Validation of Devices and Methods for Noninvasive Estimation of Central Aortic Blood Pressure in Children

To the Editor:

We would like to congratulate Milne et al., because they conducted this study, which covers a great gap about the validity and feasibility of devices for noninvasive estimation of central blood pressure (c-BP) in children. This will be a reference article and thus it is critical to clarify a few issues.

Both ART.LAB and SphygmoCor apparatuses are used for the noninvasive estimation of c-BP. In clinical practice, the pulse waves recorded by these devices are calibrated using BP values noninvasively measured at the brachial artery. Thus, a great emphasis should be given on the fact that in this study the recorded pulses by ART.LAB were validated by mean arterial pressure and diastolic BP values which were measured by invasive intra-arterial BP recordings. Because the errors of noninvasive brachial BP measurement (ie, by cuff sphygmomanometer) are expected to be transferred to the c-BP estimation, it would be enlightening if the authors provide (if possible) the respective error in c-BP estimation by the ART.LAB system when it is calibrated using mean and diastolic brachial BP values measured noninvasively, similarly to the procedure followed at the noninvasive study arm.

In this study, peripheral systolic and diastolic BP values were measured in triplicate by auscultation using a calibrated aneroid sphygmomanometer. These values are critical for the calibration and consequently for the accuracy of ART.LAB and SphygmoCor devices. Thus, it is essential to pay particular attention when applying these technologies, to the selection of a validated sphygmomanometer, as well as to which BP value will be used for the calibration (ie, mean or median of the 3 readings or the mean of the last 2 measurements).

Another methodological decision that we often have to make in validation studies that require multiple hemodynamic measurements by different devices and methods is the specific sequence of the measurements and more importantly whether their order will be randomized. To better interpret the results of this study, it would be useful to know what was the order of the exams (if not randomized): (1) applanation tonometry (SphygmoCor), (2) carotid wall tracking (ART.LAB), and (3) brachial BP measurement, in each study arm.

The quality control of the recorded pulse waves is another essential part of the procedure of noninvasive c-BP estimation. This study revealed that radial tonometry was more difficult to perform than carotid ultrasound wall-tracking in children. This is an important technological limitation of tonometry that should be taken into consideration during the assessment of c-BP in similar populations. However, to be able to compare, with a consistent manner, the quality of recorded waves between the 2 technologies (or between different studies), it is imperative to use specific quality criteria, analysis, and indices for the evaluation of the recordings by each device. Thus, it would be informative to know the quality indices and their critical values that were used as indicative of acceptable or nonacceptable recordings for each apparatus (SphygmoCor and ART.LAB).

As regards to the agreement between 2 different measurements, Pearson correlation coefficient together with Bland–Altman plots are commonly used in the literature. However, it should be highlighted that correlation coefficients ($r$), such as Pearson or Spearman, which are often used to assess agreement may be some times inappropriate because they measure association and not concordance. Namely, one set of measurements may take systematically higher or lower values than another, but it can still provide a high but misleading $r$ value. To overcome this limitation, it is often recommended to apply the intraclass correlation coefficient which can be used complimentary to Pearson or Spearman correlation coefficient.3

Another issue that needs to be carefully interpreted is the number of data points illustrated in Figure 1. Because 9 children were examined in the invasive study arm, it is expected that 9 pairs of measurements (invasive and noninvasive c-BP values) must have been analyzed. It is not, though, clear why both plots (Figure 1) depict >9 data points.

Finally, it is worth mentioning that central hemodynamics may be influenced by body position.4 At the invasive study arm, all BP measurements were performed at the supine position, whereas at the noninvasive study arm BP was measured at the sitting position. Thus, a direct comparison of the estimated c-BP values (or BP amplification) between the 2 study arms should be made with caution. For example, the invasive study arm showed only slight amplification in contrast to the noninvasive arm where a significant BP amplification was evident. Moreover, besides the body position, heart rate is a major determinant of pressure amplification. Potential differences of children heart rate between the 2 study arms may also explain this discrepancy observed in BP amplification.

Beyond any doubt this study provides novel and needed data about the validity of the 2 examined commercial devices for c-BP estimation in children. However, it is also revealed that there is currently a lack of standardized methods and protocols for the validation of such devices. Thus, the interpretation or comparison of results reported by the available validation studies should be made with great caution, mostly because there is a great discrepancy and variability in their methodologies.

Disclosures

None.

Theodore G. Papaioannou
Theofani Karageorgopoulou
Christodoulos Stefanadis
Dimitrios Tousoulis
Biomedical Engineering Unit, First Department of Cardiology
Hippokration Hospital, Medical School
National and Kapodistrian University of Athens
Athens, Greece

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Theodore G. Papaioannou, Theofani Karageorgopoulou, Christodoulos Stefanadis and Dimitrios Tousoulis

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