HTN Guidelines & Implementation

KAAP Progress in Pediatrics
10/04/2018

Douglas L Blowey, MD
Children's Mercy Hospital – Kansas City, MO

Natalie Sollo, MD
KU School of Medicine - Wichita

Rishi Adhikari, MD
Wesley Healthcare - Wichita

Disclosure

- We have no relevant financial relationships with the manufacturer(s) of any commercial product(s) and/or provider of commercial services discussed in this CME activity
- *We* do not intend to discuss any unapproved or investigative use of a commercial product/device in our presentation.

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Educational Objectives

- Explain to families the importance of measuring blood pressure in children.
- Describe the key changes present in the new BP guidelines.
- Create strategies to incorporate the new HTN guidelines into your practice
- Develop an evaluation strategy for children with hypertension
- Identify the indication for and the value of specialized testing
- Construct a plan for non-pharmacologic and pharmacologic treatment of hypertension in children

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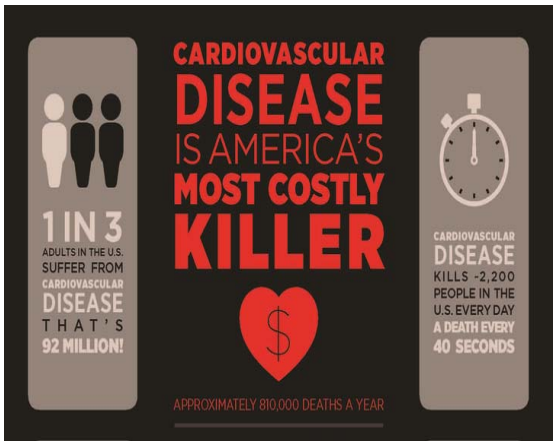
Clinical significance of high BP



Adverse outcomes

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Clinical significance of high BP - Children

Accelerated

vascular aging

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Onset of CV Disease begins in Childhood

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45-77% showed some gross evidence of coronary arteriosclerosis

JAMA 1953:152;1090
JAMA 1971:216;1185

PDAY

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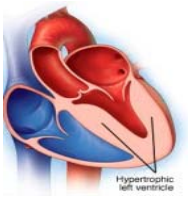
Indirect (surrogate) markers of CVD



Left Ventricular Hypertrophy (LVH)

Carotid Intima-media Thickness (CMIT)

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1 of 3

Children with HTN have LVH

Nephrol Dial Transplant 2009;24:370

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1 of 4

Children with HTN have ↑ cIMT

Pediatr 2003;111:61
Hypertension 2006;48:40

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Children with HTN have lower scores on neurocognitive tests

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J Pediatr 2003;143:720

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Children with HTN also have:

- Arterial stiffness
- Endothelial dysfunction
- Low-grade inflammation
- Diastolic dysfunction
- Renal changes

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J Clin Hypertens 2011;13 Pediatr Nephrol 2009:24 Neuroendocrinol Lett 2005:26

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CV Risk factors track from Childhood to adulthood

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Obesity →

Diabetes mellitus →

Hypertension →

Hyperlipidemia →

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J Pediatr 2001;138:469
Circulation 1978;58:626

Onset of CV Disease begins in Childhood

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Gaps/Issues

- Expanded breadth of new evidence
- Normative data biased
- BP table difficult to use in practice
- Incongruence with adult guidelines
- Emergence of ABPM

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CLINICAL PRACTICE GUIDELINE Guidance for the Clinician in Rendering Pediatric Care

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,[a] David C. Kaelber, MD, PhD, MPH, FAAP, FACP, FACMI,[b] Carissa M. Baker-Smith, MD, MS, MPH, FAAP, FAHA,[c] Douglas Blowey, MD,[d] Aaron E. Carroll, MD, MS, FAAP,[e] Stephen R. Daniels, MD, PhD, FAAP,[f] Sarah D. de Ferranti, MD, MPH, FAAP,[g] Janis M. Dionne, MD, FRCPC,[h] Bonita Falkner, MD,[i] Susan K. Flinn, MA,[j] Samuel S. Gidding, MD,[k] Celeste Goodwin,[l] Michael G. Leu, MD, MS, MHS, FAAP,[m] Makia E. Powers, MD, MPH, FAAP,[n] Corinna Rea, MD, MPH, FAAP,[o] Joshua Samuels, MD, MPH, FAAP,[p] Madeline Simasek, MD, MSCP, FAAP,[q] Vidhu V. Thaker, MD, FAAP,[r] Elaine M. Urbina, MD, MS, FAAP,[s] SUBCOMMITTEE ON SCREENING AND MANAGEMENT OF HIGH BLOOD PRESSURE IN CHILDREN

Pediatrics. 2017;140(3):e20171904

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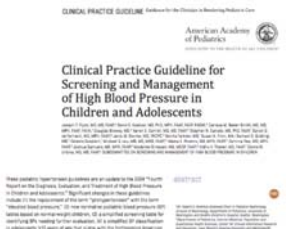
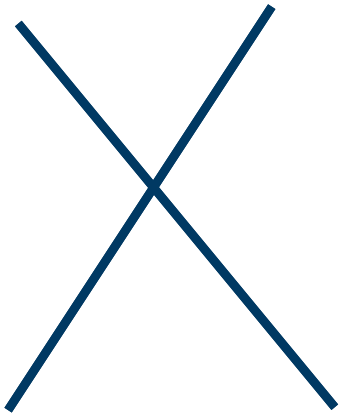
A big document!

- 8 significant changes
- 30 key action statements
- 27 additional recommendations



Goals of the updated guideline

- Patient and family centered approach
- Reduce unnecessary and costly interventions
- Improve diagnoses and outcomes
- Support implementation
- Provide direction for future research



Revised Definitions

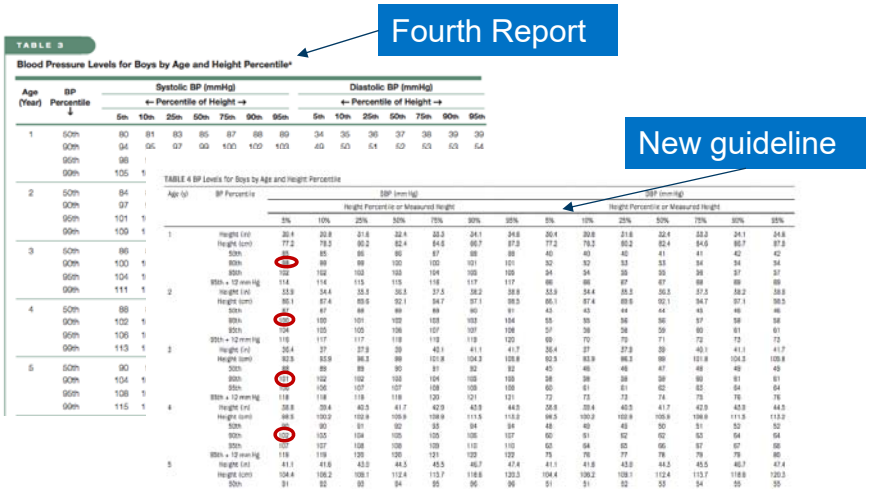
Adult values used now for teens

	For Children Aged 1–13 y	For Children Aged ≥13 y
	Normal BP: <90th percentile	Normal BP: <120/<80 mm Hg
Previously called prehypertension	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 mm Hg (whichever is lower)	Stage 1 HTN: 130/80 to 139/89 mm Hg
Changed from +5 to +12	Stage 2 HTN: ≥95th percentile + 12 mm Hg, or ≥140/90 mm Hg (whichever is lower)	Stage 2 HTN: ≥140/90 mm Hg

New Blood Pressure Tables

- Based on normal weight children only
- Cutoffs are lower than in the Fourth Report tables
- Complete tables include the actual heights, and have the cutoffs for the actual categories

New BP tables

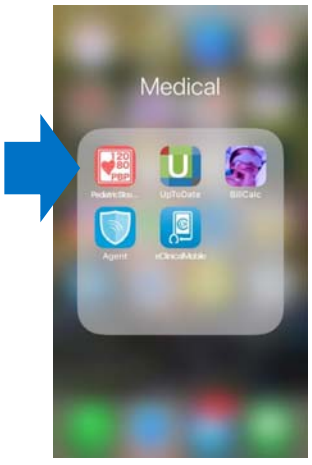


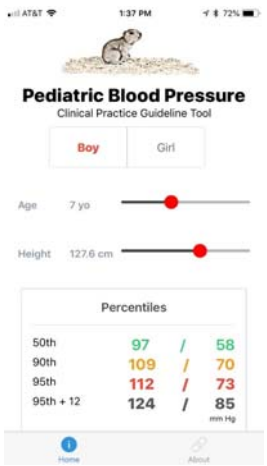
Screening BP Values

Screening table is based off the 90th percentile for BP and the 5th percentile for height

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

Apps





When to measure BP

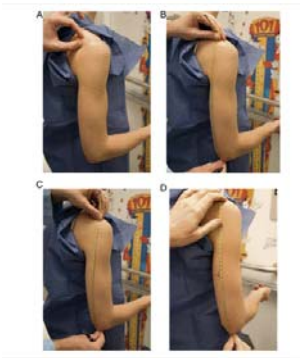
- Annually ages 3 and up
- From birth, every visit, for high risk patients
  - Obese
  - Kidney disease, urologic malformations, FH of renal disease
  - Coarctation, Congenital Heart Disease, repaired or not
  - Diabetes
  - Prematurity <32 weeks, SGA, VLBW, history of umbilical lines
  - Recurrent UTIs, hematuria, proteinuria
  - Malignancy, solid organ transplant, bone marrow transplant
  - On medications associated with increased BP
  - Systemic disease associated with increased BP

Measurement methods

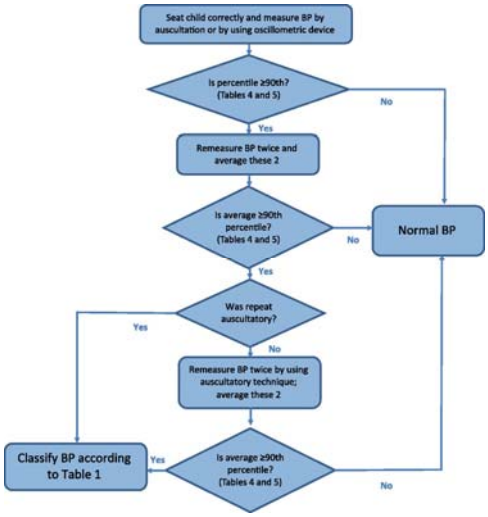
- Manual vs. Oscillometric
- Forearm or wrist- not recommended
- Ambulatory blood pressure monitoring
  - White coat hypertension
  - Masked hypertension
- Home monitoring

Measurement best practices

- Child should be seated for 3-5 minutes in a quiet room, back supported, feet uncrossed on the floor.
- Right arm (unless unusual aortic anatomy)
- At heart level, supported, uncovered above the cuff
- Correct cuff size- bladder length 80-100% of the circumference, width at least 40%
- For leg measurements, patient should be prone, cuff at mid-thigh, auscultation over popliteal artery.



Modified BP measurement algorithm.



Joseph T. Flynn et al. Pediatrics doi:10.1542/peds.2017-1904

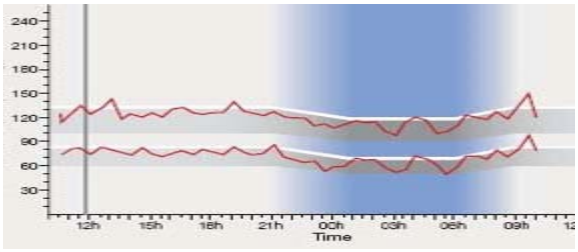
PEDIATRICS

Blood pressure follow up

Stage	Next steps	Recheck	
Normal	Recheck annually		
Elevated	Lifestyle changes	Recheck in 6 months	If still high after 12 months, ABPM
Stage 1	Lifestyle changes	Recheck in 1-2 wks, and if still high, recheck in 3 months	If still high after 3 visits, ABPM, evaluation, referral, and treatment
Stage 2	Lifestyle changes	Recheck or refer in 1 week	If persistent, treat. If symptomatic, or >30% above 95th, or >180/120, send to ED for immediate care

Ambulatory blood pressure monitoring (ABPM)

ABPM is a noninvasive way of obtaining BP over a 24-hour period while the patient is in their own environment, representing a true reflection of their blood pressure.



- Useful tool to assess BP pattern
- Not required to make diagnosis of HTN
- Patient required to get ABPM followed by specialists.

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Evaluation

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Evaluation

- Etiology
- Associated comorbidity
- Effect of HTN : Target organ damage
- For monitoring the effects of treatment/ intervention

Primary vs secondary HTN

- Primary
- Secondary:
  - Renal or renovascular
  - Cardiac: COA and arch anomaly
  - Endocrine
  - Environmental
  - medication

Evaluation

- History
- Physical examination
- Lab evaluation
- ~~EKG~~
- Echocardiogram
- Imaging for renovascular disease
- Vascular structure and function

History

- Perinatal History
- Nutritional history
- Physical activity history
- Psychosocial history
- Family history

Evaluation: History

- KAS 13:
  - *In children and adolescents being evaluated for high BP, the provider should obtain a perinatal history, appropriate nutritional history, physical activity history, psychosocial history, and family history and perform a physical examination to identify findings suggestive of secondary causes of HTN (grade B, strong recommendation).*

History and PE

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[a]	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
	Truncal obesity	Insulin resistance syndrome
Head, neck	Elfin facies	Williams syndrome
	Moon facies	Cushing syndrome
	Thyromegaly, goiter	Hyperthyroidism
	Webbed neck	Turner syndrome
Skin	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
Hematologic	Pallor	Renal disease
	Sickle cell anemia	

History and PE

Table 2 (continued)

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
	Epigastric, flank bruit	RAS
	Palpable kidneys	Polycystic kidney disease
		Hydronephrosis
		Multicystic dysplastic kidney
Genitourinary	Ambiguous or virilized genitalia	Congenital adrenal hyperplasia
	Urinary tract infection	Renal disease
	Vesicoureteral reflux	
	Hematuria, edema, fatigue	
	Abdominal trauma	
Extremities	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)

Labs and imaging

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Who needs extensive evaluation?

- KAS 11:
  - Children and adolescents ≥6 years 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 (grade C, moderate recommendation).

TABLE 10 Screening Tests and Relevant Populations

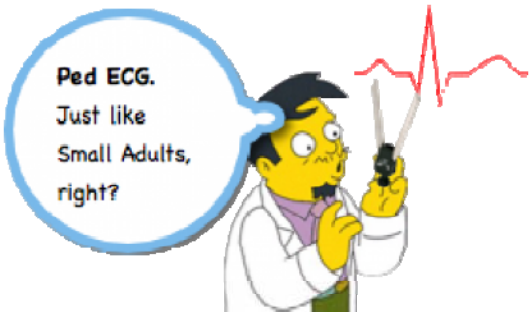
Patient Population	Screening Tests
All patients	Urinalysis Chemistry panel, including electrolytes, blood urea nitrogen, and creatinine Lipid profile (fasting or nonfasting to include high-density lipoproteina and total cholesterol) Renal ultrasonography in those <6 y of age or those with abnormal urinalysis 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.

Cardiac specific evaluation

- For etiology: COA, re-COA
- Evaluation of target organ damage
- Monitoring of the effects of treatment/ intervention

How about EKG



When to do EKG

- *KAS 19*
  - *Clinicians should not perform electrocardiography (ECG) in hypertensive children and adolescents being evaluated for LVH.*

Echocardiogram

- **KAS 15:**
- *It is recommended that echocardiography be performed to assess for cardiac target organ damage (LV mass, geometry, and function) at the time of consideration of pharmacologic treatment of HTN;*
- *LVH should be defined **as LV mass >51 g/m2.7 (boys and girls)** for children and adolescents older than 8 years and defined **by LV mass >115 g/BSA for boys and LV mass >95 g/BSA for girls;***
- ***Repeat echocardiography** may be performed to monitor **improvement or progression of target organ damage at 6- to 12-month** intervals. Indications to repeat echocardiography include persistent HTN despite treatment, concentric LV hypertrophy, or reduced LV ejection fraction; and*
- ***In patients without LV target organ injury at initial echocardiographic assessment**, repeat **echocardiography at yearly intervals may be considered** in those with stage 2 HTN, secondary HTN, or chronic stage 1 HTN incompletely treated (noncompliance or drug resistance) to assess for the development of worsening LV target organ injury (grade C, moderate recommendation).*

Echocardiogram:

- LVH is defined as left ventricular mass, indexed **>51 g/m2.7 or LVM >115 g/body surface area (BSA) for boys and LVM >95 g/BSA for girls**. An LV RWT >0.42 indicates concentric geometry. LV wall thickness >1.4 cm is abnormal.
- Decreased LV EF is a value <53%

Coarctation of Aorta

- HTN
- BP gradient (UL to LL)
- RF delay
- Systolic murmur interscapular region
- Ejection click (? BAV and associated COA)
- Suspicion of genetic condition conditions such as Turners, Williams
- Abdominal COA: neurofibromatosis, Williams syndrome, Alagille syndrome, or Takayasu arteritis.

Coarctation of Aorta repair: BP monitoring

- KAS 12:
  - Children and adolescents who have undergone coarctation repair should undergo ABPM for the detection of HTN (including MH) (grade B, strong recommendation).

Renal and renovascular imaging:

- ***KAS 16.***
  - *Doppler renal ultrasonography may be used as a noninvasive screening study for the evaluation of possible RAS in normal weight children and adolescents ≥8 years of age who are suspected of having renovascular HTN and who will cooperate with the procedure (grade C, moderate recommendation).*

- ***KAS: 17***
  - *In children and adolescents suspected of having RAS, either CTA or MRA may be performed as a noninvasive imaging study. Nuclear renography is less useful in pediatrics and should generally be avoided (grade D, weak recommendation).*

HTN and Athletes

HTN and Athletes

"I would be a lot healthier if you'd stop finding things wrong with me!"

HTN and Athletes

- Sports participation should be encouraged
- Exercise has beneficial effects in HTN and cardiac structure
- No data linking the HTN to sudden death related to sports in children
- BUT; many cases of sudden death are unknown etiology

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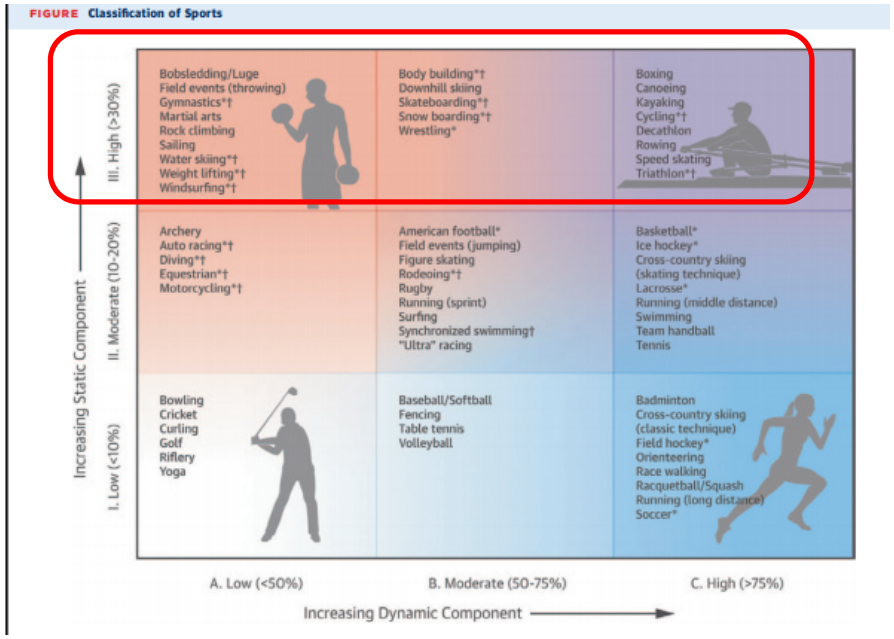

AHA/ACC

- ***limit competitive athletic participation among athletes with LVH*** *beyond that seen with athlete's heart until BP is normalized by appropriate antihypertensive drug therapy,*

- ***restricting athletes with stage 2 HTN*** *(even among those without evidence of target organ injury)* ***from*** *participating in* ***high-static*** *sports (eg, weight lifting, boxing, and wrestling)* ***until HTN is controlled*** *with either lifestyle modification or drug therapy.*

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HTN and Athletes

- KAS28:
  - Children and adolescents with HTN may participate in competitive sports once hypertensive target organ effects and risk have been assessed (grade C, moderate recommendation).
- KAS 29:
  - Children and adolescents with HTN should receive treatment to lower BP below stage 2 thresholds before participating in competitive sports (grade C, weak recommendation).

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Treatment

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Who?

Any child with an abnormal blood pressure

>90th %'tile

>120/80 mmHg

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Why?

Prevention of pediatric morbidity associated with hypertension

Prevention of adult onset cardiovascular disease

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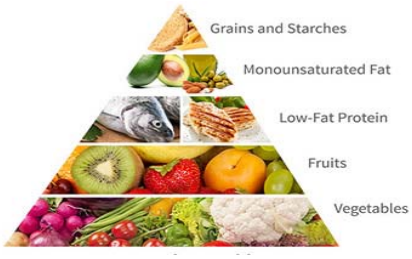
KAS 20

lifestyle



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Who needs medication?

- Persistent Stage 1 HTN after 6-12 months of lifestyle modifications
- Symptomatic HTN
- Stage 2 HTN without a clear modifiable risk factor
- HTN with CKD or DM

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KAS 14:

Treatment goals

In children and adolescents diagnosed with HTN, the treatment goal with nonpharmacologic and pharmacologic therapy should be a reduction in SBP and DBP to < 90th percentile and < 130/80 mmHg in adolescents ≥ 13 years old.

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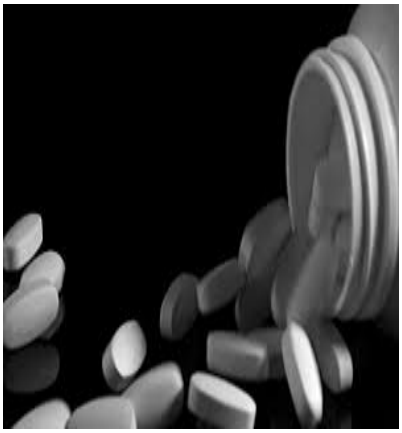
KAS 21



- Angiotension Converting Enzyme (ACE) inhibiotor
- Angiotension Receptor Blocker (ARB)
- Long-acting Calcium channel blocker
- Thiazide diuretic

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Drug treatment considerations

- ACE/ARB – may not be as effective in African Americans
- ACE/ARB – preferred in CKD and DM
- ACE/ARB – associated with fetal toxicity

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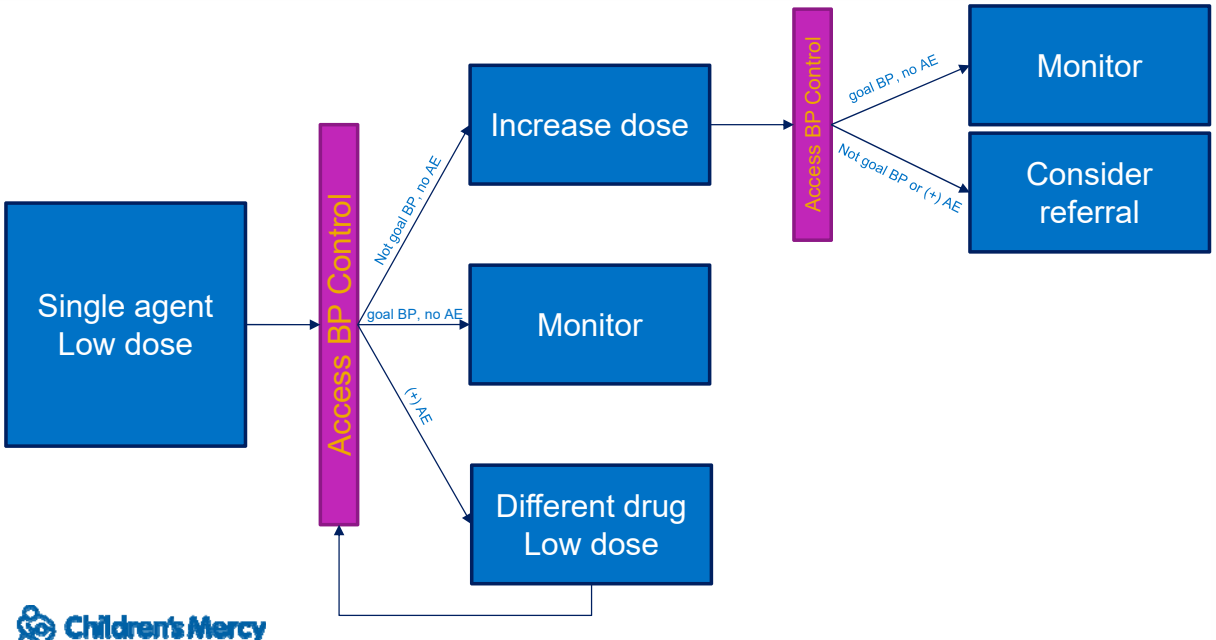

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Angiotensin converting enzyme inhibitor

Contraindications	Pregnancy, angioedema
Common AE's	Cough, headache, dizziness, asthenia
Severe AE's	Hyperkalemia, acute kidney injury, angioedema, fetal toxicity
Drugs	**Benazepril***, Captopril, **Enalapril***, **Fosinopril***, **Lisinopril***, Ramipril, Quinapril

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* FDA Pediatric Labeling

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Angiotensin receptor blocker

Contraindications	Pregnancy
Common AE's	headache, dizziness
Severe AE's	Hyperkalemia, acute kidney injury, fetal toxicity
Drugs	**Candesartan*,** Irbesartan, **Losartan*, Olmesartan*, Valsartan***

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* FDA Pediatric Labeling

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Thiazide diuretics

Contraindications	anuria
Common AE's	dizziness, hypokalemia
Severe AE's	Cardiac dysrhythmias, cholesterics jaundice, new onset diabetes mellitus, pancreatitis
Drugs	Chlorthalidone, **Chlorothiazide*, Hydrochlorothiazide***

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* FDA Pediatric Labeling

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Long-acting calcium channel blockers

Contraindications	Hypersensitivity to CCB's
Common AE's	Flushing, peripheral edema, dizziness
Severe AE's	angioedema
Drugs	**Amlodipine*,** Felodipine, Isradipine (ER), Nifedipine (ER)

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* FDA Pediatric Labeling

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Summary

- CV disease begins in childhood
- All children with elevated BP should be “treated”
- HTN is defined as BP >95th %’tile or 130/80 mmHg
- Most children do not have an identifiable cause of HTN but an identifiable cause is more likely in children < 6 years of age or those with severe HTN
- An extensive evaluation is not needed for most children with HTN
- Treatment options include lifestyle modifications (all) and antihypertensive medications (ACE, ARB, Thiazide, CCB)

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General information

https://kidshealth.org/ChildrensMercy/en/#catfitness

DASH diet resource

https://www.nhlbi.nih.gov/files/docs/public/heart/dash_brief.pdf

AAP HTN Guideline

http://pediatrics.aappublications.org/content/early/2017/08/21/peds.2017-1904

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Key References

- Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents. Joseph T. Flynn, David C. Kaelber, Carissa M. Baker-Smith, Douglas Blowey, Aaron E. Carroll, Stephen R. Daniels, Sarah D. de Ferranti, Janis M. Dionne, BonitaFalkner, Susan K. Flinn, Samuel S. Gidding, Celeste Goodwin, Michael G. Leu, Makia E. Powers, Corinna Rea, Joshua Samuels, Madeline Simasek, Vidhu V.Thaker, Elaine M. Urbina, SUBCOMMITTEE ON SCREENING AND MANAGEMENT OF HIGH BLOOD PRESSURE IN CHILDREN. Pediatrics Aug 2017, e20171904; **DOI:** 10.1542/peds.2017-1904; https://www.nhlbi.nih.gov/files/docs/resources/heart/hbp_ped.pdf
- Ben D Levine, Aaron L Baggish, et al. Eligibility and Disqualification recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 1: Classification of Sports: Dynamic, Static, and Impact: A Scientific Statement From the American Heart Association and American College of Cardiology. *Circulation.* 2015;132
- Henry R Black, Domenic Sica, et al. Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 6: Hypertension. A Scientific Statement from the American Heart Association and the American College of Cardiology. *Circulation.* 2015;132

Thank You

Questions?

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