

Childhood Hypertension: A Case-Based Approach

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- An asymptomatic 16-year-old boy has elevated blood pressure documented on several visits, with an average blood pressure of 144/92 mm Hg.
- His height and weight are above the 97th percentile for age.
- His father has hypertension and takes antihypertensive medication.



What is the most appropriate approach for this boy?

- 1. Have the boy return for a repeat blood pressure measurement in 6 months.
- 2. Provide lifestyle counseling to increase physical activity and lower dietary salt and repeat blood pressure measurement in 6 months.
- **3**. Begin diagnostic evaluation for stage 2 hypertension.
- 4. Admit to the hospital for immediate blood pressure reduction.





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Definition of Hypertension

- Hypertension—average SBP and/or DBP that is greater than or equal to the 95th percentile for sex, age, and height on 3 or more occasions.
 - Adolescents ≥13 y/o with BP ≥130/80 are considered to be hypertensive
- Elevated BP average SBP or DBP levels that are greater than or equal to the 90th percentile, but less than the 95th percentile.
 - Adolescents ≥13 y/o with BP levels greater than or equal to 120/80 mmHg should be considered to have elevated BP





BP Classification – 2017 AAP CPG

TABLE 3 Updated Definitions of BP Categories and Stages	
For Children Aged 1—<13 y	For Children Aged \geq 13 y
Normal BP: <90th percentile	Normal BP: <120/<80 mm Hg
Elevated BP: ≥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: ≥95th percentile to <95th percentile + 12 mmHg, or 130/80 to 139/89 mmHg (whichever is lower)	Stage 1 HTN: 130/80 to 139/89 mm Hg
Stage 2 HTN: ≥95th percentile + 12 mm Hg, or ≥140/90 mm Hg (whichever is lower)	Stage 2 HTN: ≥140/90 mm Hg

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BP Classification – 2016 ESH Pediatric GL

TABLE 1. Classification of hypertension in children and adolescents

Category	0–15 years SBP and/or DBP percentile	16 years and older SBP and/or DBP values (mmHg)
Normal	<90th	<130/85
High-normal	\geq 90th to <95th percentile	130-139/85-89
Hypertension	\geq 95th percentile	≥140/90
Stage 1 hypertension	95th percentile to the 99th percentile and 5 mmHg	140-159/90-99
Stage 2 hypertension	>99th percentile plus 5 mmHg	160-179/100-109
ISH	SBP \geq 95th percentile and DBP $<$ 90th percentile	≥140/<90

ISH, isolated systolic hypertension.

Lurbe et al, J Hypertertension 2016

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Case 1- Initial Diagnostic Evaluation

- ABPM is done, demonstrating sustained hypertension while awake and asleep, with only 7% SBP dipping.
- Urinalysis is normal. Creatinine is 0.7 mg/dL (62 µmol/L)
- Random glucose elevated. Triglycerides and LDL cholesterol elevated. HDL cholesterol low



Ambulatory Blood Pressure Monitoring

- Patient wears lightweight BP monitor that takes BP at regular intervals for 24hr
- Readings are recorded by monitor and later downloaded to a personal computer
- Study is analyzed by comparing the patient's BP to a set threshold value
- Equipment available for use in children
- Validity confirmed in children





Uses of ABPM – 2017 AAP CPG

- Confirm diagnosis of HTN after 3 high office BP readings
 - White coat vs. sustained ambulatory HTN
- Evaluate BP patterns in high-risk conditions
 - Coarctation of the aorta, diabetes, chronic kidney disease
- Assess adequacy of BP treatment
 - CKD: 24-hr MAP <50th percentile
 - Repeat ABPM in all treated patients



BP Patterns by Office & Ambulatory BP



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The most likely explanation for HTN in this boy is:

- 1. Excess dietary sodium intake
- 2. Primary hypertension, based on a parent with hypertension.
- 3. Secondary to pre-diabetes
- 4. Secondary to obesity



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Case 1 Therapy: Initial Approach

- Weight loss is primary therapy but difficult to achieve
- Increased Physical Activity
 - 2017 AAP CPG: "Vigorous" physical activity
- Active of the success success of the Aerobic exercise or combination training
 - nterven Ready participating in and intensify it Try to find an activity
- Nutrition **CO** Seling
 - CPG: Provide advice on the DASH diet
 - SH eating plan: increased fruits and vegetables, low-fat dairy products ± sodium restriction (www.dashdiet.org)
 - AHA: Reduce sodium intake to 1500-2300 mg/day



Case 1: Outcome

- He met with a nutritionist who taught him about healthy eating
 - Reduced sodium intake
 - Cut down on snacks and portion sizes at meals
- His father started taking him to the gym 4 days per week
 - He used the treadmill and did weight training
- Over a 2-year period he lost 15 lbs., and his BMI dropped from >97th percentile to the 93rd percentile
- His blood pressure fell to the elevated BP range 120's/70s





Case 2: Young child

- 5 y/o boy, presents for routine well-child visit
- Not seen in >2 years
- BP's 137/85, 129/90, confirmed by you with manual sphygmomanometer



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What to Do about the Child with an Elevated BP?

- Repeat Elevated BP's
- Blood pressure in childhood is quite labile and can fluctuate widely, even in children with secondary HTN
- The 2017 AAP CPG recommends that at least three abnormal readings, obtained at different times, are needed before the "diagnosis" of HTN can be made.
- Elevated BP's obtained by oscillometry should be confirmed by auscultation



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BP Measurement Devices







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Pros and Cons of Oscillometric BP Monitors

- Pros
 - •User-friendly
 - •Can be programmed to take repeated measurements
 - BP's are consistent once device is accommodated to patient and patient is accommodated to device
 Readings can often be printed out or retrieved later from device

- Cons
 - •Don't really measure blood pressure
 - •Known to over-estimate SBP and under-estimate DBP
 - •Measurements won't be consistent between different brands of devices
 - •Alerting response on first reading due to over-inflation



Use Correct Auscultatory Technique

- Seated, back supported, feet on floor
- Rest for 5 minutes
- No talking, device use or other activity
- Use correct sized cuff
- Repeat at 1-min intervals









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Proper cuff size is crucial to accurate BP measurement

 Manufacturer's recommendations on cuffs may not be accurate due to obesity-associated increased arm circumference

Use the Correct Sized Cuff

- Ideally arm circumference should be measured and the proper size cuff chosen
- A variety of cuff sizes must be kept on hand in the office

Cuff size: Take care to get it right



The width of the bladder of the blood pressure cuff should be 40% of the circumference of the upper arm, measured at the midpoint between the olecranon and acromion (left). The length of bladder should be 80% to 100% of the circumference of the upper arm, again at a point midway between the olecranon and acromion (right).³

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Position the Patient Correctly



7 SIMPLE TIPS TO GET AN ACCURATE BLOOD PRESSURE READING



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Case 2 – Additional History

- Has had intermittent headaches without any accompanying symptoms
- Was a term baby with no neonatal complications and no prior hospitalizations or surgeries
- No medication or supplement use
- FH of HTN affecting father, 3 of 4 grandparents, mother has T2DM. No FH of kidney disease



Case 2 - Exam

- Normal appearance
- Weight 33.9 kg (>97%tile)
- Height 118.1 cm (50%tile)
- BMI 24 kg/m2 (>97%tile)
- HEENT, cardiac, abdominal, GU exams all normal



Case 2 – Referred to HTN Clinic

- Referral BP's 137/85, 129/90
- UE BP's in our office: 132/92, 128/88, 140/89
- Mean BP: 133/80
 - 90th percentile: 107/68
 - 95th percentile: 111/71
 - 95th percentile + 12 mmHg: 123/83
- Thus he has stage 2 HTN



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Case 2: 6 y/o with Stage 2 HTN

- LE BP's done: 102/55, 108/70
- Labs, imaging studies ordered
- Started on propranolol
- Normal UA, creatinine, electrolytes, elevated renin
- Echocardiogram: structurally normal heart with LVH
- Complete kidney US: kidneys of normal appearance and size bilaterally
- CT- angiogram performed



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Case 2: CT Angiogram





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Relevant Guidance from the 2017 AAP CPG

- 16. Doppler renal ultrasonography may be used as a noninvasive screening study for the evaluation of possible RAS in normal wt children and adolescents ≥8 y of age who are suspected of having renovascular HTN and who will cooperate with the procedure.
 - C, moderate
- 17. In children and adolescents suspected of having RAS, either CTA or MRA may be performed as noninvasive imaging studies.
 - D, weak



Distribution of HTN Causes by Age



Flynn et al, Hypertension 2012

Relevant Guidance from the 2017 AAP CPG

- 11. Children and adolescents ≥6 y of age do not require an extensive evaluation 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 (Table 14) suggestive of a secondary cause of HTN.
 - C, Moderate



Case 2: Follow-up

- Propranolol and amlodipine needed to control BP
- Repeat echo 6 mo later improved LVH
- Followed with repeat kidney ultrasounds to monitor kidney growth
- Underwent surgical reconstruction of abdominal aorta and reimplantation of renal arteries bilaterally
- Now off antihypertensive medications but still being closely followed







- A14-year-old soccer player referred for evaluation of elevated blood pressure detected at a pre-sports participation screening at her school.
- Blood pressures obtained at the screening ranged from 137– 149/75–80 mmHg.





Case 3: Initial evaluation

- Repeat office BP's are similar to the readings at the sports physical
- She denies any symptoms of hypertension.
- She is at the 50th percentile for height and weight and has no other chronic health problems or abnormal physical examination findings. Both parents have hypertension.



Next step should be:

- 1. Start hydrochlorothiazide 25 mg daily
- 2. Refer to IR for arteriogram
- 3. Perform 24-hr ambulatory BP monitoring
- Request that the school nurse check her BP daily for the next 10 days



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Further Evaluation

- 24-hr ABPM demonstrates sustained ambulatory hypertension with normal nocturnal dipping
- Urinalysis, electrolytes, BUN and Cr are normal.
- Fasting lipids: total cholesterol 195, LDL cholesterol 90, HDL cholesterol 52, triglycerides 165.



What is your diagnosis?

- 1. Metabolic Syndrome
- 2. Primary hypertension
- 3. Renal artery stenosis
- 4. Polycystic kidney disease





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Management of HTN in Children & Adolescents

- Treatment includes 3 components:
 - Non-pharmacologic measures
 - Antihypertensive medications
 - Ongoing monitoring



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Indications for Antihypertensive Drug Therapy in Children

- Symptomatic hypertension
- Secondary hypertension
- Hypertensive target-organ damage
- Diabetes (Types 1 and 2)
- Persistent hypertension despite non-pharmacologic measures
- Stage 2 hypertension



Goal for Antihypertensive Treatment in Children

- 19. In children and adolescents diagnosed with HTN, the treatment goal with non-pharmacologic and pharmacologic therapy should be a reduction in SBP and DBP to <90th percentile and <130/80 mm Hg in adolescents ≥ 13 years old.
 - C, moderate
- 23-2. Children or adolescents with both CKD and HTN should be treated to lower 24-hr MAP <50th percentile by ABPM
 - B, strong

Flynn et al, Pediatrics 2017; 140:e20171904



Approach to Prescribing Antihypertensives

- Pediatricians should only prescribe drugs that have published pediatric efficacy & safety data
- Follow "stepped care" approach
 - Begin with starting dose of a single drug
 - Increase dose until goal BP or maximum dose reached, or adverse effects
 occur
 - Add another drug from a different class, etc.
- Multiple-drug regimens usually needed to reach goal BP, even in primary HTN



Stepped-Care Approach



Step 1	Begin with the initial dose of de	recommended sired medication		
	If BP control is	s not achieved:		
Step 2	Increase dose unti is reached, or maxin	il desired BP target num dose is reached		
	If BP control is	s not achieved:		
Step 3	Add a second r a complementary m	medication with nechanism of action		
	Proceed to highest recommended	d dose if necessary and desira	ble	
	If BP control is	s not achieved:		
Step 4	Add a third antihypertensive drug of a different class	Consult a physic experienced in trea childhood and adole hypertension	ian ating escent Joseph T F	lyɲn, MD / @drjosflynn
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Sports Participation and Hypertension

- 28. Children and adolescents with HTN may participate in competitive sports once hypertensive target organ effects and cardiovascular risk have been assessed.
 - C, moderate
- 29. Children and adolescents with HTN should receive treatment to lower BP below stage 2 thresholds before participation in competitive sports.
 - C, moderate



Classification of Various Sports

III. High	(> 50% MVC)	Bobsledding/luge,*† field events (throwing), gymnastics,*† martial arts,* sailing, sport climbing, water skiing,*† weight lifting,*† windsurfing*†	Bodybuilding,*† downhill skiing,*† skateboarding,*† snowboarding,*† wrestling*	Boxing,* canoeing/kayaking, cycling,*† decathlon, rowing, speed skating,*† triathlon*†	
II. Moderate	(20% to 50% MVC)	Archery, auto racing,*† diving,*† equestrian,*† motorcycling*†	American football,* field events (jumping), figure skating,* rodeoing,*† rugby,* running (sprint), surfing,*† synchronized swimming†	Basketball,* cross-country skiing (skating technique), ice hockey,* lacrosse,* running (middle distance), swimming, team handball	
Increasing star I. Low	(< 20% MVC)	Billiards, bowling, cricket, curling, golf, riflery	Baseball/softball,* fencing, table tennis, volleyball	Badminton, cross-country skiing (classic technique), field hockey,* orienteering, race walking, racquetball/ squash, running (long distance), soccer,* tennis	
	L	A. Low (< 40% maximal O_2)	B. Moderate (40% to 70% maximal O_2)	C. High (> 70% maximal O_2)	
Increasing dynamic component					

Mitchell et al, JACC 2005; 45:1366

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Case 3: Outcome



- Clinic BP readings remained at stage 2 HTN level
- Allowed to participate in light workouts with team, but restricted from competition
- Echocardiogram done normal EF, mild concentric LVH
- Started on therapy with amlodipine 5 mg daily
- Dose increase to 10 mg based on home BP readings
- Follow-up clinic BP 132/78
- Allowed to compete in soccer



Resources

- 2017 AAP CPG
 - <u>https://pediatrics.aappublications.org/content/140/3/e20171904.long</u>
- NEJM video on BP measurement
 - https://www.nejm.org/doi/full/10.1056/NEJMvcm0800157
- 2014 AHA Pediatric ABPM statement
 - <u>https://www.ahajournals.org/doi/10.1161/HYP.00000000000000007</u>





Thank you!

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