

# Pediatric Hypertension

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Case-based

Interactive!

Get out your phone

Open web browser

Go to [PollEv.com/JDSMD](https://PollEv.com/JDSMD)

(not case sensitive)

- Danielle Cannon
- Class of 2023, SUNY Upstate MS-4
- I loved family medicine at Binghamton's Clinical Campus
- Goal of caring for congenital heart disease in young and old
- I'm heading to Med-Peds
- Let's talk about where we're going with today's presentation



## what you'll do

Child in office

See a high BP

Suspect HTN

Diagnose HTN

Non-pharm mgmt

Pharm mgmt

Referral, urgency

## what we'll cover

When & how to measure blood pressure

Definitions & classification of hypertension

Initial suspicion of hypertension

pace of progress towards diagnosis

history, physical exam, tests

How to diagnose primary or secondary HTN

Non-pharmacologic treatment

Pharmacologic treatment

Reasons for referral and hypertensive urgency  
and more

# Case 1

8 y.o. girl in your family medicine continuity practice.  
It's August. Here for well child checkup before school.  
BMI 92%-ile, BP 118/83 (elevated) today, previously hi

We need to go in an unexpected direction...

# Case 1

8 y.o. girl in your family medicine practice.

August well child checkup before school.

BMI 92<sup>0</sup>ile, BP 118/83 (elevated) today,  
previously hi

## Case 1a

8 y.o. girl in your family medicine practice.

August well child checkup before school.

BMI 92%ile, BP 118/83 (elevated) today,  
previous hi  
prev. cough, worse with exercise,  
wheezed with viral URI's in past

Could this kid have asthma?

Spirometry shows FEV<sub>1</sub>/FVC 58% (low)

FEV<sub>1</sub> is only 61% predicted (mod obstr)

Does she have asthma?

Why is it important to make the diagnosis?

Why is it important to treat this child?

## Case 1b

8 y.o. girl in your family medicine practice.

August well child checkup before school.

BMI 92%ile, BP 118/83 (elevated) today,  
previously hi

## Case 1a

8 y.o. girl in your family medicine practice.

August well child checkup before school.

Chronic cough, worse in spring, worse around shaggy dogs, worse with exercise, wheezed with viral URI's in past

Could this kid have asthma?

Spirometry shows FEV<sub>1</sub>/FVC 58% (low)

FEV<sub>1</sub> is only 61% predicted (mod obstr)

Does she have asthma?

Why is it important to make the diagnosis?

Why is it important to treat this child?

## Case 1b

8 y.o. girl in your family medicine practice.

August well child checkup before school.

BMI 92<sup>nd</sup> percentile, BP 118/83 (elevated) today, previously hi

Could this child have hypertension?

Why is it important to make the diagnosis?

Why is it important to treat this child?



## Case 1a

asthma suspicion



asthma diagnosis



asthma treatment



decr hosp  
decr ER visits  
decr symptoms  
incr exertion-sports



improved  
mortality



quality of life  
quantity of life  
? pulm. remodelling

short  
term

long  
term

## Case 1b

HTN suspicion



HTN diagnosis



HTN treatment



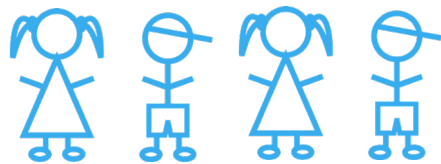
decr \_\_\_\_?  
decr \_\_\_\_?  
decr \_\_\_\_?  
incr \_\_\_\_?



improved  
\_\_\_\_?



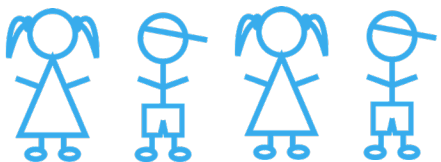
? quality of life  
? quantity of life  
? cardiovasc. remodelling



dietary measures



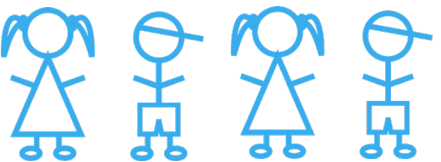
standard diet



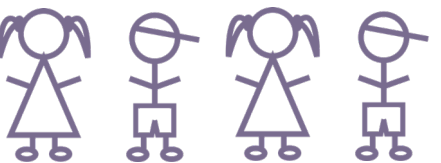
exercise measures



standard activity



amlodipine



placebo

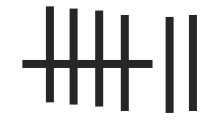


40

years

benefits

harms



# High Blood Pressure in Children and Adolescents: Screening

November 10, 2020

## Recommendation Summary



Population	Recommendation	Grade
Children and adolescents	The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of screening for high blood pressure in children and adolescents.	I

### Detection:

inadequate evidence about accuracy of screening for hypertension

### Benefits early detection, intervention, treatment:

HTN in children & teens does track into adult HTN

inadequate evidence about benefit of screening on adverse health outcomes

inadequate evidence about benefit of treatment on adverse health outcomes

### Harms early detection, intervention, treatment:

inadequate evidence on harms of screening

inadequate evidence about harms of treatment

**To cite:** 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(3):e20171904

American Academy  
of Pediatrics



DEDICATED TO THE HEALTH OF ALL CHILDREN™

# Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents

Joseph T. Flynn, MD, MS, FAAP,<sup>a</sup> David C. Kaelber, MD, PhD, MPH, FAAP, FACP, FACMI,<sup>b</sup> Carissa M. Baker-Smith, MD, MS, MPH, FAAP, FAHA,<sup>c</sup> Douglas Blowey, MD,<sup>d</sup> Aaron E. Carroll, MD, MS, FAAP,<sup>e</sup> Stephen R. Daniels, MD, PhD, FAAP,<sup>f</sup> Sarah D. de Ferranti, MD, MPH, FAAP,<sup>g</sup> Janis M. Dionne, MD, FRCPC,<sup>h</sup> Bonita Falkner, MD,<sup>i</sup> Susan K. Flinn, MA,<sup>j</sup> Samuel S. Gidding,



## Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents

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These pediatric hypertension guidelines are an update to the 2004 “Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents.” Significant changes in these guidelines include (1) the replacement of the term “prehypertension” with the term “elevated blood pressure,” (2) new normative pediatric blood pressure (BP) tables based on normal-weight children, (3) a simplified screening table for identifying BPs needing further evaluation, (4) a simplified BP classification in adolescents  $\geq 13$  years of age that aligns with the forthcoming American Heart Association and American College of Cardiology adult BP guidelines, (5) a more limited recommendation to perform screening BP measurements only at preventive care visits, (6) streamlined recommendations on the initial evaluation and management of abnormal BPs, (7) an expanded role for ambulatory BP monitoring in the diagnosis and management of pediatric hypertension, and (8) revised recommendations on when to perform echocardiography in the evaluation of newly diagnosed hypertensive pediatric patients (generally only before medication initiation), along with a revised definition of left ventricular hypertrophy. These guidelines include 30 Key Action Statements and 27 additional recommendations derived from a comprehensive review of almost 15 000 published articles between January 2004 and July 2016. Each Key Action Statement includes level of evidence, benefit-harm relationship, and strength of recommendation. This clinical practice guideline, endorsed by the American Heart Association, is intended to foster a patient- and family-centered approach to care, reduce unnecessary and costly medical interventions, improve patient diagnoses and outcomes, support implementation, and provide direction for future research.

### abstract

FREE

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- 30 main recommendations (KAS's, Key Action Statements)
- 25 additional consensus recommendations
- They have an evidence rating scheme
- All recommendations based upon weak or no evidence, almost all expert consensus
- How do they justify 30 Key Action Statements and 25 consensus recommendations?
- Section 2.4 “Importance of Diagnosing HTN in Children and Adolescents”
- 1 ½ columns in 74 page guideline
- most focuses on growing prevalence of pediatric HTN
- pediatric-adolescent HTN tracks into adulthood
- only outcomes justification is “intermediate evidence” from autopsy studies and vascular imaging studies (LV mass, carotid artery intima and media thickness, pulse wave velocity for arterial stiffness)
- not the robust evidence we are used to in guidelines
- gives us latitude for our own ideas about value dx and tx

# Ideas about Pros & Cons Dx & Tx Pediatric HTN

## Benefits Screen, Treat

Finding HTN could raise health awareness

Could spur improved lifestyle efforts

- diet, exercise, healthy weight

Could spur lifestyle stuff for whole family

Could find occasional important secondary hypertension underlying disease

Could reduce HTN in adults

Could actually maybe improve cardiovascular outcomes much later

## Harms Screen, Treat

Finding HTN could label kids-teens as having a disease, could be consequences

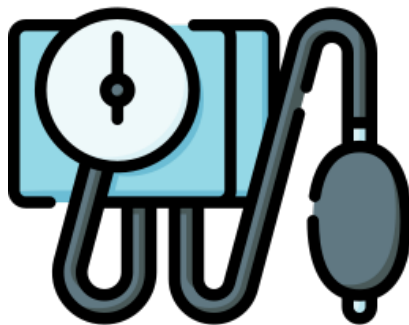
Medical mgmt incurs expensive costs

Lifestyle measures (gym, healthier food) incur expense and burdens

Meds may have side effects

Meds may be unsafe in teen pregn

131/86



no outcomes evidence  
pathophys. rationale  
expert opinion  
hopeful-wishful thinking



do nothing  
**Nihilism**  
ignore it

If it was your kid with hypertension, would you want it ignored?  
Got to do something.

The AAP guideline gives you options and the range of many things you can do for pediatric hypertension.

# Pediatric & Adolescent HTN

## Key take-home 1:

Rationale not like other guidelines.

Insufficient evidence on pros, cons, long-term outcomes of screen, diagnosis, treatment Peds HTN

You have discretion

- Evidence is insufficient to guide you on this matter
- When you screen, diagnose, manage, and treat pediatric & adolescent HTN, you have a lot of discretion
- Pick and choose among the 30 Key Action Statements
- Follow the ones you think make the most sense
- Most likely to confer benefits and minimize harms and burdens on individual children and families
- Pay attention over your career for updates on evidence
- The remainder of this presentation picks and chooses topics to present that seem reasonable, valuable, or controversial and thus benefit from review
- Let's get back to the content



- Yael Bruk
- Class of 2024, SUNY Binghamton junior
- Although I'm the most junior member of presentation team
- I have a bit of expertise
- I work summers back home as a medical assistant taking blood pressures on children at a pediatric cardiology clinic
- You can cure a lot of pediatric hypertension by measuring it right!
- Let's talk about where we're going and measuring blood pressure in children



## Objectives

When & how to measure blood pressure

Definitions & classification of hypertension

Initial suspicion of hypertension

pace of progress towards diagnosis

history, physical exam, tests

How to diagnose primary or secondary HTN

Non-pharmacologic treatment

Pharmacologic treatment

Reasons for referral and hypertensive urgency

## Case 2

Mom is here with her newborn and 2 year old for the toddler's well child checkup. Mom has chronic HTN and recent preeclampsia. Her brother and father also have HTN. As you review the 2 year old's height, weight, and head circumference, mom asks, "hey, when do you start measuring blood pressure in children?"

At what age is it recommended to start routinely measuring blood pressures in the clinic?

- a) Birth
- b) When the child can walk
- c) At 3 years old
- d) At 5 years old
- e) None of the above

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At what age is it recommended to start routinely measuring blood pressures in the clinic?

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- a) Birth
- b) When the child can walk
- c) At 3 years old**
- d) At 5 years old
- e) None of the above

## Key take-home 2:

Routine BP's at well child visits starting 3 yrs old

BP's at all visits in setting of risk factors or symptoms

# When to measure blood pressure

AAP 2017 guideline Key Action Statements 1 & 2:

- Routinely measure blood pressure at every well child visit starting at 3 years old
- And any age or visit when risk factors are present such as:
  - Obesity, coarctation, diabetes, hypothyroidism, CKD
  - BP-raising meds (e.g. steroids)
  - prematurity <32 wks, SGA, very LBW

Also measure BP in presence of

- Cardiac symptoms (tachycardia, palpitations, shortness of breath, chest pain)
- Symptoms of hypertensive emergency (headache, seizure, change in mental status, vomiting, focal neurological complaint, visual disturbances)

## Case 3

A nurse has just joined your family medicine office after a decade of adult medical-surgical hospital care. As she's about to get a 5 year old from the waiting room, she stops and hurries to find you.

"I haven't done this since nursing school. I have a question. As long as I get the right sized cuff, measuring blood pressure in a child is the same as in an adult, right?"

You answer, ...

- a) "smaller cuff, but otherwise same technique as adult measurement"
- b) "smaller cuff, and a small additional difference"

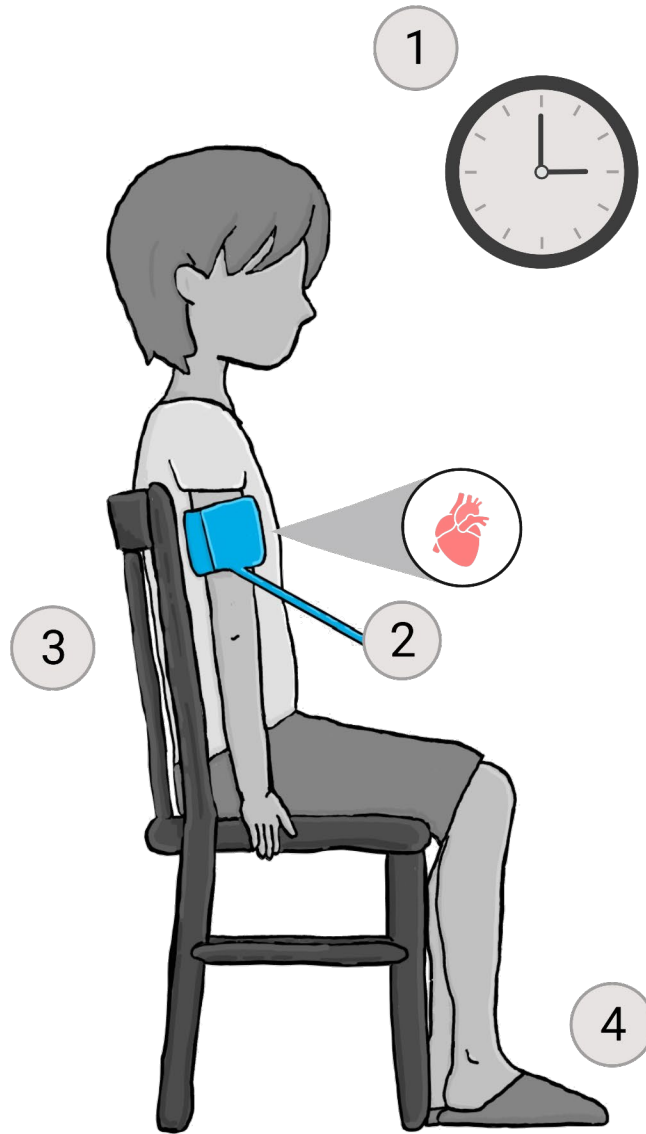
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You answer, ...



# How to measure blood pressure



Adults: either arm  
Children: right arm

Reduces chance of  
missing coarctation

# How to size the BP cuff

Cuff to be wrapped about halfway down the upper arm at level of heart

Remember when you learned blood pressure measurement in med school?

There is a rectangular inflatable air bladder within one side of the cuff

The bladder has to be the right size in relation to the arm.

Correct size based upon bladder width and bladder length



# How to size the BP cuff

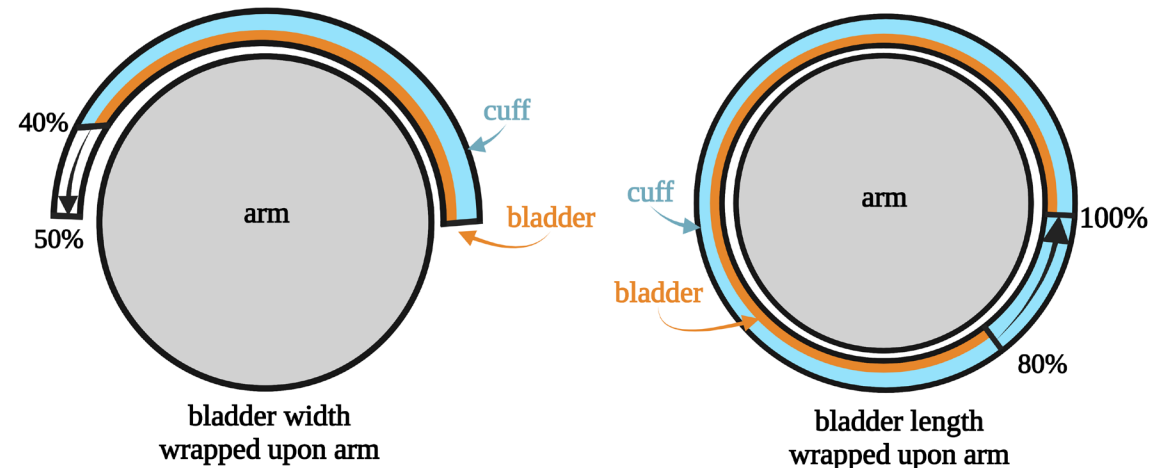
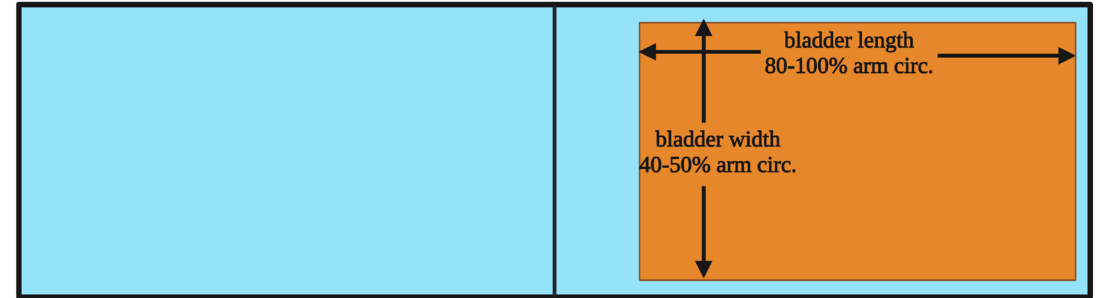
Properly sized bladder width should wrap 40-50% around the circumference of the arm

Lay the cuff down the length of the arm so that the bladder's width wraps around the arm.

Properly sized bladder length should wrap 80-100% around the circumference of the arm.

Wrap the cuff length around the circumference of the arm. The full cuff may wrap around 2x or more, but it's the bladder that counts.

You can cure a lot of hypertension by using the right sized cuff!



## Key take-home 3:

Right arm

Proper size cuff

Seated quiet 5 min,  
proper position

Average properly  
measured BP's

# How to measure blood pressure

Seated quietly 5 minutes, back supported feet on ground

Right arm always to reduce chance missing coarctation

Cuff bladder width 40-50% mid-arm circumference

Cuff bladder length 80-100%

Manual auscultation method remains gold standard

Oscillometric automated device reasonably accurate

If BP elevated, take correctly 2 more times and average properly measured blood pressures

Now let's talk about how to classify blood pressure results.  
It's more complicated than adult numbers.

Start with a case.

## Case 4

It's August. 9 year old female presents with mom for annual well child checkup before school starts.

Her vital signs: T 98.3, HR 65, RR 14, BP 110/74, Height 51.7 in, weight 70 lbs, BMI 18.4

How confident do you feel classifying her BP as normal, elevated, stage 1, or stage 2?

- a) Easy peasy (85-100% confident)
- b) Pretty sure (70-85% confident)
- c) Iffy (50-70% confident)
- d) Unsure (<50% confident)

It's August. 9 year old female presents with mom for annual well child checkup before school starts.

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How confident do you feel classifying her BP as normal, elevated, stage 1, or stage 2?

Older the child, higher the blood pressure

At any age, chart shows 50<sup>th</sup>, 90<sup>th</sup>, 95<sup>th</sup>, 95<sup>th</sup>+12mm percentiles of BP

Taller the child, higher the blood pressure

Chart shows height by percentiles, inches, cm's

Our case:

- age 9 years
- height 51.7 inches
- find BP norms

Many EMR's give you BP percentile by age & height automatically

# How Blood Pressure Norms Chart Works

one for boys, one for girls

**TABLE 5** BP Levels for Girls by Age and Height Percentile

Age (y)	BP Percentile	SBP (mm Hg)						
		Height Percentile or Measured Height						
		5%	10%	25%	50%	75%	90%	95%
8	Height (in)	47.6	48.4	49.8	51.4	53	54.5	55.5
	Height (cm)	121	123	126.5	130.6	134.7	138.5	140.9
	50th	95	94	95	97	98	99	100
	90th	107	107	108	110	111	112	113
	95th	110	111	112	113	115	116	117
9	95th + 12 mm Hg	122	123	124	125	127	128	129
	Height (in)	49.3	50.2	51.7	53.4	55.1	56.7	57.7
	Height (cm)	125.3	127.6	131.3	135.6	140.1	144.1	146.6
	50th	95	95	97	98	99	100	101
	90th	108	108	109	111	112	113	114
10	95th	112	112	113	114	116	117	118
	95th + 12 mm Hg	124	124	125	126	128	129	130
	Height (in)	51.1	52	53.7	55.5	57.4	59.1	60.2
	Height (cm)	129.7	132.2	136.3	141	145.8	150.2	152.8
	50th	96	97	98	99	101	102	103
11	90th	109	110	111	112	113	115	116
	95th	113	114	114	116	117	119	120
	95th + 12 mm Hg	125	126	126	128	129	131	132
	Height (in)	53.4	54.5	56.2	58.2	60.2	62.1	63
	Height (cm)	135.6	138.3	142.8	147.8	152.8	157.8	160
12	50th	98	99	101	102	104	105	106
	90th	111	112	113	114	116	118	120

from Table 5 of BP guideline AAP 2017

## back to Case 4

It's August. 9 year old female well child checkup

Vital signs: T 98.3, HR 65, RR 14, weight 70 lbs, BMI 18.4, Height 51.7 in, BP 110/74 (**between 90<sup>th</sup>-95<sup>th</sup> %-ile**)

Can you classify her BP as normal, elevated, stage 1, or stage 2?

- a) Easy peasy (85-100% confident)
- b) Pretty sure (70-85% confident)
- c) Iffy (50-70% confident)
- d) Unsure (<50% confident)

There's one more thing you need, the category definitions



# Elevated BP Categories

Normal:  
 $< 90^{\text{th}}$  percentile

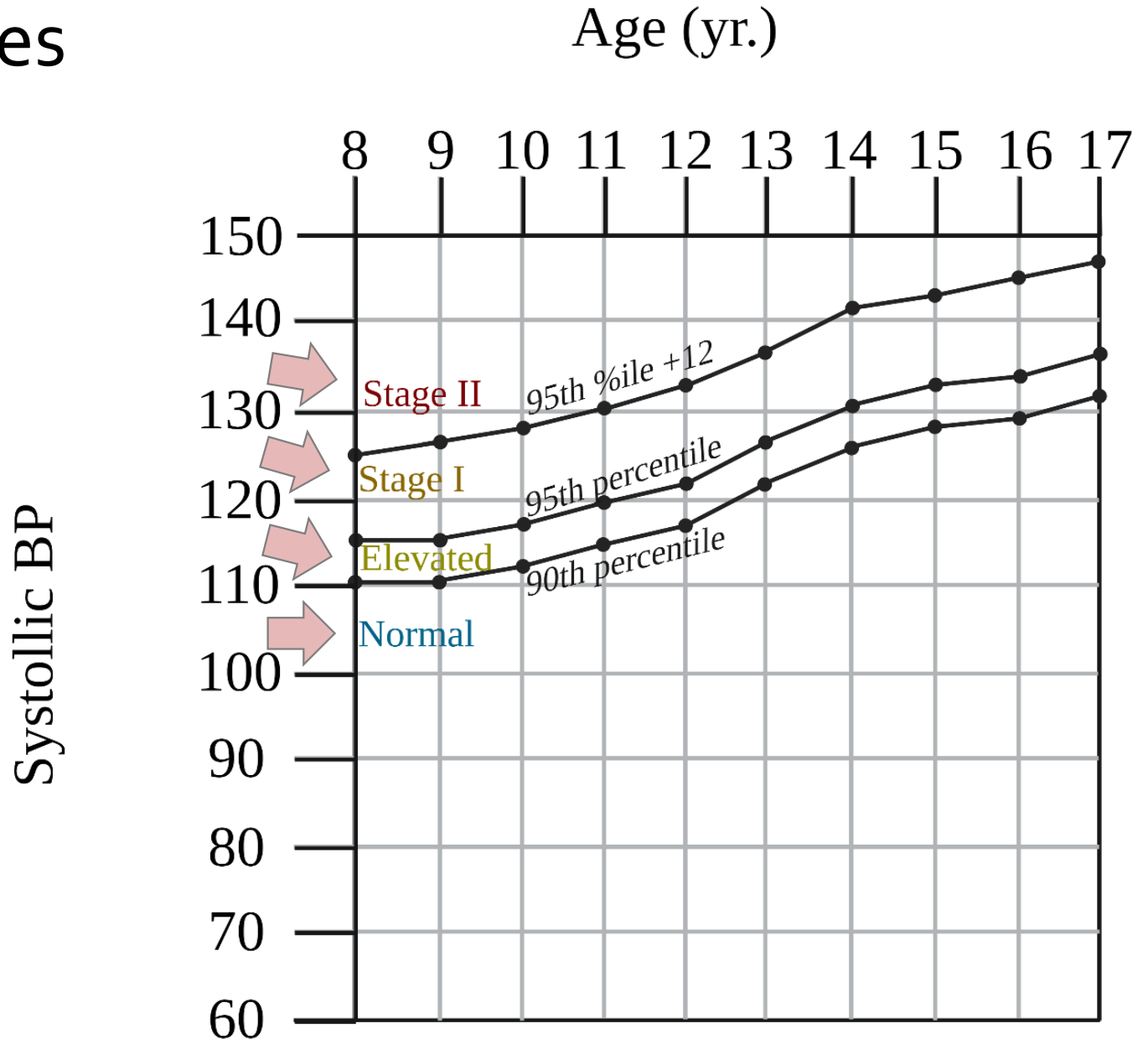
Elevated:  
 $90^{\text{th}}$  to  $< 95^{\text{th}}$  %-ile

Stage 1:  
 $95^{\text{th}}$  to  $< 95^{\text{th}}$  %-ile + 12mm Hg

Stage 2:  
 $\geq 95^{\text{th}}$  %-ile + 12 mm Hg

Systolic or diastolic qualifies

Example illustrated of systolic threshold curves for boy of  $50^{\text{th}}$  percentile height



## wrap up Case 4

9 year old female well child checkup

Vital signs: T 98.3, HR 65, RR 14, weight 70 lbs, BMI 18.4, Height 51.7 in, BP 110/74 (**between 90<sup>th</sup>-95<sup>th</sup> %-ile**)

Can you classify her BP as normal, elevated, stage 1, or stage 2?

- a) Normal (<90<sup>th</sup> percentile)
- b) Elevated (90<sup>th</sup> to <95<sup>th</sup> %-ile)
- c) Stage 1 (95<sup>th</sup> to 95<sup>th</sup> %-ile + 12 mm)
- d) Stage 2 ( $\geq$ 95<sup>th</sup> %-ile + 12 mm)

9 year old female well child  
checkup

Vital signs: T 98.3, HR 65, RR 14,  
weight 70 lbs, BMI 18.4, Height  
51.7 in, BP 110/74 (**between 90<sup>th</sup>-  
95<sup>th</sup> %-ile**)

Can you classify her BP as normal,  
elevated, stage 1, or stage 2?

Key take-home 4:  
not ready for the  
key take-home  
point

it's more  
complicated

case 5 will help

## wrap up Case 4

9 year old female well child checkup

Vital signs: T 98.3, HR 65, RR 14, weight 70 lbs, BMI 18.4,  
Height 51.7 in, BP 110/74 (**between 90<sup>th</sup>-95<sup>th</sup> %-ile**)

Can you classify her BP as normal, elevated, stage 1, or  
stage 2?

- a) Normal (<90<sup>th</sup> percentile)
- b) Elevated (90<sup>th</sup> to <95<sup>th</sup> %-ile)**
- c) Stage 1 (95<sup>th</sup> to 95<sup>th</sup> %-ile + 12 mm)
- d) Stage 2 ( $\geq$ 95<sup>th</sup> %-ile + 12 mm)

# Case 5

It's October.

16 year old male presenting for sports pre-participation physical before basketball season.

On exam T 97.9, HR 67, RR 16, O<sub>2</sub> sat 98% RA, height 70.7 in, weight 145 lbs, BMI 20.4 (48<sup>th</sup> %-ile), BP 131/81 (90<sup>th</sup> to <95<sup>th</sup> %-ile)

How would you classify his blood pressure?

- a) Normal (<90<sup>th</sup> percentile)
- b) Elevated (90<sup>th</sup> to <95<sup>th</sup> %-ile)
- c) Stage 1 (95<sup>th</sup> to 95<sup>th</sup> %-ile + 12 mm)
- d) Stage 2 ( $\geq$ 95<sup>th</sup> %-ile +12 mm)

# Elevated BP Categories

Age-height-percentiles scheme only applies <13 years old.

≥13 years old, AAP recom. using fixed adult thresholds consistent with ACC-AHA

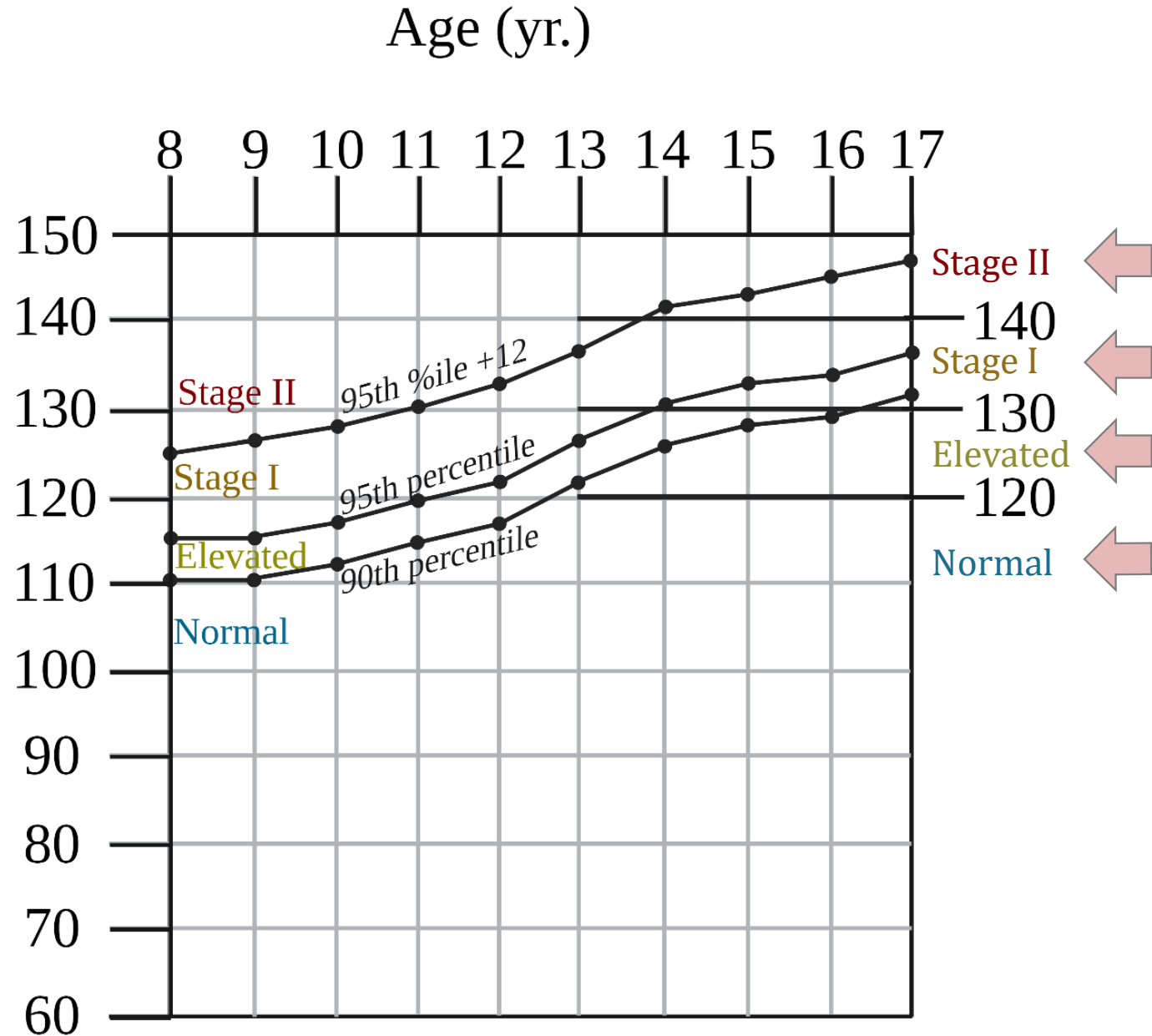
Normal: < 120      DBP < 80

Elevated: 120-129      DBP < 80

Stage 1: 130-139      DBP ≤ 89

Stage 2: 140+      DBP 90+

Systolic BP



## wrap up Case 5

16 year old male presenting for sports pre-participation evaluation.

On exam T 97.9, HR 67, RR 16, O<sub>2</sub> sat 98% RA, height 70.7 in, weight 145 lbs, BMI 20.4 (48<sup>th</sup> %-ile), BP 131/81 (90<sup>th</sup> to <95<sup>th</sup> %-ile)

How would you classify his blood pressure?

- a) Normal (<120)
- b) Elevated (120-129)
- c) Stage 1 (130-139)
- d) Stage 2 ( $\geq$ 140)

16 year old male presenting for sports pre-participation evaluation.

On exam T 97.9, HR 67, RR 16, O<sub>2</sub> sat 98% RA, height 70.7 in, weight 145 lbs, BMI 20.4 (48<sup>th</sup> %-ile), BP 131/81 (90<sup>th</sup> to <95<sup>th</sup> %-ile)

How would you classify his blood pressure?



## wrap up Case 5

16 year old male presenting for sports pre-participation evaluation.

On exam T 97.9, HR 67, RR 16, O<sub>2</sub> sat 98% RA, height 70.7 in, weight 145 lbs, BMI 20.4 (48<sup>th</sup> %-ile), BP 131/81 (90<sup>th</sup> to <95<sup>th</sup> %-ile)

How would you classify his blood pressure?

- a) Normal (<120)
- b) Elevated (120-129)
- c) Stage 1 (130-139)**
- d) Stage 2 (≥140)

# Unified BP Categories

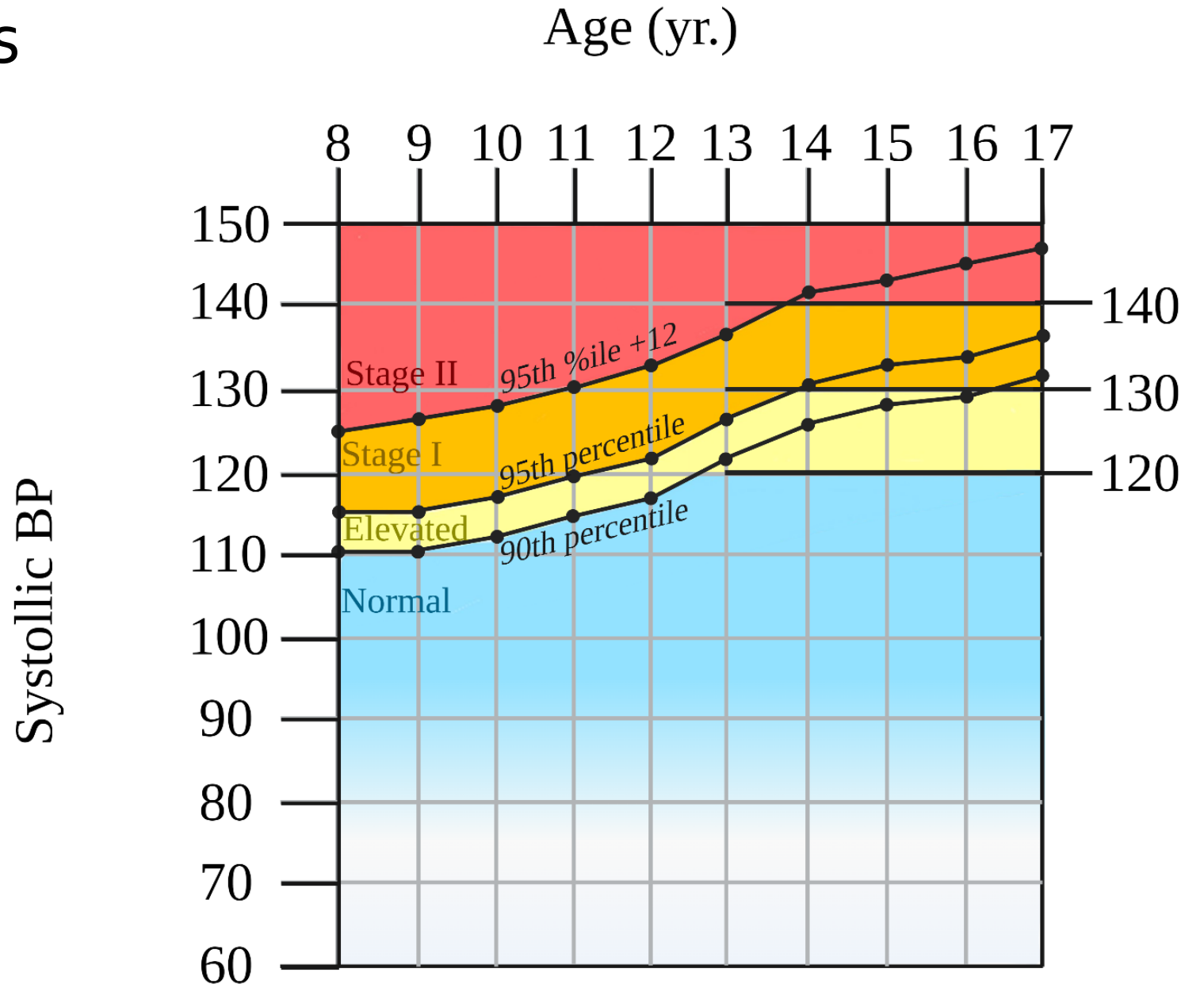
To classify levels of normal, elevated, stage 1, and stage 2 blood pressure:

0-12 years old: use thresholds  
90<sup>th</sup> %-ile, 95<sup>th</sup>, 95<sup>th</sup> + 12

- or 120-130-140 thresholds
- whichever is lower

≥13 years old: use thresholds  
120, 130, 140

Overall scheme with colors to  
see levels under 13 and 13+



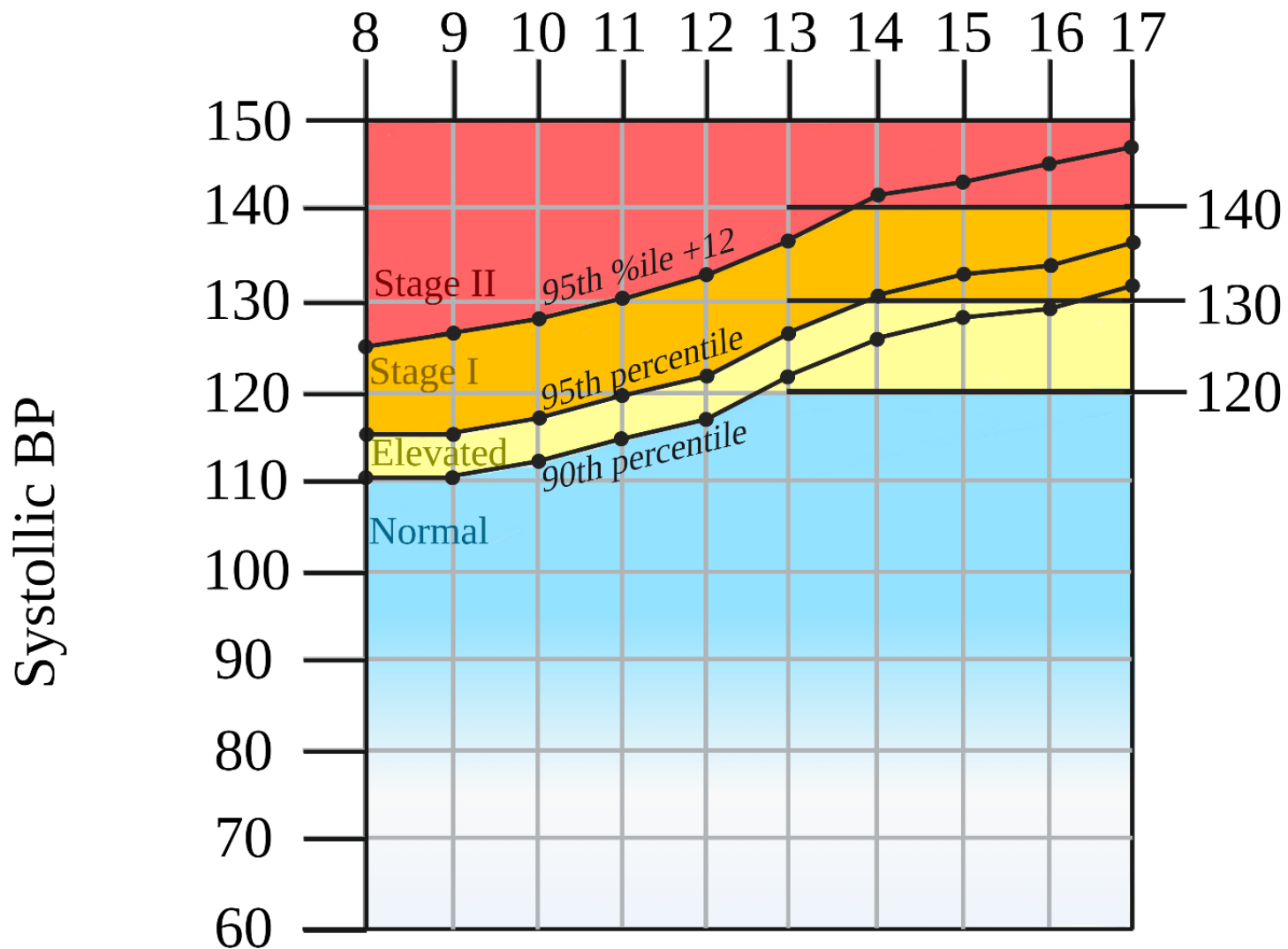
# Categories normal, elevated, HTN

## Key take-home 4:

Thresholds classify normal, elevated, stage 1, stage 2 HTN

<13 yrs. 90<sup>th</sup> %-ile, 95<sup>th</sup>, 95<sup>th</sup> + 12

≥13 yrs. 120-130-140



Now we know when to measure blood pressure  
and how to measure blood pressure  
and how to categorize elevated results.

But you have only one visit with elevated blood pressure.

You suspect hypertension, but you don't have the  
diagnosis yet.

Use history, physical exam, testing, and follow-up visits  
to arrive at the right diagnosis.

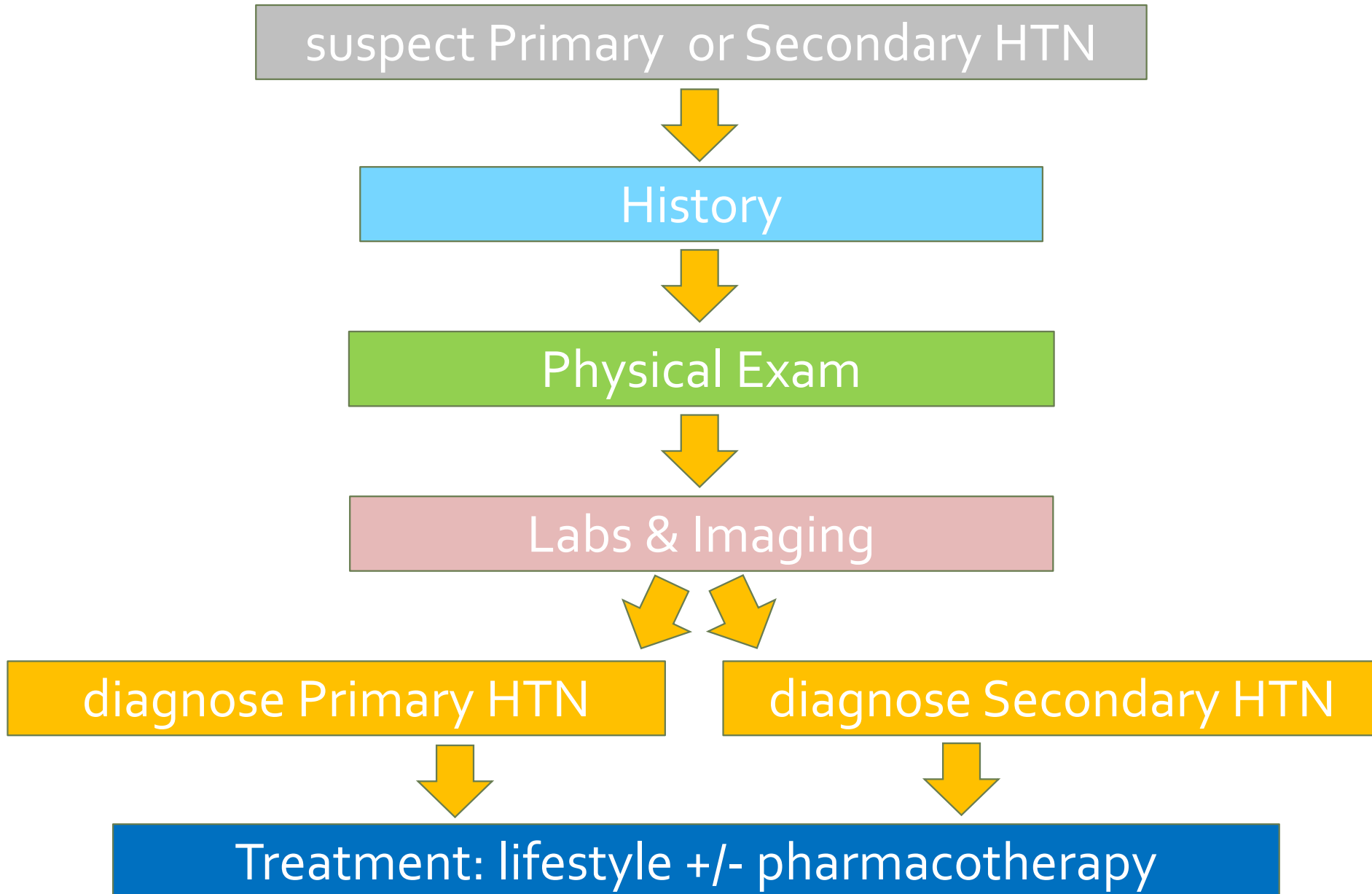
AAP 2017 guideline offers recommendations about the  
pace of your pursuit of the diagnosis.

# Escalating approach, gauged to severity

BP category	BP evaluation schedule	Initiate diet-exercise-wt loss	Diagnostic evaluation	Initiate pharmacotherapy	Consider subspecialty referral
Normal	Annual	yes			
Elevated	Initial measurement	yes			
	Second: repeat in 6 mos	yes			
	Third: repeat in 6 mos	yes	yes		yes
Stage 1	Initial	yes			
	Second: repeat in 1-2 wks	yes			
	Third: repeat in 3 mos	yes	yes	yes	yes
Stage 2	Initial	yes			
	Second: repeat in 1 wk	yes	yes	yes	yes

adapted from Table 11 of BP guideline AAP 2017

# Evaluation Approach



# Primary and Secondary Hypertension

## Primary HTN

Primary HTN is the leading cause of hypertension in children  $\geq 6$  yrs in the United States.

Primary is the same idea as essential hypertension in adults.

Constitutional, there's no underlying disease causing it  
6 years old or older.

Often overweight or obese.

Often hypertension runs in family.

Often systolic more elevated, whereas primarily diastolic elevations associated more with secondary HTN.

If child fits the factors above and nothing on history or physical suggests secondary hypertension, diagnosis is Primary HTN

Get just the basic labs, not extensive ones.

## Secondary HTN

Secondary HTN much less common than primary

Must consider in children  $< 6$  yrs old

Often diastolic elevation more prominent than systolic

Most common secondary cause is renal

- renal parenchymal disease

- renal structural abnormalities

- renovascular disease

Other causes

- cardiac including coarctation

- endocrine (uncommon, numerous possible hormones)

- environmental (lead, cadmium, mercury, phthalates)

- sleep-disordered breathing and obstr. sleep apnea

- neurofibromatosis

- meds (decongest, NSAIDs, steroids, illicit drugs, herbal)

- mono-genic syndromal HTN

So let's apply what you just learned to practice thinking about primary versus secondary hypertension.

For this, let's use a case

A 4 year old boy for well child checkup



# Case 6

4 year old boy also here for annual well child checkup.

T 97.9, HR 73, RR 12, height 32 1/2" (50<sup>th</sup> %-ile), O<sub>2</sub> sat 98% RA, BP 108/79 mm Hg (SBP stage 1 level, DBP stage 2 level), BMI 38<sup>th</sup> %-ile.

PMH: otitis media 9 mos old.

PSH: none.

Meds: none

Birth history: term vaginal delivery no complications

SocHx: socializing well in pre-school, enjoys drawing, likes fruits and vegetables, averages 2 hours of screen time per day

FamHx: mom and dad healthy, 6 year old brother healthy

Your initial suspicion for hypertension in this child is:

- a) Primary HTN
- b) Secondary HTN

4 year old boy for well child checkup.

HR 73, RR 12, BP 108/79 mm Hg (SBP stage 1 level, DBP stage 2 level), BMI 38<sup>th</sup> %-ile.

PMH: OM 9 mos old. Meds: none

Birth Hx: term vaginal, no complic.

SocHx: preschool, good diet, 2 hrs screen time

FamHx: mom and dad healthy, 6 year old brother healthy

Your initial suspicion for hypertension in this child is:

# Case 6

4 year old boy also here for annual well child checkup.

T 97.9, HR 73, RR 12, height 32 1/2" (50<sup>th</sup> %-ile), O<sub>2</sub> sat 98% RA, BP 108/79 mm Hg (SBP stage 1 level, DBP stage 2 level), BMI 38<sup>th</sup> %-ile.

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Birth history: term vaginal delivery no complications

SocHx: socializing well in pre-school, enjoys drawing, likes fruits and vegetables, averages 2 hours of screen time per day

FamHx: mom and dad healthy, 6 year old brother healthy

Your initial suspicion for hypertension in this child is:

- a) Primary HTN
- b) Secondary HTN**

# initial suspicion Secondary hypertension

Let's point out the factors suggesting secondary rather than primary hypertension

4 year old boy also here for annual well child checkup.

T 97.9, HR 73, RR 12, height 32 1/2" (50<sup>th</sup> %-ile), O<sub>2</sub> sat 98% RA, BP 108/79 (SBP stage 1 level, DBP stage 2 level), BMI 38<sup>th</sup> %-ile.

PMH: otitis media 9 mos old. PSH: none. Meds: none

Perinatal history: term vaginal delivery no complications

SocHx: socializing well in pre-school, enjoys drawing, likes fruits and vegetables, averages 2 hours of screen time per day

FamHx: mom and dad healthy, 6 year old brother healthy

# initial suspicion Secondary hypertension

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PMH: otitis media 9 mos old. PSH: none. Meds: none

Perinatal history: term vaginal delivery no complications

SocHx: socializing well in pre-school, enjoys drawing, likes fruits and vegetables, averages 2 hours of screen time per day

FamHx: mom and dad healthy, 6 year old brother healthy (**no FamHx HTN**)

Let's discuss history, physical exam, and testing

# History & Physical Exam

AAP guideline offers a large list of potential findings which can suggest secondary hypertension.

They mostly group into broad categories

- **Renal:** flank or epigastric bruit, palpable kidneys
- **Cardiovascular:** chest pain, palpitations, dyspnea upon exertion, heart murmur, friction rub, BP difference between extremities
- **Endocrine:** tachycardia, proptosis, goiter, abdominal mass, moon facies, striae, obesity, acne, hirsutism
- **Sleep disordered breathing:** obesity, adenotonsillar hypertrophy
- **Skin:** malar rash, café-au-lait spots, ambiguous genitalia, joint swelling
- **Meds:** NSAIDs, steroids, decongestants, illicit drugs, herbals

Now let's look at testing

# Labs, Imaging, Testing

## suspect primary hypertension

### column 1

screening labs for all

looking for secondary causes

- 3 limb blood pressures (both arms, 1 leg) for coarctation
- Urinalysis for renal disease
- BMP for renal disease, electrolyte abnorm. diseases
- renal sono for kidney dz. for <6 yrs old or for any abnormal urinalysis, BUN, creatinine
- no EKG!

### column 2

labs in the obese (BMI  $\geq 95^{\text{th}}$  %ile)

looking for metabolic syndrome comorbidities

- A1c/fasting glucose for type 2 diabetes
- ALT/AST or LFT's for fatty liver
- lipids for hyperlipidemia & cardiac risk

## suspect secondary HTN

### column 3

all screening labs in column 1

labs in column 2 if obese

selected additional tests as suggested/indicated by history and physical exam, for example...

- TSH for thyroid disease
- drug screen for illicit stimulants
- sleep study for SDB-OA
- CBC esp. for growth delay or CKD
- anything else suggested by history & physical

# Timing of work on Peds HTN

BP category	BP evaluation schedule	Initiate diet-exercise-wt loss	Diagnostic evaluation	Initiate pharmacotherapy	Consider subspecialty referral
Normal	Annual	yes			
Elevated	Initial measurement	yes			
	Second: repeat in 6 mos	yes			
	Third: repeat in 6 mos	yes	yes		yes
Stage 1	Initial	yes			
	Second: repeat in 1-2 wks	yes			
	Third: repeat in 3 mos	yes	yes	yes	yes
Stage 2	Initial	yes			
	Second: repeat in 1 wk	yes	yes	yes	yes

adapted from Table 11 of BP guideline AAP 2017



These secondary HTN cases are rare

Here's a much more conventional, typical case

It's a 10 year old back with mom in August for her next well child checkup

# Case 7

It's August. 10 year old female returns with mom for annual well child checkup before school.

T 98.5, HR 66, RR 12, O<sub>2</sub> sat 98% RA, BP 132/84 mm Hg (SBP 132 is Stage 1 HTN), BMI 89<sup>th</sup> percentile. Review of history is:

PMHx: otitis media age 3.

PSHx: none.

Meds: none.

Perinatal history: gestational age 39 wks, maternal chronic HTN in pregnancy, no birth or labor complications.

SocHx: doing well in school, spends free time reading and riding bike, diet mostly home-cooked meals by mom and occasional junk food, sleeps well at night with some snoring.

FamHx: Father has bicuspid aortic valve, mom has HTN and hx of thyroidectomy, maternal grandfather had HTN and chronic kidney failure.

# Case 7

10 year old female annual well child checkup before school.

T 98.5, HR 66, RR 12, BP 132/84 (SBP stage 1 level), BMI 89<sup>th</sup> %-ile.

PMHx: otitis media age 3. PSHx: none. Meds: none.

Birth Hx: 39 wks EGA, maternal chronic HTN in pregnancy

SocHx: school good, reads & rides bike, mostly home-cooked meals by mom and occasional junk food, sleeps well with some snoring.

FamHx: Father bicuspid aortic valve, mom HTN and thyroidectomy, maternal grandfather had HTN and CKD.

Your initial suspicion for hypertension in this child is:

- a) Primary HTN
- b) Secondary HTN

10 year old female well child checkup

T 98.5, HR 66, RR 12, BP 132/84 (SBP stage 1 level), BMI 89<sup>th</sup> %-ile.

Birth Hx: 39 wks EGA, maternal chronic HTN in pregnancy

SocHx: reads & rides bike, mostly home-cooked meals, some snoring.

FamHx: father bicuspid Ao valve, mom HTN, grandfather HTN

Your initial suspicion for hypertension in this child is:

# Case 7

10 year old female annual well child checkup before school.

T 98.5, HR 66, RR 12, BP 132/84 (SBP stage 1 level), BMI 89<sup>th</sup> %-ile.

PMHx: otitis media age 3. PSHx: none. Meds: none.

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SocHx: school good, reads & rides bike, mostly home-cooked meals by mom and occasional junk food, sleeps well with some snoring.

FamHx: Father bicuspid aortic valve, mom HTN and thyroidectomy, maternal grandfather had HTN and CKD.

Your initial suspicion for hypertension in this child is:

- a) **Primary HTN**
- b) Secondary HTN

# initial suspicion Primary hypertension

Let's point out the factors suggesting primary rather than secondary hypertension.

10 year old female returns with mom for annual well child checkup.

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# initial suspicion Primary hypertension

Let's point out the factors suggesting primary rather than secondary hypertension.

**10 year old** female returns with mom for annual well child checkup.

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PMHx: otitis media age 3. PSHx: none. Meds: none.

Perinatal history: 39 wks EGA, maternal chronic HTN in pregnancy,

SocHx: doing well in school, spends free time reading and riding bike, diet mostly home-cooked meals by mom and occasional junk food, sleeps well at night with some snoring.

FamHx: Father has bicuspid aortic valve, **mom has HTN** and hx of thyroidectomy, maternal **grandfather had HTN** and CKD

This is what's common. This is what we're good at working on.

# Diagnosing Primary & Secondary HTN

## Key take-home 5:

Diagnose Primary Hypertension if

(1) child fits profile  
and

(2) history, exam, and tests do not suggest underlying disease

Diagnose Secondary HTN when underlying disease identified

## Primary Hypertension

6 years and older

Overweight, obese

Systolic elevation more prominent

Family history HTN  
parents and/or  
grandparents

## Secondary Hypertension

Any age including <6 yrs

Diastolic elevation more prominent

Anything on history, exam, tests points to underlying disease

Now let's discuss management



# Case 8

A 16 year old male for his annual well check.

On exam T 98.5, HR 77, RR 16, O<sub>2</sub> sat 99% RA, height 67 in, weight 195 lbs, BMI 30, BP 138/86. The patient denies feeling nervous or anxious.

You note two prior visits with BP 139/80 and 136/84. He has gained 15 lbs in the last year and seen his BMI rise by 2.

You make the diagnosis of stage 1 primary hypertension.

How would you manage his hypertension?

- a) Obtain more confirmatory blood pressure measurements
- b) Wait for hypertension to progress to Stage 2 before acting
- c) Start non-pharmacologic management emphasizing diet, exercise, and weight management
- d) Start blood pressure medications

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- a) Obtain more confirmatory blood pressure measurements
- b) Wait for hypertension to progress to Stage 2 before acting
- c) Start non-pharmacologic management emphasizing diet, exercise, and weight management**
- d) Start blood pressure medications

## Key take-home 6:

Non-pharm. mgmt:  
DASH diet, exercise,  
weight loss for  
overweight

Goal BP <90<sup>th</sup> %-ile  
or 130/80

# Treatment Elevated BP & HTN

Initial management is conservative and includes:

Dietary modification including salt restriction, DASH diet

Moderate to vigorous regular exercise 30-60 minutes 3-5 x per week  
and restriction of sedentary activity

Weight reduction for children who are overweight

Counsel to improve other behaviors that influence blood pressure  
and cardiovascular risk such as smoking, alcohol, caffeine, energy  
drinks

Goal of treatment is to reduce BP to <90<sup>th</sup> %-ile (<13 yrs) or <130/80  
(≥13 yrs)

If conservative measures are insufficient to reduce blood pressure to  
goal, then consider medications.

Treatment of secondary hypertension differs only by also treating  
the root cause (CKD, congenital heart disease, etc.), as well as  
general non-pharmacologic and pharmacologic management.

## Case 9

The same 16 year old male with BMI 30, and three consecutive BP's 139/80, 136/84, and 138/86 here for follow up.

He and his mom report good improvements in eating healthier.

But he has not been able to stick with any consistent exercise.

Weight unchanged at 195, today's BP 136/83.

How would you manage his hypertension?

- a) Obtain more confirmatory blood pressure measurements
- b) Wait for hypertension to progress to Stage 2 before acting
- c) Continue non-pharmacologic management alone emphasizing diet, exercise, and weight loss
- d) Start blood pressure medications

Same 16 year old male with BMI 30, and three consecutive BP's 139/80, 136/84, and 138/86 here for follow up.

He and his mom report good improvements in eating healthier. No consistent exercise.

Weight unchanged at 195, today's BP 136/83.

How would you manage his hypertension?

## Case 9

The same 16 year old male with BMI 30, and three consecutive BP's 139/80, 136/84, and 138/86 here for follow up.

He and his mom report good improvements in eating healthier.

But he has not been able to stick with any consistent exercise.

Weight unchanged at 195, today's BP 136/83.

How would you manage his hypertension?

- a) Obtain more confirmatory blood pressure measurements
- b) Wait for hypertension to progress to Stage 2 before acting
- c) Continue non-pharmacologic management alone emphasizing diet, exercise, and weight loss
- d) **Start blood pressure medications**

If cannot get to goal on diet, exercise, weight loss, consider pharmacotherapy

## Key take-home 7:

Pharmacotherapy:  
ACE/ARB, CCB,  
thiazide diuretic, less  
preferred BB

Goal BP <90<sup>th</sup> %-ile  
or <130/80

# Pharmacotherapy

Short term studies show first line medications are similarly effective at controlling blood pressure, generally well-tolerated

Studies comparing first line medications for longer term outcomes and cardiovascular outcomes are lacking

Thus clinicians may choose agent(s) based upon concurrent disorders (DM, CKD, migraines, etc.) and clinician preference.

Recommended medications are same as in adults

- ACEI/ARB, CCB, thiazide diuretics
- Beta-blockers not initially, less preferred
- consider ACEI & ARB contraindication in pregnancy when treating reproductive aged girls

Start with low dose monotherapy, titrate, and add medication(s) if goal not achieved. Thiazide diuretic recommended 2<sup>nd</sup> agent.

Continue non-pharmacologic measures diet, exercise, weight loss

Goal remains BP <90<sup>th</sup> %-ile (<13 yrs) or <130/80 (≥13 yrs)



# One more goal of pharmacotherapy

Think about adult HTN care

extra hard-working cardiac muscle pumping at high pressures

expect left ventricular hypertrophy (LVH); LVH of adult HTN correlates with cardiac consequences (CAD, CHF, valve dz, etc.)

treat HTN expecting reduction of long-term consequences like LVH

but you'd never check serial echocardiograms in adults just to see whether you're improving the LVH

Yet that's what the AAP guideline recommends for children

Key Action Statement 15 recommends that if pediatric HTN needs meds, check echo beforehand to assess for pediatric equivalent of LVH, termed increased LV mass

If LV mass elevated, repeat echo every 6-12 months to follow, goal of med therapy is to reduce-reverse-normalize increased LV mass

What little evidence AAP cites is disease-oriented speculation and extrapolated from adults; AAP concedes evidence lacking

Peds Nephro & Peds Cardio in Syracuse endorse and follow echo's

Which brings us to referral

# When to Refer

BP category	BP evaluation schedule	Initiate diet-exercise-wt loss	Diagnostic evaluation	Initiate pharmacotherapy	Consider subspecialty referral
Normal	Annual	yes			
Elevated	Initial measurement	yes			
	Second: repeat in 6 mos	yes			
	Third: repeat in 6 mos	yes	yes		yes
Stage 1	Initial	yes			
	Second: repeat in 1-2 wks	yes			
	Third: repeat in 3 mos	yes	yes	yes	yes
Stage 2	Initial	yes			
	Second: repeat in 1 wk	yes	yes	yes	yes

adapted from Table 11 of BP guideline AAP 2017

## Key take-home 8:

Refer any child with confirmed HTN whom you think would benefit from referral (for 2<sup>o</sup> causes w/up, for meds, for anything -- at your discretion)

# When to Refer

As you saw on the AAP's table, they recommend consider referral of any child with confirmed elevated BP or HTN

The topic of pediatric hypertension straddles two specialties:

- pediatric nephrology, where most secondary causes arise
- pediatric cardiology, where target-organ damage accrues

In Binghamton, Peds Nephro is the referral destination at Upstate

In other regions, kids go to cardiology or dedicated pediatric hypertension centers

Referral to tertiary center 1-2 hours away is a hardship on most, so we suggest being choosy. Does subspecialist need to see...

- obese teen with primary HTN?  
clearly no
- 5 year old with abnormal urinalysis and needs meds?  
clearly yes

# Case 10

10 year old female, mom says child hasn't been her energetic self and seems "puffy in her face and ankles". Child only admits to feeling vaguely unwell.

On exam T 98.4, HR 87, RR 22, O<sub>2</sub> sat 93% RA, height 54.2 in (50<sup>th</sup> %-ile), weight 79 lbs (70<sup>th</sup> %-ile) up 7 lbs from well child checkup 3 months ago when 72 lbs (50<sup>th</sup> %-ile), BP 155/101. 95<sup>th</sup> %-ile for age and height is 116/76.

Which of the following are true?

- a) This is Stage 2 Hypertension
- b) This is Acute Severe Hypertension
- c) Acute Severe Hypertension defined as symptomatic, 30+ points above 95<sup>th</sup> %-ile, and/or  $\geq 180/120$  in adol.
- d) Acute Severe Hypertension should be evaluated in ER and/or hospital
- e) B, C, and D

10 year old female not energetic and seems “puffy in her face and ankles”. Child admits to feeling vaguely unwell.

HR 87, RR 22, O<sub>2</sub> sat 93% RA, height 54.2 in (50<sup>th</sup> %-ile), weight 79 lbs (70<sup>th</sup> %-ile) up 7 lbs from well child checkup 3 months ago when 72 lbs (50<sup>th</sup> %-ile),

BP 155/101. 95<sup>th</sup> %-ile for age and height is 116/76.

Which of the following are true?

# Acute Severe Hypertension

Definition:

Symptomatic, and/or

30+ points above 95<sup>th</sup> %-ile SBP or DBP, and/or

≥180/120 in adolescent

Target organ damage in progress or likely imminent.

Youths decompensate more easily than adult hypertensives

# Acute Severe Hypertension

Hospitalize in order to

- evaluate, stabilize target organ function
  - AKI, CHF, encephalopathy
- hunt for underlying disorder
  - almost always underlying secondary HTN process
- and reduce blood pressure acutely and safely
  - BP goal 95<sup>th</sup> %-ile levels SBP & DBP, reduce by 25% of planned reduction in first 8 hours
  - oral or IV meds depending on oral intake status
  - options mainly extrapolated from adult use at pediatric doses (eg. hydralazine, labetalol, nicardipine, clonidine, isradipine, esmolol, nitroprusside, etc.)

Key take-home 9:

Acute severe HTN

Symptoms or very high BP #'s

Hospitalize to stabilize, investigate, and treat

## wrap up Case 10

10 year old female, mom says child hasn't been her energetic self and seems "puffy in her face and ankles".

On exam BP 155/101. 95<sup>th</sup> %-ile for age and height is 116/76.

Which of the following are true?

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- d) Acute Severe Hypertension should be evaluated in ER and/or hospital**
- e) B, C, and D



# Key take home points

- 1) Evidence base for pediatric HTN not great, you have much discretion
- 2) Routine BP's at well child visits starting 3 yrs old. BP's at all visits in setting of risk factors or symptoms
- 3) Right arm. Proper size cuff. Seated quiet 5 min, proper position. Average properly measured BP's
- 4) Thresholds classify normal, elevated, stage 1, stage 2 HTN. <13 yrs: 90<sup>th</sup> %-ile, 95<sup>th</sup>, 95<sup>th</sup> + 12. ≥13 yrs: 120-130-140. Elevated on 3 visits to diagnose
- 5) Diagnose Primary Hypertension if child fits profile, and history, physical exam, and tests do not suggest underlying disease
- 6) Non-pharm. mgmt: DASH diet, exercise, weight loss for overweight. Goal BP <90<sup>th</sup> %-ile or <130/80
- 7) Pharmacotherapy: ACE/ARB, CCB, thiazide diuretic, less preferred BB. Goal BP <90<sup>th</sup> %-ile or <130/80
- 8) Refer any child whom you think would benefit from referral
- 9) Diagnose acute severe HTN by symptoms or very high BP #'s. Hospitalize to stabilize, investigate, and treat.

# References

- 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(3):e20171904
- Screening for High Blood Pressure in Children and Adolescents: US Preventive Services Task Force Recommendation Statement. *JAMA*. 2020;324(18):1878-1883.

# Acknowledgements

- original illustrations by Yael Bruk, Binghamton University, class of 2024
- fourth project team member, Dr. Tara Sharma, PGY-3 at UHS FM residency, contributed greatly but could not be with us today

# Key take home points

- 1) Evidence base for pediatric HTN not great, you have much discretion
- 2) Routine BP's at well child visits starting 3 yrs old. BP's at all visits in setting of risk factors or symptoms
- 3) Right arm. Proper size cuff. Seated quiet 5 min, proper position. Average properly measured BP's
- 4) Thresholds classify normal, elevated, stage 1, stage 2 HTN. <13 yrs: 90<sup>th</sup> %-ile, 95<sup>th</sup>, 95<sup>th</sup> + 12. ≥13 yrs: 120-130-140. Elevated on 3 visits to diagnose
- 5) Diagnose Primary Hypertension if child fits profile, and history, physical exam, and tests do not suggest underlying disease
- 6) Non-pharm. mgmt: DASH diet, exercise, weight loss for overweight. Goal BP <90<sup>th</sup> %-ile or <130/80
- 7) Pharmacotherapy: ACE/ARB, CCB, thiazide diuretic, less preferred BB. Goal BP <90<sup>th</sup> %-ile or <130/80
- 8) Refer any child whom you think would benefit from referral
- 9) Diagnose acute severe HTN by symptoms or very high BP #'s. Hospitalize to stabilize, investigate, and treat.

Discussion?

Questions?

Thanks!