Hypertension Essentials

Sun-Young Ahn, M.D.
Kirtida Mistry, MBBCh, DCH, MRCPCH, FASN
Division of Nephrology
Children’s National Health System
The George Washington University School of Medicine and Health Sciences
Prevalence

- Second to asthma and obesity in prevalence of chronic diseases in childhood

- 1970’s and 1980’s: 0.3%-1.2% of children had HTN

➢ Current estimates:
  - 3-5% of all children have HTN
  - 3-24% of all children have elevated BPs
  - High BPs consistently greater in boys (15%-19%) than in girls (7%-12%)
    - 20-47% of obese children are hypertensive
      - Prevalence of HTN in children increases with increasing BMI percentile
  - Increasing prevalence linked to obesity, high salt food intake, sedentary lifestyle

- Underestimate of disease?
  - Providers don’t routinely measure BP
  - Providers don’t routinely recognize BP elevations
Hypertension and Obesity

- Obesity prevalence and role in HTN
  - Prevalence (2-19 years old) remains high at 17% based on NHANES 2011-2012 data
  - Obstructive sleep apnea common
  - Dysfunctional adipocyte -> imbalance in expression of pro- and anti-inflammatory adipokines -> Hypertension

Adipose Tissue Dysfunction:
- Macrophage infiltration
- Increased FFA
- Hyperleptinemia
- Adiponectin deficiency
- Increased resistin
- RAAS hormone secretion
- Mineralocorticoid stimulating factor

RAAS Activation
- SNS Activation
- Oxidative stress and Inflammation

Endothelial dysfunction
- Impaired pressure natriuresis
- Vascular hypertrophy

I told you he had high blood pressure!
Why is identifying and controlling hypertension so important?

- Pediatric hypertension correlates to hypertension in adulthood
- Childhood hypertension is a risk factor for cardiovascular disease in adults
- Poor BP control is the number one attributable risk of death in the world (WHO) - accounts for 62% of cerebrovascular disease and 49% of ischemic heart disease in adults
Updated Guidelines for Pediatric Hypertension


National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. *Pediatrics* 2004; 114; 555

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

Changes from 2004 Report

1. Replacement of the term “prehypertension” with the term “elevated blood pressure”

2. New normative pediatric blood pressure (BP) tables based on normal-weight children
   - BP values in new update several mmHg lower than similar tables in Fourth Report

3. Simplified screening table for identifying BPs needing further evaluation

4. Simplified BP classification in adolescents ≥13 years of age that aligns with the American Heart Association and American College of Cardiology adult BP guidelines
### Prior staging of hypertension

<table>
<thead>
<tr>
<th></th>
<th>1-17 yrs old</th>
<th>≥ 18 yrs old</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal</strong></td>
<td>&lt;90\textsuperscript{th} percentile</td>
<td>&lt;120/80 mmHg</td>
</tr>
<tr>
<td><strong>Pre-hypertension</strong></td>
<td>90\textsuperscript{th} to 95\textsuperscript{th} percentile, or BP greater than 120/80 mmHg</td>
<td>120-139/80-89 mmHg</td>
</tr>
<tr>
<td><strong>Stage 1 hypertension</strong></td>
<td>95\textsuperscript{th} to 99\textsuperscript{th} percentile + 5mmHg</td>
<td>140-159/90-99 mmHg</td>
</tr>
<tr>
<td><strong>Stage 2 hypertension</strong></td>
<td>≥ 99\textsuperscript{th} percentile + 5mmHg</td>
<td>≥ 160/100 mmHg</td>
</tr>
</tbody>
</table>

BP%iles according to age, gender, and height

---


*Pediatrics* 2004;114;555
# Staging of Hypertension According to Current Guidelines

<table>
<thead>
<tr>
<th></th>
<th>1-13 yrs old</th>
<th>≥ 13 yrs old</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal</strong></td>
<td>&lt;90(^{th}) percentile</td>
<td>&lt;120/&lt;80 mmHg</td>
</tr>
<tr>
<td><strong>Elevated BP</strong></td>
<td>≥90(^{th}) to 95(^{th}) percentile, or 120/80 mmHg to &lt;95(%)ile (whichever is lower)</td>
<td>120/&lt;80 to 129/&lt;80 mmHg</td>
</tr>
<tr>
<td><strong>Stage 1 hypertension</strong></td>
<td>≥95(^{th}) to 95(^{th}) (%)ile + 12 mmHg or 130/80 to 139/89 mmHg (whichever is lower)</td>
<td>130/80 to 139/89 mmHg</td>
</tr>
<tr>
<td><strong>Stage 2 hypertension</strong></td>
<td>≥ 95(^{th}) percentile + 12 mmHg or ≥ 140/90 mmHg (whichever is lower)</td>
<td>≥ 140/90 mmHg</td>
</tr>
</tbody>
</table>

Apps to calculate BP percentiles

**Pediatric Blood Pressure Guide**
Clinical Practice Tool
Gregory Drake Wilson

$0.99

**PediBP**
Pediatric Management of HighBP
Arthur Uber

$0.99

Simple, easy-to-use access to the UPDATED 2017 Pediatric Blood Pressure Guidelines. An essential for all Pediatricians and Subspecialists.
BP measurement
Technique is important!

- Should rest for at least 5 minutes before BP measurement.
- Should be sitting in an upright position with back supported and feet uncrossed on the floor, or for younger children, lying down.
- Blood pressure readings from the leg usually 10-20 mmHg higher than those from the arm.
- The arm should be at heart level and supported.
- Cuff should be inflated to 20-30 mmHg above the point at which the radial pulse disappears. Overinflation should be avoided.
- Width of the cuff bladder should be at least 40% of the mid-arm circumference and the bladder length should wrap around at least 80%-100% of the upper arm circumference.
### Factors affecting BP measurement

<table>
<thead>
<tr>
<th>Factor</th>
<th>Increase in Blood Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talking</td>
<td>7-10 mmHg</td>
</tr>
<tr>
<td>Listening</td>
<td>5 mmHg</td>
</tr>
<tr>
<td>Crossed Legs</td>
<td>2-8 mmHg</td>
</tr>
<tr>
<td>No back support</td>
<td>6-10 mmHg</td>
</tr>
<tr>
<td>Arm unsupported</td>
<td>Systolic: 1-7 mmHg; Diastolic: 5-11 mmHg</td>
</tr>
<tr>
<td>Arm positioned with center of bladder at heart level</td>
<td>Each inch above this level decreases BP by ≥2 mm Hg, and vice versa*</td>
</tr>
<tr>
<td>Oscillometric Device</td>
<td>Systolic: 10 mmHg; Diastolic: 5 mmHg</td>
</tr>
<tr>
<td>Distended urinary bladder</td>
<td>10-15 mmHg</td>
</tr>
<tr>
<td>Recent caffeine intake</td>
<td>Systolic: 10 mmHg; Diastolic: 5 mmHg</td>
</tr>
<tr>
<td>Recent smoking</td>
<td>Systolic: 6 mmHg; Diastolic: 5 mmHg</td>
</tr>
<tr>
<td>Cuff over clothing</td>
<td>Systolic: 5-50 mmHg</td>
</tr>
<tr>
<td>Cuff too small</td>
<td>Systolic: 10 mmHg; Diastolic: 2-8 mmHg</td>
</tr>
</tbody>
</table>
Proper staging of BPs

- If initial BP elevated (≥90th percentile), providers should perform 2 additional oscillometric or auscultatory BP measurements at same visit and average measurements.

- If the averaged oscillometric reading is ≥90th percentile, 2 auscultatory measurements should be taken and averaged to define the BP category.
When should BPs be measured?

- BP should be measured annually in children and adolescents ≥3 years of age

- BP should be checked in all children and adolescents ≥3 years of age at every health care encounter if they have
  - obesity
  - history of prematurity
  - taking medications known to increase BP
  - have renal disease
  - history of aortic arch obstruction
  - coarctation of aorta
  - diabetes
“White coat hypertension” refers to BPs greater than the 95th percentile in the physician’s office and BPs below the 95th percentile outside the physician’s office.

Masked hypertension: normal blood pressures in the physician’s office and elevated blood pressures outside of the office.

Both white coat and masked hypertension have been linked to increased cardiovascular risk in adults, and masked hypertension has been associated with left ventricular hypertrophy in children.
When to refer patient?

- Patients with persistently elevated BP on 6 month follow up
- Stage 1 and Stage 2 HTN
Follow up

- Normal BP → check annually
- Elevated BP
  - Lifestyle modification, sleep, weight management
  - Recheck in 6 months → Elevated
  - ABPM
  - Screening evaluation
  - Possible referral to Nephrology/Cardiology
Stage 1 HTN

Lifestyle modification

Recheck BP in 1-2 weeks

UE + LE BP

Lifestyle modification  Recheck in 3 months

ABPM

Diagnostic evaluation, Start Rx, Consider referral
Stage 2 HTN

- UE + LE BP, Lifestyle modification
- Recheck BP within 1 week or refer
- ABPM, diagnostic evaluation, begin Rx
- Refer
- Anytime patient symptomatic OR >180/120 mmHg
  - Send to ED immediately
Clinical Evaluation

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
Clinical Evaluation

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
<table>
<thead>
<tr>
<th>Lab Evaluation: Baseline Screening</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ALL</strong></td>
</tr>
<tr>
<td>• UA</td>
</tr>
<tr>
<td>• Electrolytes, BUN, creatinine</td>
</tr>
<tr>
<td>• Lipid panel</td>
</tr>
<tr>
<td>• RUS if &lt;6 yo, abnormal UA, electrolytes, BUN or creatinine</td>
</tr>
<tr>
<td><strong>Obese</strong></td>
</tr>
<tr>
<td>• HbA1C</td>
</tr>
<tr>
<td>• AST &amp; ALT</td>
</tr>
<tr>
<td><strong>PRN</strong></td>
</tr>
<tr>
<td>• Fasting blood glucose</td>
</tr>
<tr>
<td>• TSH</td>
</tr>
<tr>
<td>• Drug screen</td>
</tr>
<tr>
<td>• Sleep study</td>
</tr>
<tr>
<td>• CBC</td>
</tr>
<tr>
<td>• Additional based on clinical suspicion</td>
</tr>
</tbody>
</table>
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

• Effect of sodium restriction on blood pressure

He and MacGregor. J Human Hypertension. 2002

• Meta-analysis of randomized trials: effect on blood pressure of modest salt reduction
  - Dose response to salt reduction: 100 mmol ↓ in salt intake → BP ↓ 7/4 mmHg in hypertensive and 4/2 mmHg in normotensive individuals
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 elevated BP
  - 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

- Exercise


  - Sustained exercise training over 3-6 months $\rightarrow \downarrow$ SBP 6-12 mmHg & $\downarrow$ DBP 3-5 mmHg
  - Weight loss
  - Cardiovascular benefits
Lifestyle Modification

- Limit alcohol intake
- Smoking cessation
- Yoga
- Meditation
HTN and Sport Participation

- Non-competitive physical activity is encouraged
  - In long term exercise decreases SBP and DBP in those with HTN
  - Adult data: lower all-cause mortality in physically fit patients
HTN and Sport: AAP Recommendations

AAP policy statement “Athletic Participation by Children and Adolescents Who Have Systemic Hypertension”

- Pre-HTN: no limitations
- Stage 1 HTN and no end organ damage (LVH, heart disease): No limitations
### HTN and Sport: AAP Recommendations

- **Stage 2 HTN and no end organ damage (LVH, heart disease)**

Restrict high static activities until BP is controlled.

---

**Table: Sport Recommendations**

<table>
<thead>
<tr>
<th>Stage (BP Control)</th>
<th>IIA (Low Moderate)</th>
<th>IIB (Moderate)</th>
<th>IIC (High)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ill. Moderate (20-50% MVC)</td>
<td>Archery, Auto racing, Diving, Equestrian, Motorcycling</td>
<td>American football, Field events (jumping), Figure skating, Rodeoing, Rugby, Running (sprint), Surfing, Synchronized swimming</td>
<td>Basketball, Ice hockey, Cross-country skiing (skating technique), Lacrosse, Running (middle distance), Swimming, Team handball</td>
</tr>
<tr>
<td>II Moderate (50-70% MVC)</td>
<td>Bowls, Cricket, Curling, Golf, Riffey</td>
<td>Baseball/softball, Fencing, Table tennis, Volleyball</td>
<td>Badminton, Cross-country skiing (classic technique), Field hockey, Orienteering, Race walking, Racquetball/squash, Running (long distance), Soccer, Tennis</td>
</tr>
<tr>
<td>I Low (&lt; 40% MVC)</td>
<td>Billiards, Bowling, Cricket, Curling, Golf, Riffey</td>
<td>Baseball/softball, Fencing, Table tennis, Volleyball</td>
<td>Badminton, Cross-country skiing (classic technique), Field hockey, Orienteering, Race walking, Racquetball/squash, Running (long distance), Soccer, Tennis</td>
</tr>
<tr>
<td>Increasing Static Component</td>
<td>Increasing Dynamic Component</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary

• Ensure BP is accurately measured
• Symptomatic hypertensive patients need prompt evaluation and treatment
• Refer patients with persistently elevated BP, stage 1 and 2 HTN
• 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
Questions?