Hypertension in Primary Care

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Disclosures - None

Learning Objectives
- Understand some of the reasons that proper identification and management of pediatric patients with HTN is of increasing concern
- Review advances in heritable forms of HTN
- Review the value of Ambulatory Blood Pressure Monitoring—ABPM

Milwaukee Regional Medical Center
1. Pediatric Hypertension is of Increasing Concern

- What defines hypertension in childhood?
  - A systolic or diastolic BP > 95th %ile for age, gender and height, after 3 screenings
  - In the Houston BP screening project (McNeice 2007)
    - 20% first BP screens abnormal
    - 9.4% hypertensive
    - 9.5% pre-hypertensive
    - 3.2% prevalence after 3 screens
1. Pediatric Hypertension is of Increasing Concern

- What is pre-hypertension?
  - $90-95^{th}$ percentile for age and size or $>120/80$ even if below the $90^{th}$ percentile up to the $95^{th}$ percentile
  - Practically speaking, SBP reaches the 120 range in boys and girls at age 12 y between the $90^{th}$ and $95^{th}$ percentile
  - Practically speaking, DBP reaches the 80 range in boys and girls at age 16 between the $90^{th}$ and $95^{th}$ percentile

(a few words about BP measurement)

- The bladder width of an appropriately sized BP cuff should cover a minimum of 40% of the arm circumference at a point midway between the olecranon and the acromion
- The bladder length of an appropriately sized BP cuff should cover a minimum of 80-100% of the arm circumference
- BP measures are overestimated to a greater degree with a cuff that is too small than they are underestimated by a cuff that is too large
- When in doubt, use the bigger cuff!

(a few words about BP measurement)
Please have a thigh cuff available
(courtesy of Patti Ring, APNP)

(a few words about BP measurement)

A Child ≥ 3 Years of Age
• Measure BP at least once at every health care visit

A Child < 3 Years of Age
• Measure BP if the child
  √ Was in a neonatal ICU
  √ Has congenital heart disease
  √ Has recurrent UTI, hematuria or proteinuria
  √ Has renal disease of FHx of same
  √ Has a solid or liquid organ Tx
  √ Has a malignancy
  √ Takes hypertensinogenic Rx
  √ Has evidence of ↑ ICP
  √ Has a systemic disease associated with hypertension

1. Pediatric Hypertension is of Increasing Concern

• What is the prevalence of childhood hypertension?
• National Health and Nutrition Examination Survey (NHANES)
  √ Pre-hypertension 10%
  √ Hypertension 3.7%
  » Trends disproportionately affect non-Hispanic blacks (4.2%) and Mexican-Americans (4.6%) compared to whites (3.3%)
1. **Pediatric Hypertension is of Increasing Concern: Low Birth Weight**

- Increasing evidence suggests that LBW infants are at greater risk for the development of both hypertension and renal disease in later life
- Kidneys weigh less and have smaller numbers of nephrons for weights < 10 %ile vs > 10 %ile,
- Children with IUGR have fewer nephrons than children without
- Children with birthweights < 2.5 kg vs > 2.5 kg have fewer nephrons with a mean reduction of 20%

Kidney International 66:S107-111, 2005

1. **Pediatric Hypertension is of Increasing Concern: Low Birth Weight**

- Reduction in nephron mass, with resultant increased capillary pressure and consequent increased glomerular flow (AKA glomerular hyperfiltration) leads to hypertension
- Glomerular hyperfiltration autoperpetuates renal damage

1. **Pediatric Hypertension is of Increasing Concern: NICU Graduates**

- Incidence of hypertension in neonates ranges between 0.2-3%
- Incidence of hypertension in NICU admits is probably higher than in healthy term infants-0.81%
- Incidence in NICU admits with BPD, PDA, IVH, or indwelling catheters rises to 9%
- Normotensive infants at NICU discharge can develop hypertension later
  ✓ Incidence of 2.6% detected at a mean age of 2 months

1. Pediatric Hypertension is of Increasing Concern: NICU Graduates

- SBPs increase by 20 mmHg when feeding
- Sucking on a pacifier increases SBPs by 10 mmHg
- The ideal infant for BP measurement
  - Prone or supine
  - 1.5 hours after a feed or intervention
  - Undisturbed for 15 minutes after cuff placed
  - Asleep or quiet
  - 3 successive readings at 2 min intervals
  - Oscillometric
  - Not all devices are the same

1. Pediatric Hypertension is of Increasing Concern: Obesity

- The increasing prevalence of hypertension in childhood and adolescence parallels the increasing prevalence of obesity.
- The worldwide childhood obesity epidemic has had such a profound impact on the frequency of hypertension, that primary hypertension should be considered one of the most common health conditions of the young
- Hypertension referral center data confirm the relationships between obesity and hypertension

<table>
<thead>
<tr>
<th>Year Published/Author</th>
<th>% Primary Hypertension</th>
<th>% Secondary Hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988, Feld</td>
<td>16</td>
<td>84</td>
</tr>
<tr>
<td>1994, Arar</td>
<td>23</td>
<td>77</td>
</tr>
<tr>
<td>2005, Flynn</td>
<td>48 (2/3 BMI&gt;90)</td>
<td>52</td>
</tr>
<tr>
<td>2006, Cock (P=0.022)</td>
<td>54 (mean BMI 88 ± 14 %ile)</td>
<td>46 (mean BMI 68 ± 33 %ile)</td>
</tr>
<tr>
<td>2010, Kapur</td>
<td>91 (mean BMI 35.9 kg/m2)</td>
<td>9 (mean BMI 25.4 kg/m2)</td>
</tr>
</tbody>
</table>

1. Pediatric Hypertension is of Increasing Concern: Obesity

- Children (as well as adults) with central obesity have chronically elevated sympathetic nervous system tone that contributes to the development of hypertension in many patients
  ✓ SNS activation increases vascular tone

1. Pediatric Hypertension is of Increasing Concern: Childhood Cancer Survivors

- Complications of therapeutic interventions
  ✓ Hypertension and pre-hypertension in long-term survivors of childhood and adolescent cancers (n=103)
    › Overall-28%
    › ALL-35%
    › AML-40%
    › Wilm’s-70%
  ✓ Much more to be learned!

Pediatric Blood Cancer 09 79-82 2007
1. Pediatric Hypertension is of Increasing Concern:
   - Low birth weight infants, NICU graduates, obese patients and childhood cancer survivors are patients seen in general pediatric settings
     - They may constitute a significant proportion of a given practice
     - They need careful attention paid to their BPs

2. Heredity and Hypertension
   - A 7 year old male presents to your office for routine care.
   - His BP on repeated measures (using the correct cuff!) is in the range of 150-160/90
   - Having recently attended the 61st Annual Spring Conference at Blank Children’s Hospital you carefully collect the following information before you refer the patient to a Pediatric Nephrologist
     - Dad had early onset, severe hypertension that is resistant to standard therapy
     - Paternal grandmother died of advanced cardiovascular disease at age 40
     - Paternal uncle had early onset, severe hypertension that is resistant to standard therapy
   - You also elicit a comprehensive review of systems that has one notable finding
     - Chronic constipation
     - This seems unremarkable since “all children” suffer from constipation in your clinic
   - You wonder about what to do next and so you pick up the phone and call your nephrology consultant
   - What do you suppose your consultant asks you to do?
2. Heredity and Hypertension

- Sodium-140
- Potassium-2.0
- Chloride-89
- CO2-38

You realize that this child has a hypokalemic metabolic alkalosis and also obtain plasma and urinary aldosterone levels. They are both low.

LIDDLE’S SYNDROME

- A rare autosomal dominant disorder that typically presents at a young age with hypertension
- At this point you have essentially made the diagnosis with the aldosterone levels, excluding primary hyperaldosteronism, however there remain some other causes such as licorice ingestion and apparent mineralocorticoid excess
- Gene testing demonstrates mutations in the β and γ subunits of the collecting tubule sodium channel
- These mutations impair the removal of this channel
2. Heredity and Hypertension

- **LIDDLE’S SYNDROME**
  - The result is a constitutive increase in sodium reabsorption with suppression of renin and aldosterone, and a secondary increase in potassium excretion
  - The hypokalemia drives the intracellular movement of hydrogen ion, and in the renal tubular cells this results in increased hydrogen ion secretion into the urine
  - Hypokalemia also increases renal ammoniagenesis resulting in increased secretion and increased generation of bicarbonate
  - The result is alkalosis
3. Value of ABPM (Ambulatory Blood Pressure Monitoring)

Mobile Technology

So What?
• White Coat Hypertension (WCH)
  √ 25% children with repeated abnormal office BPs have WCH-avoid further w/u
  √ Patients with “masked HTN” have the same prevalence of end organ damage as those with persistent HTN
  √ “non dippers” associate with the greatest levels of end-organ damage, CV morbidity and mortality, and progression of renal disease

3. Value of ABPM

• Provides oscillometric, cross-checked blood pressures over a 24 hour period
• Generally provides 60 or so individual systolic and diastolic measures
• Awake and asleep measures are made
• Awake measures are obtained with “normal” activity

3. Value of ABPM

• Average blood pressures are tallied over the 24 hour period and subsets of awake and asleep averages are also obtained
• BP loads are calculated during the same time periods-the percent of SBP and DBP measures exceeding the 95th percentile
• Standard deviations can be used to evaluate BP variability
• Nocturnal “dipping” of BP should be >10% and is also evaluated
3. Value of ABPM

- BP levels
  - Elevations in BP averages and loads are associated with both increased target organ damage (TOD) (children and adults) and cardiovascular mortality (adults)

- BP variability
  - In children with hypertension, increased BP variability correlates better than other ABPM parameters with increased LVMI ("LVH")
  - In adults increased BP variability is associated with progression of TOD and triggering of vascular events

- BP dipping
  - Associates with TOD and also with secondary causes of hypertension (children and adult)
3. Value of ABPM

- A patient, now 17 years of age
- Previously health, at 12 years of age accompanied mom to Sam’s Club where they both checked their BPs. His was 180/120
- Mom brought him to his Pediatrician the next day. Serial BPs over the course of a few days were 140-160/108-120
- Referred to Pediatric Cardiology
  - √ LVH by echocardiography and ECG
  - √ BP right arm 150/108, right leg 168/doppler

3. Value of ABPM

- Cardiology, con’t
  - √ BP right arm 150/108, right leg 168/doppler
  - √ UA sm blood and protein, creatinine 0.7 (eGFR 86, stage 2 CKD)
  - √ Started amlodipine
  - √ Referred to Pediatric Nephrology
- Subsequent course
  - √ BP gradually brought under good control with amlodipine + ACE
  - √ CKD persisted

3. Value of ABPM

- Subsequent course, con’t
  - √ Exhaustive evaluation revealed no etiology of CKD
  - √ Family history of renal transplantation and hypertension on father’s side
  - √ US normal, including doppler interrogation
  - √ Developed recurrent joint swelling and erythema, transient but limiting
    - › had “bone fragment” removed from right great toe
    - › uric acid 13.6
3. Value of ABPM

- Subsequent course, con’t
  - Joint aspirate showed uric acid crystals
    - w/u failed to reveal a cause
  - Renal biopsy showed uric acid nephropathy
  - Started treatment with allopurinol and colchicine
  - BP remained under good control
  - Stable serum creatinine
- Parents wished to try him off of antihypertensive therapy

#3. Value of ABPM

<table>
<thead>
<tr>
<th>Blood Pressure Loads</th>
<th>Systolic</th>
<th>Diastolic</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 hour (normal &lt; 25%)</td>
<td>16%</td>
<td>28%</td>
</tr>
<tr>
<td>Awake (normal &lt; 25%)</td>
<td>15%</td>
<td>30%</td>
</tr>
<tr>
<td>Asleep (normal &lt; 25%)</td>
<td>19%</td>
<td>24%</td>
</tr>
</tbody>
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<th>Blood Pressure Loads</th>
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<tr>
<td>Nocturnal Dip (normal &gt; 10%)</td>
<td>11.45%</td>
<td>20.45%</td>
</tr>
</tbody>
</table>

Clinic BP 108/70 (22%/62%/22%/62%)

12/29/2017: Patient on no antihypertensive therapy.
Clinic BP 110/72 (28%/68%/28%/68%)

Patient's mean Ambulatory BP

Blood Pressure Values

<table>
<thead>
<tr>
<th>24 hour BP</th>
<th>Awake BP</th>
<th>Sleep BP</th>
</tr>
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<tbody>
<tr>
<td>131/78</td>
<td>138/82</td>
<td>121/66</td>
</tr>
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