

Childhood Hypertension

Gizem Gencan¹

Abstract

A significant public health issue is the rising prevalence of hypertension (HT) among children and adolescents. According to studies, controlling and preventing HT in children will result in adequate early treatment and a favorable prognosis, which will lessen the burden of adult cardiovascular disease. HT is defined as systolic or diastolic blood pressure at or above the 95th percentile (P) for age, sex, and height at least three times. When children are initially examined, their blood pressure is normal, and blood pressure measurements begin from age three if there are no risk factors for hypertension. Blood pressure should be monitored yearly in children three years and older.

Children typically experience primary HT. Renal parenchymal illnesses (60–80%), renovascular diseases (10%), and aortic coarctation (2%) are the most frequent causes. In young patients with HT, screening tests (complete urinalysis, hemogram, electrolytes, urea, creatinine, calcium, phosphorus, uric acid, lipid panel, urinary and renal doppler ultrasonography, eye exam, echocardiography, thyroid function tests, renin, and aldosterone) should be carried out. Additional required tests are ordered in response to the patient's new symptoms.

Both medical procedures and lifestyle modifications are part of HT treatment. Recommendations for food and exercise are non-drug therapy. The most widely prescribed medications include calcium channel blockers, vasodilators, diuretics, -blockers, and angiotensin-converting enzyme (ACE) inhibitors. Because of their adverse effects, -blockers are not the first choice. It is advised to use just one medicine for treatment if possible. If, despite raising the maximum dose, blood pressure cannot be controlled by a single medication, a second medication is administered. HT treatment aims to reduce or prevent the risk of cardiovascular disease and damage to target organs in both the early and late stages.

1 Yozgat Bozok University Faculty of Medicine Research and Training Hospital, Department of Pediatrics

1. Introduction

A significant public health issue is the rising prevalence of hypertension (HT) among children and adolescents. Research indicates that preventing and managing hypertension in pediatric patients can result in timely and effective treatment, leading to favorable outcomes and ultimately reducing the prevalence of cardiovascular disease in the adult population.

Hypertension (HT) is defined as having a systolic or diastolic blood pressure equal to or greater than the 95th percentile (P) for an individual's age, sex, and height, and this must be observed on at least three distinct occasions. During the initial assessment of pediatric patients, blood pressure levels are typically within the normal range. However, if there are no identifiable risk factors for hypertension, blood pressure monitoring may commence at the age of three years. It is recommended that blood pressure be assessed every year in children who are three years of age or older. Measuring blood pressure during each medical follow-up is recommended for individuals with hypertension risk factors, such as obesity, diabetes mellitus, and kidney diseases. In the case of children below the age of three, it is recommended to measure blood pressure during each follow-up visit if there exists a risk of hypertension due to factors such as prematurity, low birth weight, umbilical catheterization during the neonatal period, recurrent urinary tract infections, renal pathologies, and other related conditions.

In 2017, the American Academy of Pediatrics (AAP) revised its clinical practice guidelines to provide a more precise definition of hypertension and prehypertension in children.

Blood Pressure Staging (2017 – AAP)

Blood Pressure Stage	Children aged 1-13	Children > 13 years old
Normal Blood Pressure	-Systolic and Diastolic Blood Pressure <90 P	-Blood Pressure <120/80 mmHg
High Blood Pressure (prehypertension)	-95 P > Systolic and/or Diastolic Blood Pressure ≥ 90 P, or -95P > Blood Pressure > 120/80 mmHg (whichever is lower) (Patient's Blood Pressure is >120/80 mmHg, and this value is classified as High Blood Pressure even if the patient is <90P)	- Systolic Blood Pressure between 120-129 mmHg and Diastolic Blood Pressure < 80 mmHg
Stage 1 HT	95P + 12 mmHg > Systolic and/or Diastolic Blood Pressure ≥ 95 P or Blood Pressure between 130/80 – 139/89 mmHg (whichever is lower)	Blood Pressure 130/80 – 139/89 mmHg
Stage 2 HT	Systolic and/or Diastolic Blood Pressure ≥ 95 P + 12 mmHg, or Blood Pressure $\geq 140/90$ mmHg (whichever is lower)	Blood Pressure $\geq 140/90$ mmHg
Isolated systolic hypertension	Systolic Blood Pressure ≥ 95 P and Diastolic Blood Pressure <90P	$\geq 140/ < 90$

2. Blood Pressure Measurement Method

The procedure involves obtaining a measurement on the right upper arm using an appropriate cuff while the individual is seated (or supine for newborns). Before the measurement, the individual should rest for at least 5 minutes. In cases where automatic oscillometric devices indicate elevated blood pressure readings, verifying the results using android devices is recommended.

Age Appropriate Cuff (Cuff) Sizes

	Arm circumference (cm)	Cuff width (cm)	Cuff length (cm)
Newborn	10	4	8
Infant	6-15	5	15
Child	16-21	8	21
Adolescent	22-26	10	24
Adult	27-34	13	30
Older adult	35-44	16	38

3. Causes of Hypertension

The prevalence of primary hypertension is highest among pediatric patients. Renal parenchymal diseases account for most cases at 60-80%, then renovascular diseases at 10%, and aortic coarctation at 2%. Additional etiologies encompass endocrine etiologies, pharmacological utilization, intraventricular hemorrhage, bronchopulmonary dysplasia, essential hypertension, and white coat hypertension.

4. Diagnostic Approach to Hypertension in Children

Screening tests should be performed in the first step in pediatric patients with HT. Afterward, necessary further tests are requested according to the additional symptoms of the patient.

4.1. Screening Tests

- Complete urinalysis (for proteinuria)
- Hemogram
- Electrolytes, urea, creatinine, calcium, phosphorus, uric acid
- Lipid panel (triglyceride, cholesterol)
- Urinary ultrasonography (USG) and renal Doppler USG
- Eye examination (for HT retinopathy)
- Echocardiography (ECO) (for left ventricular hypertrophy and aortic coarctation)
- Hormone levels: fT4, TSH, Renin, Aldosterone

4.2. Advanced Tests

- Fasting insulin and glucose (if obesity)

- 24 h urinary protein excretion and creatinine clearance (if there is renal pathology)
- Spot urine Na, K (in case of monogenic HT)
- Blood gases (in case of monogenic HT)
- 24-hour urine VMA, HVA and 5HIAA (in Pheochromocytoma clinic)
- MIBG scintigraphy (if urine metanephrines are high)
- DMSA / MAG3 or DTPA (if there is an anomaly in urinary USG)
- Captopril scintigraphy (if renal artery stenosis is suspected)
- Renal angiography (DSA) or MR angiography (less invasive than DSA)

5. Hypertension Treatment

Targets in the treatment of HT;

- To reduce or prevent the risk of cardiovascular disease and target organ damage in the early and late stages.

- The objective is to decrease blood pressure levels to less than 95 P for primary hypertension cases without any associated organ damage while considering factors such as gender, age, and height. Additionally, for individuals 13 years or older, the aim is to lower blood pressure levels to below 130/80 mmHg.

- In order to achieve a reduction in blood pressure levels for individuals with chronic kidney disease (CKD), diabetes mellitus (DM), or hypertension (HT) accompanied by target organ damage, it is recommended to maintain a blood pressure level below 90 P. If proteinuria is present, the target blood pressure level should be further reduced to below 75 P.

The management of HT encompasses pharmacological interventions and modifications to one's daily habits and behaviors. Non-pharmacological interventions encompass dietary and physical activity guidelines. A recommended dietary approach involves restricting salt intake to less than 2300 mg per day while increasing consumption of minerals such as potassium and magnesium, as well as folic acid and fiber. Additionally, a diet high in unsaturated and low overall fat is advised. Physical activity is believed to have advantageous effects on hypertension and risk factors associated with cardiovascular diseases. It is recommended that patients engage in exercises other than weight lifting. Furthermore, engaging in competitive sports within unregulated Stage II HT is not permissible.

Drug Treatment of Hypertension

The pharmacological agents most frequently employed in clinical practice include ACE inhibitors, calcium channel blockers, vasodilators, diuretics, and β -blockers. Beta-blockers are not the preferred initial option due to their adverse effects. It is advisable, if feasible, to pursue a monotherapy approach for treatment. In cases where the maximum dosage of a single drug fails to regulate blood pressure, the addition of a second drug is considered. Typically, the administration of ACE inhibitors in combination with diuretics or vasodilators in conjunction with diuretics (or infrequently β -blockers) is observed.

The “ACD” strategy is a practical and reasonable approach for the long-term treatment of children with hypertension.

“ACD” Strategy; “A”; ACE inhibitors (ACEI) (Enalapril,..) and angiotensin receptor blockers (ARB) (losartan,..).

“C”; Calcium channel blockers. Dihydropyridines (nifedipine, amlodipine) and non-dihydropyridines (verapamil, diltiazem; concomitant use with β -blockers is contraindicated (ventricular dysfunction or AV block)

“D”; Diuretics (furosemide, hydrochlorothiazide [HCTZ])

“B”; Beta-blockers (propranolol or atenolol) alone or in combination (B + D or B + C) are not preferred in most hypertensive children.

If more than one drug will be used, “A” category drugs can be combined with “C” or “D” group drugs (A + C or A + D, or A + C + D).

6. Hypertensive Crisis Management and Treatment

Hypertensive emergency: The presence of severe symptomatic hypertension, characterized by a rapid increase in blood pressure, along with one or more instances of target organ damage, is observed. Clinical manifestations such as seizure or encephalopathy, papilledema, retinal hemorrhage or exudate, and indications of heart failure or renal failure may be observed.

Hypertensive urgency: Severe hypertension or rapid increase in blood pressure but no target organ damage or significant symptoms.

Other findings may be present (findings suggesting the underlying cause of hypertension):

- Hematuria, proteinuria, and edema (glomerulonephritis)

- Ataxia, focal neurological deficit, lethargy, coma (intracranial mass or intracranial trauma)
- Decreased femoral pulses or lower extremity blood pressure (Coarctation of the aorta)
 - High-dose sympathomimetic use (cocaine, amphetamine,..)
 - Pregnancy (eclampsia)
 - Abdominal murmur (renovascular disease)

6.1. Diagnostic Evaluation:

- Extremely high blood pressure should be confirmed (measurement technique, cuff size, and location should be checked)
 - Blood pressure should be measured from all four extremities (especially in infants and small children)
 - Other causes of severe hypertension should be excluded (primary head trauma, intracranial mass, aortic coarctation, use of sympathomimetics..)
 - Blood tests: CBC, reticulocyte count; serum electrolytes (Ca, BUN, Cr,.) should be checked
 - Urine tests: TIT, urine culture, pregnancy test, and urine drug screening should be done.
 - Other diagnostic tests: ECG, Tele-AC X-ray (heart failure), ECHO, and Cranial CT (if there is evidence of trauma or intracranial mass) should be evaluated.

6.2. Treatment

- It is imperative to assess the patient's airway and respiration and ensure the airway is secured, including intubation.
- It is imperative to initiate vascular access.
- To measure blood pressure, it is recommended to insert an intra-arterial catheter if feasible. Alternatively, frequent blood pressure measurements can be taken using the auscultation or oscillometric method.
- In cases of hypertensive emergency, it is recommended to initiate intravenous therapy and to avoid reducing blood pressure by more than 25% of the intended total decrease within the initial 8-hour period.

- The clinical situation determines whether intravenous or oral therapy is appropriate for managing hypertensive urgency.
- It is advisable to prioritize medications that exhibit a swift antihypertensive response.

Resources:

- Simone G, Mancusi C, Hanssen H. Et al. Hypertension in children and adolescents. *Eur Heart J*. 2022 Sep 14;43(35):3290–3301. doi: 10.1093/eurheartj/ehac328.
- Lurbea E, Rosei E.A, Cruickshank J.K, Dominiczak A. Et al. 2016 European Society of Hypertension guidelines for the management of high blood pressure in children and adolescents. *J Hypertens* 34:1887–1920 Copyright 2016 Wolters Kluwer Health, Inc. All rights reserved.
- Baştuğ F, Dursun İ, Tülpar S, Yel S, Naçacıoğlu H, Kısaarslan A, Pınarbaşı A.S, Şahin N, Çiçek S. Çocuk Nefroloji El Kitabı, Klinik Pratik Yaklaşımlar. Çocuk Nefroloji Derneği, Kayseri 2018; 33-53.
- Lurbe, Empar; Agabiti-Rosei, Enrico; Cruickshank, J. Kennedy; Dominiczak, Anna; Erdine, Serap; Hirth, Asle; Invitti, Cecilia; Litwin, Mieczyslaw; Mancia, Giuseppe; Pall, Denes; Rascher, Wolfgang; Redon, Josep; Schaefer, Franz; Seeman, Tomas; Sinha, Manish; Stabouli, Stella; Webb, Nicholas J.; Wühl, Elke; Zanchetti, Alberto (2016). 2016 European Society of Hypertension guidelines for the management of high blood pressure in children and adolescents. *Journal of Hypertension*, 34(10), 1887–1920.
- Phadke K, Goodyer P, Bitzan M. Hypertension. *Manual of Pediatric Nephrology*. Springer 2014; 315-349
- Hypertension: in Avner E.D, Harmon W.E, Niaudet P, Yoshikawa N, Emma F, Goldstein S.L (eds) *Pediatric Nephrology (7th ed)* Springer-Verlag Berlin Heidelberg 2016 pp. 1905-2099
- Tümer N, özkaya N. Yenidoğan döneminde hipertansiyon tanı ve tedavi adı tıp fakültesi dergisi; 2(1): 33-38
- Seliem WA, Falk MC, Shadbolt B, Kent AL. Antenatal and postnatal risk factors for neonatal hypertension and infant follow-up. *Pediatr Nephrol*. 2007;22(12):2081-7.
- nmalFlynn J. Etiology, clinical features and diagnosis of neonatal hypertension. 2014 [cited 2015, Mar 29.]. www.uptodate.com.
- Tej K Mattoo, MD, DCH, FRCP. Evaluation of hypertension in children and adolescents. 2017 www.uptodate.com.
- Flynn JT, Kaelber DC, Baker-Smith CM, et al. Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents. *Pediatrics* 2017; 140.
- Seeman T, Hamdani G, Mitsnefes M. Hypertensive crisis in children and adolescents. *Pediatr Nephrol`* ; Jun 28, 2018.

