Pediatric Hypertension: Never Too Early to Start

Peter Ziemkowski, MD, FAAFP

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The content of my material/presentation in this CME activity will include discussion of unapproved or investigational uses of products or devices as indicated: Some anti-HTN medications (ramipril, chlorthalidone,...) do not have Pediatric indications per the FDA, but are recommended as treatment by the American Academy of Pediatrics. My presentation will mention those drugs that are approved specifically, but also the concept of using adult studies to guide anti-hypertensive treatment in children.

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Dr. Ziemkowski is a graduate of the University of Illinois at Chicago and completed his family medicine residency at the Michigan State University Kalamazoo Center for Medical Studies. He practices family medicine in southwest Michigan, where he is on the faculty of the Western Michigan University Homer Stryker, MD, School of Medicine’s Family Medicine Residency Program and serves as associate dean for Student Affairs. He has been teaching for 20 years and maintains a blog for residents. Dr. Ziemkowski is board certified in family medicine, and he is also certified by the American Board of Preventive Medicine (ABPM) in clinical informatics. He seeks to use technology to help educate patients on healthy lifestyles. Other clinical interests include the care of metabolic conditions associated with cardiovascular risk, including hypertension, hyperlipidemia, diabetes, and obesity. He believes that primary prevention of these diseases and their complications will deliver the greatest benefit to the greatest number of patients.
Learning Objectives

1. Evaluate children with confirmed hypertension, and overweight children with prehypertension, for additional risk factors for comorbidities.

2. Develop an evidence-based treatment plan that encourages patient adherence to the prescribed therapy.

3. Recognize the tendency to and contribution of clinical inertia and adopt treatment algorithms that advance care appropriately in uncontrolled patients.

4. Counsel parents of children with prehypertension or hypertension to make therapeutic lifestyle changes to lower blood pressure.

Audience Engagement System

Step 1

Step 2

Step 3
2017 AAP Clinical Practice Guidelines

• Goals
  • Develop an updated, evidence-based guideline
    • Provide recommendations on diagnosis, evaluation, and management of childhood HTN.
    • Aimed at practicing clinicians seeing patients in the outpatient setting.

Poll Question 1

Out of all the following risk factors for primary hypertension in children, which is considered the strongest?

A. Low birth weight
B. Male sex
C. Elevated BMI
D. Ethnicity
E. Family history of hypertension

2017 AAP Clinical Practice Guidelines

• Rationale
  • Increase in childhood hypertension since 2004 “Fourth Report”
    • 3.5% of children with HTN.
    • 10%-11% with elevated blood pressure
      • Increase in prevalence due to obesity
  • High blood pressure in childhood increases risk for adult HTN and cardiovascular disease.
  • Youth with HTN demonstrate evidence of accelerated vascular aging.

4 Questions

1. How should systemic HTN (primary, renovascular, white-coat, masked) in children be diagnosed and what is the optimal approach?
2. What is the recommended workup for pediatric HTN?
   • How do we best identify the underlying etiology of secondary HTN in children?
3. What is the optimal goal SBP and/or DBP for children and adolescents?
4. In children 0 to 18 years of age, how does treatment with lifestyle vs. anti-HTN agents influence indirect measures of CVD risk?

% Age/Sex/height?

- Hypertension - basis:
  - Children: normative distribution in healthy children.
  - Adults: related to clinical outcome data.
- In general, be alert. Many online resources still reference the 2004 NHLBI report!
- Make sure the one you use is based on 2017 AAP Guideline

- Tables:

- Calculators:
  - Canadian Pediatric Endocrine Group: https://apps.cpeg-ccep.net/BPz_cpeg_dde/
  - (works well in mobile browser)

2017: Major changes from 2004 Report

- Strict Evidence-based approach
  - Reviewed 15,000 articles
- Replaced “prehypertension” with “elevated blood pressure”
- New normative tables based on children with normal weight
- Simplified screening table
- Simplified BP classification age ≥ 13 years
  - Aligned with AHA/ACC adult guideline
- Limited BP screening to preventative care visits
2017: Major changes from 2004 Report

- Streamlined evaluation and management recommendations
- Expanded role of 24-hour ambulatory BP
- Limited recommendation on echocardiography
  - Generally at medication initiation
- Revised LVH definition
- Revised treatment goals based on published evidence
  - Lower treatment goals for primary HTN
  - Ambulatory goal for Chronic Kidney Disease

Factors to consider

- Inherent variability
  - Only ~5% of adolescents had same BP on 3 separate visits.
- “Accommodation Effect”
  - Adjustment to the experience of having your BP measured.
- Higher BP in childhood correlates with higher BP in adulthood.
Epidemiology

• AAP 2017
  • Clinical setting/repeated BP measurement
  • Pediatric Hypertension = ~ 3.5% (2% - 5%)
    • (CDC estimates ~ 1.3 million age 12-19 y/o)
    • Missed up to 75% of pediatric patients in primary care setting
  • Persistently elevated BP (formerly prehypertension)
    • 2.2% to 3.5 %
      • (BP in 90th to 94th percentiles or 120/80 to 130/90 in adolescents)
      • Higher rates with those overweight or obese (3.8% to 24.8%)

Definition (2017 American Academy of Pediatrics)

• New normative tables based on normal-weight children
  • Excluded BMI ≥ 85th %
  • Based on auscultatory measurements of ~ 50,000 children and adolescents
  • SBP and DBP arranged by age, sex and height %
  • Provide actual heights in cm and inches directly in table
  • Organized in more simple format

• Practical Change:
  • Excluding overweight/obese -> values are several mmHg lower than previous guideline!

New BP Tables

• Fourth report tables generated from ~70,000 healthy children,
  • many overweight or obese!
  • Likely biased normative BP values upward
• New normative tables commissioned for this practice guideline
  • based on readings from ~50,000 normal-weight children.

Definition (2017 American Academy of Pediatrics)

• Definition of Hypertension (1-18 years)
  • Normal ≤ 50th percentile
  • Elevated BP > 90th percentile
    • no longer called prehypertension
  • Stage 1 HTN ≥ 95th percentile
  • Stage 2 HTN ≥ 95th percentile + 12 mmHG

New BP Tables

- Fourth report tables generated from ~70,000 healthy children,
  - many overweight or obese!
  - Likely biased normative BP values upward
- New normative tables commissioned for this practice guideline
  - based on readings from ~50,000 normal-weight children.

<table>
<thead>
<tr>
<th></th>
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<th>2017 CPG</th>
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<tr>
<td>HTN</td>
<td>8%</td>
<td>13%</td>
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<tr>
<td>Stage 1</td>
<td>6%</td>
<td>10%</td>
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<tr>
<td>Stage 2</td>
<td>2%</td>
<td>3%</td>
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</table>

Reclassification to a higher BP category was associated with increased odds of abnormal Target Organ Damage (TOD) and tended to have higher BMI & DBP.

FIGURE. Prevalence of elevated blood pressure (BP) and hypertension among youths, by new and former guidelines — United States, 2001–2016


<table>
<thead>
<tr>
<th>Height (in)</th>
<th>5th Percentile</th>
<th>10th Percentile</th>
<th>25th Percentile</th>
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<td>97.1</td>
<td>97.8</td>
<td>98.5</td>
<td>99.0</td>
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</table>
**Screening**

- **Simplified table**
  - 90th % BP for age and sex for children at 5th % for height
  - Negative predictive value of > 99%
  - Quick screening table for staff
  - Not for diagnosis!
    - Actual cutoff up to 9 mm Hg higher
    - > 120/80 for ≥ 13 y/o
      - to align with adult guideline

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**TABLE 6 Screening BP Values Requiring Further Evaluation**

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<thead>
<tr>
<th>Age, y</th>
<th>Boys</th>
<th>Girls</th>
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<tr>
<td></td>
<td>SBP, mm Hg</td>
<td>DBP, mm Hg</td>
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<td>98</td>
<td>52</td>
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<td>12</td>
<td>113</td>
<td>75</td>
</tr>
<tr>
<td>≥13</td>
<td>120</td>
<td>80</td>
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</table>
Measurement

- Initial BP at visit
  - Oscillometric or Auscultatory
  - Measured in right arm, relaxed/seated
    - Unless atypical aortic arch anatomy
    - Appropriate size cuff
  - If initial BP elevated (> 90th percentile)
    - take 2 additional measurements and average them
  - If auscultatory-> average determines BP category
  - If oscillatory AND average > 90th %
    - Take 2 auscultatory measurements and average to determine BP category

Measurement

- Begin routinely at 3 y/o
  - Measure annually in otherwise healthy children
    - not at each encounter as previously
  - Measure at every encounter in:
    - Obesity (BMI ≥ 95th percentile)
    - Renal disease
    - Diabetes
    - Aortic arch obstruction/coarctation
    - Taking medications known to increase BP
  - Measure in children < 3 y/o
    - At increased risk for developing HTN

- Key Action Statement 1.
  - BP should be measured annually in children and adolescents ≥3 years of age
    - (grade C, moderate recommendation).

- Key Action Statement 2.
  - BP should be checked in all children and adolescents ≥3 years of age at every health care encounter if they have obesity, are taking medications known to increase BP, have renal disease, a history of aortic arch obstruction or coarctation, or diabetes (see Table 9)
    - (grade C, moderate recommendation).
Repeating High Blood Pressure Measurements

- BP in childhood varies considerably:
  - Between visits &
  - During a single visit.
- Clinician should
  - Repeat high BP reading at the visit
  - Obtain multiple measurements over time before diagnosing HTN!

- Leg BP 10-20 mm Hg higher than corresponding arm
- Pharmacologic causes of Elevated BP
  - OTC: Decongestants, caffeine, NSAIDs, Herbal/Nutritional supplements
  - RX: stimulants for ADD/ADHD, Contraceptives, Steroids, TCAs
  - Illicit: Amphetamine, Cocaine

<table>
<thead>
<tr>
<th>BP Category</th>
<th>BP Screening Schedule</th>
<th>Lifestyle Counseling (Weight, Nutrition)</th>
<th>Check Upper and Lower Extremity BP</th>
<th>ABPM</th>
<th>Diagnostic Evaluation</th>
<th>Initiate Treatment</th>
<th>Consider Sub-specialty Referral</th>
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<tr>
<td>Normal</td>
<td>Annual</td>
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<td>Elevated BP</td>
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<td>X</td>
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<td>Repeat in 6 months</td>
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<td>Repeat in 1-2 weeks</td>
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<td></td>
<td>X</td>
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<td></td>
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<tr>
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<td>X</td>
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<td></td>
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<td>Repeat in 3 months</td>
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<td>X</td>
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<td>X</td>
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<td>Stage 2 HTN</td>
<td>Initial Measurement</td>
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<td>X</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Repeat/refer to specialty care within 2 week</td>
<td></td>
<td>X</td>
<td>X</td>
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<td>X</td>
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</table>

Management

• Normal BP:
  • If BP normal or normalizes after repeat readings (< 90th %)
    • No action needed
    • Measure BP at next routine well-child visit


Management

• Elevated BP (previously prehypertension)
  1. Initially
     • Recommend lifestyle interventions
       • Healthy diet, sleep, physical activity
       • Consider nutrition/weight management referral
     • Repeat BP by auscultation in 6 months
  2. Remains elevated after 6 months
     • Check upper and lower extremity BP (Right arm, left arm, 1 leg)
     • Repeat lifestyle counseling
     • Recheck in 6 months by auscultation

3. Remains elevated after 12 months
   • Order ambulatory (ABPM) if available
   • Conduct diagnostic evaluation
     • U/A, Chem profile (BMP), Lipids (fasting/non), Renal U/S < 6 y/o or with abnormal U/A or renal function
     • if Obese: A1c, AST/ALT, fasting Lipids
     • Optional: fasting glucose, TSH, drug screen, sleep study, CBC
   • Consider subspecialty referral
     • Nephrology/Cardiology

4. If BP normalizes at any point
   • Return to annual BP screening

Management

• Stage 1 HTN
  1. Initially— if asymptomatic
     • Recommend lifestyle interventions
       • Healthy diet, sleep, physical activity
       • Repeat BP by auscultation in 1-2 weeks
  2. Remains Stage 1 after 1-2 weeks
     • Check upper and lower extremity BP
       • Right arm, left arm, 1 leg
     • Repeat lifestyle counseling
       • Consider nutrition/weight management referral if appropriate
     • Recheck in 3 months by auscultation

3. Remains Stage 1 after 3 months
   • Order ambulatory (ABPM) if available
   • Conduct diagnostic evaluation
     • U/A, Chem profile (BMP), Lipids (fasting/non), Renal U/S < 6 y/o or with abnormal U/A or renal function
     • if Obese: A1c, AST/ALT, fasting Lipids
     • Optional: fasting glucose, TSH, drug screen, sleep study, CBC
   • Initiate treatment
     • Consider subspecialty referral
       • Nephrology/Cardiology


Management

• Stage 2 HTN
  1. Initially
     • Check upper and lower extremity BP
       • Right arm, left arm, 1 leg
     • Recommend lifestyle interventions
       • Healthy diet, sleep, physical activity
     • within 1 week
       • Repeat BP by auscultation -OR-
       • Consider subspecialty referral

2. Remains Stage 2 on recheck
   • Order ambulatory (ABPM) if available
   • Conduct diagnostic evaluation
     • U/A, Chem profile (BMP), Lipids (fasting/non), Renal U/S < 6 y/o or with abnormal U/A or renal function
     • if Obese: A1c, AST/ALT, fasting Lipids
     • Optional: fasting glucose, TSH, drug screen, sleep study, CBC
   • Initiate treatment –OR–
     • Refer to subspecialty care within 1 week

3. If Stage 2 and symptomatic
   OR BP > 30 mmHg above 95th %
   (OR > 180/120 in adolescent)
   • Referral to immediate care (ED)

• **Key Action Statement 3:**
  • Trained health care professionals in the office setting should make a diagnosis of HTN if a child or adolescent has auscultatory-confirmed BP readings ≥95th percentile on 3 different visits
    • (grade C, moderate recommendation).

• **Key Action Statement 4:**
  • Organizations with EHRs used in an office setting should consider including flags for abnormal BP values both when the values are being entered and when they are being viewed
    • (grade C, weak recommendation).


**BP Measurement**

- Auscultatory vs. Oscillometric
- Forearm and/or Wrist
- Ambulatory BP Measurement
- In Obese Children
- At-Home
- School-based

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<tr>
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<th>Office BP</th>
<th>Ambulatory BP</th>
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<td>Normal</td>
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</tr>
<tr>
<td>Sustained HTN</td>
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<tr>
<td>White Coat HTN</td>
<td>Elevated</td>
<td>Normal</td>
</tr>
<tr>
<td>Masked HTN</td>
<td>Normal</td>
<td>Elevated</td>
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</table>
Ambulatory Readings

Key Action Statement 5:
- Oscillometric devices may be used for BP screening in children and adolescents. When doing so, providers should use a device that has been validated in the pediatric age group. If elevated BP is suspected on the basis of oscillometric readings, confirmatory measurements should be obtained by auscultation
  - (grade B, strong recommendation).

Key Action Statement 6:
- ABPM should be performed for the confirmation of HTN in children and adolescents with office BP measurements in the elevated BP category for 1 year or more or with stage 1 HTN over 3 clinic visits
  - (grade C, moderate recommendation).


• Key Action Statement 7:
  • The routine performance of ABPM should be strongly considered in children and adolescents with high-risk conditions (see Table 12) to assess HTN severity and determine if abnormal circadian BP patterns are present, which may indicate increased risk for target organ damage
    • (grade B, moderate recommendation).


• Key Action Statement 8:
  • ABPM should be performed by using a standardized approach (see Table 13) with monitors that have been validated in a pediatric population, and studies should be interpreted by using pediatric normative data
    • (grade C, moderate recommendation).

• Key Action Statement 9:
  • Children and adolescents with suspected WCH should undergo ABPM. Diagnosis is based on the presence of mean SBP and DBP <95th percentile and SBP and DBP load <25%
    • (grade B, strong recommendation).


• Key Action Statement 10:
  • Home BP monitoring should not be used to diagnose HTN, MH, or WCH but may be a useful adjunct to office and ambulatory BP measurement after HTN has been diagnosed
    • (grade C, moderate recommendation).
Poll Question 2

A 10 year old female is found to have an elevated blood pressure when measured in their left arm, but normal when measured in their right. Which of the following studies would be most useful in determining the cause of this finding?

A. Blood for elevated cortisol levels
B. Urine drug screen
C. Echocardiogram
D. Polysomnography
E. Blood and urine for elevated catecholamine levels

Poll Question 3

A 16 year old male is found to have an elevated blood pressure c/w Stage 2 hypertension when measured in both left and right arm. On exam, he is noted to be tachycardic and have significant acne on his face and back, along with striae on his abdomen. This presentation is most consistent with which cause of secondary hypertension?

A. Hyperthyroidism
B. Pheochromocytoma
C. Obstructive sleep apnea
D. Drug-induced
E. Coarctation of the aorta
Primary and Secondary HTN

• Primary HTN **(most common)**
  - Older (≥ 6 y/o)
  - Family hx HTN (parent/grandparent)
  - Overweight/obese

• Secondary HTN
  - Renal and/or Renovascular
    - (34%-79% and ~12%)
  - Cardiac, including Aortic Coarctation
  - Endocrine
  - Environmental exposure
    - Lead, Cadmium, Mercury, Phthalates
  - Neurofibromatosis
  - Medication related

• Monogenic HTN
  - Familial hyperaldosteronism type I
  - Glucocorticoid remediable aldosteronism
  - Liddle syndrome
  - Pseudohypoaldosteronism type II (Gordon syndrome)
  - Apparent mineralocorticoid excess
  - Familial glucocorticoid resistance
  - Mineralocorticoid receptor activating mutation
  - Congenital adrenal hyperplasia


Evaluation

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

• Physical Exam
  - Focused on clues from history and possible causes of secondary HTN
  - BP measured in right/left arm + 1 leg
    - Normally leg 10-20 mmHg higher than arm
    - Frequently normal!

• Laboratory Evaluation
  - Basic screening tests
  - Specific tests based on history and physical exam
    - (noted previously in Management)

• Assess for target organ damage
  - EKG: Unnecessary for LVH!
    - High specificity/poor sensitivity
    - extremely low PPV.
  - Imaging
    - Echocardiography at time of consideration of pharmacologic treatment.
**Key Action Statement 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 14 (continued)

<table>
<thead>
<tr>
<th>Body System</th>
<th>Finding, History</th>
<th>Possible Etiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vital signs</td>
<td>Tachycardia, hypotension</td>
<td>Hyperthyroidism, hypothyroidism, PCC, Newborn heart disease, Dehydration of the aorta</td>
</tr>
<tr>
<td>Eyes</td>
<td>Proptosis, Retinal changes</td>
<td>Hyperthyroidism, Severe HTN, more likely to be associated with secondary HTN</td>
</tr>
<tr>
<td>Ear, nose, throat</td>
<td>Adenotonsillar hypertrophy</td>
<td>SBP, Sleep apnea, Nasal obstruction</td>
</tr>
<tr>
<td>Height, weight</td>
<td>Growth retardation</td>
<td>Genetic renal failure, Cushing syndrome, Obesity (BMI)</td>
</tr>
<tr>
<td>Head, neck</td>
<td>Echinococcum, goiter, Webbed neck</td>
<td>Truncal obesity, Truncal obesity, Turner syndrome</td>
</tr>
<tr>
<td>Skin</td>
<td>Palmar flushing, diaphoresis</td>
<td>Acne, hirsutism, striate, Hyperpigmentation, Hypersulfation, Neurofibromatosis, Tuberculosis</td>
</tr>
<tr>
<td>Hematologic</td>
<td>Palmar, Scleral scleritis</td>
<td>Renal disease, Anabolic steroid abuse, Anabolic steroid abuse, Azathioprine</td>
</tr>
</tbody>
</table>

---

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


• **Key Action Statement 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).

• **Key Action Statement 14**
  • Clinicians should not perform electrocardiography in hypertensive children and adolescents being evaluated for LVH
    • (grade B, strong recommendation).

• **Key Action Statement 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).


• **Key Action Statement 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).

• **Key Action Statement 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).
Uric Acid

- Prior small studies suggest:
  - Childhood UA levels associated with adult BP level
  - Lowering UA can decrease BP
  - Increased UA can blunt lifestyle benefits on BP
- No large-scale multicenter trials
- Not sufficient evidence to support routine measurement!

Microalbumin

- in adults, MA = marker of HTN related injury, predictor of CVD
- No evidence to support such relationship in children

Key Action Statement 18:
- Routine testing for MA (microalbumin) is not recommended for children and adolescents with primary HTN
  - (grade C, moderate recommendation).


Treatment

- Goal:
  - to reach BP level that reduces risk of target organ damage in childhood,
  - and reduce risk of HTN and CVD in adulthood.
  - may even reverse TOD in youth!
- Optimal BP level:
  - < 90th percentile or < 130/80 mmHg
  - Whichever is lower

Lifestyle/Nonpharmacologic

- Diet
  - DASH diet
- Physical Activity
  - 40 minutes moderate/vigorous activity 3 to 5 days a week
- Weight Loss and Related CV Risk Factors
  - Motivational Interviewing to address obesity, promote physical activity and dietary changes
  - Regular patient/family contact
  - > 1 hour physical activity daily
- Stress Reduction

Key Action Statement 19:

- 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 mm Hg in adolescents ≥ 13 years old
  - (grade C, moderate recommendation).

Key Action Statement 20:

- At the time of diagnosis of elevated BP or HTN in a child or adolescent, clinicians should provide advice on the DASH diet and recommend moderate to vigorous physical activity at least 3 to 5 days per week (30–60 minutes per session) to help reduce BP
  - (grade C, weak recommendation).


Treatment - Pharmacologic

Pharmacologic tx if:
- Remain hypertensive despite lifestyle modifications -OR-
- Symptomatic HTN -OR-
- Stage 2 HTN w/o modifiable risk factor -OR-
- Any HTN with CKD or diabetes tx
- Initiate single medication at low dose.

- Titrate every 2 to 4 weeks until:
  - BP controlled, max dose, adverse effects (home BP/clinic visits)
  - Add second agent if not controlled

Generally in children:
- Start with ACEi, ARB, long-acting CCBs, thiazide diuretics
  - β-blockers not recommended initially
- Anti-HTN drugs decrease BP with few adverse effects
- Few comparative studies
  - No clinically significant differences between classes
- No CV endpoint studies
- No long-term studies of anti-HTN safety
Choice of agent

- African American children
  - Higher dose of ACEi-or-
  - Long-acting CCB, thiazide diuretic
- Female/Childbearing potential
  - Informed of risk of ACEi/ARB and fetal injury or death – generally avoided
  - CCB, β-blocker if appropriate
- Children w/ CKD, proteinuria, DM
  - ACEi or ARB unless contraindication
- Others classes reserved for those who do not respond to 2 preferred drugs
  - α-blockers, β-blockers, combination α & β-blockers, centrally acting agents, K-sparing diuretics, direct vasodilators
- See Table 17:
  - Most drugs approved starting at
    - 1-6 years or 35-50 kg
  - Enalapril
    - approved ≥ 1 month
      - 0.08 mg/kg/d (up to 5 mg)
      - To 0.6 mg/kg/d (up to 40 mg)
      - Suspension preparation on package insert.
- HCTZ
  - Approved “child” (> 6 m)
    - 1-2 mg/k/d (up to 37.5 mg/d)
Choice of agent

• **Key Action Statement 21:**
  • In hypertensive children and adolescents who have failed lifestyle modifications (particularly those who have LV hypertrophy on echocardiography, symptomatic HTN, or stage 2 HTN without a clearly modifiable factor [eg, obesity]), clinicians should initiate pharmacologic treatment with an ACE inhibitor, ARB, long-acting calcium channel blocker, or thiazide diuretic
  • (grade B, moderate recommendation).  

• **Key Action Statement 22:**
  • ABPM may be used to assess treatment effectiveness in children and adolescents with HTN, especially when clinic and/or home BP measurements indicate insufficient BP response to treatment
  • (grade B, moderate recommendation).

• **Key Action Statement 23:**
  • Children and adolescents with CKD should be evaluated for HTN at each medical encounter;
  • Children or adolescents with both CKD and HTN should be treated to lower 24-hour MAP to <50th percentile by ABPM; and
  • Regardless of apparent control of BP with office measures, children and adolescents with CKD and a history of HTN should have BP assessed by ABPM at least yearly to screen for MH
  • (grade B; strong recommendation).
Treatment Resistant HTN

• Persistently elevated BP despite:
  • 3 or more agents of different classes at maximal effective dose, and at least one diuretic
  • Requires:
    • Correct office BP measurement
    • Confirmation of treatment adherence
    • Confirmation by ABPM

• Treatment
  • Dietary sodium restriction
  • Elimination of BP elevating substances
  • Identification of causes of secondary HTN
  • Optimization of current therapy
  • Additional agents
    • Aldosterone receptor antagonist (spironolactone) is optimal additional agent in adults
    • No information for children

• Key Action Statement 24:
  • Children and adolescents with CKD and HTN should be evaluated for proteinuria
    • (grade B, strong recommendation).

• Key Action Statement 25:
  • Children and adolescents with CKD, HTN, and proteinuria should be treated with an ACE inhibitor or ARB
    • (grade B, strong recommendation).

• Key Action Statement 26:
  • Children and adolescents with T1DM or T2DM should be evaluated for HTN at each medical encounter and treated if BP is ≥95th percentile or >130/80 mm Hg in adolescents ≥13 years of age
    • (grade C, moderate recommendation).
Acute Severe HTN

• Usually well above Stage 2 levels
  • Little evidence for evaluation/management in children
  • Usually due to underlying secondary cause of HTN
    • Expedient evaluation for secondary cause, TOD as necessary
    • May include renal function, echocardiography, CNS imaging
  • Goal: 95th % in ~ 24 hours
    • 25% of planned reduction in first 8 hours
    • Oral agents if tolerate, IV otherwise

• Key Action Statement 27:
  • In children and adolescents with acute severe HTN and life-threatening symptoms, immediate treatment with short-acting antihypertensive medication should be initiated, and BP should be reduced by no more than 25% of the planned reduction over the first 8 hours
    • (grade expert opinion D, weak recommendation).


• Key Action Statement 28:
  • Children and adolescents with HTN may participate in competitive sports once hypertensive target organ effects and risk have been assessed
    • (grade C, moderate recommendation).

• Key Action Statement 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).

• Key Action Statement 30:
  • Adolescents with elevated BP or HTN (whether they are receiving antihypertensive treatment) should typically have their care transitioned to an appropriate adult care provider by 22 years of age (recognizing that there may be individual cases in which this upper age limit is exceeded, particularly in the case of youth with special health care needs). There should be a transfer of information regarding HTN etiology and past manifestations and complications of the patient’s HTN
    • (grade X, strong recommendation).
AAFP

• Reviewed AAP 2017 Guidelines
  • February 2018 “Affirmation of Value”
  • The AAFP uses the category of “Affirmation of Value” to support clinical practice guidelines that provide valuable guidance, but do not meet our criteria for full endorsement. The primary reasons for not endorsing this guideline included:
    • There was a lack of transparency in the methodology used for study evaluation.
    • While recommendations based on expert opinion were identified, it was unclear how those recommendations were developed.
    • The management of conflicts of interest was not well described.
    • There was inadequate discussion of the potential harms of medications for long-term use in children.

USPSTF 2013

• Acknowledges:
  • Childhood BP, to a significant degree, predicts adult BP.
  • Hypertensive children are at risk for progression of metabolic disorders.
    • Insulin resistance, lipid abnormalities...
  • Some evidence that drugs and/or lifestyle changes are effective in reducing BP.
  • No evidence of harm in screening for hypertension in children...

• However:
  • No evidence that routine BP measurements in childhood accurately identifies individuals at risk for adult cardiovascular disease.
  • Rejected identifying secondary hypertension as a rationale for screening as it was considered rare
USPSTF 2013

- **Risk Assessment**
  - Strongest risk factor: elevated BMI
  - Also: low birthweight, male, ethnicity, family history

- **Screening Tests:**
  - Clinical sphygmanometry has reasonable sensitivity
  - But false-positives occur with subsequent normalization

- **Treatment**
  - Stage 1: lifestyle and pharmacologic; medications not recommended as first-line tx.

- **Balance harms/benefits**
  - Inadequate evidence:
    - Diagnostic screening test
    - Effectiveness of treatments and harms of screening or treatment
  - Cannot determine balance of benefits/harms of screening or treatment.

Recommendation (USPSTF 2013)

- (I) Insufficient
  - “Current evidence insufficient to assess the balance of benefits and harms”

- Applies to children/adolescent who do not have symptoms of hypertension

Expert Opinion

- Pediatric/Adolescent HTN can contribute to premature atherosclerosis and early CVD.
- Prevalence of childhood HTN has increased along with increased prevalence of obesity.
- Overweight children are more likely to be hypertensive.
- Hispanic children are more likely to have elevated BP than other ethnic groups.
- Family history of HTN is present in ~50% of children with HTN.
- White-coat hypertension is very common in children.
  - Unsure of significance.
- Secondary HTN:
  - ~70% due to renal disease
  - ~11% endocrine

Poll Question 4

Joyce L is a 16 year old female is found to have a blood pressure of 132/86. She has no significant symptoms. She really does not like to use medications, unless she absolutely has to. She weighs 76 kg, stands 158 cm tall and has a BMI of 30.4 kg/m². This reading is most consistent with a diagnosis of?

A. Normal Blood Pressure
B. Elevated Blood Pressure
C. Stage 1 HTN
D. Stage 2 HTN
E. Unable to determine from data given.
Joyce’s care

Joyce’s blood pressure remains elevated to the same range on subsequent recheck 2 weeks later. She receives all appropriate evaluation, which fails to show an identified cause of secondary hypertension.

You correctly treat her by weight management counseling, introduce physical activity and diet management. You schedule her back to recheck her BP in three months.

Poll Question 5

Joyce’s does not return until her mother makes her an appointment for a 17 y/o exam. She is now 159 cm tall, and has lost 5 kg, but her blood pressure, on subsequent evaluations, is consistently within the Stage 1 range. Which of the following is the most appropriate intervention at this time?

A. No therapy, recheck BP in 6 months
B. Encourage healthy diet, sleep and physical activity
C. Weight management counseling, introduce physical activity and diet management
D. Initiate drug therapy using a single agent.
E. Initiate drug therapy using two agents.
Poll Question 6

Remembering that Joyce really would prefer to take as few medications as possible, which of the following is the most appropriate single drug to use for her at this time?

A. Enalapril (an ACEi)
B. Losartan (an ARB)
C. Amlodipine (a CCB)
D. Clonidine (a central α-agonist)
E. Hydralazine (a vasodilator)

Best Practice Recommendations

- Use established workflow to encourage correct pediatric blood pressure measurement.
- Use simple screening tables or electronic system to identify abnormal BP values in children.
- Follow-up elevated BP in appropriate time frame.
- Encourage lifestyle changes frequently.
- Do not delay pharmacotherapy when appropriate.
Questions

Contact Information

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Resources

- AAP 2017 Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents
  - https://pediatrics.aappublications.org/content/140/3/e20171904
- CDC: High Blood Pressure During Childhood and Adolescence:
  - https://www.cdc.gov/bloodpressure/youth.htm
- AHS: High Blood Pressure in Children:
  - https://www.heart.org/en/health-topics/high-blood-pressure/why-high-blood-pressure-is-a-silent-killer/high-blood-pressure-in-children
- CPEG-GPEC 2017 Pediatric BP Calculator
  - https://apps.cpeg-gcep.net/BPz_cpeg_dde/

References

References


Answers

1. C
2. C
3. D
4. C
5. D