#### **Arizona Chapter**

INCORPORATED IN ARIZONA





Sheena Sharma, MD





#### I have no financial disclosures or other conflicts of interest to report



## Today's Agenda:

- 1. Epidemiology
- 2. Defining Hypertension
- 3. Measuring Blood Pressure Accurately
- 4. Diagnosis
- 5. Patient Management
- 6. Primary vs. Secondary Hypertension



#### **PEDIATRICS**°

Sι

Volume 140, Issue 3 September 2017



< Previous Article Next Article >

FROM THE AMERICAN ACADEMY OF PEDIATRICS | CLINICAL PRACTICE GUIDELINE | SEPTEMBER 01 2017

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

Joseph T. Flynn, MD 록; David C. Kaelber, MD; Carissa M. Baker-Smith, MD; Douglas Blowey, MD; Aaron E. Carroll, MD; Stephen R. Daniels, MD; Sarah D. de Ferranti, MD; Janis M. Dionne, MD; Bonita Falkner, MD; Susan K. Flinn, MA; Samuel S. Gidding, MD; Celeste Goodwin; Michael G. Leu, MD; Makia E. Powers, MD; Corinna Rea, MD; Joshua Samuels, MD; Madeline Simasek, MD; Vidhu V. Thaker, MD; Elaine M. Urbina, MD;

SUBCOMMITTEE ON SCREENING AND MANAGEMENT OF HIGH BLOOD PRESSURE IN CHILDREN

Address correspondence to Joseph T Flynn. Email: joseph.flynn@seattlechildrens.org

**POTENTIAL CONFLICT OF INTEREST:** The authors have indicated that they have no potential conflicts of interest to disclose.

FINANCIAL DISCLOSURE: The authors have indicated that they have no financial relationships relevant to this article to disclose.

Pediatrics (2017) 140 (3): e20171904.

#### **Arizona Chapter**

INCORPORATED IN ARIZONA





INCORPORATED IN ARIZONA

American Academy of Pediatrics

#### Last Patient of Your Day....

5-year-old African American male was sent to your ER by his Pediatrician who recorded a blood pressure of 155/95mmHg in his clinic when the child presented for a routine physical examination.

PMHx: Frequent episodes of otitis media PSHx: Tonsillectomy and adenoidectomy 6 months ago FHx: Mother and father both have hypertension and type 2 diabetes mellitus Allergies: None Medications: None



#### American Academy of Pediatrics

#### Last Patient of your Day....

What is (are) the next best step(s) in the management of this patient?

- 1. Repeat the blood pressure manually
- 2. Determine if the patient is symptomatic
- 3. Order an oral antihypertensive medication while an IV is being placed
- 4. Order a renal ultrasound, EKG, BMP, and CBC

#### **Arizona Chapter**

INCORPORATED IN ARIZONA

American Academy of Pediatrics

## Part 1: Epidemiology

## iatrics

## Prevalence of Hypertension

- Prevalence of hypertension in children and adolescents is ~3.5%
- Prevalence of persistently elevated blood pressure (BP) (previously defined as "prehypertension" is ~2.2%-3.5% with higher rates among those overweight and obese
- Demonstrated relationship between higher BP in childhood correlating with higher BP in adulthood and onset of hypertension in young adulthood



#### • Obesity:

- Hypertension prevalence ranges from 3.8-24.8% in youth with overweight and obesity
- Up to 50% of children with obesity do not have the expected nocturnal BP dip
- Childhood obesity is associated with higher future BP, even as early as infancy



https://www.verywellhealth.com/childhood-obesity-overview-4014273



- Sleep disordered breathing:
  - Includes primary snoring, sleep fragmentation, and obstructive sleep apnea syndrome
  - Children who sleep less than 7 hours/night or have more severe obstructive sleep apnea syndrome are more likely to have hypertension



OIP.fCeU3iEE6UpJ5OK-LRnXlQHaFk (474×356)



- Chronic Kidney Disease:
  - ~50% of children and adolescents with chronic kidney disease have hypertension
  - 48-79% of those with end-stage renal disease have hypertension, with 20-70% having uncontrolled hypertension
  - Almost 20% of pediatric hypertension may be due to chronic kidney disease



- Prematurity:
  - Low birth weight and preterm birth are risk factors for hypertension in children
  - Further studies are needed



https://www.nbcnews.com/health/health-news/premature-births-timehigh-us-march-dimes-report-finds-rcna57451





INCORPORATED IN ARIZONA

American Academy of Pediatrics

# Part 2: Defining Hypertension

## **Blood** Pressure Stages

Updated Definitions of BP Categories and Stages

For Children Aged 1-<13 y	For Children Aged ≥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 mm Hg (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

Pediatrics (2017) 140 (3): e20171904. https://doi.org/10.1542/peds.2017-1904



## **Blood Pressure Tables**

#### BP Levels for Boys by Age and Height Percentile

Age (y)	BP Percentile	SBP (mm Hg)				DBP (mm Hg)						
		Height	Height Percentile or Measured Height					Height Percentile or Measur				
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50
1	Height (in)	30.4	30.8	31.6	32.4	33.3	34.1	34.6	30.4	30.8	31.6	32
	Height (cm)	77.2	78.3	80.2	82.4	84.6	86.7	87.9	77.2	78.3	80.2	82
	50th	85	85	86	86	87	88	88	40	40	40	41
	90th	98	99	99	100	100	101	101	52	52	53	53
	95th	102	102	103	103	104	105	105	54	54	55	55
	95th + 12 mm Hg	114	114	115	115	116	117	117	66	66	67	67

Pediatrics (2017) 140 (3): e20171904. https://doi.org/10.1542/peds.2017-1904



American Academy of Pediatrics dedicated to the health of all children\*

## Screening BP Table

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

Based on the 90% BP for age and sex for children at the 5% of height = negative predictive value of >99%

Should be used as a screening tool only to identify children and adolescents who need further evaluation

Should not be used to diagnose elevated BP or hypertension

Pediatrics (2017) 140 (3): e20171904. https://doi.org/10.1542/peds.2017-1904



INCORPORATED IN ARIZONA

American Academy of Pediatrics

Part 3: Measuring Blood Pressure Accurately

## **BP** Variability

- BP can be affected by anxiety, activity, caffeine intake, medications, etc
- One study showed that only 56% of adolescents had the same hypertension stage on 3 different occasions

Multiple measurements over time are needed!



#### Blood Pressure Measurement Technique

#### Best BP Measurement Practices

1. The child should be seated in a quiet room for 3–5 min before measurement, with the back supported and feet uncrossed on the floor.

2. BP should be measured in the right arm for consistency, for comparison with standard tables, and to avoid a falsely low reading from the left arm in the case of coarctation of the aorta. The arm should be at heart level, <u>90</u> supported, and uncovered above the cuff. The patient and observer should not speak while the measurement is being taken.

3. The correct cuff size should be used. The bladder length should be 80%-100% of the circumference of the arm, and the width should be at least 40%.

4. For an auscultatory BP, the bell of the stethoscope should be placed over the brachial artery in the antecubital fossa, and the lower end of the cuff should be 2–3 cm above the antecubital fossa. The cuff should be inflated to 20–30 mm Hg above the point at which the radial pulse disappears. Overinflation should be avoided. The cuff should be deflated at a rate of 2–3 mm Hg per second. The first (phase I Korotkoff) and last (phase V Korotkoff) audible sounds should be taken as SBP and DBP. If the Korotkoff sounds are heard to 0 mm Hg, the point at which the sound is muffled (phase IV Korotkoff) should be taken as the DBP, or the measurement repeated with less pressure applied over the brachial artery. The measurement should be read to the nearest 2 mm Hg.

5. To measure BP in the legs, the patient should be in the prone position, if possible. An appropriately sized cuff should be placed midthigh and the stethoscope placed over the popliteal artery. The SBP in the legs is usually 10%–20% higher than the brachial artery pressure.

Adapted from Pickering TG, Hall JE, Appel LJ, et al. Recommendations for blood pressure measurement in humans and experimental animals: part 1: blood pressure measurement in humans: a statement for professionals from the Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. *Circulation*. 2005;111(5):697–716.

#### Arizona Chapter

INCORPORATED IN ARIZONA

American Academy of Pediatrics dedicated to the health of all children\*

#### Which Cuff to Use?



http://www.aafp.org/afp/2006/0501/afp20060501p1558-f2.jpg

#### Arizona Chapter

INCORPORATED IN ARIZONA

American Academy of Pediatrics



INCORPORATED IN ARIZONA



#### Determination of proper BP cuff size

С





A, Marking spine extending from acromion process.B, Correct tape placement for upper arm length.C, Incorrect tape placement for upper arm length.D, Marking upper arm length midpoint.







INCORPORATED IN ARIZONA

American Academy of Pediatrics DEDICATED TO THE HEALTH OF ALL CHILDREN®

# **Part 4:**

Diagnosis

#### When Should BP Start Being Measured and How Often?

- Starting at age 3 and **annually** if otherwise healthy
- At every health encounter for those with obesity, renal disease, diabetes, aortic arch obstruction or coarctation,
  - or those taking medications known to increase BP
- Conditions under which children younger than 3 years should have BP measured:
  - History of prematurity <32 week's gestation or small for gestational age, very low birth weight, other neonatal complications
  - Congenital heart disease (repaired or unrepaired)
  - Recurrent urinary tract infections, hematuria, or proteinuria
  - Known renal disease or urologic malformations
  - Family history of congenital renal disease
  - Solid-organ transplant
  - Malignancy or bone marrow transplant
  - Treatment with drugs known to raise BP
  - Other systemic illnesses associated with hypertension (e.g. neurofibromatosis, sickle cell disease, etc)
  - Evidence of elevated intracranial pressure



#### **BP** Measurement Algorithm



Pediatrics (2017) 140 (3): e20171904. https://doi.org/10.1542/peds.2017-1904

#### Arizona Chapter

INCORPORATED IN ARIZONA



#### **Arizona Chapter**

INCORPORATED IN ARIZONA

American Academy of Pediatrics

# Part 5: Patient Management

trics

## What to do Next?

Normal BP	Elevated BP
Measure BP at next routine well- child care visit otherwise no additional action	Recommend lifestyle interventions (e.g. healthy diet, sleep, and physical activity) Repeat BP in 6 months by auscultation. Consider nutrition/weight management referral If BP is elevated after 6 months, upper and lower extremity BP should be checked (right arm, left arm, and 1 leg), repeat lifestyle counseling, and repeat again in 6 months by auscultation If BP remains elevated, then ABPM should be ordered, screening tests done, and consider referral to Cardiology or Nephrology
	Arizona Chapter

INCORPORATED IN ARIZONA

American Academy of Pediatrics

#### Arizona Chapter

INCORPORATED IN ARIZONA



Screening	Tests and	Relevant	Popu	lations
-----------	-----------	----------	------	---------

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	Hemoglobin A1c (accepted screen for diabetes)		
addition to the above	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		

Pediatrics (2017) 140 (3): e20171904. https://doi.org/10.1542/peds.2017-1904

## What to do Next?

#### Stage 1 Hypertension

If patient is asymptomatic, then provide lifestyle counseling and recheck BP in 1-2 weeks by auscultation

If BP remains at stage 1 level, check upper and lower extremity BP (right arm, left arm, and 1 leg), and BP should be checked in 3 months by auscultation. Consider nutrition/weight management referral

If BP remains at stage 1 level after 3 visits, ABPM should be ordered, diagnostic evaluation conducted, and treatment should be initiated. Consider subspeciality referral.



### What to do Next?

#### **Stage 2 Hypertension**

Upper and lower extremity BP should be checked (right arm, left arm, and 1 leg), lifestyle recommendations given, and BP measurement repeated within 1 week. Alternatively, the patient could be referred to subspecialty care within 1 week.

If the BP reading remains at stage 2 on repeat, then diagnostic evaluation including ABPM should be conducted and treatment initiated, or the patient should be referred to subspecialty care within 1 week

If the BP is at stage 2 and the patient is symptomatic, or the BP is >30mmHg above the 95<sup>th</sup> percentile (or >180/120mmHg in an adolescent), refer to immediate care such as the ER



## A Word on ABPM



OIP.T8F5R7WqOpHcyhGgPvpoCAAAAA (474×259)

Records BPs every 20-30 minutes throughout the day and night

ABPM is more accurate for the diagnosis of hypertension than clinic-measured BP, is more predictive of future BP, and can assist in the detection of secondary hypertension. Increased LVMI and LVH correlate more strongly with ABPM parameters than casual BP

Should be performed for the confirmation of hypertension in children and adolescents with office BP measurements in the elevated BP category for 1 year or more or with stage 1 hypertension over 3 clinic visits



## White Coat Hypertension

- BP <u>>95<sup>th</sup>%</u> in the office but <95<sup>th</sup>% outside of the clinical setting
- Up to half of children who are evaluative for elevated office BP have white coat hypertension
- Continue to obtain BPs yearly at well-child checks with consideration of repeating ABPM in 1-2 years



#### Patient Evaluation: History

### Perinatal History

## Nutritional History

### Physical Activity History

### Psychosocial History

#### Family History



## **Physical Examination**

## Look for possible secondary causes of hypertension but most often it is normal!



https://guideofgreece.com/



https://people.com/doctors-blamedwoman-rash-swelling-overweight-lupusexclusive-8347779

#### **Arizona Chapter**

INCORPORATED IN ARIZONA





https://www.slideshare.net/slideshow/hyp erthyroidism-and-the-safety-of-radioiodinein-children-57497442/57497442

## Echocardiography

A significant percentage of children and adolescents with hypertension demonstrate the degree of left ventricular hypertrophy(LVH) associated with adverse outcomes in adults



https://www.vrogue.co/post/left-ventricular-hypertrophy-chest-x-ray



#### Echocardiography Recommendations

- When to perform an echo:
  - At the time of consideration of pharmacologic treatment of hypertension
  - May repeat to monitor improvement or progression of target organ damage at 6–12-month intervals especially if there is persistent hypertension despite treatment, concentric LVH or reduced LV ejection fraction
  - May repeat at yearly intervals in those with stage 2 hypertension, secondary hypertension, or chronic stage 1 hypertension incompletely treated (noncompliance or drug resistance) to assess development or worsening LV damage





# Renal Imaging: Renal Ultrasound with Doppler

Renal ultrasound with doppler should be considered if renal artery stenosis is suspected (e.g. stage 2 hypertension, significant diastolic hypertension, hypertension with hypokalemia, or size discrepancy on standard ultrasound)



https://storage.googleap is.com/drvazaouzmskie/case-report-renal-artery-stenos is.html

#### Arizona Chapter

INCORPORATED IN ARIZONA



## Renal Imaging: CTA and MRA

- Either are acceptable as noninvasive imaging modalities but neither is a substitute for the gold standard, angiography
- CTA typically involves significant radiation exposure and MRA requires sedation



https://healthjade.net/renal-artery/



#### Treatment Goal

The treatment goal in diagnosed hypertension with nonpharmacologic and pharmacologic therapy is a reduction in SBP and DBP to <90<sup>th</sup>% or <130/80mmHg, whichever is lower







INCORPORATED IN ARIZONA



#### Nonpharmacologic Interventions: Diet

DASH Diet Recommendations

Food	Servings per Day
Fruits and vegetables	4-5
Low-fat milk products	≥2
Whole grains	6
Fish, poultry, and lean red meats	≤2
Legumes and nuts	1
Oils and fats	2-3
Added sugar and sweets (including sweetened beverages)	≤1
Dietary sodium	<2300 mg per d

Adapted from Barnes TL, Crandell JL, Bell RA, Mayer-Davis EJ, Dabelea D, Liese AD. Change in DASH diet score and cardiovascular risk factors in youth with type 1 and type 2 diabetes mellitus: the SEARCH for Diabetes in Youth study. *Nutr Diabetes*. 2013;3:e91; US Department of Health and Human Services, US Department of Agriculture. Appendix 7. Nutritional goals for age-sex groups based on dietary reference intakes and dietary guidelines recommendations. In: *2015-2020 Dietary Guidelines for Americans*. Washington, DC: US Department of Health and Human Services, US Department of Agriculture; 2015; and Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents; National Heart, Lung, and Blood Institute. Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents: Summary Report. *Pediatrics*. 2011;128 (suppl 5): S213–S256.

Nonpharmacologic Interventions: Physical Activity

> Moderate to vigorous physical activity at least 3-5 days per week (30-60 minutes per session)



INCORPORATED IN ARIZONA

American Academy of Pediatrics

## Pharmacologic Treatment

- When to initiate:
  - Children who remain hypertensive despite a trial of lifestyle modifications
  - Symptomatic hypertension
  - Stage 2 hypertension without a clearly modifiable factor (e.g. obesity)
  - Any stage of hypertension associated with CKD or diabetes mellitus
- How to initiate:
  - Start a single medication at the low end of the dosing range
  - Dose can be titrated every 2-4 weeks using home BP measurements, but have the patient seen in the office every 4-6 weeks until BP has normalized (<90<sup>th</sup>%)
  - If BP is not controlled with a single agent, then consider adding a thiazide
  - Follow-up should be every 3-4 months once BP goal has been achieved



## Which Agent to Choose?

- Can choose either an ACE inhibitor, ARB, long-acting calcium channel blocker, or thiazide diuretic
- Tips:
  - African Americans may need a higher initial dose of an ACE inhibitor or may respond better to a long-acting calcium channel blocker or diuretic
  - Beta-blockers are <u>not</u> recommended as initial treatment
  - Children with hypertension and CKD, proteinuria, or diabetes mellitus should be started on an ACE inhibitor or ARB unless there is a contraindication



## Hypertension and the Athlete

AAP policy statement "Athletic Participation by Children and Adolescents Who Have Systemic Hypertension" recommends that children with stage 2 HTN be restricted from high-static sports (classes IIIA to IIIC) in the absence of end organ damage, including LVH or concomitant heart disease, until their BP is in the normal range after lifestyle modification and/or drug therapy



## **Classification of Sports**



**Arizona Chapter** 

INCORPORATED IN ARIZONA

American Academy of Pediatrics DEDICATED TO THE HEALTH OF ALL CHILDREN®





INCORPORATED IN ARIZONA

American Academy of Pediatrics

## Part 6: Primary vs Secondary Hypertension

#### **Primary Hypertension**

#### Older age (≥6 years)

Positive Family History of Hypertension

#### Overweight and/or Obesity

More Likely to Have Systolic Hypertension

#### **Arizona Chapter**

INCORPORATED IN ARIZONA

American Academy of Pediatrics

## Secondary Hypertension

#### Renal and/or Renovascular Disease



Renal parenchymal disease can include any condition that affects the renal tissue (e.g. glomerulonephritis, diabetic nephropathy, reflux nephropathy, etc.)

#### Arizona Chapter

INCORPORATED IN ARIZONA

American Academy of Pediatrics



#### Secondary Hypertension: Cardiac, Including Coarctation of the Aorta

**Coarctation of the Aorta** 



Usually results in right arm BP that is 20mmHg or greater than lower extremity BP

Associated with Neurofibromatosis, Williams Syndrome, Alagille Syndrome or Takayasu Arteritis

Hypertension can reoccur after repair in 17-77% of patients

Recommendation is yearly ABPM starting at 12 years after repair at the latest

#### **Arizona Chapter**

INCORPORATED IN ARIZONA



RA. Right Atrium RV. Right Ventricle LA. Left Atrium LV. Left Ventricle SVC. Superior Vena Cava IVC. Inferior Vena Cava MPA. Main Pulmonary Artery Ao. Aorta TV. Tricuspid Valve MV. Mitral Valve PV. Pulmonary Valve AoV. Aortic Valve

https://www.ncbi.nlm.nih.gov/books/NBK430913/

# **Arizona Chapter**

INCORPORATED IN ARIZONA

American Academy of Pediatrics dedicated to the health of all children®

## Secondary Hypertension



# **Arizona Chapter**

INCORPORATED IN ARIZONA

American Academy of Pediatrics

## Secondary Hypertension



#### Secondary Hypertension: Neurofibromatosis



https://www.orthobullets.com/pediatrics /4054/neurofibromatosis



https://orthoinfo.aaos.org/en/diseases--conditions/neurofibromatosis

Many secondary causes of hypertension occur in NF-1:

- Renal artery stenosis
- Coarctation of the aorta
- Middle aortic syndrome
- Pheochromocytoma
- Idiopathic hypertension



#### Secondary Hypertension: Medication Related

Common Pharmacologic Agents Associated With Elevated BP in Children

Over-the-counter drugs	Decongestants	
	Caffeine	
	Nonsteroidal anti-inflammatory drugs	
	Alternative therapies, herbal and nutritional supplements	
Prescription drugs	Stimulants for attention-deficit/hyperactivity disorder	
	Hormonal contraception	
	Steroids	
	Tricyclic antidepressants	
Illicit drugs	Amphetamines	
	Cocaine	

Arizona Chapter INCORPORATED IN ARIZONA American Academy of Pediatrics DEDICATED TO THE HEALTH OF ALL CHILDREN\*

Pediatrics (2017) 140 (3): e20171904. https://doi.org/10.1542/peds.2017-1904



INCORPORATED IN ARIZONA

American Academy of Pediatrics

#### Last Patient of Your Day....

5-year-old African American male was sent to your ER by his Pediatrician who recorded a blood pressure of 155/95mmHg in his clinic when the child presented for a routine physical examination.

PMHx: Frequent episodes of otitis media PSHx: Tonsillectomy and adenoidectomy 6 months ago FHx: Mother and father both have hypertension and type 2 diabetes mellitus Allergies: None Medications: None



#### American Academy of Pediatrics

#### Last Patient of your Day....

What is (are) the next best step(s) in the management of this patient?

- 1. Repeat the blood pressure manually
- 2. Determine if the patient is symptomatic
- 3. Order an oral antihypertensive medication while an IV is being placed
- 4. Order a renal ultrasound, EKG, BMP, and CBC

# Thank you!

# **Questions?**

