Hypertension in Children and Adolescents

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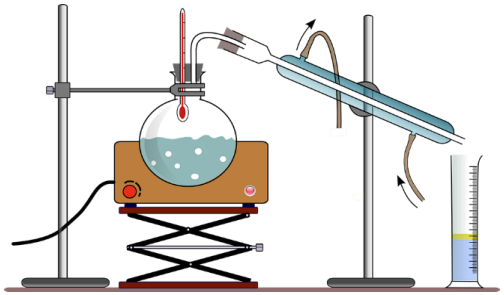
Objectives

- Identify issues diagnosing hypertension
- Know the causes of hypertension in young people
- Know the pharmacologic and non-pharmacologic treatments
- Have strategies for treating resistant hypertension



Outline

- Definition of Hypertension: variability by age and gender
- Making the diagnosis
  - Correct measurement of blood pressure
  - Office vs. Home vs. Ambulatory
- Causes
- Treatment
- Resistant hypertension

Definition

Pediatric Definition of Hypertension

For Children Aged 1–13 y

Normal BP: <90th percentile

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

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

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

Flynn JT, Kaelber DC, et al. Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents. Pediatrics. 2017 Sep;140(3):e20171904

Pediatric Definition of Hypertension

For Children Aged ≥13 y
Normal BP: <120/<80 mm Hg
Elevated BP: 120/<80 to 129/<80 mm Hg
Stage 1 HTN: 130/80 to 139/89 mm Hg
Stage 2 HTN: ≥140/90 mm Hg

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Pediatric Definition of Hypertension

TABLE 6 Screening BP Values Requiring Further Evaluation

Age, y	BP, mm Hg			
	Boys		Girls	
	Systolic	DBP	Systolic	DBP
1	98	52	98	54
2	100	55	101	58
3	101	58	102	60
4	102	60	103	62
5	103	63	104	64
6	105	66	105	67
7	106	68	106	68
8	107	69	107	69
9	107	70	108	71
10	108	72	109	72
11	110	74	111	74
12	113	75	114	75
≥13	120	80	120	80

Flynn JT, Kaelber DC, et al. Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents. Pediatrics. 2017 Sep;140(3):e20171904

Perspective

- Early 20th century, high BP's considered 'compensatory' and needed to get blood through narrowed vessels!
- A 'normal' BP, unlike body temperature, does not really exist but rather optimal BP's are levels below which adverse outcomes occur as a statistical relationship

Diagnosing

Measuring BP Accurately

- Seated, feet on the floor: *not sitting or lying on exam table*
- Avoid caffeine, exercise, smoking
- Empty bladder
- No talking
- Bare arm
- Arm supported
- Mid cuff at mid sternal level
- Correct cuff size
- Measure both arms – and legs in children
- Measure 1-2 min apart
- Average 2 readings on to Dx

Measuring Blood Pressure

Identifying Hypertension

- Office measurement
- Home BP monitoring
  - Brachial BPs taken at home multiple times over several days - 2x/day ≥ 3 days
- Ambulatory BP monitoring (ABPM):
  - Gold Standard*
  - 24h monitoring of brachial BPs with readings every 15-30min during daytime and night-time

Unger et al, J HTN 2020

Why is ABPM Valuable

- Correlates more closely with hypertension-induced organ damage & risk of cardiovascular events
- Captures nocturnal blood pressures and captures blood pressure variability better
- Can identify white-coat and masked hypertension
- More reproducible

Unger et al, J HTN 2020

Advantages of ABPM

- Confirming elevated office BP measurements and excluding misleading office elevations
- For patients with variable BPs +/- checking nocturnal dipping and morning rise
- Reviewing response to treatment especially in "treatment-resistance"

Disadvantages of ABPM

- Often not available
- Clunky and inconvenient
- Needs patient compliance
- Because of operational limits, new adult guidelines recommend home BP's over ABPM *unless issues of diagnosis and resistance predominate*

Definition of Hypertension: 24 Hr

Appendix 3 90th and 95th percentiles of mean day- and night-time systolic and diastolic BP, stratified according to gender and height

	Systolic BP				Diastolic BP			
	Day		Night		Day		Night	
BOYS Height (cm)	90th pct	95th pct	90th pct	95th pct	90th pct	95th pct	90th pct	95th pct
120	120.6	123.5	103.7	106.4	79.1	81.2	61.9	64.1
125	121.0	124.0	104.9	107.8	79.3	81.3	62.2	64.3
130	121.6	124.6	106.3	109.5	79.3	81.4	62.4	64.5
135	122.2	125.2	107.7	111.3	79.3	81.3	62.7	64.8
140	123.0	126.0	109.3	113.1	79.2	81.2	62.9	65.0
145	124.0	127.0	110.7	114.7	79.1	81.1	63.1	65.2
150	125.4	128.5	111.9	115.9	79.1	81.0	63.3	65.4
155	127.2	130.2	113.1	117.0	79.2	81.1	63.4	65.6
160	129.2	132.3	114.3	118.0	79.3	81.3	63.6	65.7
165	131.3	134.5	115.5	119.1	79.7	81.7	63.7	65.8
170	133.5	136.7	116.8	120.2	80.1	82.2	63.8	65.9
175	135.6	138.8	118.1	121.2	80.6	82.8	63.8	65.9
180	137.7	140.9	119.2	122.1	81.1	83.4	63.8	65.8
185	139.8	143.0	120.3	123.0	81.7	84.1	63.8	65.8

Wühl E, Witte K, Soergel M, Mehls O, Schaefer F; Distribution of 24-h ambulatory blood pressure in children: normalized reference values and role of body dimensions. J Hypertens. 2002 Oct;20(10):1995-2007.

Causes

Causes of Hypertension: Primary

- Essential Hypertension??
- High blood pressure that occurs without a specific identifiable cause
- "Hypertension is a *complex polygenic disorder* in which many genes or gene combinations influence BP. The current tabulation of known genetic variants contributing to BP and hypertension includes more than 25 rare mutations and 120 single-nucleotide polymorphisms"

Whelton PK, et al. ACC/AHA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: Executive Summary. J Am Coll Cardiol. 2018 May 15;71(19):2199-2269.

Causes Hypertension: Secondary

Common

- Renal parenchymal disease
- Renal Vascular Disease
- Obstructive sleep apnea
- Drugs, supplements

Uncommon

- Pheochromocytoma
- Cushing's syndrome
- Hyperthyroidism
- Hypothyroidism
- Coarctation of the aorta – undiagnosed and repaired
- Primary aldosteronism

***Children <12 yrs more likely to have a cause**

Hyperaldosteronism

- In adults, now found more common: 5-10%+
- Rare in children
- Hypokalemia infrequent: 9-37%
- Consider as a Dx for resistant hypertension, spontaneous or diuretic-induced hypokalemia, adrenal masses, or a family history of early-onset hypertension or stroke
- Key test: aldosterone renin ratio (ARR)

Coarctation of the Aorta

- Narrowing of the proximal descending aorta
- Congenital defect
- Clinical Exclusion
  - Measurement of arm and leg blood pressures: >20 mmHg differential significant
  - Palpation of femoral pulses
  - Listening for posterior thoracic flow murmur
- Echocardiogram if clinically suspected

Isselbacher EM, Preventza O, Hamilton Black Iii J, et al. 2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease: A Report of the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines. J Am Coll Cardiol. 2022 Dec 13;80(24):e223-e393.

Causes in Children and Adolescents

TABLE 3
Causes of Childhood Hypertension According to Age Group

Age	*Causes*
One to six years	Renal parenchymal disease; renal vascular disease; endocrine causes; coarctation of the aorta; essential hypertension
Six to 12 years	Renal parenchymal disease; essential hypertension; renal vascular disease; endocrine causes; coarctation of the aorta; iatrogenic illness
12 to 18 years	Essential hypertension; iatrogenic illness; renal parenchymal disease; renal vascular disease; endocrine causes; coarctation of the aorta

Luma GB, Spiotta RT. Hypertension in children and adolescents. Am Fam Physician. 2006 May 1;73(9):1558-68. PMID: 16719248.

Diagnostic Testing

- CBC, CMP, uric acid
- Urinalysis
- Renal imaging: Ultrasound, Duplex Scan
- Drug screen
- Echocardiogram (?)
- Hormone levels: thyroid, adrenal
- Sleep study?
- Plasma renin level?
- Catecholamine study?
- 24 Hour Ambulatory Monitoring
- Angiotensin/Renin Ratio

Treatment

Treatment Strategy: Simplified

Phase	BP Level	Treatment
Hypertension, Prehypertension ("Elevated")	90-95th %tile	Lifestyle
Phase 1	>95-99th %tile	Lifestyle; Medication if unsuccessful
Phase 2	>99th %tile	Medication and lifestyle

Luma GB, Spiotta RT. Hypertension in children and adolescents. Am Fam Physician. 2006 May 1;73(9):1558-68. PMID: 16719248.

Non-Pharmacologic Intervention

- Weight loss
- Diet: DASH
  - Dietary Approaches to Stop Hypertension
- Sodium reduction
- Potassium supplementation
- Exercise, aerobic and/or resistance

ACC/AHA Guideline 2017

Drug Treatment

First Line

- Thiazide diuretics
- ACE Inhibitors
- ARB's
- Calcium channel blockers
  - Dihydropyridines, e.g amlodipine, nifedipine
  - Non-dihydropyridines, e.g. verapamil, diltiazem

Secondary

- Diuretics – loop
- Diuretics – potassium sparing
- Aldosterone antagonists (MRA's)
- Beta blockers
- Alpha blockers
- Central acting
- Direct vasodilators
- Renin inhibitor

Jones et al. 2025 High Blood Pressure Guideline JACC VOL. 86, NO. 18, 2025

Treatment in Pregnancy

- Nifedipine
- Labetalol
- Methyldopa
- Avoid:
  - ACEi / ARB
  - Direct renin inhibitors

Resistance

Causes of Resistant Hypertension

- Lifestyle
- Poor compliance
- Improper BP measurement technique
- Excess sodium
- Inadequate medication dose/combination
- Drug interactions; Illicit drugs
- Unrecognized secondary causes
  - e.g. sleep apnea, renal disease (list)

Drugs Causing BP Elevation

- Amphetamines
- Antidepressants
- Anti-psychotics
- Caffeine
- Decongestants
- Herbal supplements
  - e.g. Ma Huang/ephedra
- Licorice
- Cyclosporine
- **NSAIDS**
- Oral contraceptives
- Recreational drugs
- Systemic corticosteroids

Strategies for Resistant HTN

- Ensure proper BP measurement technique
- Confirm with 24 hr BP monitoring
- Maximize drug Rx from different classes
  - ACEI/ARB, calcium channel blocker, diuretic
  - Consider secondary agents: MRA, beta blocker
  - Combination pills to maximize compliance
- Maximize lifestyle interventions
- Discontinue interfering drugs/substances
- Reconsider secondary causes
- Confirm compliance

Compliance tips

- Have patients take medications at times most reliable: consider bedtime
- Monitor drug refill frequency
- Have patients bring their medications to all visits in the original bottles
  - Verify they are taking each
  - Check date of refill and number of pills left
- For patients with overdue visits, refill only to the next scheduled visit
- Consider nurse visit for interim evaluation
- Urge home BP measurements and log entry

Summary Thoughts

- Ensure correct methods for measurement
- Target a blood pressure goal of < 90th %tile
- First consider non-pharmacologic intervention
- First line drugs: thiazides, ACEi / ARBs, CCBs
- Always consider compliance
- Consider more ambulatory blood pressure monitoring
- Keep in mind secondary causes
- Strategies for resistance discussed


WE HAVE MET THE ENEMY AND HE IS US.
WALT KELLY

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Questions?

Thank You!