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Editorial

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Aneroid Auscultatory Sphygmomanometers and Automated Oscillometric Devices as Mercury-Free Alternatives in Children

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▸ See the article "Replacing Mercury Sphygmomanometers With Mercury-Free Sphygmomanometers for the National Health Survey in Children: Direct Comparisons Applying Two Types of Mercury-Free Sphygmomanometer" in volume 54 on page 270.

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Up to recently, measuring blood pressure (BP) with mercury sphygmomanometers has been accepted as a gold standard method for several reasons. First, it is potentially the most accurate among the currently available BP measurement methods, and second, it is the method most widely used to evaluate the risks of hypertension (HTN) and the benefits of treating HTN. In addition, mercury sphygmomanometers have only a little variation between different brands in terms of accuracy.[1)]

With the outbreak of Minamata disease in Japan in 1956 caused by mercury which is revealed to be a persistent bioaccumulative toxic pollutant, the international communities have become alert to the toxicity of mercury, and thus the World Health Organization (WHO) called for a phase-out of mercury sphygmomanometers from healthcare settings (https://www.who.int/publications-detail-redirect/WHO-SDE-WSH-05.08.), creating unforeseen challenges to find mercury-free alternatives to accurately measure BP, especially in pediatric population. At present, the most widely used mercury-free alternatives are aneroid auscultatory sphygmomanometers and automatic oscillometric devices.

Recently, Kim and colleagues[2)] found that in the comparison of measured BP values, an aneroid auscultatory sphygmomanometer correlated well with mercury sphygmomanometer, while an automatic oscillometric device did not, in Korean youths aged 10–18 years. Accordingly, they suggested aneroid auscultatory devices, not oscillometric devices, as possible alternatives for mercury sphygmomanometers in children and adolescents.

Among mercury-free alternatives, the aneroid auscultatory sphygmomanometers are most similar to the mercury sphygmomanometers, given that they directly measure systolic and diastolic BP using the auscultatory method. Thus, the recent pediatric HTN guidelines recommended that for the confirmative diagnosis of HTN, auscultatory devices should be used.[1)]

However, they differ from the mercury sphygmomanometers in that the mercury pressure gauge is replaced by the mechanical pressure gauge using a spring. This difference potentially causes the accuracy of aneroid devices to be low and inconsistent compared to that of the mercury sphygmomanometers. The reported data on the accuracy of aneroid devices in

Data Sharing Statement
The data generated in this study is available from the corresponding author upon reasonable request.

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clinical use are quite mixed, with the frequency of defective devices varying from zero to more than 30%.[3)4)] In addition, the auscultatory measurement of BP requires specialized technique to perform, and thus potentially increases the probability of observer error, even though there is a lack of studies on the extent of that with aneroid devices.

The basis of the automated oscillometric method is that it directly detects mean arterial pressure, and indirectly estimates systolic and diastolic BP using specific algorithms.[5)] The algorithms used by different companies vary, and are never publicly disclosed. Furthermore, they may be changed from one model to another, without the user knowing. While there are many oscillometric devices that have passed the Association for the Advancement of Medical Instrumentation and British Hypertension Society protocols, these protocols evaluate monitors according to how well they perform in a population of subjects, not individual patients. Thus, it is possible that an oscillometric monitor with an average error within the recommended ± 5 mmHg tolerance for the population might have an error over 5 mmHg in some individuals.[6)]

Despite this, automatic oscillometric recorders have several advantages. First, it requires minimal practitioner training, and second, since it provides an automated digital reading of the BP, the observer errors are greatly reduced, especially when performing a series of readings in a short period of time, which is recommended in recent pediatric HTN guidelines to increase the reliability of the patient's average BP, and perhaps also to minimize the white coat effect.[1)] In addition, it is unlikely to show the 'drift' over time that leads to inaccuracies of mechanical devices such as the mercury or aneroid devices. Electronic pressure transducers are usually stable over time, and if something goes wrong with the device, it is much more likely not to work at all than to give an erroneous reading.

With these advantages, oscillometric devices are particularly useful for the population screening and large-scale research studies, and have become a standard method in adults in clinical settings. Additionally, recent pediatric HTN guidelines recommended that oscillometric devices validated in children can be used for BP screening.[1)] Furthermore, the oscillometric method has large potential for BP measurement. For instance, this method is used almost exclusively for ambulatory BP monitoring, one of the standard tools for the diagnosis of hypertension in children and increasingly so for home BP monitoring.[7)8)] There are steadily accumulating evidences indicating that BP values obtained by ambulatory BP monitoring predict cardiovascular risks better than clinic measured BP. Accordingly, it is likely that the number of BP readings is more important in predicting cardiovascular risks than the accuracy of individual readings.[9)]

Nevertheless, in the diagnosis of HTN, the clinic BP measurement will be used persistently, and thus important clinical decisions will continue to be made on very small number of BP readings (rarely more than three). Therefore, a continuous effort to raise the accuracy of BP measuring methods is required.

Auscultatory and oscillometric devices are cuff-based sphygmomanometers. When measuring BP with these devices, patients may become uncomfortable and nervous, which may decrease the accuracy of measured BP especially in children. Recently, with the advance of information and communication technology and the widespread mobile smartphone devices and smartwatches, cuffless BP measurement devices using pulse-transit-time and photoplethysmography signals have been developed. Although they do not yet meet the usual criteria of validation and are not yet recommended by professional societies, they have great potential for BP screening and monitoring.[10)]

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