring the pressure ('total charge') "… either in the aorta itself" or "… a point fairly close to the aorta."[1] This technique was refined by Korotkoff in 1905 and the principles of measurement have since remained almost unchanged as used in clinical practice and research today. While it is accepted that high arm (brachial) BP is a powerful cardiovascular (CV) risk factor,[2] there is incontrovertible evidence that aortic (central) systolic BP (SBP) can differ markedly (e.g. >30 mmHg) among people with the same or similar brachial SBP,[3] and that antihypertensive drugs can differentially affect brachial compared with central SBP.[4] These latter two facts alone should place a question mark over brachial BP holding sway as the reference standard in clinical practice. Indeed, ample added information has come to light in the 21st century to verify this claim.

Techniques to non-invasively estimate central BP have undergone major development in recent years, such that it is now possible to derive a good estimate of central BP using an automated device with similar appearance and operating characteristics to conventional brachial cuff methods. This measurement approach is highly familiar to doctors and theoretically should be appealing for widespread clinical use, or at least provides the opportunity for such. But despite this, clinical take up of central BP methods is virtually absent and, while acknowledging the pathophysiological, pharmacological and therapeutic interest of central BP, it is currently not recommended for routine clinical use in hypertension management guidelines.[5] Notwithstanding several knowledge gaps and limitations in need of rectifying, there exists substantial evidence in favour of the case that central BP should be a useful tool for general use in clinical practice.

Evidence to support use of central BP in clinical practice

Brachial BP is a biological marker used to identify increased vulnerability to CV disease and is the most important modifiable CV risk factor worldwide.[2] In order for central BP to be endorsed as a clinical assessment tool, several evidentiary criteria must be satisfied to ultimately prove greater clinical value over and above conventional brachial BP. In addition to accuracy, reproducibility and acceptance to patients, these criteria also include: diagnostic superiority; proof of elevated risk associated with central BP independent of other established CV risk factors and; evidence that knowledge of central BP changes patient management.[6] To these ends, there is supporting data for central BP along multiple evidence streams that are summarised in Table 1. Data to support the first five summary points in Table 1 were recently reviewed in detail,[7] but more corroborative evidence on the autonomous strength of central BP has since emerged and these studies are detailed below.

Improved prognostic capacity

A critical step in determining the practical worth of a new biological marker is to assess whether it improves the predictive accuracy for clinical events beyond the conventional marker after adjusting for known risk factors in an optimised statistical model.[6] This is best evaluated with the incremental change in the concordance index (c statistic) for central BP versus brachial BP in predicting outcomes.[8] Cheng and colleagues[9] recently validated central BP thresholds for diagnosing hypertension based on prediction of CV and stroke mortality. Optimal central BP and 'central hypertension' thresholds were estimated at <110/80 mmHg and ≥130/90 mmHg respectively in a derivation cohort ($n = 1272$) and then tested in a separate (validation) cohort ($n = 2501$). Stronger associations of CV mortality with both central pulse pressure and systolic BP (SBP) compared with brachial cuff BPs were observed. Moreover, central BP had an additional contribution to the prediction of future CV and stroke mortality beyond brachial BP and independent from traditional CV risk factors of sex, age, body mass index, smoking and serum lipids (demonstrated by improved incremental c statistic).[9]

Although the study of Cheng et al.[10] had some limitations and raises questions yet to be answered (e.g. racial generalizability, calibration methods),[11] this important work is the first to produce outcome-based diagnostic thresholds for central BP. The increased discriminatory power of central BP proves the concept that it should be a better clinical biomarker of CV disease risk than brachial