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Hypertension in childhood  
Approach to diagnosis  
Part 1 Block 10

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# Introduction

- Hypertension is the most common risk factor for the development of coronary heart disease, stroke and chronic kidney disease
- CVS is the the second most important cause of death in adults in SA [1]
- It accounts for 7.5% of the health care spending in SA [2]

1. Bradshaw D et al. Medical Research Council Policy Brief. March 2003. Tygerberg MRC 2003.
2. Douberty J et al. Centr Afr J Med 1996;42:21-24

# Incidence of Hypertension

- Increasing in both adults and children – mainly due to an increase in primary hypertension
- This is in line with increasing incidence of obesity and physical inactivity<sup>1</sup>
- In a recent study in school aged children the prevalence of hypertension was 4.5%<sup>2</sup>

1. National High Blood Pressure Education Program Working Group on High BP in children and Adolescents 4<sup>th</sup> Report *Pediatr* 2004; 114 556

2. Sorof et al. *Pediatrics* 2004; 113:475-482

# Origin and aetiology of adult hypertension

- BP is determined by genetic and environmental influences
- Increasing evidence that chronic diseases in adults like CHD, type II diabetes mellitus and HT are determined by a range of characteristics originating **antenatally and which continue throughout infancy and childhood**

## Mechanisms of disease:

### In utero programming in the pathogenesis of HT

- In early life humans are “plastic”, molded by their environment
- During critical periods of development nutritional and other environmental cues can permanently alter the structure, homeostatic systems and functions of the body – a process termed **programming**
- Critical periods coincide with periods of rapid cell division e.g. for the kidney **nephrogenesis** completed by 34-36 w

## Longterm effects of in utero programming

- Adverse nutritional and environmental factors influence renal development
- Low birth weight babies have ↓ number of nephrons
- Link between developmental plasticity and chronic diseases like CHD, HT, stroke, T2DM – LBW
- Adult hypertension – linked to ↓ in nephron number

## 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 determines risk
- Serial measurements of BMI necessary to monitor besity
- Those whose BMI's cross percentiles upwards beyond the age of 2 years should have their BPs monitored routinely

# Teenage hypertension = new disease

- Linked to childhood obesity – “MacDonald Syndrome”
- Ambulatory systolic BP showed an ↑increase with ↑ BMI <sup>(1)</sup>
- Increased risk of CVS disease + Metabolic Syndrome (obesity, insulin resistance + dyslipidaemia)
- IUGR linked to risk of HPT in childhood, marker for adult cardiovascular disease <sup>(2)</sup>

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 <sup>1</sup>
- 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

1. Galobardes, B et al. Epidemiol Rev 2004; 26:7-21

# 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<sup>1,2</sup>
- 1. Easy-to- use childhood BP tables (International Pediatric Hypertension Association [Http://www.pediatrichypertension.org](http://www.pediatrichypertension.org)
- 2. [Http://nhlbi.nih.gov/health/prof/heart/hbp/hbp\\_measure\\_child.htm](http://nhlbi.nih.gov/health/prof/heart/hbp/hbp_measure_child.htm)>(2007)

# Tracking

- Tracking of a characteristic is defined as either stability of a certain variable over time or the predictability of later values from earlier measurements <sup>1,2</sup>
- BP tracks from childhood to adulthood <sup>3,4</sup>

1. Tracking: prediction of future values from serial measurements. *Biometrics* 1981; 37: 427-437

2. An index of tracking for longitudinal data. *Biometrics* 1981; 37: 439-446

3. Blood pressure tracking. *J Cardiovasc Risk* 1997; 4: 251-256

4. Tracking of systolic BP during childhood: a 15 year follow up population- based family study in eastern Finland. *J Hypertens* 2002; 20: 195-202

## Definition of Hypertension

- Normal : SBP and DBP  $<$  90<sup>th</sup> percentile BP for sex, age and height percentile
- Hypertension : SBP and/or DBP  $\geq$  95<sup>th</sup> 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:<sup>1</sup>
- → specific management implications
- National High BP Education Program Working Group on High BP in Children and Adolescents – 4th Report Paediatrics 2004;114(2):555-576

- **Prehypertension** = systolic or diastolic BP  $>90^{\text{th}}$  to  $<95^{\text{th}}$  percentile\* or if BP exceeds 120/80 mm Hg even if  $<90^{\text{th}}$  to  $<95^{\text{th}}$  percentile
- **Stage 1 HT** = systolic or diastolic BP between  $95^{\text{th}}$  -  $99^{\text{th}}$  percentile \*plus 5 mm Hg
- **Stage 2 HT** = systolic or diastolic BP  $>99^{\text{th}}$  percentile \* plus 5 mm Hg
- \*Value for age, gender and height percentile measured on at least 3 separate occasions

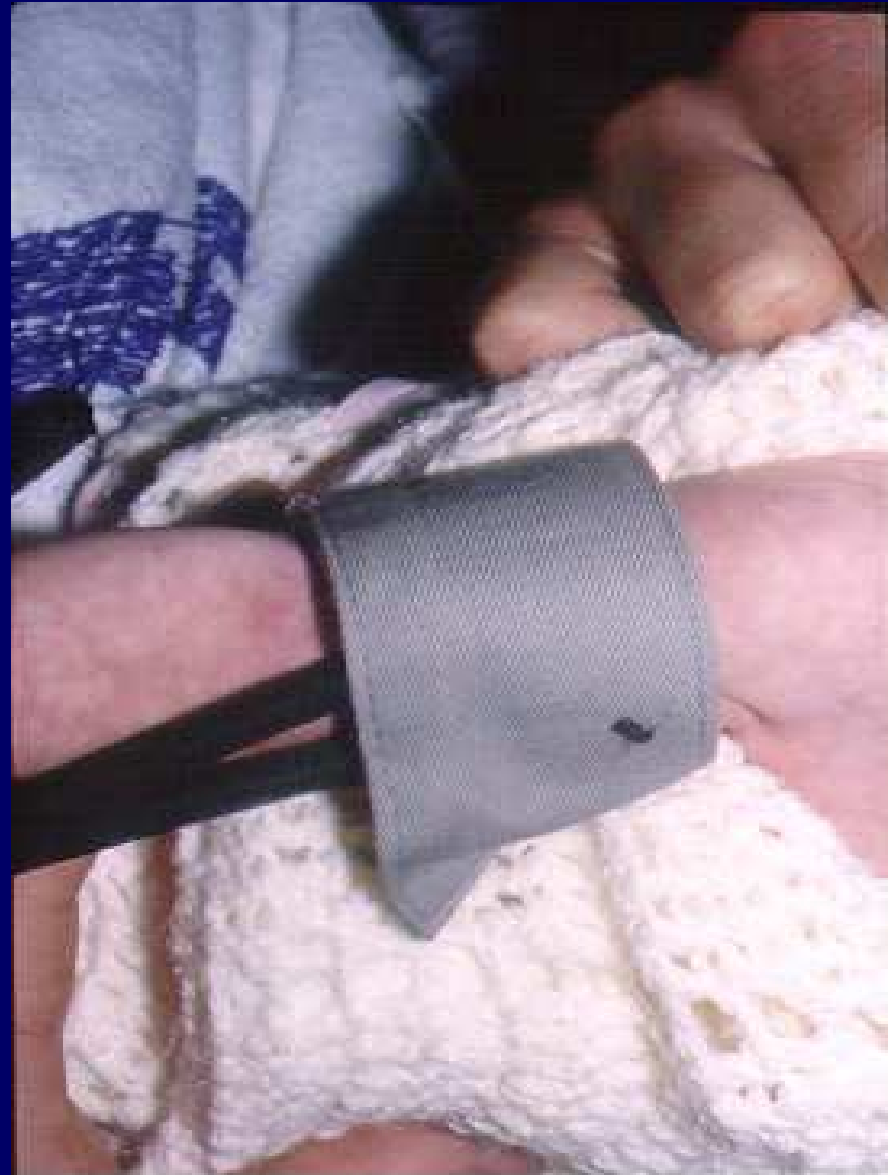
## Measurement Mistakes Due to Wrong Cuff Size

- ❑ Length: The cuff must encircle the arm completely
- ❑ Width: should be 40-50% of the arm circumference
- ❑ Use the widest cuff that can be applied to the upper arm



## Measurement Mistakes Due to Wrong Cuff Size

- Rather use too large cuff than one that is too small
- Large cuffs can be folded to the appropriate size in smaller infants as long as the bladder encircles the arm





# Purpose of BP Measurement

To identify pathology

- ? Disease causing secondary HT
- ? Essential HT

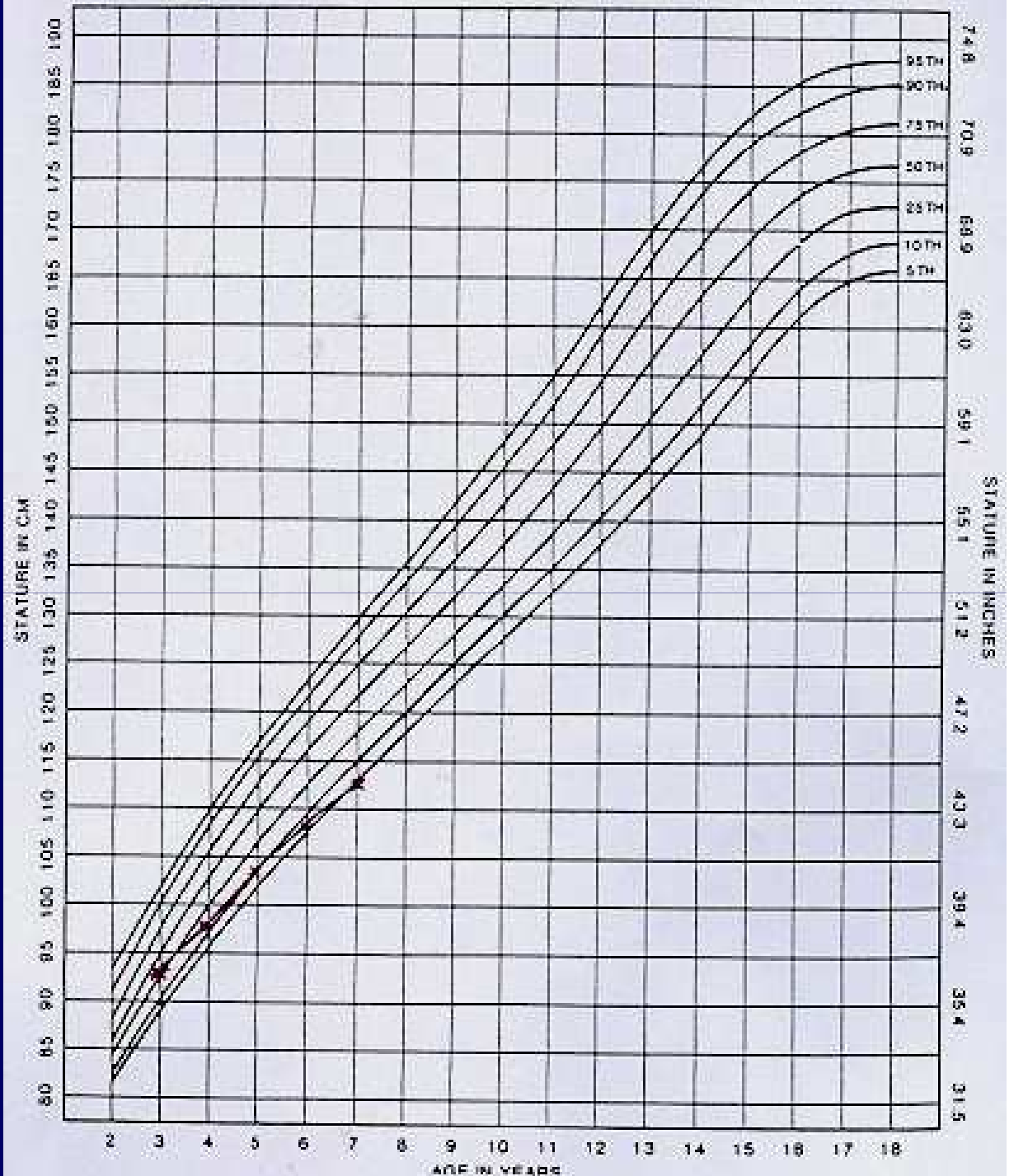
Important

- Not to create anxiety by incorrect technique
- Fail to recognize normality
- 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

Age	Systolic Blood Pressure by Percentile of Height, mmHg+							Diastolic Blood Pressure by Percentile of Height, mmHg+						
	5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
1	98	99	101	103	104	107	106	54	54	55	56	57	58	58
2	101	102	104	106	108	108	110	59	59	60	61	62	63	63
3	104	105	107	109	110	109	113	63	63	64	65	66	67	67
4	106	107	109	111	112	111	115	66	67	68	69	70	71	71
5	108	109	110	112	114	112	116	69	70	71	72	73	74	74
6	109	110	112	114	115	114	117	72	72	73	74	75	76	76
7	110	111	113	115	117	115	119	74	74	71	76	77	78	78
8	111	112	114	116	118	117	120	75	76	72	78	79	79	80
9	113	114	116	118	119	119	121	76	77	74	79	80	81	81

Age	BP Percentile*	Systolic Blood Pressure by Percentile of Height mmHg							Diastolic Blood Pressure by Percentile of Height, mmHg						
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
1	95 <sup>th</sup>	98	99	101	103	104	107	106	54	54	55	56	57	58	58
1	99 <sup>th</sup>	105	106	108	110	112	113	114	61	62	63	64	65	66	66
2	95 <sup>th</sup>	101	102	104	106	108	108	110	59	59	60	61	62	63	63
2	99 <sup>th</sup>	109	110	111	113	115	117	117	66	67	68	69	70	71	71
3	95 <sup>th</sup>	104	105	107	109	110	109	113	63	63	64	65	66	67	67
3	99 <sup>th</sup>	111	112	114	116	118	119	129	71	71	72	73	74	75	75
4	95 <sup>th</sup>	106	107	109	111	112	111	115	66	67	68	69	70	71	71
4	99 <sup>th</sup>	113	114	116	118	129	121	122	74	75	76	77	78	78	79

## 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

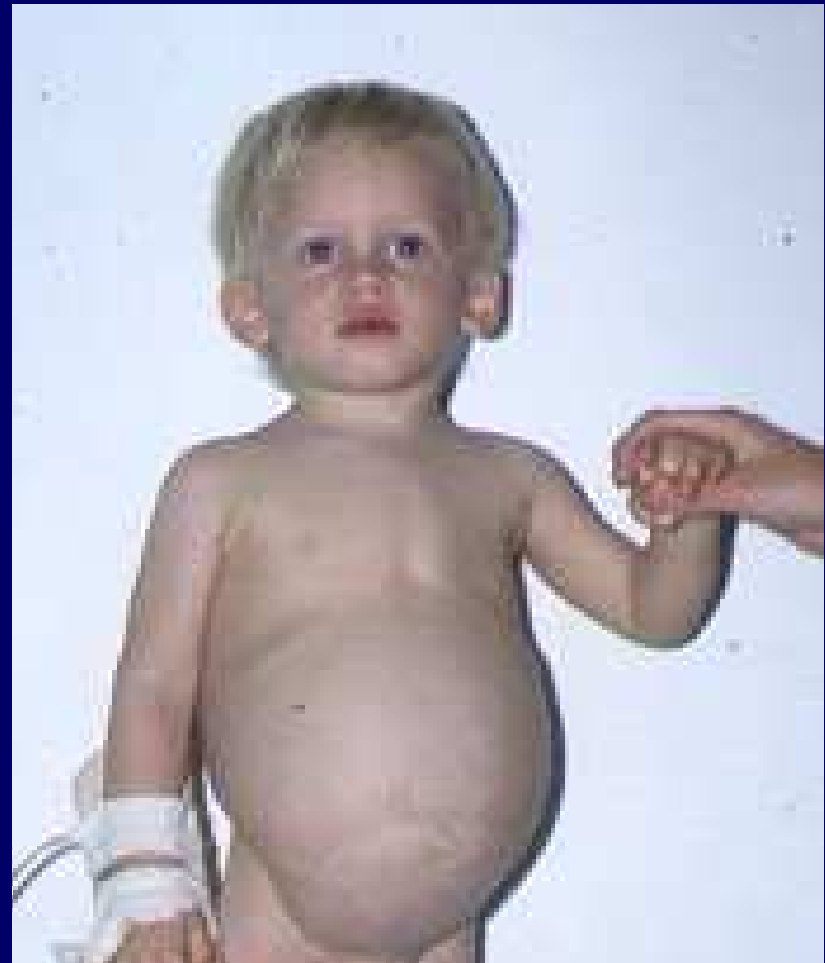
- Low incidence in healthy term infants 0.2 to 3%
- Thus routine BP measurement is not advocated
- Not so for preterm and high-risk newborns in NICU:
- HT more common in infants (9%) with
  - BPD (Chronic lung disease)
  - PDA
  - Intraventricular haemorrhage
  - Indwelling umbilical arterial catheters
  - 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

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Severe hypertension suggests renal disease

Acute onset of HT suggests acute renal disease

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# Work-up for Hypertension

- Start with complete history
- Physical examination - ? Evidence of an underlying cause or end organ damage
  - Anthropometry
  - 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