Hypertension in childhood
Approach to diagnosis and management

Prof G van Biljon
Department of Paediatrics
University of Pretoria
Origin and aetiology of adult hypertension

- Research has shown that chronic diseases in adults like CHD, type II diabetes mellitus and HT are determined by a range of characteristics which originate antenatally and continue throughout infancy and childhood.
- In early life humans are “plastic”, molded by their environment.
- Adverse intrauterine conditions can permanently alter the structure, homeostatic systems and functions of the body – a process termed programming.
- Link between developmental plasticity and chronic diseases like CHD, HT, stroke, Type II Diabetes and LBW
- Adverse intra-uterine conditions result in Low Birth Weight (LBW) babies who have ↓ in nephron number
- Adult hypertension – linked to ↓ in nephron number
Teenage hypertension = new disease

- Linked to childhood obesity – “MacDonald Syndrome”
- Ambulatory systolic BP showed a correlation between teenage HT and increasing BMI \(^{(1)}\)
- Increased risk of CVS disease + Metabolic Syndrome (obesity, insulin resistance + dyslipidaemia)
- IUGR linked to risk of HPT in childhood, marker for adult cardiovascular disease \(^{(2)}\)

1 Paediatrics 2008;121:115-22
2 Arch Pediatr Adolesc Med 2006; 160:977-81
Origins & Aetiology of Adult Hypertension

The most important of these early life determinants are

- Poor socio-economic environment
- Those whose mothers had pregnancy induced HT
- Those whose mothers smoke throughout pregnancy
- Those with low birth weight
- Who were not breast-fed
- Who have high sodium diets in infancy
- Who are obese in childhood or adolescence

Monitoring childhood BW and BP

- It is rate of ↑ in fatness after the age of 2 years rather than the level of fatness at any given age that needs monitoring.
- Serial measurements of BMI becomes necessary.
- Children whose BMI’s cross percentiles upwards beyond the age of 2 years should have their BP routinely monitored.
Interpretation of BP

- BP in children correlates with body size and increases with age.
- BP “tracks across the life course, such that those at the higher end of the BP distribution in early life tend to be at the higher end of the distribution.
- Age and sex-specific height percentiles should be used to interpret the measured BP\(^1,2\).

1. Easy-to-use childhood BP tables (International Pediatric Hypertension Association 
   \(\text{Http://www.pediatrichypertension.org}\)

Definition of Hypertension

- Normal: SBP and DBP < 90\textsuperscript{th} percentile BP for sex, age and height percentile

- Hypertension: SBP and/or DBP \geq 95\textsuperscript{th} percentile for BP for age, sex and height percentile on 3 separate occasions
Definition of Hypertension

- National High BP Education Program Working Group defined 3 categories of high BP in children:¹
  - → specific management implications

- Pre hypertension
- Stage 1 HT
- Stage 2 HT

- **Prehypertension** = systolic or diastolic BP >90\textsuperscript{th} to <95\textsuperscript{th} percentile* or if BP exceeds 120/80 mm Hg even if <90\textsuperscript{th} to <95\textsuperscript{th} percentile

- **Stage 1 HT** = systolic or diastolic BP between 95\textsuperscript{th} - 99\textsuperscript{th} percentile *plus 5 mm Hg

- **Stage 2 HT** = systolic or diastolic BP >99\textsuperscript{th} percentile * plus 5 mm Hg

- *Value for age, gender and height percentile measured on at least 3 separate occasions
Technical aspects of measuring BP

- Use correct cuff size:
  - Cuff must encircle the arm
  - Width should be 40-50% of the arm circumference
  - Rather use too wide cuff

- Situation
  - Environment
  - Anxious, crying infant
  - White coat hypertension
  - Activity
Purpose of BP Measurement

To identify pathology and differentiate between

- Underlying disease secondary HT
- Essential HT

Important

- Incorrect diagnosis of HT e.g. poor technique → anxiety
- Miss a treatable condition
Need to know patient’s:

- Age
- Sex
- Height

Plot height on percentile chart
## 95th Percentiles of Blood Pressure for Boys for Age & Height Percentiles

<table>
<thead>
<tr>
<th>Age</th>
<th>Systolic Blood Pressure by Percentile of Height, mmHg+</th>
<th>Diastolic Blood Pressure by Percentile of Height, mmHg+</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>5%</td>
<td>10%</td>
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<td>9</td>
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<tr>
<td>Age</td>
<td>BP Percentile*</td>
<td>Systolic Blood Pressure by Percentile of Height, mmHg+</td>
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<td>4</td>
<td>99th</td>
<td>113</td>
</tr>
</tbody>
</table>
Clinical manifestations of HT in neonates + infants

- Failure to thrive
- Irritable
- Feeding problems, vomiting
- Seizures
- Respiratory failure, cyanosis or apnoea
- Cardiac failure
HT in neonates and infants

- Low incidence in healthy term infants 0.2 to 3%
- So unusual - routine BP determination is not advocated
- Not so for preterm and high-risk newborns in NICU:
- HT more common in infants (9%) with
  - BPD (Chronic lung disease)
  - PDA
  - Intraventricular haemorrhage
  - Indwelling umbilical arterial catheters
  - Antenatal steroids
  - Maternal HT
  - Postnatal acute renal failure

Presenting features of HT in toddlers/older Children

- CNS: Convulsions (25%), coma, facial palsy (12%) , hemiplegia (8%)
- Visual symptoms (27%): blurring, blindness
- Renal: Oedema, haematuria, proteinuria, polydipsia, polyuria, enuresis, acute renal failure
- CVS: Acute heart failure and pulmonary oedema, LV hypertrophy
- Respiratory: Acute respiratory distress
- Other: poor growth, vomiting, abdominal pain, epistaxis
- Some may be asymptomatic
Presenting features of HT in this toddler

- Abdominal distension
- Polydipsia
- Polyuria
- FTT
- Left renal hypoplasia
Core Messages

- Likelihood of identifying a secondary cause is
  - Directly related to level of BP and
  - Inversely related to age of the child

- In the majority of children HT is due to an identifiable cause

- Severe elevation of BP, regardless of age, warrants urgent evaluation and referral
Core Messages

Severe hypertension suggests renal disease

Acute onset of HT suggests acute renal disease
e.g. Acute post streptococcal glomerulonephritis
Work-up for Hypertension

- Start with complete history
- Physical examination - ? Evidence of an underlying cause or end organ damage
  - Antropometry
  - Body habitus (pattern of obesity)
  - Skin: café au-lait spots, striae
  - Pulses in all extremities
  - Measure BP in all 4 limbs (at least right arm and right leg)
  - Cardiac and neurological examination
  - Fundi (arteriolar narrowing)
  - Abdominal mass, palpable bladder, flank bruits, oedema
  - Examine thyroid
Hypertension

Multiple Café-au-lait spots
Bilateral renal artery stenosis associated with Neurofibromatosis
- Malar skin rash
- Petechiae and purpura
- CNS symptoms
- SLE
Iatrogenic HT

- Iatrogenic
- Steroid treatment
Work-up for hypertension in neonates

- Obtain focused history
  - ? Pertinent prenatal exposures
  - Clinical course
  - Any concurrent conditions
  - Procedures e.g., umbilical catheter
  - Current medication

- Physical examination- focused to assist in narrowing the differential diagnosis

- BP readings should be obtained in all four extremities to rule out coarctation of the aorta
Diagnostic Evaluation

- Investigations should be tailored to
  - The age of the child
  - The severity of BP elevation
  - Positive findings on history and examination

- Appropriate investigations should be done to
  - Exclude an underlying cause
  - Exclude acute complications and associated diseases
  - Determine effects on target organs
Special Investigations

A limited number of investigations will often confirm suspected pathology or help to direct further tests:

- Urine dipstix, microscopy and culture
- Blood Urea, Creatinine, Electrolytes
- Full blood count
- Renal ultra sound
- CXR and ECG
- Peripheral Plasma Renin Activity
HT Crisis = Malignant HT

- Hallmark
  - Fibrinoid necrosis
  - Ischaemia of end organs
- Manifestations
  - Encephalopathy
  - Retinal haemorrhages
  - Cardiac failure
  - Renal complications
Hypertensive Urgency

- **Definition**
  - Severe HT without accompanying end organ damage

- **Manifestations**
  - Headache, blurred vision and nausea, but no evidence of end organ involvement

- The BP level at which these changes occur is not predictable

- Depends on the rate of rise in BP
Management of severe HT

- Life threatening condition
- Serious sequelae if inadequately treated
- Equally serious complications if over enthusiastically treated
- Rate of BP reduction depends upon starting BP and age of the child
Management

Hypertensive crises
Treat urgently: Reduce BP within minutes to hours in order to avoid life-threatening complications. Avoid precipitous drop in BP.

Hypertensive urgency
Control BP over 72 hours to one week.
Management of acute malignant hypertension

- Aim to reduce blood pressure by:
  - 1/3 of total desired reduction in 1st 12 hrs
  - Next 1/3 over 12-36 hrs
  - Last 1/3 over 36-72 hrs

- Aim to treat the cause – e.g. if fluid overloaded give a diuretic.
Pathophysiology of chronic hypertension

- In chronic HT the cerebral autoregulatory zone is shifted to a higher BP range compared to normotensive patients.
- If the BP is lowered too rapidly below this range, perfusion of the target organs may become compromised.
- \(\rightarrow\) cerebral ischaemia, stroke, blindness.
Impaired Cerebral Autoregulation during Ischemia

![Graph showing cerebral blood flow vs. cerebral perfusion pressure for different tissue conditions.](image-url)
Drug Treatment

- Order in which drugs are administered may vary depending on the
  - History
  - Physical examination
  - Laboratory findings
- Oral drugs can occasionally be used
- Use parenteral drugs for altered mental status
Tailor anti HT drugs according to cause

Renin induced HT
R type HT

Drugs to:
Suppress renin
Reduce Angiotensin II
Examples:
β blocker, ACEI, ARB

Volume Na+ Dependent HT
V type HT

Drugs to:
Reduce volume
Vasodilate
Examples:
Diuretics, CCB
Drugs for treatment of HT crises

1. Furosemide IV
   and
2. Labetolol (Trandate) IV

3. Amlodipine oral
   May be repeated 6 hours later, then 12 hourly
   If repeated doses are required, start and continue oral therapy as soon as possible
Treatment of chronic hypertension

• For uncomplicated primary HT+ no target-organ damage, BP goal be < 95\textsuperscript{th} percentile

• For chronic renal disease, DM or HT target organ damage, BP goal <90\textsuperscript{th} percentile

• Specific classes of antihypertensive drugs should be used according to the underlying pathogenesis or illness
## Classification of chronic hypertension in children and therapy recommendations

<table>
<thead>
<tr>
<th>Stage</th>
<th>BP percentile</th>
<th>Therapeutic lifestyle changes</th>
<th>Pharmacologic treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prehypertension</td>
<td>90&lt;sup&gt;th&lt;/sup&gt; to &lt; 95&lt;sup&gt;th&lt;/sup&gt; or BP &gt; 120/80 mm Hg even if &lt; 90&lt;sup&gt;th&lt;/sup&gt; percentile</td>
<td>Introduce physical activity, Diet management, Weight reduction if overweight</td>
<td>None unless compelling indications e.g. chronic kidney disease</td>
</tr>
<tr>
<td>Stage 1 hypertension</td>
<td>95-99&lt;sup&gt;th&lt;/sup&gt; percentile plus 5 mm Hg</td>
<td>Introduce physical activity, Diet management, Weight reduction if overweight</td>
<td>Initiate therapy based on indications, e.g. positive family history of cardiovascular disease, essential hypertension, DM etc.</td>
</tr>
<tr>
<td>Stage 2 hypertension</td>
<td>&gt; 99&lt;sup&gt;th&lt;/sup&gt; percentile plus 5 mm Hg</td>
<td>Regular physical exercise, Diet management, Weight reduction if overweight</td>
<td>Initiate therapy</td>
</tr>
</tbody>
</table>
Treatment of Chronic Hypertension

- Advise a change in lifestyle
  - Limit TV viewing and increase physical activity
  - Limit junk food
- A weight reduction programme for obese individuals
- Regular aerobic exercise for essential hypertension
- Dietary advice
  - Limit salt and saturated fat intake
  - Increase dietary fibre intake
Step wise treatment

- For ambulatory patients begin with lowest dose of preferred drug
- ↑dose at each visit until control is achieved
- For patients with persistent HT despite an optimal dose of a 1st line drug, add 2nd or 3rd drug
- There is no specific order in which drugs should be added, however, for some conditions certain drugs are indicated
Treatment of chronic hypertension

- For uncomplicated 1°HT+ no target-organ damage, BP goal be <95th percentile
- For chronic renal disease, DM or HT target organ damage, BP goal<90th percentile
- Specific classes of antihypertensive drugs should be used according to the underlying pathogenesis or illness
Treatment of Chronic Hypertension

Chronic kidney disease & proteinuria

Drugs to:
Decrease proteinuria
ACEI, ARB, β-Blocker
Treatment of Chronic Hypertension

Neuro-secretory cause
e.g. pheochromocytoma

Combined $\alpha$ & $\beta$-adrenergic receptor blocker
Labetolol
Prazosin and Atenolol

Apparent $\uparrow$ mineralocorticoid or Liddle Syndrome ($\downarrow$ renin)

Drugs that act on collecting tubules
Triamterene
Amiloride
<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pheochromocytoma</td>
<td>Dangerous to start with β blocker only → unopposed α-stimulation</td>
</tr>
<tr>
<td>CNS disease or coma</td>
<td>CCB increase risk of CNS hemorrhage</td>
</tr>
<tr>
<td>Acute renal failure or Bilateral renal art. stenosis</td>
<td>ACEI</td>
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</table>
## Drugs: Unsafe in Specific Situations

<table>
<thead>
<tr>
<th>Acute cardiac decompensation</th>
<th>CCB</th>
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<tbody>
<tr>
<td></td>
<td>• ↑ risk of cardiac ischaemia</td>
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<tr>
<td></td>
<td>• ↑ heart rate</td>
</tr>
<tr>
<td></td>
<td>• ↑ catecholamine levels</td>
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<table>
<thead>
<tr>
<th>Asthma</th>
<th>β-blocker</th>
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Reminder

- Measurement of BP is part of routine examination
- Incorrect measurement is worthless
- No point in measuring it, but not interpreting value
- Medical negligence if no action is taken when child has hypertension
References

1. Paediatrics 2008;121:115-22

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