Hypertension in Children
Seek and ye shall find!

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Objectives
1. Describe screening for hypertension
2. Discuss prevalence of hypertension
3. Describe the primary care provider’s role in evaluation of the hypertensive patient
4. Review first line treatment of hypertension
5. Review effective management of hypertension in metabolic syndrome
6. Review recommendations for sports clearance for the child with hypertension
Screening: How are we doing?

- Nat'I Ambulatory Medical Care Survey
- Nat'I Hospital Ambulatory Care Survey
- 142 million visits/yr for children 3-18 yrs
- Screening done in only 35% - 41% of ALL visits
- 20% of visits were for preventive care
  - 71% had BP screening in 2008-2009
  - 84% of those with dx of obese/overweight screened

And, if we screen, do we pay attention? (apparently not!)

- BP obtained at 80% of visits (2000/2501)
- Elevated BP DOCUMENTED at 39% of visits
- RECOGNIZED at only 17% of visits
- More likely to be noticed if overweight/obese
  - Of these, only 20% abnormal BPs noted
- Normal weight children - only 7% of abnormal BPs noted

Who should we check?

- All children > 3 years at all health encounters
- Children < 3 years with at risk conditions
  - Premature / NICU grad
  - CHD
  - Recurrent UTI/Proteinuria
  - Urologic malformation
  - Fam Hx congenital renal disease
  - Organ transplantation
  - Malignancy / Bone marrow transplant
  - Medications
  - Systemic illnesses / genetic conditions
  - Increased ICP
How should we take BPs?

- 390 children, 580 visits at a pediatric hypertension clinic
- Compared BP results from Vital sign station (VSS) vs Exam room (EXR), after being seated for 10 minutes
- Significantly higher BPs at VSS in all groups (statistically, AND clinically important) \( p < .01 \)


How we take BPs matters

<table>
<thead>
<tr>
<th>Age</th>
<th>VSS SBP</th>
<th>EXR SBP</th>
<th>VSS DBP</th>
<th>EXR DBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6</td>
<td>120 +/- 20</td>
<td>107 +/- 17</td>
<td>72 +/- 14</td>
<td>64 +/- 13</td>
</tr>
<tr>
<td>7-12</td>
<td>136 +/- 16</td>
<td>124 +/- 14</td>
<td>76 +/- 12</td>
<td>73 +/- 11</td>
</tr>
<tr>
<td>12-18</td>
<td>143 +/- 15</td>
<td>132 +/- 14</td>
<td>81 +/- 13</td>
<td>76 +/- 11</td>
</tr>
</tbody>
</table>

Podoll A. Pediatrics. 2007;199:e538

BP measurement technique

- Child seated quietly > 5 minutes
- Right arm supported, level of the heart
  - BP measure increases dramatically with lowering of the arm from heart level
- Appropriate cuff size

Cubital fossa at heart level
Determine cuff size

Bladder width at least 40% of arm circumference

Length of bladder = 80-100% circumference

How to measure BP:

Technique / Equipment

- Auscultation = gold standard
- If electronic BP abnormal, confirm with aneroid manometer and auscultation
- Reduce cuff pressure
- SLOWLY, no faster than 2mm/sec
- Be sure electronic device is calibrated/validated

Mercury vs Aneroid Devices

- 193 patients in diabetes clinic
- 4 BPs taken, 2 aneroid, 3 & 4 randomized

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Mercury SBP</th>
<th>Aneroid SBP</th>
<th>Mercury DBP</th>
<th>Aneroid DBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10 years</td>
<td>96</td>
<td>96.1</td>
<td>60.6</td>
<td>59.5</td>
</tr>
<tr>
<td>10 - 18 years</td>
<td>107.7</td>
<td>107</td>
<td>67.1</td>
<td>65.7**</td>
</tr>
</tbody>
</table>

** difference of -1.78, significant p<.001

Not important, unless you are a researcher

Shah AS. Pediatrics.2012;129:e1205
Identify BP %ile based on patient’s age and height

<table>
<thead>
<tr>
<th>Age</th>
<th>SBP (mmHg)</th>
<th>Height Percentile</th>
<th>DBP (mmHg)</th>
<th>Height Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>50th</td>
<td>102</td>
<td>50th</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>90th</td>
<td>116</td>
<td>95th</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>99th</td>
<td>127</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Example of BP tables for a 12 year old boy

Classification of BP in children

<table>
<thead>
<tr>
<th>SBP or DBP Percentile</th>
<th>Normal</th>
<th>Prehypertension</th>
<th>Stage 1 hypertension</th>
<th>Stage 2 hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;90th %ile</td>
<td>90th to &lt;95th %ile, or if BP &gt; 120/80 even if &lt; 90th %ile up to &lt;95th %ile</td>
<td>95th - 99th %ile plus 5 mmHg</td>
<td>&gt;99th %ile plus 5 mmHg</td>
</tr>
</tbody>
</table>

Prevalence of Hypertension

Acosta AA. J Peds. 2012;160:757

- 1010 students age 15.4 y +/- 1.1 y
- 45.2% male
- Hispanic 49.3%; Caucasian 25%; Black 16%
- Avg 2-4 readings to determine BP
- If BP > 90th %ile, 2 additional visits
- 1st visit: 20% abnormal
  - 52% normal BP on follow-up - classified as variable
  - 7.5% persistent prehypertension
  - 4% hypertension
Prevalence of Hypertension

- Data on 199,513 children
- Age
  - 3-5 years: 24.3%
  - 6-11 years: 34.5%
  - 12-17 years: 41.2%
- Ethnicity
  - Caucasian: 35.9%
  - Black: 7.8%
  - Hispanic: 17.6%
  - Asian/Pacific: 11.7%
  - Other: 27%

Prevalence of Hypertension

<table>
<thead>
<tr>
<th>Age</th>
<th>Normal</th>
<th>PreHTN</th>
<th>HTN</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
<td>81.9%</td>
<td>12.76%</td>
<td>5.4%</td>
</tr>
<tr>
<td>3-5</td>
<td>85.3%</td>
<td>8.3%</td>
<td>6.4%</td>
</tr>
<tr>
<td>6-11</td>
<td>88.4%</td>
<td>6.5%</td>
<td>5.1%</td>
</tr>
<tr>
<td>12-14</td>
<td>79.3%</td>
<td>15.3%</td>
<td>5.4%</td>
</tr>
<tr>
<td>15-17</td>
<td>68.7%</td>
<td>26.3%</td>
<td>4.9%</td>
</tr>
</tbody>
</table>

Prevalence of Hypertension

- Follow-up on 6,739 of 10,848 children
- 257 with persistent HTN
- Prevalence of 0.14%
- 29 started on Rx at 1st visit
### Blood pressure and BMI

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Overweight</th>
<th>Obese</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normotension</td>
<td>67.7%</td>
<td>18.7%</td>
<td>13.7%</td>
<td>718</td>
</tr>
<tr>
<td>Variable</td>
<td>45%</td>
<td>17.2%</td>
<td>37.8%</td>
<td>151</td>
</tr>
<tr>
<td>Prehypertension</td>
<td>42%</td>
<td>36%</td>
<td>38%</td>
<td>116</td>
</tr>
<tr>
<td>Hypertension</td>
<td>12%</td>
<td>16%</td>
<td>72%</td>
<td>25</td>
</tr>
</tbody>
</table>

Acosta AA. J Peds. 2012;160:757

### Hypertension - Prevalence is 1-5%

- Risk factors for primary hypertension
  - Increased BMI
  - Low birth weight
  - Gender
  - Ethnicity
  - Positive family history

### Risk factors: Gender / Ethnicity

- 58,698 kids, 78,556 visits
- 51% boys, 49% girls
- 59% white
- 31% black
- 14% hispanic

Rosner B. Hypertension. 2009;54:502
Risk factors: Ethnicity
- Odds of prehypertension 1.8 - 2.2 x greater in overweight vs normal weight children
- Ethnic differences are present in boys but not girls
- Differences not explained by obesity
- Hispanic boys significantly higher BPs than Caucasians (both normal and overweight)
- Normal weight Black boys more likely to have higher BP than normal weight Caucasians
- No significant differences in overweight boys across ethnic groups


Change in obesity prevalence - NHANES data

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2-5 y</td>
<td>5%</td>
<td>10.4%</td>
</tr>
<tr>
<td>6-11 y</td>
<td>6.5%</td>
<td>19.6%</td>
</tr>
<tr>
<td>12-19 y</td>
<td>5%</td>
<td>18.1%</td>
</tr>
</tbody>
</table>

Link between Obesity & HTN
- Ambulatory blood pressure monitoring of 109 children all with BMI >95%
- All hypertensive categories worsened with increasing obesity
  - 24% Normotensive
  - 25% preHTN
  - 3% HTN
  - 38% non-dippers (BP does not decrease >10mmHg at night)
  - 25% nocturnal HTN

Link between Obesity & HTN

- 73 obese children
  - 51 boys, 22 girls
  - 14.2 +/- 2.3 years
- Ambulatory BP monitoring, physiologic exercise testing, office BPs x 3


Obesity & HTN (cont.)
Dippers vs Non-dippers

- 42% of subjects non-dippers
- Work capacity lower in non-dippers
- Office HTN more common in non-dippers
  - Dippers HTN = 42.4%
  - Non-dippers HTN = 45.2%
- Ambulatory BP monitoring
  - Dippers HTN = 45%
  - Non-dippers HTN = 83.2%


Teens, Obesity, HTN and LV Mass

723 patients, mean age 18

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Normentensive</th>
<th>PreHTN</th>
<th>HTN</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>723</td>
<td></td>
<td>65</td>
<td>127</td>
</tr>
<tr>
<td>DM 2</td>
<td>258</td>
<td></td>
<td>21.9%</td>
<td>55.9%</td>
</tr>
<tr>
<td>BMI</td>
<td>234</td>
<td></td>
<td>34.1</td>
<td>38.7</td>
</tr>
<tr>
<td>LVMI</td>
<td></td>
<td></td>
<td>35.9</td>
<td>40.7</td>
</tr>
</tbody>
</table>

Pre-pubertal Children, Obesity, HTN and LV Mass

<table>
<thead>
<tr>
<th>Lean = 22</th>
<th>Obese = 44</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>15.5</td>
</tr>
<tr>
<td>%Body fat</td>
<td>18.3</td>
</tr>
<tr>
<td>Body fat mass</td>
<td>5.3 kg</td>
</tr>
<tr>
<td>Lean BM</td>
<td>21.9 kg</td>
</tr>
<tr>
<td>Sys HTN</td>
<td>0/22</td>
</tr>
<tr>
<td>Dias HTN</td>
<td>0/22</td>
</tr>
<tr>
<td>LVMI</td>
<td>30.0</td>
</tr>
<tr>
<td>&gt;38.6 g/m^2.7</td>
<td>9.1%</td>
</tr>
</tbody>
</table>


Obesity, HTN, and LV Mass

Author conclusions

- Casual BPs failed to detect 55% of HTN documented by ABPM
- LVMI correlated with
  - BMI
  - lean body mass
  - body fatness
  - 24 hour SBP/DBP

Office BP measurement abnormal, now what?

- Pressures >90th%ile repeat
- Prehypertension reassess in 6 months
- Stage 1 recheck in 1-2 weeks
- Stage 2 evaluate or refer
Core evaluation, before tx of confirmed HTN

- History, including family history, sleep history
- Physical exam
  - BMI
  - Acanthosis
  - Pulses
  - Arm and Leg BPs
  - Funduscopic exam
- Lab: CBC, BMP, UA, microscopy and culture, Glucose, Insulin
- Renal ultrasound & renal doppler

Additional evaluation

- LAB
  - Obese Patients:
    - Liver function tests
    - Lipid profile
  - Renin/Aldosterone
  - Catecholamines
  - Steroids
- Echocardiogram
- Ambulatory blood pressure monitoring
- Renovascular imaging
- Sleep study if sx of sleep apnea

Non-pharmacologic therapy

- Reduced sodium diet
  1500 - 2300 mg/day
  (Current average 3800-4000 mg/day)
- Weight loss
- Physical activity
Antihypertensive Medications

- ACE inhibitors
- Angiotensin receptor blockers
- Calcium channel blockers
- Aldosterone antagonists
- Diuretics
- Cardioselective beta blockers: atenolol, metoprolol
- Central alpha agonists

Prescribing patterns in pediatric HTN

- 23% of 4296 HTN children received anti-HTN Rx
- 27% of patients with obesity
- 19% of younger age group 11-14
- 33% of older age group 15-19
- 28% of Caucasians
- 19% of Blacks
- 25% of Hispanics

Who prescribed?

- Adult PCP 63%
- Ped PCP 5%
- Specialist 10%
- PCP + Specialist 14%
- Adult + Peds PCP 3%
- Unknown 5%
Does treatment work?

- 88 patients with primary HTN
  - Life style recommendations
  - Medications if LVH present, or severe ambulatory HTN
- 40/88 LVH or severe ambulatory HTN
- 9 others added to the drug group
  - Severe LVH 10 pts 1 p=0.006
  - LVH 39 pts 27 p=0.0001


Physical Activity and BP

- Exercise reduces SBP and DBP in those with hypertension
- “Available data do not indicate that strenuous DYNAMIC exercise places athletes at risk of acute complications of HTN during exercise, or of worsening of their baseline BP values.”


What to do with athletes?

- Prehypertension - no restriction
- Stage 1, and no end organ damage
  - No restriction
  - BP re-check in 1-2 weeks, sooner if symptomatic
- Stage 2, no end organ damage
  - Restrict from high static sports (IIa - IIIc) until BP normal
- Hypertension and concomitant CV disease
  - Eligibility should be based on the type/severity of the CV disease

Sports are classified related static and dynamic components

- High static activities examples
  IIIa Weight lifting, water skiing, gymnastics
  IIIb Body building, wrestling, downhill skiing
  IIIc Boxing, cycling, rowing, speed skating

- Football is considered IIB, moderate, yet weight lifting is a core activity of preparation for football players.

What don’t we know?
Screening for hypertension in children & adolescents: Systematic Review

- Is screening effective in delaying onset or reducing adverse health outcomes related to hypertension?
  - No randomized controlled trials
- Can we diagnose with accuracy?
  - 24 hour ambulatory measurement vs office 3 BPs, 2 separate visits
  - Sensitivity 0.65 (CI 0.45-0.80)
  - Specificity 0.75 (CI 0.63-0.84)


What don’t we know?

- Is there association between HTN & intermediate outcomes in adults?
  - Tracking occurs, but wide range of sensitivity 0 - 0.63 and specificity 0.77 - 1.0
  - Positive predictive value 0.19 - 0.65
  - Microalbuminuria in Blacks with pediatric HTN
…And more that we don’t know

• Are therapy/interventions in Pediatric HTN effective in reducing intermediate and long-term adverse outcomes in adults?
  – No randomized controlled trials

  More research desperately needed!!

Questions?