



Business Development Virtual
Pediatric Lecture Series
Pediatric Hypertension

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PEDIATRIC HYPERTENSION

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Objectives

- The importance of diagnosing HTN in childhood
- The definition of childhood HTN
- Clinical presentation of childhood hypertension
- When/how to check blood pressure in children
- Causes of HTN in children and adolescents: Primary vs Secondary
- Diagnostic work up
- Evaluation of associated risk factors for cardiovascular disease
- Evaluation of end organ damage
- Approach to treatment

Hypertension (HTN) in childhood and adolescence

- Prevalence of clinical HTN ~3.5%
 - Overweight/obesity: 3.8-24.8%
 - Sleep disordered breathing: 3.6-14%
 - CKD: ~50%
 - Preterm birth: 7.3%
- Serious health problem
- Under diagnosed

Importance of Diagnosing HTN in Children

- Well established that HTN in adults-is associated with high risk for cardiovascular disease (MI, CVA, CHF, PVD, Retinopathy)
- Some evidence of association between HTN and atherosclerosis in children and adolescents
- Patients with HTN, especially obese may have additional risk factors (hyperlipidemia, Diabetes,) for cardiovascular disease

Importance of Diagnosing HTN in Children

- Tracking-children with elevated BP are more likely to have HTN as adults: Muscatine study (2445 children)
- Systolic BP > 90% = X 2 more likely to have adult HTN
Diastolic BP > 90% = X 4 more likely to have adult HTN
- Long term prognosis and outcome can be improved by control of HTN with lifestyle changes and medications

Previous Definition of Hypertension (HTN)

- Normal BP=Systolic and Diastolic < 90% for age, gender, height %
- Pre-Hypertension=Systolic or Diastolic 90-95%
- Stage 1 Hypertension= Systolic or Diastolic >95%-99%+5mmHg or in adolescents > 120/80
- Stage 2 Hypertension =Systolic or Diastolic >99%+5mmHg
- At least 3 abnormal readings on separate occasions

Definition of hypertension (HTN)

TABLE 1

Updated Definitions of BP Categories and Stages

For children aged 1-13 y

For children aged ≥ 13 y

Normal BP: < 90th percentile

Normal BP: < 120/< 80 mm Hg

Elevated BP: \geq 90th percentile to < 95th percentile or 120/80 mm Hg to < 95th percentile (whichever is lower)

Elevated BP: 120/< 80 to 129/< 80 mm Hg

Stage 1 HTN: \geq 95th percentile to < 95th percentile + 12 mm Hg, or 130/80 to 139/89 mm Hg (whichever is lower)

Stage 1 HTN: 130/80 to 139/89 mm Hg

Stage 2 HTN: \geq 95th percentile + 12 mm Hg, or \geq 140/90 mm Hg (whichever is lower)

Stage 2 HTN: \geq 140/90 mm Hg

BP = blood pressure; HTN = hypertension.

Definition of hypertension (HTN)

- Normal distribution of BP is based on measurements in over 50,000 normal weight children and adolescents
- BP standards are based on gender, age and height
- BP tables with the 50th, 90th, 95th, 95th +12 percentiles for gender, age and height
- Dx of HTN if auscultatory confirmed BP readings \geq 95th percentile on 3 different visits

When Should BP be Measured

The American Academy of Pediatrics advise:

-BP should be measured annually in children/adolescents ≥ 3 years of age

-BP should be checked in all children/adolescents ≥ 3 years of age at every health encounter if they have obesity, are taking medications known to increase BP, have renal disease, a history of aortic arch obstruction or coarctation, or diabetes

When should BP be measured under 3 years of age

- History of prematurity/neonatal complication
- Congenital heart disease: repaired /not repaired
- Recurrent UTI's / hematuria / proteinuria
- Known renal disease / urological malformations
- Family history of Congenital renal disease
- Solid organ transplant
- Malignancy/bone marrow transplant
- Treatment with drugs known to cause HTN
- Other systemic illnesses associated with HTN
(neurofibromatosis, tuberous sclerosis, sickle cell disease)
- Elevated intracranial pressure

Pharmacologic Agents Associated with Elevated BP

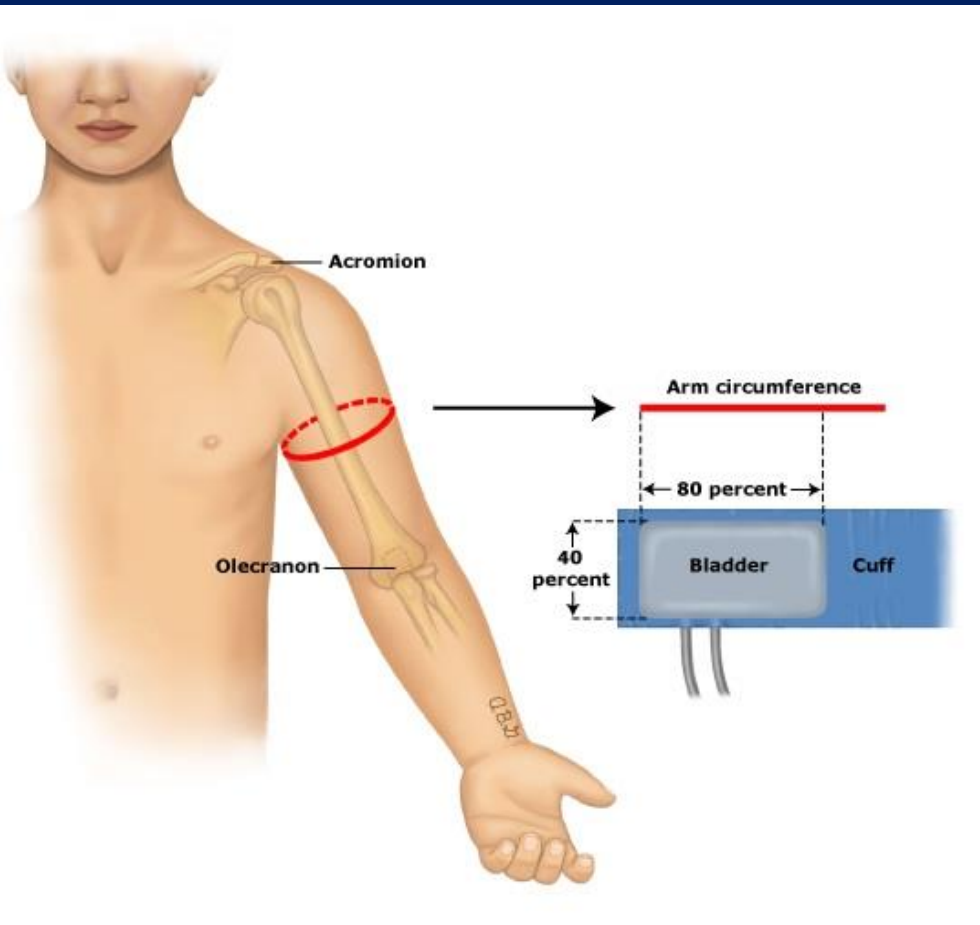
Associated With Elevated BP in Children	
Over-the-counter drugs	Decongestants Caffeine Nonsteroidal anti-inflammatory drugs Alternative therapies, herbal and nutritional supplements
Prescription drugs	Stimulants for attention-deficit/hyperactivity disorder Hormonal contraception Steroids
Illicit drugs	Tricyclic antidepressants Amphetamines Cocaine

Adapted from the Fourth Report.¹

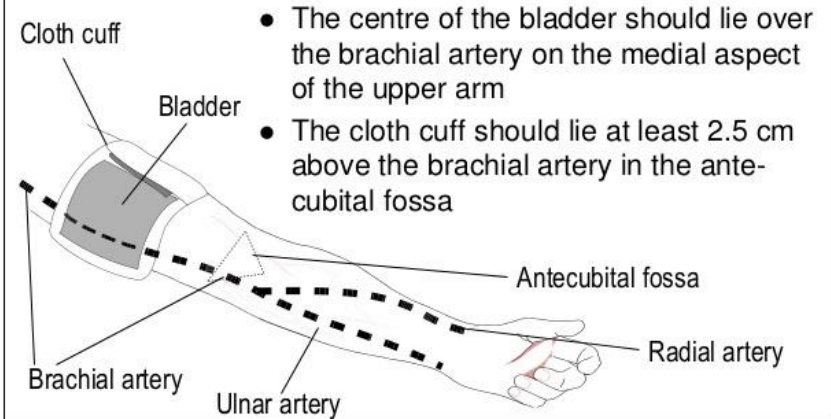
Guidelines for measurement of BP

- Quiet for 3-5 minutes
- Sitting, back supported, feet uncrossed on floor
- Right arm at heart level, supported, uncovered above the cuff
- Lower end of cuff 2-3 cm above antecubital fossa
- Auscultation (preferred, or at least add to confirm)
- Bladder width= at least 40% of arm circumference
 - Length 80-110% of arm circumference
- To measure BP in legs, patient prone, cuff placed midhigh

Guidelines for measurement of BP



Positioning the cuff



Patient Management on the Basis of Office BP

- Normal BP

-If BP normal or normalizes after repeat readings (BP <90%), measure BP at next routine well child visit

- Elevated BP

-Initial visit: lifestyle interventions, nutrition and/or weight management referral considered, measurement repeated in 6 months by auscultation

-2nd visit: If remains at elevated BP, upper and lower extremity BP checked (right and left arm, 1 leg), lifestyle counseling repeated, BP rechecked in 6 months by auscultation

-3rd visit: If remains at elevated BP after 12 months (after 3 auscultatory measurements), ABPM should be ordered if available, diagnostic evaluation, consider Cardiology or Nephrology referral

Patient Management on the Basis of Office BP

- Stage 1 HTN

- Initial visit: If patient asymptomatic, lifestyle counseling and recheck BP in 1 to 2 weeks by auscultation

- 2nd visit: If BP reading still at stage 1 level, check upper and lower extremity BP (both arms, 1 leg), nutrition and/or weight management referral, BP recheck in 3 months by auscultation

- 3rd visit: If BP reading continues to be at stage 1 level after 3 visits, ABPM (if available), diagnostic evaluation, subspecialty referral, and treatment should be initiated

Patient Management on the Basis of Office BP

- Stage 2 HTN

- Initial visit: upper and lower extremity BP (both arms, 1 leg), lifestyle recommendations, BP measurement repeated within 1 week (or can be referred to subspecialty care within 1 week)

- 2nd visit: If BP reading still at stage 2 level, then diagnostic evaluation including ABPM, treatment initiated or patient referred to subspecialty care within 1 week

- If BP reading still at stage 2 HTN and patient is symptomatic, or BP >30 mmHG above the 95th (or >180/120 mmHg in an adolescent), refer to ED

Patient Management on the Basis of Office BP

TABLE 11 Patient Evaluation and Management According to BP Level

BP Category (See Table 3)	BP Screening Schedule	Lifestyle Counseling (Weight and Nutrition)	Check Upper and Lower Extremity BP	ABPM ^a	Diagnostic Evaluation ^b	Initiate Treatment ^c	Consider Subspecialty Referral
Normal	Annual	X	—	—	—	—	—
Elevated BP	Initial measurement	X	—	—	—	—	—
	Second measurement: repeat in 6 mo	X	X	—	—	—	—
	Third measurement: repeat in 6 mo	X	—	X	X	—	X
Stage 1 HTN	Initial measurement	X	—	—	—	—	—
	Second measurement: repeat in 1–2 wk	X	X	—	—	—	—
	Third measurement: repeat in 3 mo	X	—	X	X	X	X
Stage 2 HTN ^d	Initial measurement	X	X	—	—	—	—
	Second measurement: repeat, refer to specialty care within 1 wk	X	—	X	X	X	X

X, recommended intervention; —, not applicable.

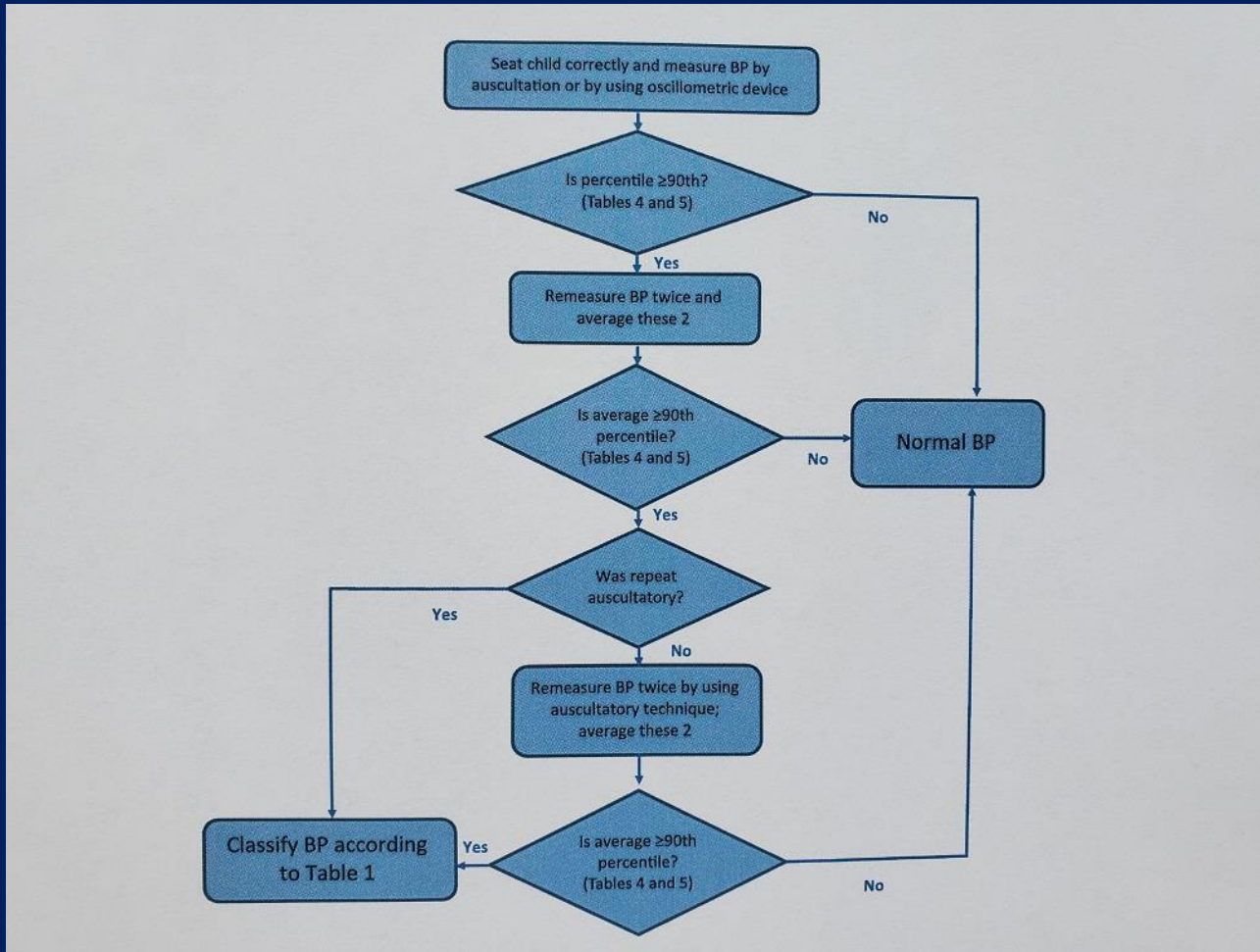
^a ABPM is done to confirm HTN before initiating a diagnostic evaluation.

^b See Table 15 for recommended studies.

^c Treatment may be initiated by a primary care provider or subspecialist.

^d If the patient is symptomatic or BP is >30 mm Hg above the 95th percentile (or >180/120 mm Hg in an adolescent), send to an ED.

Patient Management on the Basis of Office BP



Ambulatory Blood Pressure Monitoring (ABPM)

- ABPM should be performed for confirmation of HTN if office BP measurements in elevated BP category ≥ 1 year or with stage 1 HTN over 3 clinic visits
- An ambulatory BP monitor consists of a BP cuff attached to a box slightly larger than a cell phone, that is worn by the patient for 24 hours. It is programmed to check BP periodically throughout the day and night, with data later downloaded to a computer for analysis by MD

Ambulatory Blood Pressure Monitoring (ABPM)



It is not the same as a home BP machine, and is similar to a Holter monitor

Ambulatory Blood Pressure Monitoring (ABPM)

- Routine performance of ABPM should be considered in children and adolescents with high risk conditions to assess HTN severity and determine if abnormal circadian BP patterns present

TABLE 12 High Risk Conditions for Which ABPM May Be Useful

Condition	Rationale
Secondary HTN	Severe ambulatory HTN or nocturnal HTN indicates higher likelihood of secondary HTN ^{161,167}
CKD or structural renal abnormalities	Evaluate for MH or nocturnal HTN, ¹⁶⁸⁻¹⁷² better control delays progression of renal disease ¹⁷³
T1DM and T2DM	Evaluate for abnormal ABPM patterns, ^{174,175} better BP control delays the development of MA ¹⁷⁶⁻¹⁷⁸
Solid-organ transplant	Evaluate for MH or nocturnal HTN, better control BP ¹⁷⁹⁻¹⁸³
Obesity	Evaluate for WCH and MH ^{23,189-192}
OSAS	Evaluate for nondipping and accentuated morning BP surge ^{45,46,193,194}
Aortic coarctation (repaired)	Evaluate for sustained HTN and MH ^{58,112,113}
Genetic syndromes associated with HTN (neurofibromatosis, Turner syndrome, Williams syndrome, coarctation of the aorta)	HTN associated with increased arterial stiffness may only be manifest with activity during ABPM ^{54,195}
Treated hypertensive patients	Confirm 24-h BP control ¹⁵⁵
Patient born prematurely	Evaluate for nondipping ¹⁹⁶
Research, clinical trials	To reduce sample size ¹⁹⁷

Under Diagnosis of HTN

- ~3.5% of children have HTN by definition
- Cohort of 14,187 children and adolescents observed 3 times at well check visits (in a large academic out patient urban clinic)
- 507 (3.6%) had HTN on ≥ 3 measurements
- Only 131 (26%) had a documented HTN or pre HTN diagnosis in the charts

Diagnosis of HTN

- Masked Hypertension

- Normal office BP, but elevated BP on ABPM
- Found in 5.8% of unselected children studied by ABPM
- At risk patients for MH: patients with obesity, secondary forms of HTN
- Increase risk for end organ hypertensive damage

- White Coat Hypertension

- BP \geq 95th percentile in office, but ABPM with mean SBP and DBP $<$ 95th percentile and SBP and DBP load $<$ 25%
- Exaggerated exercise BP and/or increased LVMI in 62% of the WCH group suggest that this condition is NOT benign and may represent pre-hypertensive state.

Clinical presentation

- Asymptomatic-Incidental, on routine exam
- Symptomatic –
- Cardiac : CHF, Palpitations, murmur
- CNS : headache, vomiting, lethargy, seizures, blurred vision, confusion, CVA
- Facial palsy
- Poor feeding, failure to thrive (infants)

Clinical presentation

- Signs and symptoms of another disease:
 - Coke color urine of glomerulonephritis
 - Facial swelling of nephritis, renal failure
 - Cushingoid appearance /virilization
 - Signs of Thyrotoxicosis

Etiology

- Primary (essential)

- Used to be rare, but now more prevalent due to the obesity epidemic

- General characteristics: ≥ 6 years, positive family history of HTN (parent and/or grandparent), overweight and/or obesity

- Children and adolescents ≥ 6 years do not require extensive evaluation of secondary causes of HTN if they have + FH of HTN, are overweight/obese, and do not have history or physical examination findings suggestive of secondary causes of HTN

TABLE 14 Examples of Physical Examination Findings and History Suggestive of Secondary HTN or Related to End Organ Damage Secondary to HTN

Body System	Finding, History	Possible Etiology
Vital signs	Tachycardia	Hyperthyroidism PCC Neuroblastoma
	Decreased lower extremity pulses; drop in BP from upper to lower extremities	Coarctation of the aorta
Eyes	Proptosis	Hyperthyroidism
	Retinal changes*	Severe HTN, more likely to be associated with secondary HTN
Ear, nose, throat	Adenotonsillar hypertrophy	SDB
	History of snoring	Sleep apnea
Height, weight	Growth retardation	Chronic renal failure
	Obesity (high BMI)	Cushing syndrome
Head, neck	Truncal obesity	Insulin resistance syndrome
	Elfin facies	Williams syndrome
	Moon facies	Cushing syndrome
	Thyromegaly, goiter	Hyperthyroidism
Skin	Webbed neck	Turner syndrome
	Pallor, flushing, diaphoresis	PCC
	Acne, hirsutism, striae	Cushing syndrome
		Anabolic steroid abuse
	Café-au-lait spots	Neurofibromatosis
	Adenoma sebaceum	Tuberous sclerosis
	Malar rash	Systemic lupus
	Acanthosis nigricans	T2DM
	Pallor	Renal disease
	Sickle cell anemia	
Chest, cardiac	Chest pain	Heart disease
	Palpitations	
	Exertional dyspnea	
	Widely spaced nipples	Turner syndrome
	Heart murmur	Coarctation of the aorta
	Friction rub	Systemic lupus (pericarditis) Collagen vascular disease
	Apical heave ^a	LVH
Abdomen	Abdominal mass	Wilms tumor Neuroblastoma PCC
		RAS
	Epigastric, flank bruit	Polycystic kidney disease
	Palpable kidneys	Hydronephrosis Multicystic dysplastic kidney
		Congenital adrenal hyperplasia
		Renal disease
Genitourinary	Ambiguous or virilized genitalia	
	Urinary tract infection	
	Vesicoureteral reflux	
	Hematuria, edema, fatigue	
Extremities	Abdominal trauma	
	Joint swelling	Systemic lupus Collagen vascular disease
	Muscle weakness	Hyperaldosteronism Liddle syndrome
Neurologic, metabolic	Hypokalemia, headache, dizziness, polyuria, nocturia	Reninoma
	Muscle weakness, hypokalemia	Monogenic HTN (Liddle syndrome, GRA, AME)

AME, apparent mineralocorticoid excess; GRA, glucocorticoid-remediable aldosteronism. Adapted from Flynn JF. Evaluation and management of hypertension in childhood. *Prog Pediatr Cardiol*. 2001;12(2):177-188; National High Blood Pressure Education Program Working Group on Hypertension Control in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. *Pediatrics*. 2004;114(2):555-576.

* Findings that may be indicative of end organ damage related to HTN.

Etiology

- Secondary to another disease process:
- Suspect in:
 - Younger children
 - When HTN is severe
 - Family history
 - Signs/symptoms of underlying disease

Causes of secondary hypertension in children and adolescents

Renal disease	Psychologic causes
Pyelonephritis	Mental stress
Renal parenchymal disease	Anxiety
Congenital anomalies	Pharmacologic causes
Reflux nephropathy	Sympathomimetics
Acute glomerulonephritis	Corticosteroids
Henoch-Schönlein purpura	Stimulants
Renal trauma	Oral contraceptives
Hydronephrosis	Anabolic steroids
Hemolytic uremic syndrome	Cocaine
Renal stones	Phencyclidine (PCP)
Nephrotic syndrome	Licorice
Wilm's tumor	Nicotine
Hypoplastic kidney	Caffeine
Polycystic kidney disease	Vascular disease
Endocrine disease	Renal artery abnormalities
Hyperthyroidism	Renal vein thrombosis
Congenital adrenal hyperplasia	Coarctation of the aorta
Cushing syndrome	Patent ductus arteriosus
Primary aldosteronism	Arteriovenous fistula
Primary hyperparathyroidism	Other causes
Diabetes mellitus	Neuroblastoma
Hypercalcemia	Heavy metal poisoning
Pheochromocytoma	Acute pain
Neurologic causes	Collagen vascular diseases
Increased intracranial pressure	Neurofibromatosis
Guillain-Barré syndrome	Tuberous sclerosis

Evaluation

- Diagnose the cause of the HTN
- Evaluate Target Organ effect
- Evaluate additional risk factors for cardiovascular disease

Causes according to age

Age Range	Differential Diagnosis
<u>First year of life:</u>	<u>Secondary (99%) :</u> Coarctation of the aorta Renovascular Renal parenchymal disease Misc.: BPD, PDA, IVH Neoplasia (4%) Endocrine (1%)
<u>Age 1-12 years:</u>	<u>Secondary (70-85%) :</u> Renal parenchymal disease Reflux nephropathy Renovascular Coarctation of the aorta Endocrine Neoplasia Miscellaneous <u>Primary (essential)(15-30%)</u>
<u>Age 12-18 years:</u>	<u>Primary(essential)(85-95%)</u> <u>Secondary(5-15%)</u> Same causes as for 1-12 years

Diagnostic work up for the cause of HTN

History:

- Neonatal
- Family
- Dietary
- Risk factors (smoking, drugs-use and abuse, alcohol use)
- Symptoms-specific/non specific
- Sleep (obstructive sleep apnea)
- Activity level, exercise

Diagnostic work up for the cause of HTN

Physical exam:

- Vital signs, 4 extremities BP
- Height, weight, calculated BMI, and percentiles for age
- General: short stature, cushingoid features, webbed neck, thyroid enlargement
- Organ systems-eyes, skin, cardiac, vascular bruit, femoral pulses

Diagnostic work up for the cause of HTN

TABLE 10 Screening Tests and Relevant Populations

Patient Population	Screening Tests
All patients	Urinalysis Chemistry panel, including electrolytes, blood urea nitrogen, and creatinine Lipid profile (fasting or nonfasting to include high-density lipoproteina and total cholesterol) Renal ultrasonography in those <6 y of age or those with abnormal urinalysis or renal function
In the obese (BMI >95th percentile) child or adolescent, in addition to the above	Hemoglobin A1c (accepted screen for diabetes) Aspartate transaminase and alanine transaminase (screen for fatty liver) Fasting lipid panel (screen for dyslipidemia)
Optional tests to be obtained on the basis of history, physical examination, and initial studies	Fasting serum glucose for those at high risk for diabetes mellitus Thyroid-stimulating hormone Drug screen Sleep study (if loud snoring, daytime sleepiness, or reported history of apnea) Complete blood count, especially in those with growth delay or abnormal renal function

Adapted from Wiesen J, Adkins M, Fortune S, et al. Evaluation of pediatric patients with mild-to-moderate hypertension: yield of diagnostic testing. *Pediatrics*. 2008;122(5). Available at: www.pediatrics.org/cgi/content/full/122/5/e988.

Diagnostic work up for the cause of HTN

- Cardiology: ECHO (to evaluate for coarctation and LVH)
-Performed to assess cardiac target organ damage at time of consideration of pharmacologic treatment of HTN
- Renal scarring and renovascular:
 - Renal ultrasound (size and anatomical abnormalities)
 - -sensitivity 64-90% and specificity 68-70% for RAS
 - Renal flow scan (DMSA for scars, MAG₃ with captopril for blood flow evaluation)
 - CT/Magnetic resonance angiography
 - Renal arteriography (=Gold standard)
- Selected studies: Catecholamines in plasma/urine, genetic studies if low renin

Approach to the treatment of HTN

- Prior recommendations

- Goal : BP < 95% for gender, age and height

- BP < 90% if additional risk factors exist (CKD, diabetes)

- Current recommendations

- Goal: BP < 90th percentile or < 130/80 mmHG whichever is lower in adolescents ≥ 13 years old

Approach to the treatment of HTN

Non pharmacological :

- Weight loss when HTN is associated with obesity
- Diet -reducing Sodium intake to 1.5 grams /day, increasing fruit and vegetables, low fat dairy products
- Increasing dynamic exercise (avoid static exercises – weight lifting) , limiting sedentary activity to 2 hrs/day

Pharmacological

Indications for Pharmacological Treatment of HTN

- Symptomatic HTN
- Secondary HTN
- Hypertensive target organ damage
- Diabetes (type 1 and type 2)
- Persistent HTN despite non-pharmacological measures

Pharmacological treatment of HTN

- Start with one drug and increase gradually to maximum
- If inadequate control -add another drug
- First line : ACEI, ARB, long acting Calcium channel blockers , or thiazide
- To improve compliance-once or twice/day drug with least side effects
- For severe symptomatic HTN- admit and treat with IV medications

Anti-Hypertensive Medications

Angiotensin Converting Enzyme Inhibitor (ACEI)	Captopril [®]	Initial: 0.3 to 0.5 mg/kg per dose (tid) Maximum: 6 mg/kg per day	All ACEIs are contraindicated in pregnancy Periodically measure serum creatinine and potassium concentrations Cough and angioedema are less common with new ACEIs Some agents can be made into a suspension United States Food and Drug Administration (FDA) approval is limited to children ≥ 6 yrs of age and creatinine clearances ≥ 30 mL/min per 1.73m^2 Consider for renoprotective effect for renal disease with proteinuria and diabetes mellitus
	Enalapril [®]	Initial: 0.08 mg/kg per day up to 5 mg/d (once daily-bid) Maximum: 0.6 mg/kg per day up to 40 mg/d	
	Benazepril	Initial: 0.2 mg/kg per day up to 10 mg/d Maximum: 0.6 mg/kg per day up to 40 mg/d	
	Lisinopril	Initial: 0.07 mg/kg per d up to 5 mg/d Maximum: 0.6 mg/kg per d up to 40 mg/d	
	Fosinopril	Children > 50 kg: Initial: 5 to 10 mg/d Maximum: 40 mg/d	
Angiotensin Receptor Blocker (ARB)	Quinapril	Initial: 5 to 10 mg/d Maximum: 80 mg/d	All ARBs are contraindicated in pregnancy Periodically measure serum creatinine and potassium concentrations Losartan can be made into a suspension FDA approval is limited to children ≥ 6 y of age and creatinine clearances ≥ 30 mL/min per 1.73m^2
	Irbesartan	6 to 12 y: 75 to 150 mg/d (once daily) ≥ 13 y: 150 to 300 mg/d	
	Losartan	Initial: 0.7 mg/kg per day up to 50 mg/d (once daily) Maximum: 1.4 mg/kg per day up to 100 mg/d	

Anti-Hypertensive Medications

Calcium Channel Blocker	Amlodipine [®]	Children 6 to 17 y: 2.5 to 5 mg once daily Initial: 2.5 mg/d Maximum: 10 mg/d	Amlodipine and isradipine can be compounded into stable extemporaneous suspensions
	Felodipine	Initial: 0.15 to 0.2 mg/kg per day (tid-qid) Maximum: 0.8 mg/kg per day up to 20 mg/d	Felodipine and extended-release nifedipine tablets must be swallowed whole
	Isradipine [®]	Initial: 0.25 to 0.5 mg/kg per day (once daily-bid) Maximum: 3 mg/kg per day up to 120 mg/d	May cause tachycardia and edema
Alpha and Beta Blocker	Labetalol [®]	Initial: 1 to 3 mg/kg per d (bid) Maximum: 10 to 12 mg/kg per day up to 1,200 mg/d	Asthma and overt heart failure are contraindications Heart rate is dose-limiting May impair athletic performance Should not be used in those who have insulin-dependent diabetes
Beta Blocker	Atenolol [®]	Initial: 0.5 to 1 mg/kg per day (once daily-bid) Maximum: 2 mg/kg per day up to 100 mg/d	Noncardioselective agents (propranolol) are contraindicated in those who have asthma and heart failure
	Metoprolol [®]	Initial: 1 to 2 mg/kg per day (bid) Maximum: 6 mg/kg per day up to 200 mg/d	Heart rate is dose-limiting May impair athletic performance
	Propranolol [®]	Initial: 1 to 2 mg/kg per day (bid-tid) Maximum: 4 mg/kg per day up to 640 mg/d	Should not be used in those who have diabetes mellitus

Reference: Feld et al, Hypertension in Childhood, Pediatrics in Review, 2007; 28: 283-298

Anti-Hypertensive Medications

Class	Drug	Dose (Interval)	Common Adverse Effects/Special Considerations of Each Class
Central Alpha Blocker	Clonidine	Children ≥ 12 y: Initial: 0.2 mg/d (bid) Maximum: 2.4 mg/d	May cause dry mouth or sedation Transdermal preparation is available Sudden cessation of therapy can lead to severe rebound hypertension
Vasodilator	Hydralazine ^a	Initial: 0.75 mg/kg per day (qid) Maximum: 7.5 mg/kg per day up to 200 mg/d	Tachycardia and fluid retention are common Contraindicated with pericardial effusion, supraventricular tachycardia, and tachydysrhythmias Hydralazine can cause lupus-like syndrome
	Minoxidil ^a	Children < 12 y: Initial: 0.2 mg/kg per day (once daily-tid) Maximum: 50 mg/day Children ≥ 12 y: Initial: 5 mg/kg per day (once daily-tid) Maximum: 100 mg/day	Prolonged use of minoxidil can cause hypertrichosis Minoxidil usually is reserved for patients who have hypertension that is resistant to multiple drugs
Diuretics	Hydrochlorothiazide	Initial: 1 mg/kg per day (once daily) Maximum: 3 mg/kg per day up to 50 mg/day	All patients taking diuretics should have electrolytes monitored after initiation of therapy and periodically Potassium-sparing diuretics (spironolactone, triamterene) may cause severe hyperkalemia, especially in conjunction with ACEi or ARB Furosemide is useful adjunctive therapy for patients who have renal disease Some agents may be useful in low renin forms of hypertension
	Furosemide	Initial: 0.5 to 2 mg/kg per day (once daily-bid) Maximum: 6 mg/kg per day	
	Spironolactone ^a	Initial: 1 mg/kg per day (once daily-bid) Maximum: 3.3 mg/kg per day up to 100 mg/d	
	Triamterene	Initial: 1 to 2 mg/kg per day (bid) Maximum: 3 to 4 mg/kg per day up to 300 mg/d	

Treatment: Follow up and Monitoring

- If started on medication, patient should be seen every 4-6 weeks for dose adjustments and /or addition of another agent until goal BP achieved. Then frequency can be extended to 3 to 4 months
- If lifestyle modifications only, follow up visits can occur at 3 to 6 months so adherence can be reinforced and need for initiation of medication reassessed
- Repeat ABPM may be used to assess BP control

Summary

- HTN is a common health problem in children
- Blood pressure should be checked starting at age 3 years
- Normal BP distribution tables should be used to diagnose HTN
- Work up should be guided based on risk factors
- Most causes of secondary childhood HTN are kidney related
- Target organ damage needs to be evaluated
- Treatment should start with non-pharmacological measures and then medications added if needed
- Monitor BP control, Adherence, Target organ effects

Practice Information

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