

Diagnosis and Management of Hypertension in Children

Future of Pediatrics 2013



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Goals

- Know how to diagnose hypertension in children
- Understand when and how to work up
- Know how to determine when there is time to wait and watch vs. when immediate therapy or referral is indicated
- Know how to determine eligibility for participation in sports

Case Presentation: History

- L.R. is a 16 year old African-American female
- Presents to your office for routine school sports physical
- Asymptomatic
- Blood pressure 152/94 mmHg

Case Presentation: History

- No gross hematuria or swelling
- No symptoms referable to CNS, CVS, respiratory systems
- Not taking any medications or herbal supplements, not on oral contraceptives
- Denies use of tobacco, alcohol or other recreational drugs
- Family Hx: Several relatives on both parents' sides with essential hypertension, no history of renal disease

Case Presentation: Physical Examination

- Afebrile, Pulse 83, RR 12
- You confirm manual blood pressure in right arm 150/96 mmHg, taken twice
- BMI 29.5 kg/m², just >95%
- Alert, well appearing
- HEENT clear, normal fundi
- Lungs clear, heart normal
- Abdomen normal, no audible bruit
- No rash, acanthosis nigricans present
- Non-focal neurological exam

Question 1

Hypertension in adolescents is defined as:

- a) Average BP $\geq$ 140/90 mmHg
- b) Average BP $\geq$ 120/80 mmHg
- c) Average BP $\geq$ 95th percentile
- d) Average BP $\geq$ 90th percentile

Definitions

From: The Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. *Pediatrics* 2004;114;555-576

- Hypertension
 - Average SBP and/or DBP $\geq 95^{\text{th}}$ percentile for age, height and gender on ≥ 3 occasions

Our patient

- Average BP 151/95 mmHg
 - 95th percentile 132/86 mmHg
 - 99th percentile 140/92 mmHg
-
- She is clearly hypertensive: Av BP > 95%

Our Patient: Questions to Address

1. What stage hypertension does this patient have? (Why is this important?)
2. Is this an hypertensive emergency? (why is this important?)
3. Does she require immediate therapy?
4. Will you allow her to participate in sports?

Adults

- Definition of hypertension is based on OUTCOMES
 - The approximate level at which there is increased cardiovascular morbidity and death
 - There are established benefits of therapy to lower blood pressure below these values

Vs. Pediatrics

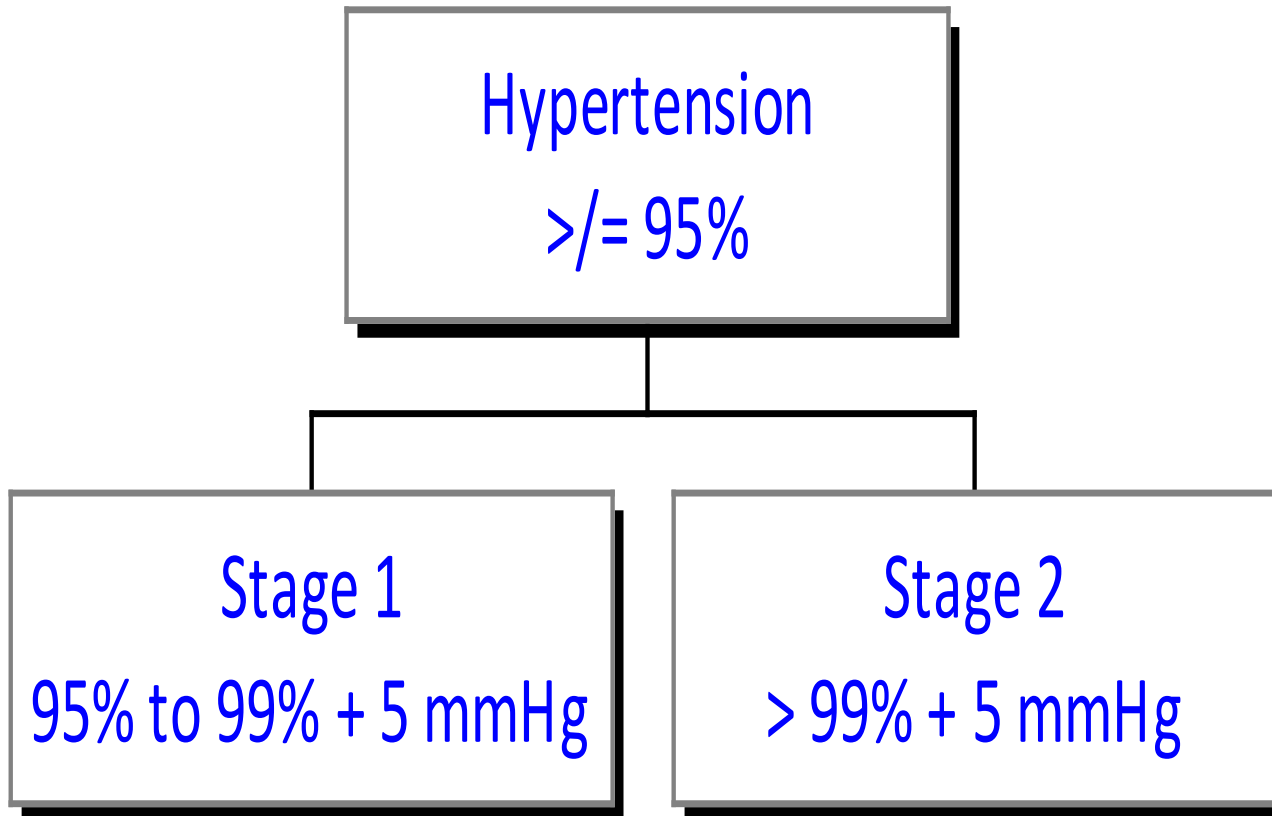
- Blood pressure definitions are based on statistical data NOT on outcomes

In Adults

- Concept of pre-hypertension:
 - For every 20 mmHg rise of SBP >115 mmHg and/or every 10 mmHg rise of DBP >75 mmHg, the risk of cardiovascular events doubles*

*Vasan et al. NEJM 2001. 345: 1291-7.

Definitions



Definitions

- Pre-hypertension
 - SBP and/or DBP $\geq 90^{\text{th}}$ percentile and $< 95^{\text{th}}$ percentile for age, height and gender
 - Adults BP $\geq 120/80$ mmHg is prehypertension
 - Adolescents (>12 yo) with BP $\geq 120/80$ mmHg but $< 95^{\text{th}}$ percentile are considered pre-hypertensive

- Recheck BP in 6 months

Definitions

- ***Normal*** blood pressure
 - Average SBP and DBP below 90th percentile for age, height and gender
 - While it is okay in the short term to achieve BP < 95% in hypertensive patients, the ultimate goal is < 90%

Determinants of Blood Pressure

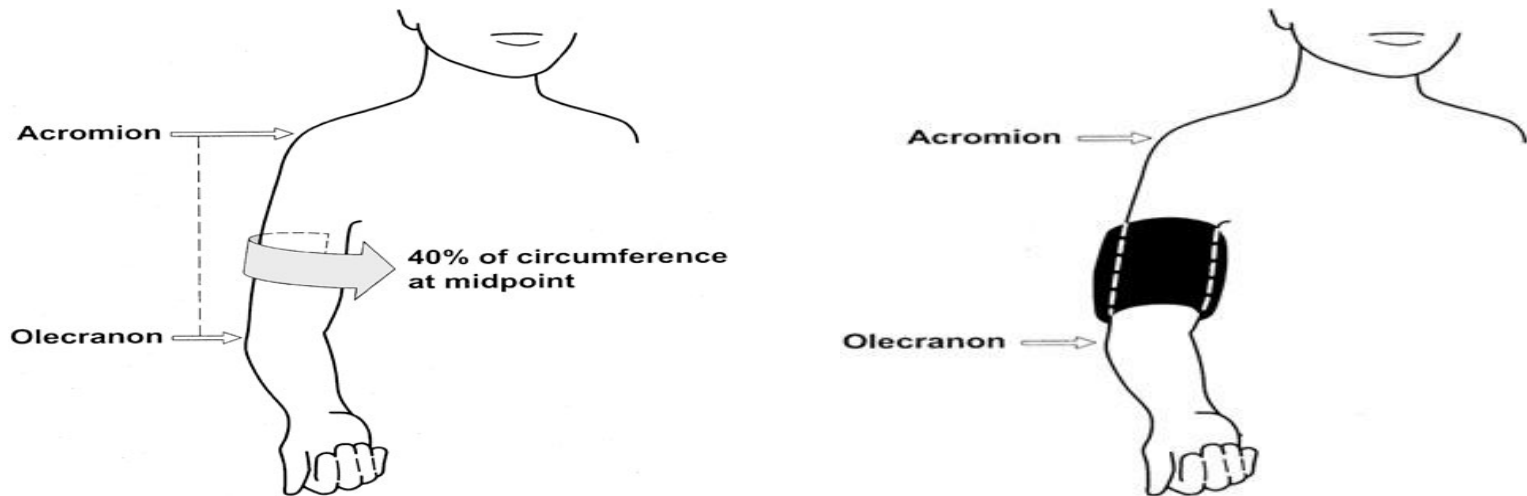
- Age - Gender - Race
- Height
- Activity Level
- Stress Level
- Position
- Weight

Question

Which mammal has the highest BP?

- a) Humans
- b) Elephants
- c) Rats
- d) Giraffe
- e) Buffalo

The Basics: Sizing the BP Cuff



- Bladder width 40% of mid-arm circumference
- Bladder length 80-100% arm circumference

Oscillometry vs. Manual BPs

- BPs differ by modality of measurement
- Park, 2001
 - 7,000 children aged 5 to 17 years
 - BPs by both techniques
 - Oscillometric readings higher
 - Systolic readings 10 mmHg higher
 - Diastolic readings 5 mmHg higher

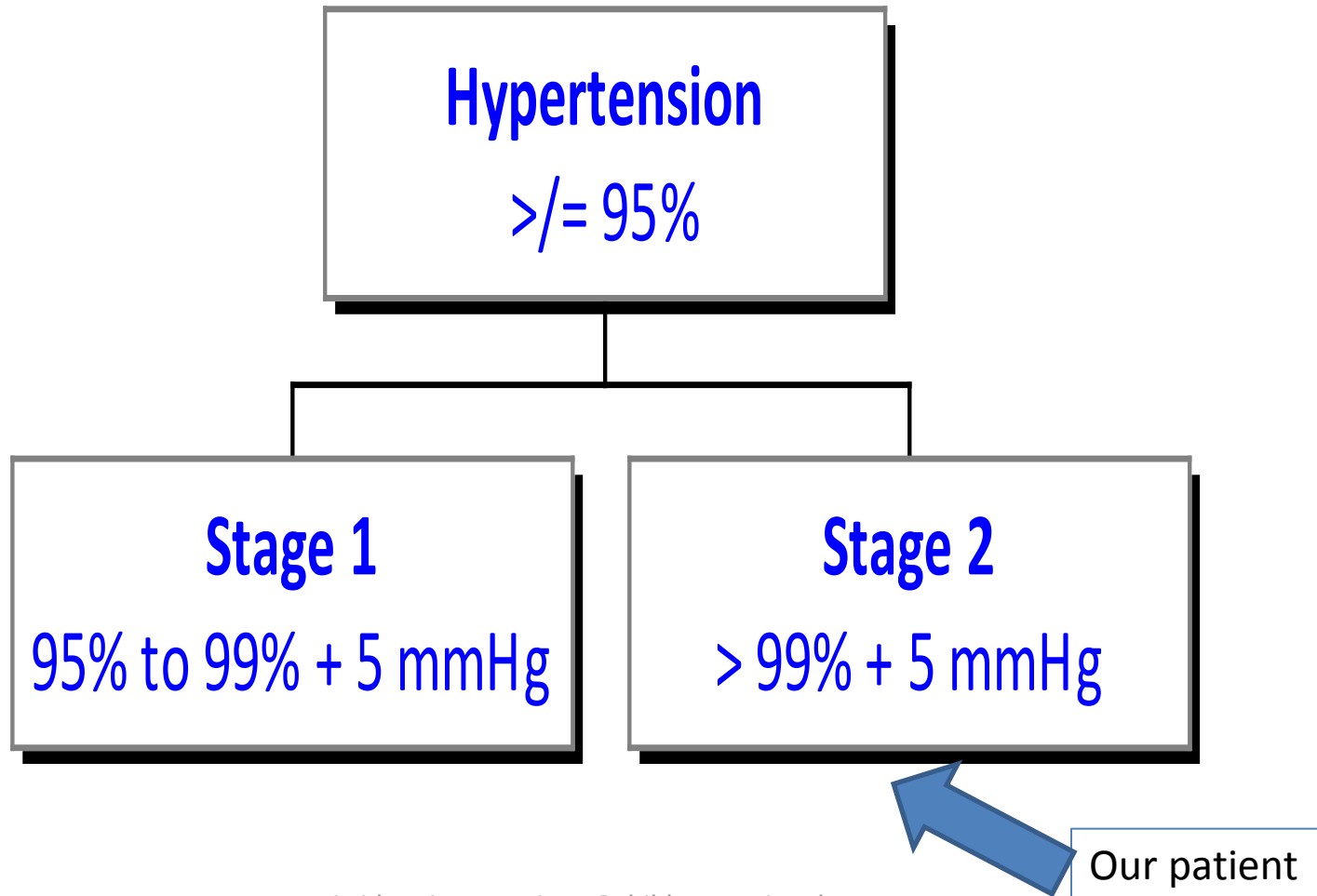
Oscillometry vs. Manual BPs

- Confirm BP obtained by oscillometry with manual auscultatory BP
- Calibrate your aneroid manometers every 6 months
- Validate oscillometric devices regularly

Back to those Questions...

- What stage of hypertension does this patient have?
 - Average BP 151/95 mmHg
 - 95% 132/86 mmHg
 - 99% 140/92 mmHg

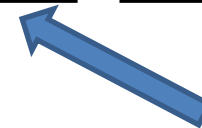
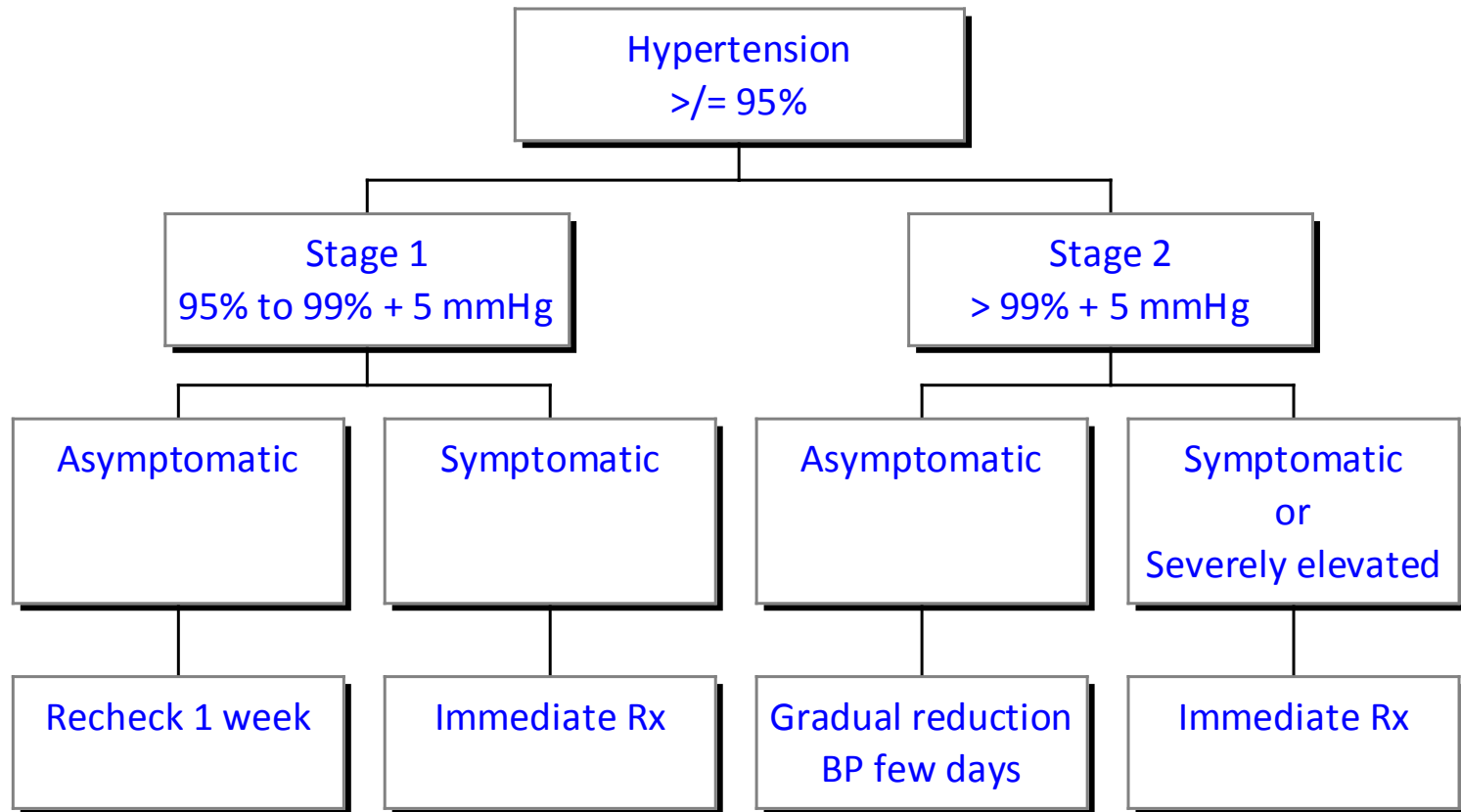
Definitions



Why Stage?

- Staging hypertension in children and adolescents provides guidance for clinicians in evaluating patients with elevated blood pressure
- Provides guidance for the urgency of management

Definitions



Our patient

Hypertensive Crisis: Emergency vs. Urgency

- Distinguished by presence or absence of acute end organ dysfunction
- End organ dysfunction may be determined by history, physical examination or investigative tests
- **Differentiation of these 2 entities determines promptness of management and degree reduction of BP**

Hypertensive Crisis: Emergency vs. Urgency

- End organ dysfunction
 - CNS: visual impairment, mental status changes, stroke, headache, seizures, focal neurologic deficits, PRES, etc.
 - Cardiovascular: chest pain, MI, pulmonary edema, congestive heart failure, etc.
 - Renal: acute renal failure
 - Ophthalmologic: retinal exudates and hemorrhages

Back to those Questions...

- Is this an hypertensive emergency?
 - No: she is symptomatic
- Why does it matter?
 - Guides urgency of management
 - You have time – do not have to send to ED immediately

Question

The prevalence of hypertension in asymptomatic children and adolescents is approximately:

- a) <1%
- b) 3.5%
- c) 5%
- d) 10%

Prevalence

Hansen et al. JAMA 2007

- Children 3-18 years, well-child visits, n > 14K
 - Hypertension: 3.6%
 - Pre-hypertension: 3.4%

McNiece et al. J Pediatr 2007

- Adolescents
 - Hypertension: 3.2%
 - Pre-hypertension: 15.7%
 - Combined prevalence of hypertension and pre-hypertension was ~30% in obese adolescents

Obesity and Hypertension

- Obese children are at substantially higher risk for developing hypertension
- Prevalence of obesity is increasing
- National Health and Nutrition Examination Survey (NHANES III): 14% of adolescents overweight

Obesity and Hypertension

- Bogalusa Heart Study:
 - 9,167 children aged 5 to 17 years
 - Obese children:
 - 2.4 x more likely to have diastolic HTN
 - 4.5 x more likely to have systolic HTN

- Houston BP Study:
 - 2,460 children aged 12 to 16 years
 - Obese children: 3 x more likely to have HTN

What Happens To Children With (Pre-) Hypertension?

- National childhood BP Database (NIH)
 - 14% of adolescents with pre-hypertension developed hypertension after 2 years
 - Independent of weight gain, children with high BP tend to become adults with hypertension, i.e. blood pressure tracks with age
 - Bogalusa heart study: of those that developed hypertension:
 - 48% had elevated SBP in childhood
 - 41% had elevated DBP in childhood
- Hence the need for early intervention

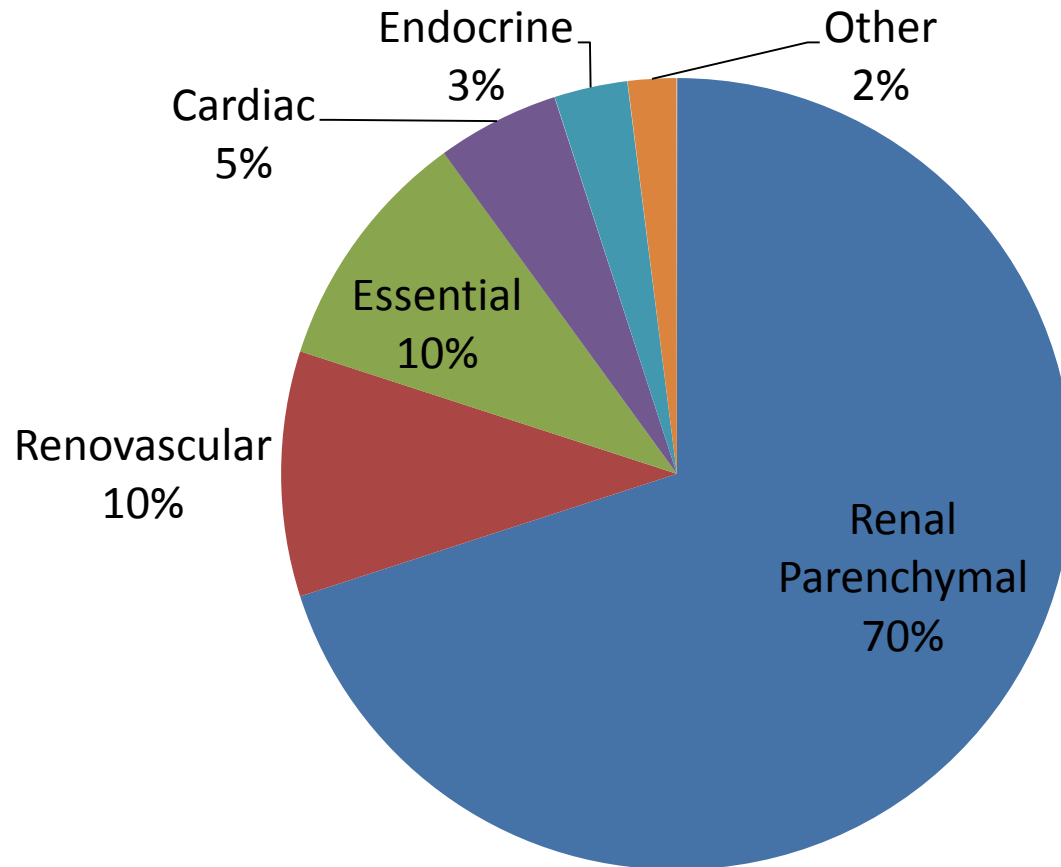
General Principles

- Identify children who are truly hypertensive
- Determine if there is a secondary cause of hypertension and if this cause is amenable to specific therapy
- Determine if pharmaceutical therapy is needed and what agent(s) should be used

Initial Evaluation

- An isolated measurement should be repeated at least once before being characterized as hypertensive
- Symptomatic or acutely ill children should be immediately evaluated and treated
- ***Remember, the younger the child and the higher the blood pressure, the greater the likelihood of secondary hypertension***

Hypertension by Etiology in Children



Hypertension: Secondary Causes

- Renal
 - Any cause of acute or chronic glomerulonephritis
 - FSGS
 - Interstitial nephritis
 - Thrombotic microangiopathy
 - AKI
 - CKD
 - Obstructive uropathy
 - Reflux nephropathy
 - CAKUT
 - Inherited disorders: ADPKD, ARPKD, Alport

Hypertension: Secondary Causes

- Vascular
 - Renal artery stenosis or thrombosis
 - RVT
 - Coarctation of the aorta
 - William's syndrome
 - Vasculitis
- Ingestions
 - Prescription medications (can you give examples?)
 - Illicit drugs (what?)
 - Herbal therapies (example?)

Illicit Drugs: Example

■ Cocaine

- 8% high school seniors report using cocaine at some point in their lifetime
 - stimulates central and peripheral α -adrenergic receptors
 - Inhibits catecholamine reuptake
 - Inhibits NO synthesis
- Marked vasoconstriction and hypertension.
- In urine for 3-5 days
- Use α -blockers (phentolamine, prazosin). Can also use Na nitroprusside/nicardipine
- **AVOID β blockers** → cause unopposed α -activity → worsening hypertension!

Question

Which of the following should be avoided in the treatment of stimulant-induced (used for Rx of ADHD) hypertension?

- a) Calcium channel blocker
- b) B blocker
- c) Thiazide diuretic
- d) ACE-inhibitor

Hypertension: Secondary Causes

- Endocrine and tumors
 - Neuroblastoma, Wilms, pheochromocytoma, hyperthyroidism, CAH, mineralocorticoid excess
- Genetic syndromes & inherited disorders
 - Williams, tuberous sclerosis, neurofibromatosis, mineralocorticoid excess, glucocorticoid remediable hypertension, Liddle syndrome
- Other
 - Trauma, pain, raised ICP, certain surgical procedures, immobilization, hypercalcemia

Diagnostic Evaluation of the Hypertensive Child

- Goals
 - Elicit signs and symptoms due to high BP
 - Is there an underlying disorder causing secondary hypertension?
 - E.g. renal disease (gross hematuria, proteinuria, edema), etc...

Diagnostic Evaluation of the Hypertensive Child

History

- Birth History: prematurity, ventilation, umbilical lines
- Illnesses: UTIs, fevers, changes in appearance of urine
- Family History: HTN, MI, renal disease
- Drugs: over the counter (decongestants), prescribed (OCPs, stimulants), illicit
- ROS: headaches, palpitations, flushing, diaphoresis, sweating, chest pain, weakness

Diagnostic Evaluation of the Hypertensive Child

Physical Examination

- Growth curve, BMI
- Unifying syndrome (Cushing, Williams, Turner, etc.)
- Four extremity BPs, HR
- Focused exam
 - Tonsillar hypertrophy
 - Skin manifestations (adenoma sebaceum, café-au-lait spots, malar rash, acne, striae)
 - Abdominal masses and bruits, renomegaly
 - Retinal changes
 - Aberrant sexual characteristics
 - Pulses

Lab Evaluation: Baseline Screening

- Microscopic urinalysis -- fresh void
- Electrolytes
- Creatinine, BUN
- CBC
- Renal ultrasound with Dopplers
- Tailor follow up studies based on history, examination and clinical suspicion: TSH, angiography, catecholamines, renin, aldosterone

Evaluation: Baseline Screening

- 24 or 48 hour ambulatory blood pressure monitoring, esp. in those in whom you suspect “white coat hypertension”
- Echocardiogram in all patients with confirmed hypertension
 - Coarctation
 - Evaluate for left ventricular hypertrophy (LVMI), i.e. end organ damage
 - LV function

Isolated Systolic Hypertension

- In adults, systolic BP is more predictive of cardiovascular morbidity and mortality
- Unclear if high BP enhances atherosclerosis or if it reflects changes in blood vessel walls
- In children, no epidemiologic data supports greater association of morbid vascular events with systolic BP

Outcomes: Cardiac Sequelae

- Currently no longitudinal data correlating childhood hypertension with cardiovascular morbidity in adulthood
- Prevalence of LVH by echo in hypertensive children:
 - 25 to 70% across several studies
- More closely associated with elevated systolic than diastolic pressures

Outcomes: Cardiac Sequelae

Sorof, 2002

- Echo evaluation of 37 hypertensive and 33 normotensive children
- LVH:
 - 30% of hypertensive group
 - 0% of normotensive group
- LV Mass Index:
 - most strongly correlated with extent of systolic hypertension

Outcomes: Cardiovascular

- Adolescents with essential hypertension:
 - Presence of obesity → increased prevalence of LVH

Daniels et al. Circulation. 1998.

- Carotid artery intimal medial thickness:
 - Increased in adults with multiple CV risk factors, including hypertension, during childhood
 - Increased in adolescents with hypertension

Outcomes

- Elevated blood pressure in childhood may adversely affect cognitive function
- Digital retinography: evidence of microvascular narrowing in children with BP in the highest quartile vs. those with lower BP

Mitchell et al. Hypertension. 2007.

- Microalbuminuria – no data in children

Lifestyle Modification

- Weight loss for obesity
 - ~10% decrease in BMI → 8-12 mmHg decrease in BP
- Maintenance of ideal body mass index
- Sodium restriction
 - Adequate Na intake
 - 4-8 yo: 1.2 g/day
 - Older: 1.5 g/day
 - Our recommendations in Hypertension Clinic: < 2 g/day (official recommendations for adults <2.3 g/day)

Lifestyle Modification

- DASH (Dietary Approach to Stop HTN)
 - Diet rich in fruits and vegetables, fiber
 - Low fat
 - Adequate intake of dietary K, Mg, and Ca
 - The diet reduced SBP by 6 mmHg and DBP by 3 mm Hg in patients with pre-hypertension
 - Those with hypertension dropped SBP by 11 and DBP by 6 mmHg
 - These changes in blood pressure occurred with no changes in body weight.

Lifestyle Modification

- Limit alcohol intake
- Smoking cessation
- Exercise – weight loss and cardiovascular benefits
- Yoga
- Meditation

Management

Asymptomatic, no evidence of secondary causes, no target organ sequelae

- Prehypertension: Check BP in 6 months
- Stage 1 hypertension: Recheck in 1 week
- Stage 2 hypertension: Pharmacologic Rx recommended
 - Our patient

Pharmacologic Therapy

- Choose an agent based on pathophysiology
- Begin with the lowest dose of an agent
- Titrate up to maximal dose as needed
- Aim for BP <90%ile for age and gender
- Add agents sequentially

Ace Inhibitor *or* Ca Channel Blocker *or* Beta Blocker



Titrate Single Agent to Desired Effect -- BP < 90%ile



If BP > 90%ile, Add a Diuretic



If BP > 90%ile, Add Agents Sequentially from Other Classes



If BP > 90%ile, Consider Minoxidil

Goals of Therapy

- BP < 90%ile for age, gender, and height
- Use lowest doses of least medications
- Use non-pharmacologic adjuncts
- Aim for fewest medication sequelae
- Aim for most patient compliance

Back to Our Patient

- Will you allow participation in sports?

Recommendations for Athletes

- NIH 26th Bethesda Conference looked at participation in athletics of children with hypertension
- Guidelines applied to children not on antihypertensive drugs and not acutely ill
- Stressed importance of reliable blood pressure techniques

Dynamic vs. Static Exercise

- Dynamic - intramuscular force not greatly increased; BP and MAP increases but dBP and tPR falls
- Static - large intramuscular forces but little change in muscle length or joint motion; sBP, MAP, dBP all rise significantly and tPR does not change

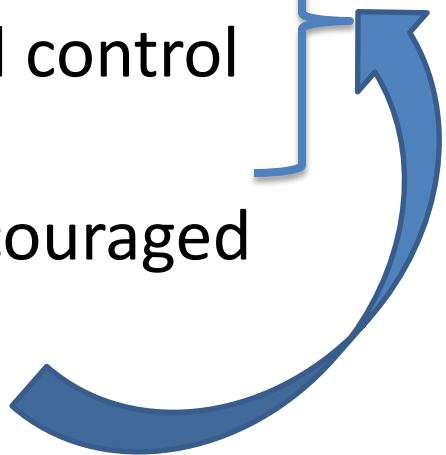
Sports with High Static Component

Low Dynamic	Moderate Dynamic	High Dynamic
Bobsledding	Body building	Boxing
Javelin / Discus	Downhill skiing	Kyaking
Gymnastics	Wrestling	Cycling
Karate / Judo		Decathlon
Luge		Rowing
Sailing		Speed skating
Rock climbing		
Water skiing		
Weight lifting		
Wind surfing		

AAP Recommendations

- Athletes with significant hypertension may compete as long as no target organ damage or heart disease
 - Office BP check needed for follow-up q 2 months
- With severe hypertension (uncontrolled stage 2), sports and highly static activities need to be restricted until BP becomes under good control
 - Cardiovascular conditioning may continue
- Healthy lifestyle choices need to be encouraged

Our patient



Summary

- Make sure that blood pressure is accurately measured
- Symptomatic hypertensive patients need prompt evaluation and treatment
- Younger patients are more likely to have a secondary cause for hypertension and always need a full work-up
- Use AAP guidelines to guide sports participation
- Become comfortable with and use a limited number of antihypertensives in different classes

Thanks!



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