

American Academy of Pediatrics Clinical Practice Guidelines for Screening and Management of High Blood Pressure in Children and Adolescents: What is New?

RAJIV SINHA¹, ABHIJEET SAHA² AND JOSHUA SAMUELS³

From ¹Institute of Child Health, Division of Paediatric Nephrology, Kolkata, and ²Division of Pediatric Nephrology, Lady Hardinge Medical College, New Delhi, India; and ³Children's Memorial Hermann Hospital, University of Texas, Health Science Center, Texas, USA.

Correspondence to: Dr Rajiv Sinha, 37, G Bondel Road, Institute of Child Health, Kolkata 700 017, India.
rajivsinha_in@yahoo.com

Childhood hypertension has become a significant health concern. There have been a slew of important new findings in this field over the last decade. This has led to an update by the American Academy of Pediatrics of the original recommendation of United States Fourth Working Group on blood pressure. We herein describe the important changes in the guideline, which include an updated normative data, change in blood pressure classification, strong endorsement of ambulatory blood pressure measurement and the reduction in the blood pressure target for both chronic kidney disease and non-chronic kidney disease hypertensive children.

Keywords: Classification, Diagnosis, Hypertension, Treatment.

Published in 2004, the Fourth Working Group Report from the National High Blood Pressure Education Program in United States of America has long been the cornerstone of childhood hypertension evaluation and management [1]. After a gap of 13 years, the American Academy of Pediatrics (AAP) recently updated the clinical practice guidelines [2]. After conducting a systematic review they generated 30 key action statements and 27 additional consensus opinion recommendations, which we have summarized herein.

DEFINITION AND CLASSIFICATION

In contrast to adults, childhood blood pressure (BP) continues to be based on normative population distribution curve rather than hard clinical outcomes [3]. One of the major changes in the recent guideline has been the updated blood pressure percentiles for both boys and girls. The updated normative data excluded overweight or obese children, which constituted nearly 20% of population, used for obtaining the previous data [4]. Increasing its user friendliness, the BP charts now have height in centimeter rather than in percentile. In addition, the guideline has also given simplified blood pressure tables for initial screening by allied health professionals. For newborns, it has recommended tables compiled by Dionne, *et al.* [5] and for infants, the normative BP values published by the Task Force in 1987 [6].

Another major change has been alteration of previous blood pressure classification. Pre- hypertension has been

re-labeled as elevated blood pressure and stage 1 and 2 hypertension has been redefined (**Table I**). For adolescents ≥ 13 years, instead of percentile-based definitions, hypertension is now defined as per adult thresholds.

MEASURING BLOOD PRESSURE IN CHILDREN

The guideline recommends annual blood pressure measurement for children ≥ 3 years and has identified sub-groups (obese, on medications known to increase blood pressure, renal disease, history of coarctation, or diabetes) for more frequent checks. Children younger than 3 years warrant regular measurements if they have any of the followings: congenital heart disease, recurrent urinary tract infection, urological malformation, solid organ transplant, bone marrow transplant, malignancy, neurofibromatosis, tuberous sclerosis or sickle cell disease. Small for gestational age newborns, premature (< 32 weeks), or very low birth weight babies and those with umbilical arterial catheterization also require regular checks.

Similar to the Fourth Task Force, standardized procedures for measurement of blood pressure in office practice were recommended. These include:

- (a) Child should be seated for 3-5 minutes with uncrossed legs in a quiet room.
- (b) BP should be measured in right arm at the heart level.
- (c) Length of the bladder cuff should be 80%-100% of arm

TABLE I NEW DEFINITION OF HYPERTENSION IN CHILDREN AND ADOLESCENTS AND SUBSEQUENT ACTION PLAN

<i>Classification</i>	<i>Children aged 1-12 y (percentile based)</i>	<i>Adolescents ≥13 y (mm Hg based)</i>	<i>Action</i>
Normotensive	< 90th percentile	< 120/<80	No additional action needed. Measure the BP at the next routine well-child care visit.
Elevated BP (Previously called pre-hypertension)	≥90 th percentile to <95 th percentile or 120/80mm Hg to <95 th percentile (whichever is lower)	120/<80 to 129/<80 mm Hg	Step1: Lifestyle modification; repeat BP after 6 mo. Step 2: If still elevated, check UL/LL BP. If these are normal – lifestyle modification continued and BP re-checked again after 6 mo. Step3: If BP still elevated, ABPM should be ordered (if available), and consider diagnostic evaluation. If BP normalizes at any point, return to annual BP screening at well-child care visits.
Stage 1 Hypertension	≥95th percentile to <95th percentile + 12 mmHg or 130/80 to 139/89 mm Hg (whichever is lower). Previous Stage 1: 95 th percentile to the 99 th percentile plus 5 mmHg)	130/80 to 139/89 mm Hg	Step1: If asymptomatic, provide lifestyle counselling and recheck the BP in 1 to 2 wk by auscultation. Step 2: If the BP reading is still at the stage 1 level, UL/LL BP should be checked and if normal nutrition and/or weight management initiated and BP rechecked in 3 months. Step 3: If BP continues to be at the stage 1 HTN level after 3 visits, ABPM should be ordered (if available), diagnostic evaluation should be conducted, and treatment should be initiated. Subspecialty referral should be considered. If symptomatic, early initiation / referral should be considered.
Stage 2 Hypertension	≥95th percentile + 12 mm Hg, ≥140/90 mm Hg or ≥140/90 mm Hg (whichever is lower) Previous Stage 2: >99th percentile plus 5 mmHg)		Step 1: If asymptomatic: UL/LL BP should be checked, lifestyle recommendations given, and the BP rechecked within 1 week (Alternatively, the patient could be referred to subspecialty care within 1 week). Step2: If the BP reading is still at the stage 2 HTN level when repeated, then diagnostic evaluation, including ABPM, should be conducted and treatment should be initiated, or the patient should be referred to subspecialty care within 1 week. If symptomatic, or the BP is >30mm Hg above the 95th percentile (or >180/120 mm Hg in an adolescent), refer to an immediate source of care, such as an emergency department.

BP: Blood pressure, ABPM: Ambulatory blood pressure measurement, LL: lower limb, UL: Upper limb. Based on Reference 2.

circumference, width at least 40% with lower end of the cuff around 2-3 cm above the antecubital fossa and stethoscope placed over brachial artery.

Blood pressure readings obtained in the school setting were recommended not to be used for diagnosis of hypertension.

Oscillometric devices were accepted as a screening tool across pediatric age group, with the caveat that any elevated blood pressure needs confirmation by auscultatory method as target organ damage are best

predicted by auscultatory method. In case of an initial 'elevated BP', two additional readings should be taken in the same visit and its average taken as final record. In office setting, hypertension should only be diagnosed based on readings on three different occasions. Forearm and/or wrist blood pressure measurements were not recommended. Subsequent management of elevated blood pressure should be decided based on its classification as per **Table I**. Organizations with electronic health records were advised to consider flagging abnormal BP values.

Office blood pressure readings have multiple drawbacks, including chances of missing White coat hypertension (WCH: office BP \geq 95th percentile but ambulatory BP $<$ 95th percentile with less than 25% BP load) or Masked hypertension (MH: office BPs are $<$ 95th percentile but ambulatory BP \geq 95th percentile with more than 25% BP load) [7]. The updated guideline recommend routine use of Ambulatory blood pressure monitoring (ABPM) as it avoids some of these pitfalls and has been shown to correlate better with target organ damage. However, it should be remembered that reference data for ABPM was obtained only from children with height $>$ 120 cm and of primarily Caucasian origin. ABPM should be performed in children more than 5 years of age for confirmation of hypertension if the BP is in the “elevated” category for at least 1 year or with stage 1 hypertension across three clinic visits. Regular use of ABPM was advocated for children with chronic kidney disease (CKD), secondary hypertension, type 1 or 2 diabetes mellitus (DM), obstructive sleep apnea syndrome (OSAS), a history of prematurity, and in children who have undergone solid-organ transplant or coarctation repair. The guideline advocated the use of the 2014 American Heart Association staging scheme for interpreting ABPM data. Repeat ABPM was advised for WCH as they have been found to have higher left ventricular mass in comparison to normal BP cohorts and increased risk of progressing to sustained hypertension [8]. Home monitoring of BP was not recommended as a diagnostic aid.

EVALUATION

History and Examination: As expected, proper history and physical examination was given paramount importance. It suggested that children over 6 years need not undergo extensive investigations if there is family history of hypertension and basic history/clinical examination are not suggestive of secondary etiology. Appropriate emphasis has been put on dietary as well as history of physical activity and psychosocial factors.

Investigations: Laboratory investigations have been summarized in one of the tables published in the guideline [2]. Suppressed plasma renin activity or elevated aldosterone renin ratio (ng/dL and ng/mL per hour, respectively) $>$ 10, especially in presence of family history of early-onset hypertension or associated hypokalemia highlights need for genetic work up. A new addition is the clear recommendation in favor of echocardiogram *vis-a-vis* electrocardiogram as it correlates better with left ventricular hypertrophy (LVH). In absence of sufficient normative data, routine measurement of other surrogate markers such as carotid intimal media thickness or pulse wave velocity were not recommended. The update also

provides guidance as to when to suspect renovascular hypertension in children (stage 2 hypertension, significant diastolic hypertension, discrepant kidney sizes on ultrasound, hypokalemia, or an epigastric and/or upper abdominal bruit on physical examination). For suspected renovascular hypertension, doppler ultrasonography was suggested to be reliable only in non-obese cooperative children above 8 years and when done by experienced hands. Although renal angiography remains the gold standard; both CT angiography and Magnetic Resonance Angiography has been accepted as non-invasive imaging modality. In contrast to previous guideline, the current guideline advised against use of nuclear renogram for renovascular hypertension and did not recommend routine check for microalbuminuria or uric acid.

TREATMENT

The guideline did not support any alteration in management of hypertension on racial, ethnic or sex differences.

Target blood pressure: The target blood pressure has been revised to less than 90th percentile in light of recent reports [9,10] of target organ damage even in children with blood pressure between 90th and 95th percentile, as well as evidence of improving left ventricular mass index with this lower threshold. For those with CKD BP targets were revised to below 50th percentile.

Non-pharmacological interventions: Dietary intervention (DASH diet including more of fruits, vegetables, low fat milk products and low salt content) and increased physical activity has been strongly supported. Importance of weight loss has been stressed and motivational interview for weight reduction were mentioned) along with encouraging patient and family educations.

Indications for starting pharmacological interventions: Starting a child on anti-hypertensive medicine is a major decision particularly since there are inadequate data on long term safety. Anti-hypertensive medications were suggested for those who remain hypertensive despite a trial of lifestyle modifications or who have symptomatic hypertension, stage 2 hypertension without a clearly modifiable factor (*e.g.*, obesity), or any stage of hypertension associated with CKD or diabetes mellitus (DM). With evidences primarily from adult studies, beta blockers was discouraged as first line anti-hypertensive.

Monitoring while on anti-hypertensive agents: For children on only life style changes, a longer follow-up (3-6 months) was suggested. If on anti-hypertensive, more frequent review (every 4-6 weeks) was suggested for dose adjustments and/or addition of more anti-hypertensive medications till target BP is achieved. Use of 24-hour

ABPM was also supported for monitoring treatment efficacy.

Treatment of resistant hypertension (persistent hypertension despite treatment with 3 or more anti-hypertensive agents of different classes) advocated were primarily based on adult studies and included: initial re-confirmation by appropriate size cuff and by ABPM, dietary sodium restriction, elimination of substances known to elevate blood pressure, identification of previously undiagnosed secondary causes of hypertension, optimization of current therapy and addition of additional agents as needed. Use of existing pediatric lipid guidelines was suggested for any dyslipidemia.

Treatment for special population: Current guideline

highlighted the importance of controlling BP in children with CKD and DM as well as need for controlling proteinuria in CKD population. As hypertension has been linked to adverse cardiac outcomes in Type 2 DM, the updated guideline emphasized the need for close monitoring of BP in these children and targeting BP <90th percentile. 24-hour ABPM was also suggested for Obstructive sleep apnea syndrome (nocturnal hypertension is common) and in children post-transplantation (high prevalence of masked hypertension).

In presence of life threatening complications like encephalopathy or heart failure, a controlled drop of BP by 25% within first 8 hour was advised, preferably by use of intravenous agents.

BOX I IMPORTANT CHANGES/NEW STATEMENTS IN THE CLINICAL PRACTICE GUIDELINE ON ELEVATED BLOOD PRESSURE BY AMERICAN ACADEMY OF PEDIATRICS, 2017

- New blood pressure charts for boys and girls.
- Blood pressure classification has been revised.
- Stepwise guidelines given for managing children with increased blood pressure (BP).
- Increased stress on importance of Ambulatory blood pressure monitoring (ABPM) in diagnosis and management of childhood hypertension
 - ABPM has been strongly recommended for confirming a diagnosis of hypertension (HTN) in children and adolescents if they have office BP measurements in the elevated BP category for 1 year or more or with stage 1 HTN over 3 clinic visits.
 - ABPM should be done for suspected White-coat hypertension or Masked hypertension.
 - Its use was particularly recommended in special group of populations such as chronic kidney disease and post transplantation.
- Children ≥6 y of age were recommended to not routinely require extensive investigation for secondary causes of HTN if they have a positive family history of HTN, are overweight or obese, and/or do not have history or physical examination findings suggestive of a secondary cause of HTN.
- Monogenic HTN should be suspected in patients with a family history of early-onset HTN, hypokalemia, suppressed plasma renin, or an elevated Aldosterone Renin Ratio (ARR).
- Renovascular HTN should be suspected in children with stage 2 HTN, significant diastolic HTN, discrepant kidney sizes on ultrasound, hypokalemia on screening investigations, or an epigastric and/or upper abdominal bruit on physical examination.
- Electrocardiogram not recommended for assessing left ventricular hypertrophy.
- Echocardiography strongly recommended to assess for target organ damage at the time of consideration of pharmacologic treatment of HTN.
- Doppler renal ultrasonography may be useful in evaluation of renal artery stenosis in normal weight children and adolescents ≥8 years of age who will cooperate with the procedure.
- Indication to initiate treatment
 - In hypertensive children and adolescents who have failed lifestyle modifications.
 - Those with target organ damage such as left ventricular hypertrophy.
 - Symptomatic HTN, or stage 2 hypertension without a clearly modifiable factor (eg, obesity).
- Target BP: Reduction in systolic BP and diastolic BP to <90th percentile
- Beta blocker should not be used as initial anti-hypertensive. Usual choice of anti-hypertensive should include ACEi, ARB, long-acting calcium channel blocker, or thiazide diuretic.

Regarding participation in competitive sports, the guideline states that children with stage 2 hypertension be restricted from static sports until their BP is in the normal range. Children with evidence of target organ damage needs proper specialist assessment prior taking a call on their participation in competitive sports.

PREVENTION OF HYPERTENSION

In presence of mounting evidence supporting tracking of blood pressure in children [11], the recent guideline stressed on the need for early implementation of strategies to prevent development of hypertension. In children and adolescents, these are primarily based on lifestyle modification including appropriate diet, regular exercise and treatment of obesity.

TRANSITION OF CARE

In keeping with worldwide focus on transition of adolescent to adult service, the current guideline has added a segment on its importance.

CONCLUSION

The recent guideline by AAP has quite a few changes (**Box 1**). Most important being the updated normative data, change in BP classification, endorsement of ABPM and the reduction in the BP target for both CKD and non-CKD hypertensive children. The guideline is likely to alter clinical practice across the globe and hopefully help in identifying children with elevated BP at an earlier stage. At the same time, it also raises some important concerns and queries. Utility of ABPM needs to be further assessed in resource-constrained set-ups. In addition, we need better clarity on the most appropriate investigations for diagnosing secondary hypertension, appropriate use of ABPM (including more inclusive ABPM normative data), importance of lifestyle modifications in pediatric hypertension, and more research on pediatric anti-hypertensive agents.

REFERENCES

1. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. *Pediatrics*. 2004;114:555-76.
2. Flynn JT, Kaelber DC, Baker-Smith CM, Blowery D, Carroll AE, Daniels SR, *et al.* Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents. *Pediatrics*. 2017;140:pii: e20171904.
3. Whelton PK, Carey RM, Aronow WS, Casey DE Jr, Collins KJ, Dennison Himmelfarb C, *et al.* 2017. ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension*. 2018;71:e13-115.
4. Xi B, Zong X, Kelishadi R, Hong YM, Khadilkar A, Steffen LM, *et al.* Establishing international blood pressure references among non-overweight children and adolescents aged 6 to 17 years. *Circulation*. 2016;133:398-408.
5. Dionne JM, Abitbol CL, Flynn JT. Hypertension in infancy: diagnosis, management and outcome. *Pediatr Nephrol*. 2012;27:17-32.
6. Report of the Second Task Force on Blood Pressure Control in Children-1987. Task Force on Blood Pressure Control in Children. National Heart, Lung, and Blood Institute, Bethesda, Maryland. *Pediatrics*. 1987;79:1-25.
7. Samuel JP, Bell CS, Hebert SA, Varughese A, Samuels JA, Tyson JE. Office blood pressure measurement alone often misclassifies treatment status in children with primary hypertension. *Blood Press Monit*. 2017;22:328-32.
8. Ramaswamy P, Chikkabyrappa S, Donda K, Osmolovsky M, Rojas M, Rafii D. Relationship of ambulatory blood pressure and body mass index to left ventricular mass index in pediatric patients with casual hypertension. *J Am Soc Hypertens*. 2016;10:108-14.
9. Stabouli S, Kotsis V, Rizos Z, Toumanidis S, Karagianni C, Constantopoulos A, *et al.* Left ventricular mass in normotensive, prehypertensive and hypertensive children and adolescents. *Pediatr Nephrol*. 2009;24:1545-51.
10. Litwin M, Niemirska A, Sladowska-Kozłowska J, Wierzbicka A, Janas R, Wawer ZT, *et al.* Regression of target organ damage in children and adolescents with primary hypertension *Pediatr Nephrol*. 2010;25:2489-99.
11. Chen X, Wang Y. Tracking of blood pressure from childhood to adulthood: A systematic review and meta-regression analysis. *Circulation*. 2008;117:3171-80.