

# The Enigma of Blood Pressure Measurement in Children with CKD

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Ambulatory BP monitoring (ABPM) is now recognized as an effective methodology for evaluation of abnormal BP and is recommended as a procedure to confirm hypertension in adults (1). In children, reference values for hypertension ( $\geq 95$ th percentile) on the basis of normative ABPM data, according to age and height, are available (2) and guidelines for ABPM application in childhood have been established (3). The 2017 clinical practice guidelines (2017 CPG) for evaluation and management of hypertension in pediatric patients also recommend use of ABPM as a tool to confirm hypertension and to identify white coat hypertension (4). ABPM has been considered superior to clinic BP measurements because the BP monitoring provides multiple measurements over a 24-hour period outside of the clinic setting and includes measurements during awake and sleep periods. Moreover, it is recognized that clinic BP measurements, in children as well as adults, are commonly obtained in a nonstandardized manner and with different automated devices.

The clinical condition most commonly associated with hypertension in childhood is CKD, wherein over 50% of children have elevated BP including many children already receiving antihypertensive drug therapy (5,6). ABPM is now strongly recommended for management of children with CKD, especially to detect masked hypertension (3). In children with CKD, both hypertension and masked hypertension are associated with left ventricular hypertrophy (LVH) (7). Thus, ABPM has been considered an effective tool to determine risk for LVH, and adverse outcome of CKD in children as well as adults. However, as demonstrated in a publication by Ku *et al.* (8) in this issue of the *Clinical Journal of the American Society of Nephrology*, it is not time to dismiss the value of clinic BP measurements in children with CKD.

These investigators conducted a study to determine whether clinic BP measurements are inferior to ABPM measurements as predictors of adverse outcomes in children with CKD. Data were analyzed from 513 participants in the CKD in Children (CKiD) study who had clinic BP measurements and ABPM performed during similar time frames. Predictors of interest were systolic BP taken at one visit or two repeated visits within a 1-year period compared with mean wake and sleep systolic ambulatory BP. The outcomes were LVH and ESKD. A c-statistic was used to determine the ability of each BP parameter to determine risk for the

two outcomes. The rather surprising finding is that the c-statistic for clinic systolic BP was similar to the c-statistic for awake ambulatory BP in ability to predict LVH. In longitudinal analysis, on data over 3.5 years of follow-up, the c-statistic for the clinic systolic BP was also similar to the c-statistic for ambulatory awake systolic BP in predicting ESKD. Thus, according to the analysis of data on a large cohort of children with CKD followed longitudinally, clinic BP measurements were not inferior to ABPM in predicting two significant adverse outcomes of CKD in children.

The good news from this study is that clinic BP measurements continue to be very valuable in management of CKD in children. Despite the significant value of BP measurements obtained over 24 hours outside of the clinic setting, there are drawbacks with 24-hour ABPM. Some children have difficulty wearing the monitors and completing the full 24 hours of measurements, monitors are not always available when needed, parent or other adult time is required to return monitors to the clinic, monitors are expensive and reimbursement, if any, for the procedure is low. Thus, the finding that clinic BP measurements may be as effective as ABPM in ascertaining risk for a poor outcome could be a relief to clinicians when the monitors are not available, when patients are too young or small to wear the monitor, when monitoring is incomplete, or when the patient refuses to cooperate with the ABPM. However, the key point about the clinic BP measurements in this study is that they are obtained by a strict BP protocol. As described in the methods, the details of BP measurement, including measurement by auscultation, training and certification of personnel, position of the child, quiet rest before measurement, and repeated measurements were exactly the same in the multiple participating sites of the CKiD study. This level of uniformity and detail on measurement of BP in children would be needed to approach the c-statistic for LVH or ESKD found in the report by Ku *et al.* (8) The variations in BP measurement methods in the clinical setting are well known. Automated devices are commonly used, rest time is limited, and repeat measurements are not regularly obtained. Because BP reference data that define the 90th and 95th percentile are on the basis of auscultated BP measurements, the 2017 CPG states that confirmation of hypertension or elevated BP should be on the basis of BP measurement by

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auscultation. To encourage more accurate BP measurements in the clinical setting for all children and adolescents, the 2017 CPG guidelines also provide considerable detail on correct BP measurement methods (4). Although the 2017 CPG BP measurement methods are very similar, the methods in the report by Ku *et al.* (8) are more rigorous, with at least three auscultated measurements at each visit. Thus, applying the CKiD protocol for clinic BP measurement could be a plausible method to ascertain risk for adverse outcome in children with CKD when ABPM is not possible.

Although not the focus of the study, the report by Ku *et al.* (8) reveals findings on a major management issue for children with CKD, which is that of BP control. Since the 2004 Forth Report on hypertension in children and adolescents, the recommendation had been to treat hypertension and elevated BP in children with CKD to a BP level that is <90th percentile (9). A previous analysis on the prevalence of hypertension, on the basis of clinic BP, in the CKiD cohort reported 14% with systolic hypertension (5). In the report by Ku *et al.* (8), 11% of children with CKD had hypertension (BP  $\geq$ 95th percentile) by clinic systolic BP and 25% had systolic hypertension by ABPM. Thus, BP control in children with CKD is less than optimal even in pediatric nephrology centers. The importance of BP control in preserving kidney function in children with CKD has been demonstrated by the European Effect of Strict BP Control and ACE Inhibition on Progression of Chronic Renal Failure in Pediatric Patients (ESCAPE) study (10). ESCAPE is a randomized trial on children with CKD that compared intensive BP treatment with conventional treatment. The treatment target for intensive treatment was 24-hour mean ambulatory pressure <50th percentile using uptitration of an angiotensin-converting enzyme inhibitor. The target for conventional treatment was mean ambulatory pressure from 50th to <95th percentile. During the 5-year study period, there was significantly lower progression to ESKD in the intensive treatment (29.9%) compared with conventional treatment (41.7%). On the basis of this strong evidence on children with CKD, the 2017 CPG now recommends treatment with an angiotensin-converting enzyme inhibitor or angiotensin receptor blocker to a 24-hour mean ambulatory BP <50th percentile (4). At this point it is difficult to determine what clinic BP level would be equivalent to a 24-hour mean ambulatory BP at the 50th percentile, and ABPM will continue to be a critical tool in managing BP in children with CKD. Although achieving an optimal BP level in children with CKD remains a major challenge, clinic BP measurements remain a valuable tool when obtained using standardized measurement techniques.

#### Disclosures

None.

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See related article, “Twenty-Four-Hour Ambulatory Blood Pressure versus Clinic Blood Pressure Measurements and Risk of Adverse Outcomes in Children with CKD,” on pages 422–428.