HYPERTENSION
OBJECTIVES

- Definitions
- Importance hypertension in children.
- Measurement BP in children
- Clinical Evaluation
- Investigations
- Management
DEFINITIONS

• **HYPERTENSION:** Systolic and/or Diastolic BP ≥ 95 % measured upon 3 separate occasions
  – **Stage 1 HTN**
    • Systolic and/or diastolic BP between 95% and 99% + 5 mmHg.
  – **Stage 2 HTN**
    • Systolic and/or diastolic BP ≥ 99% +5 mmHg

• **Pre-HTN:** BP ≥ 90 but < 95%
  – In adolescents if BP >120/80 mmHg (even if < 90th % by the tables)

• **Masked HTN:** Normal office BP, with HTN on ABPM
DEFINITIONS (CONT..)

• Primary (Essential)
  – Seen adolescents
  – No underlying etiology identified.
  – Usually asymptomatic – Detected by screening

• Secondary
  Seen in infants & young children
  – An underlying disorder can be identified
  – Usually symptomatic & severe
DEFINITIONS (CONT..)

• Hypertensive Emergency: Severe hypertension with symptoms like headache, vomiting, altered sensorium, seizure

• Hypertensive Urgency: Severe hypertension with out symptom
WHITE COAT HYPERTENSION

• Elevated BP at clinical setting, but normal BP at home or on 24 hr ABPM.

• Many of these kids have BP in pre-hypertensive range or risk factors for HTN or CV disease.

• They need ongoing follow-up like pre-HTN

• If random BP is always high, a yearly ABPM is helpful
<table>
<thead>
<tr>
<th></th>
<th>1989</th>
<th>2002</th>
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<tbody>
<tr>
<td>Adults</td>
<td>30%</td>
<td>25%</td>
</tr>
<tr>
<td>Children</td>
<td>1.1%</td>
<td>4.5%</td>
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</table>
IMPORTANCE OF HYPERTENSION IN CHILDREN

- HTN. is the most important risk factor for CAD,
  Stroke & chronic kidney disease

- Recent life style changes causes increase in incidents of BP
IMPORTANCE OF HYPERTENSION IN CHILDREN

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WHO SHOULD HAVE THEIR BP CHECKED?

• Children > 3 years old who are seen in a medical setting - at least yearly.

• Correct measurement requires an appropriately size cuff.
  – Current commercial cuff designations (infant, child, adult) are inappropriate.

• Confirm high BP x 3 before diagnosing hypertension.
  – 3 measures separated by > 1 week , unless severe (>99%) or symptomatic.
MEASURING THE BP: DETERMINING PROPER CUFF SIZE BY PATIENT ARM SIZE

The cuff bladder width should be 40% of the circumference of the arm measured at mid arm & 80% arm length
MEASUREMENT OF BP

• BP should be measured in both arms and in one leg.

  – Normally, BP is 10 to 20 mm Hg higher in the legs than the arms.

  – If the leg BP is lower than the arm BP or if femoral pulses are weak or absent, Coarctation of the aorta may be present.
WHEN SHOULD CHILDREN < 3 YEARS OLD HAVE A BP CHECK?

1. Prematurity, LBW, or NB ICU grad.

2. Chronic illness; especially renal, cardiac, neurologic or endocrine.

3. Treatment with drugs known to raise BP.

4. Systemic conditions associated with hypertension (Neurofibromatosis, Tuberous Sclerosis, Hyperthyroid, etc).
OTHER METHODS OF BP MEASUREMENTS

• Flush technique
• Doppler method
• Invasive BP monitoring
  – Most accurate
  – In ill NB- umbilical arterial catheter
  – Older child- radial artery or any central artery
• Ambulatory BP monitoring- for 24 hour record
SUMMARY OF BP MEASUREMENT

CAUSES OF SECONDARY HTN

RENAL – Chronic Pyelo & Glomerulo nephritis, Reflex nephropathy, Congenetal dysplastic kidney, poly cystic & multicystic, Tumours

VASCULAR – Co Aorta, Renal artery stenosis, Renal vein thrombosis, umbilical artery catheterization

ENDOCRINE: Hyperthyroidism & Parthyroidism, Cushing syndrome, CAH, Pheochromocytoma, Aldosteronism

Takayasarteritis, ICSOL

Hyper calcaemia, porphyria
CAUSES OF TRANSIENT HTN

- PSGN
- HUS
- HSP
- PYELONEPHRITS
- HYPERVOLUMIA
- DRUGS: Steroids, cyclosporine, Pb, Hg, Li
- INCREASE INTRA CRANIAL PRESSURE
- GUILAIN BARRE SYNDROME
ETIOLOGY OF PRIMARY HTN

• Obesity
• Insulin resistance
• Sympathetic over activity
• Vascular smooth muscle over activity
• Genetic alteration in calcium & sodium metabolism
CLINICAL FEATURES

• Primary Hypertension is usually asymptomatic
• Secondary Hypertension is usually symptomatic
• Usually vague symptoms
• Headache, vomiting, Irritability
• Visual disturbances
• Breathlessness, exercise in tolerance
• Signs of LV failure with pulmonary edema, S3 gallop
HYPERTENSIVE ENCEPHALOPATHY

• Manifest as head ache, vomiting, ataxia, altered level of consciousness
• Visual disturbances
• Seizures
• Fundus may shows papilledema
• CT scan – Cerebral edema, Posterior Reversible encephalopathy syndrome (PRES)
CLINICAL EXAMINATION

• Abnormal facies- Cushing, Turner, Williams syndrome
• Abnormal Growth- Weight, height- CRF
• Anemia, Rickets- CRF
• Genital abnormality- CAH
• Cutaneous markers like rash –HSP,SLE
• Pulse abnormality-Takayasu’s arteritis, CoA
• Renal mass-polycystic kidney, hydronephrosis, Wilms
• Abdominal bruit-renal artery stenosis, Takayasus
• Fundus, neurological examination
LABORATORY EXAMINATION

- Urine analysis - hematuria, proteinuria, culture
- Hb, Electrolytes, BUN, Creatinine
- Renal USG & Doppler study
- CT scan, MRI
- Radionuclide scan
- 17 hydroxy progesterone, TFT, Plasma Renin activity
- Lipid profile, FBS
- ECG, X ray Chest & Echo cardiogram
- Urine & plasma catecholamines, steroids
LAB EVALUATION SUMMARY

1. Documented hypertension
   - Gradient between upper and lower blood pressures
     - Yes: Coarctation of aorta
     - No: Abnormal urinalysis
       - Yes: Predominant white blood cells
         - Reflux nephritis
         - Recurrent urinary tract infections
         - Renal anomaly (and infection)
       - No: Predominant red blood cells
         - Postinfectious nephritis
         - Lupus nephritis
         - Henoch Schönlein purpura
         - Nephrocalcinosis
         - Nephrolithiasis
         - Other nephritis
         - Renal vein thrombosis
         - Thromboembolism
         - Tumor

2. Endocrine
3. Renovascular lesion
4. Essential hypertension
MANAGEMENT – PRE HYPERTENSION

BP at 90-95% for age, height and gender.

• Many have other risk factors for CV Disease.

• Many of these kids progress to stage 1 HTN.

• 67% progress within 3 years

• Treat all children with HTN with Therapeutic Lifestyle Changes
  – Healthy diet, weight loss if indicated & exercise
THERAPEUTIC LIFESTYLE CHANGES

• Wt. reduction: If obese, make a goal to gradually get BMI < 85%

• Exercise:
  – Moderate to vigorous aerobic activity for 40 min, 3-5 days/week
  – Avoid sedentary activity > 2 hrs / day

• Diet:
  – Avoid sugary foods/drinks and saturated fats. Less salt.
  – Eat fruit, vegetables, lean meats and whole grains.
  – 50/50 plate

• Involve the whole family as partners.
• Develop a health promoting reward system.
• Set achievable goals!
50/50 PLATE

50/50 Plate Model*

Choose lean meats, skinless chicken or turkey. Fish 1-2x/week. Nuts and eggs are also good sources of protein. A burrito or hamburger would include both the protein and grain portions.*

Choose mostly whole grains, beans, potatoes, lentils, or brown rice.

Protein Rich Foods

A Rainbow of Fruits and Vegetables

Grains and Starchy Vegetables

Whole fruits and vegetables are better than juice. Choose the most colorful. Eat the Rainbow!

One serving of “visible fat” (butter, salad dressing, etc.) is incorporated into the grain or vegetable serving at each meal.

CAlcium

One serving of dairy or calcium rich food (for older children, teens, and adults) should accompany the meal. Choose low fat or fat free milk or soy milk.

For those who are lactose intolerant: Choose calcium fortified soy beverage or orange juice. Though not as high in calcium content, you may also choose other foods with calcium including: broccoli, sweet potatoes, and oranges which could be included as a fruit or vegetable portion of the plate.

* For each of 3 meals use a standard dinner plate (8-10” in diameter). The plate is divided into quarters with ½ consisting of fruits and vegetables and the remaining ½ plate divided into protein rich food and grains. For toddlers use a 4-6” plate.

+ The protein portion would be the hamburger meat or burrito beans/meat, the starch is the hamburger bun or the tortilla.
CHILD WITH PRE-HTN-90% TO <95% OR >120/80 IN ADOLESCENT (CONTD)

• Complete History & Physical Examination

• If history indicates a risk of obesity
  – Sleep study

• If co-morbid risk factors present
  • Retinal exam
  • Echocardiogram
  • Fasting lipids and glucose

• If co-morbid disease present (renal, cardiac, diabetes) treat with medications (goal BP < 75%).

• Otherwise follow yearly, encourage TLC.
CLINICAL EVALUATION OF STAGE 1 AND 2 HTN

1. Rule out common secondary causes of HTN:
   - Renal: Ultrasound, BUN, Creatinine, UA, Renin
   - Cardiac: Femoral pulses, CBC, Echocardiogram
   - Endocrine: Electrolytes

2. Screen for metabolic syndrome and CVD risk: Lipid Profile & FBS

3. In patients with Severe HTN & very young look for rare causes of HTN
   - Malignancy, neurologic, drugs, pregnancy, Renovascular disease, Thyroid disease, etc

4. In all cases assess target organ damage- Eye, CVS, CNS, Renal
EVALUATION OF ESSENTIAL HYPERTENSION

Consider Essential HTN if

- Child is $\geq$ 14 years with mild-moderate BP elevation
- Family history of HTN
- Elevated BMI

- **24 hour Ambulatory BP monitoring** (ABPM) is good first step in these patients.

- If elevated BMI coexists, assess co-morbid risks
  - Fasting Glucose, lipids and insulin
INDICATIONS FOR MEDICAL TREATMENT

• Treat with medication if the child has:
  1) Secondary HTN or Stage 2 HTN

  2) Stage 1 or Pre-HTN if:
      • Their is co-existing co-morbid disease.

  3) Stage 1 HTN with evidence of end organ effect
      • Symptomatic HTN, LVH, Hypertensive Retinal changes

  4) Stage 1 HTN with failure to improve after of 6-12 mo. trial of TLCs
     BP goal: < 90%, < 75% if co-morbid disease
DRUG TREATMENT

• 1st choice medicine for Pediatric HTN:
  – Ca channel blockers- Amlodipine, Nifedipin
  – ACE inhibitors – Captopril, Enalapril, Lisinopril
    (Caution with renovascular disease)

• 2nd line drugs
  – Beta blockers- Labetolol, Metoprolol
  – Diuretics- Thiazides, Amiloride
  – Angiotensin receptor blockers- Losartan

• Avoid combination agents
# DRUG TREATMENT (CONT'D)

## Antihypertensive Medications with FDA Approval for Use in Children

<table>
<thead>
<tr>
<th>Class</th>
<th>Drug</th>
<th>Initial dosage</th>
<th>Maximum dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angiotensin-converting enzyme inhibitor*††</td>
<td>Benazepril (Lotensin)§</td>
<td>0.2 mg per kg per day up to 10 mg per day</td>
<td>0.6 mg per kg per day up to 40 mg per day</td>
</tr>
<tr>
<td></td>
<td>Enalapril (Vasotec)§</td>
<td>0.08 mg per kg per day up to 5 mg per day</td>
<td>0.6 mg per kg per day up to 40 mg per day</td>
</tr>
<tr>
<td></td>
<td>Fosinopril (Monopril)</td>
<td>Children heavier than 50 kg: 5 to 10 mg per day</td>
<td>Children heavier than 50 kg: 40 mg per day</td>
</tr>
<tr>
<td></td>
<td>Lisinopril (Zestril)§</td>
<td>0.07 mg per kg per day up to 5 mg per day</td>
<td>0.6 mg per kg per day up to 40 mg per day</td>
</tr>
<tr>
<td>Angiotensin-receptor blocker*††</td>
<td>Irbesartan (Avapro)</td>
<td>Six to 12 years of age: 75 to 150 mg per day</td>
<td>Same as initial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13 years of age: 150 to 300 mg per day</td>
<td>Same as initial</td>
</tr>
<tr>
<td></td>
<td>Losartan (Cozaar)§</td>
<td>0.7 mg per kg per day up to 50 mg per day</td>
<td>1.4 mg per kg per day up to 100 mg per day</td>
</tr>
<tr>
<td>Beta blocker</td>
<td>Propranolol (Inderal)</td>
<td>1 to 2 mg per kg per day</td>
<td>4 mg per kg per day up to 640 mg per day</td>
</tr>
<tr>
<td>Calcium channel blocker¶</td>
<td>Amlodipine (Norvasc)§</td>
<td>6 to 17 years of age: 2.5 to 5.0 mg per day</td>
<td>10 mg per day</td>
</tr>
<tr>
<td>Diuretic*</td>
<td>Hydrochlorothiazide (Hydrodiuril)</td>
<td>1 mg per kg per day up to 50 mg per day</td>
<td>3 mg per kg per day up to 50 mg per day</td>
</tr>
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</table>
DRUG TREATMENT

Step 1
Begin with the recommended initial dose of desired medication

If BP control is not achieved:

Step 2
Increase dose until desired BP target is reached, or maximum dose is reached

If BP control is not achieved:

Step 3
Add a second medication with a complementary mechanism of action
Proceed to highest recommended dose if necessary and desirable

If BP control is not achieved:

Step 4
Add a third antihypertensive drug of a different class
OR
Consult a physician experienced in treating childhood and adolescent hypertension
MANAGEMENT ALGORITHM

Measure BP and height and calculate BMI
Determine BP category for gender, age, and height

Stage 2 Hypertension
Diagnostic workup
Include evaluation for target-organ damage†
Secondary hypertension or primary hypertension

Consider referral
To provider with expertise in pediatric hypertension

Stage 1 Hypertension
Repeat BP
Over 3 visits
≥95% or 120/80 mm Hg

Diagnostic workup
Include evaluation for target-organ damage‡
Secondary hypertension or primary hypertension

Rx specific for cause

Therapeutic lifestyle changes‡

Drug Rx
Weight reduction and drug Rx

Weight ≥95%

Overweight

Drug Rx†
Weight reduction
Still ≥95%

Normotensive
Prehypertensive

Therapeutic lifestyle changes†
90–<95% or 120/80 mm Hg

Repeat BP
In 6 months
Consider diagnostic workup and evaluation for target-organ damage‡
If overweight and comorbidity exists

Educate on heart-healthy lifestyle†
For the family

Educate on heart-healthy lifestyle†

Overweight

Monitor Q 6 Mo

Weight reduction

Weight reduction

Drug Rx
Weight reduction

Overweight

Normal BMI

Overweight

Normal BMI

Overweight

Overweight

Drug Rx
Weight reduction

Drug Rx
Weight reduction

Normal BMI

Weight reduction

IAP UG Teaching slides 2015-16
SUMMARY

• Children > 3 yrs old should be screened for HTN yearly

• Secondary HTN is more common in Children

• Essential HTN is increasing in Children due to increasing levels of Obesity. Obesity control strategy more important than medication

• Treatment of mild-moderate HTN in children should involve lifestyle changes before using medications.

• Use single medications at minimum of dose before stepping up dose. Combination if not controlled with single drug at maximum dose
Thank You