

Hypertension in Children and Adolescents

Dr Abbas OWEID Olewi

Learning points

- Normal blood pressures in children
- Measurement of Blood pressure in children
- Etiology of Hypertension in children
- Evaluation of children with hypertension
- Treatment of hypertension in children

Blood Pressure in Children and Adolescents

- Normal range of blood pressure determined by body size and age
- Blood pressure standards developed based on age, gender and height of healthy population
- Blood pressure measurement preferred in the right upper extremity

Blood Pressure Measurement

- Routine measurement from 3 years
(Fourth report on childhood BP, NHLBI)
- Blood pressure must be measured appropriately for accurate interpretation
- Ideally, measure BP by auscultation, using a mercury sphygmomanometer

Blood pressure measurement

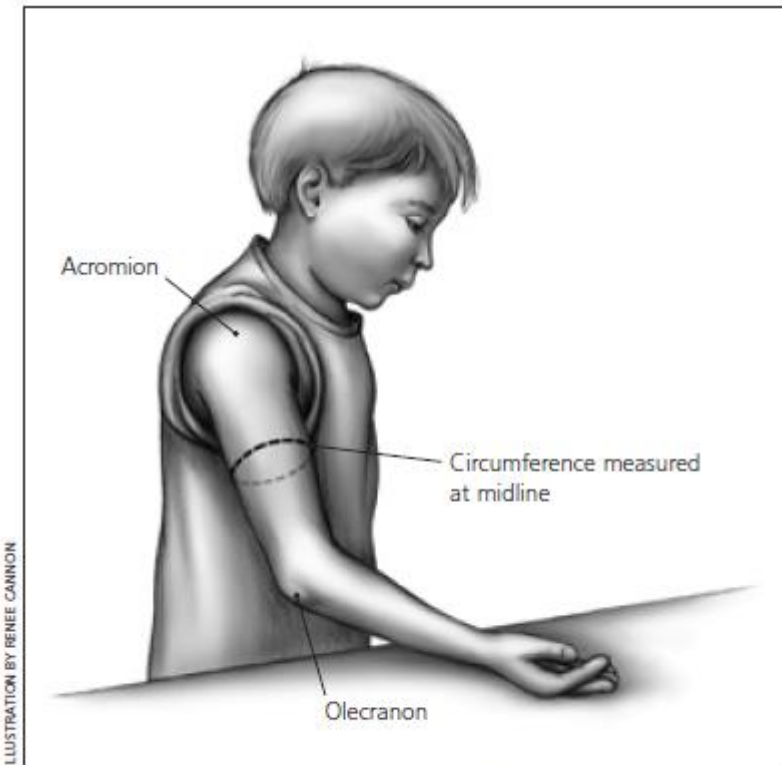


Figure 1. Arm circumference should be measured midway between the olecranon and acromial process.

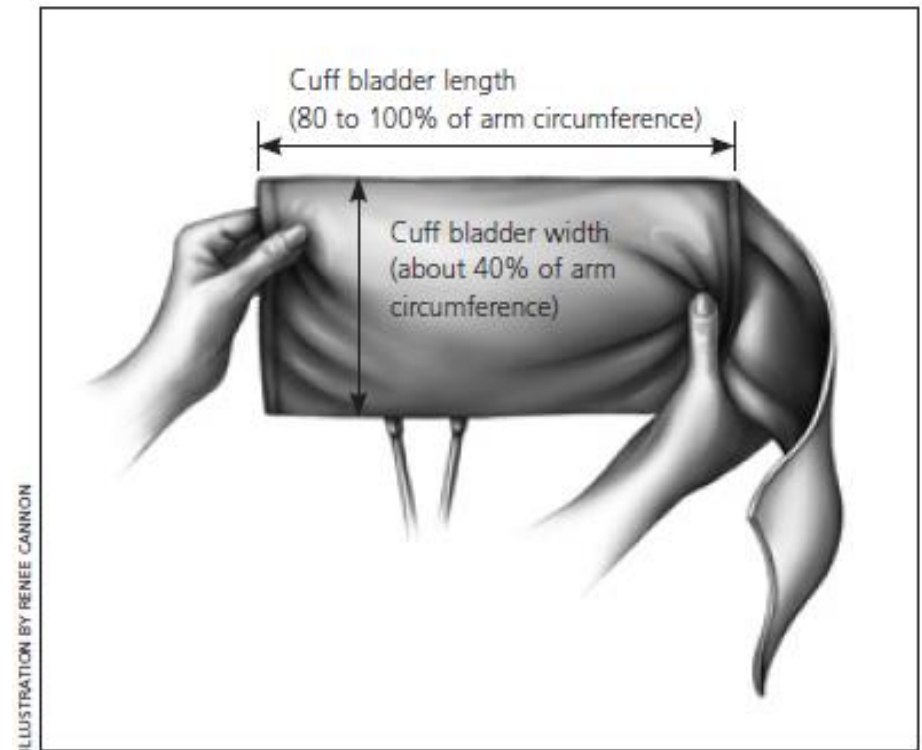


Figure 2. Blood pressure cuff showing size estimation based on arm circumference.

Definitions

- **“Normal Blood Pressure”**: $< 90^{\text{th}}$ percentile for age, gender and height.
- **“Pre-hypertension”**: SBP and/or DBP $> 90^{\text{th}}$ percentile but less than 95^{th} percentile for age, gender and height.

For age > 12 years, BP $> 120/80$ regardless of 90^{th} percentile considered pre-hypertension

Definitions

- **“Hypertension”**: SBP and/or DBP $>95^{\text{th}}$ percentile for age, gender and height

Stage 1: $95^{\text{th}} - 99^{\text{th}}$ percentile + 5 mmHg

Stage 2: $> 99^{\text{th}}$ percentile + 5 mmHg

**Confirmed on 3 or more occasions*

Definitions

- **“White Coat Hypertension”**: Blood pressure $> 95^{\text{th}}$ percentile in the physician’s office, normotensive in outside environment
- **“Masked Hypertension”**: Normal blood pressures in the physician’s office, but high at home

Blood Pressure Tables

Boys

SBP, mmHg

Percentile Height

DBP, mmHg

Percentile Height

(Year) Percentile		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
12	50th	102	103	104	105	107	108	109	61	61	61	62	63	64	64
	90th	116	116	117	119	120	121	122	75	75	75	76	77	78	78
	95th	119	120	121	123	124	125	126	79	79	79	80	81	82	82
	99th	127	127	128	130	131	132	133	86	86	87	88	88	89	90

Etiology of Hypertension

- **“Primary”** (essential)
 - rising impact of obesity (~30% of obese with HTN)
- **“Secondary”**
 - represents ~ 5% of pediatric HTN

Primary Hypertension

- Usually characterized by mild or stage 1 hypertension
- Children frequently overweight
- Often associated with FH of HTN and cardiovascular disease

Secondary HTN in Children

- More common in children than adults
- Consider this possibility in every child with HTN
- Majority of children with secondary hypertension will have renal or renovascular disease
- Thorough history and physical exam will likely give clues to underlying problems

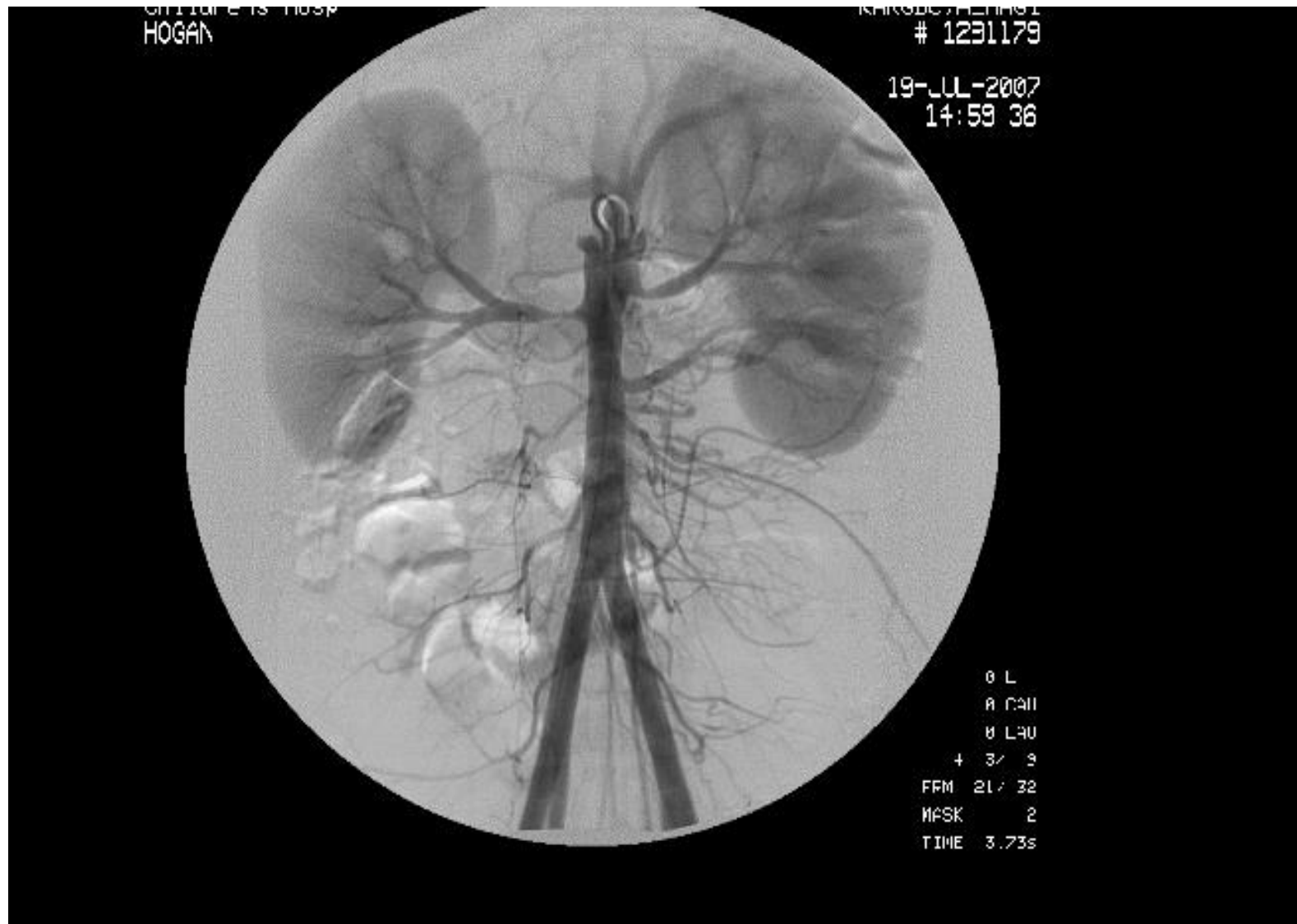
Children

TABLE 3

Causes of Childhood Hypertension According to Age Group

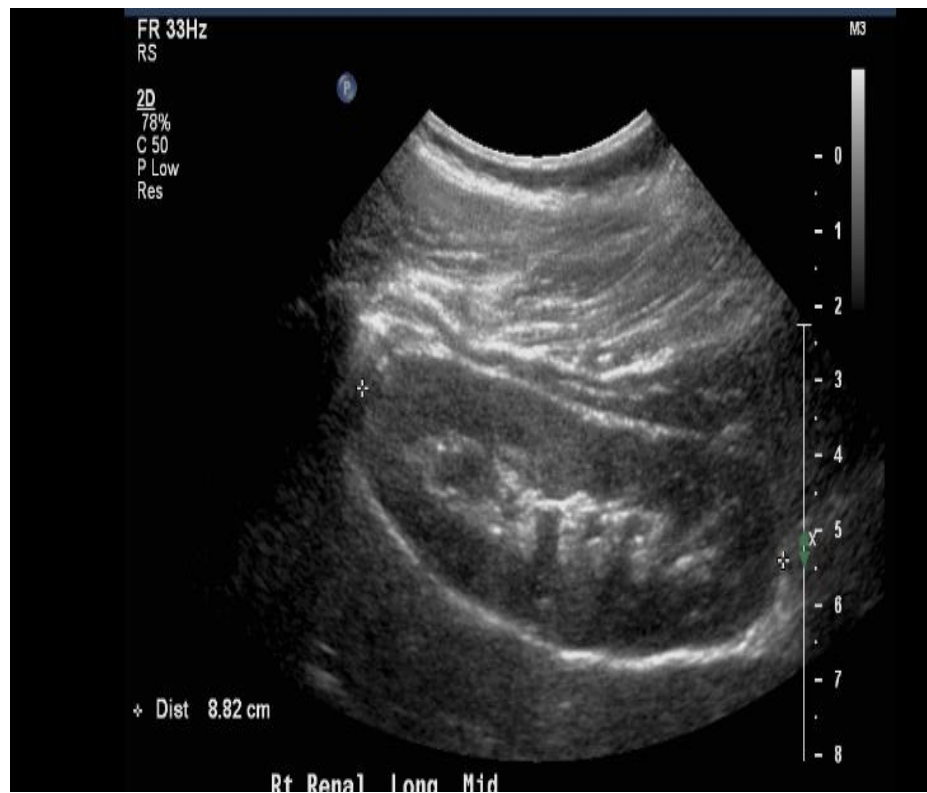
<i>Age</i>	<i>Causes</i>
One to six years	Renal parenchymal disease; renal vascular disease; endocrine causes; coarctation of the aorta; essential hypertension
Six to 12 years	Renal parenchymal disease; essential hypertension; renal vascular disease; endocrine causes; coarctation of the aorta; iatrogenic illness
12 to 18 years	Essential hypertension; iatrogenic illness; renal parenchymal disease; renal vascular disease; endocrine causes; coarctation of the aorta

Renovascular disease



ARPKD

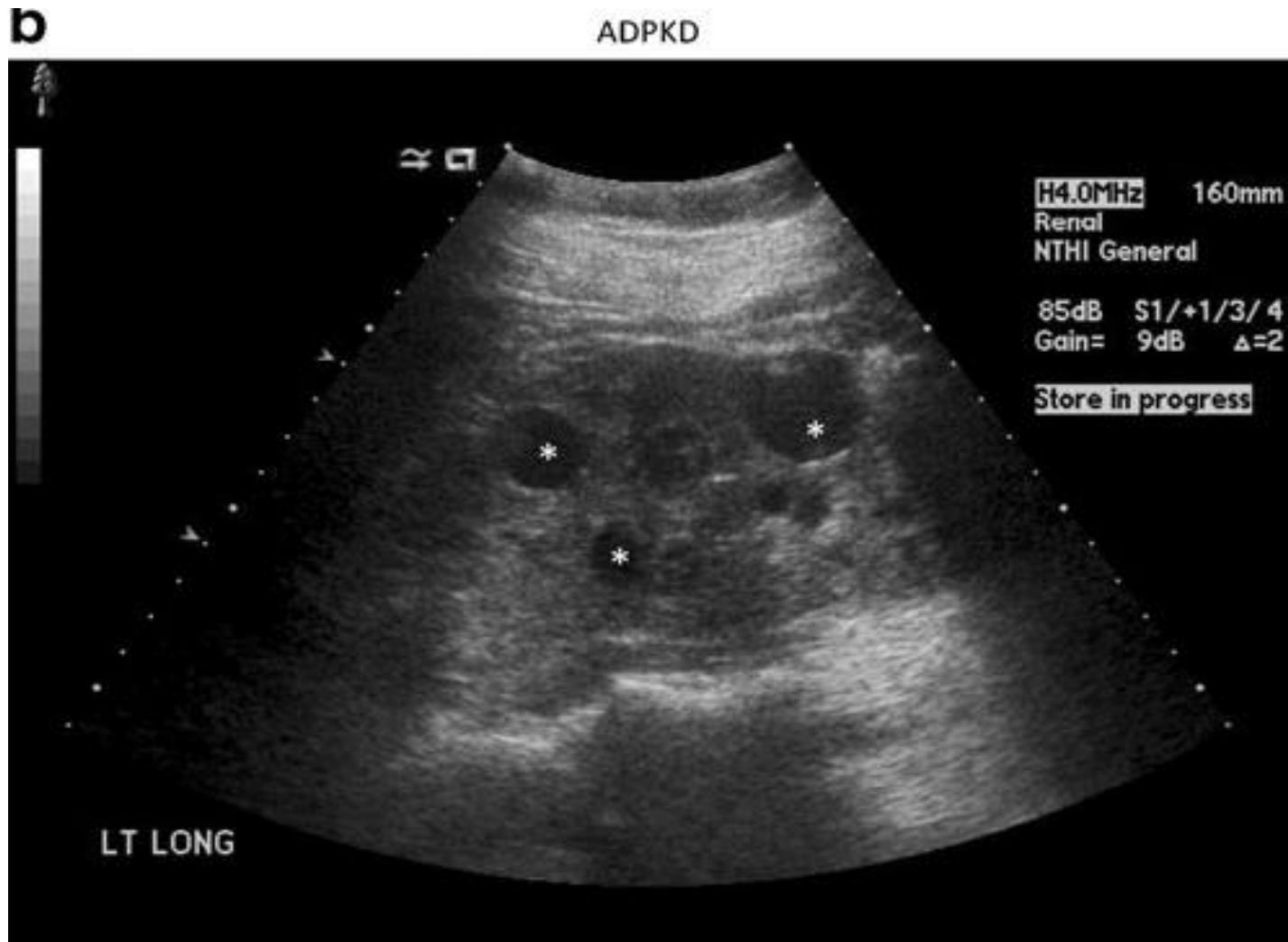
Normal



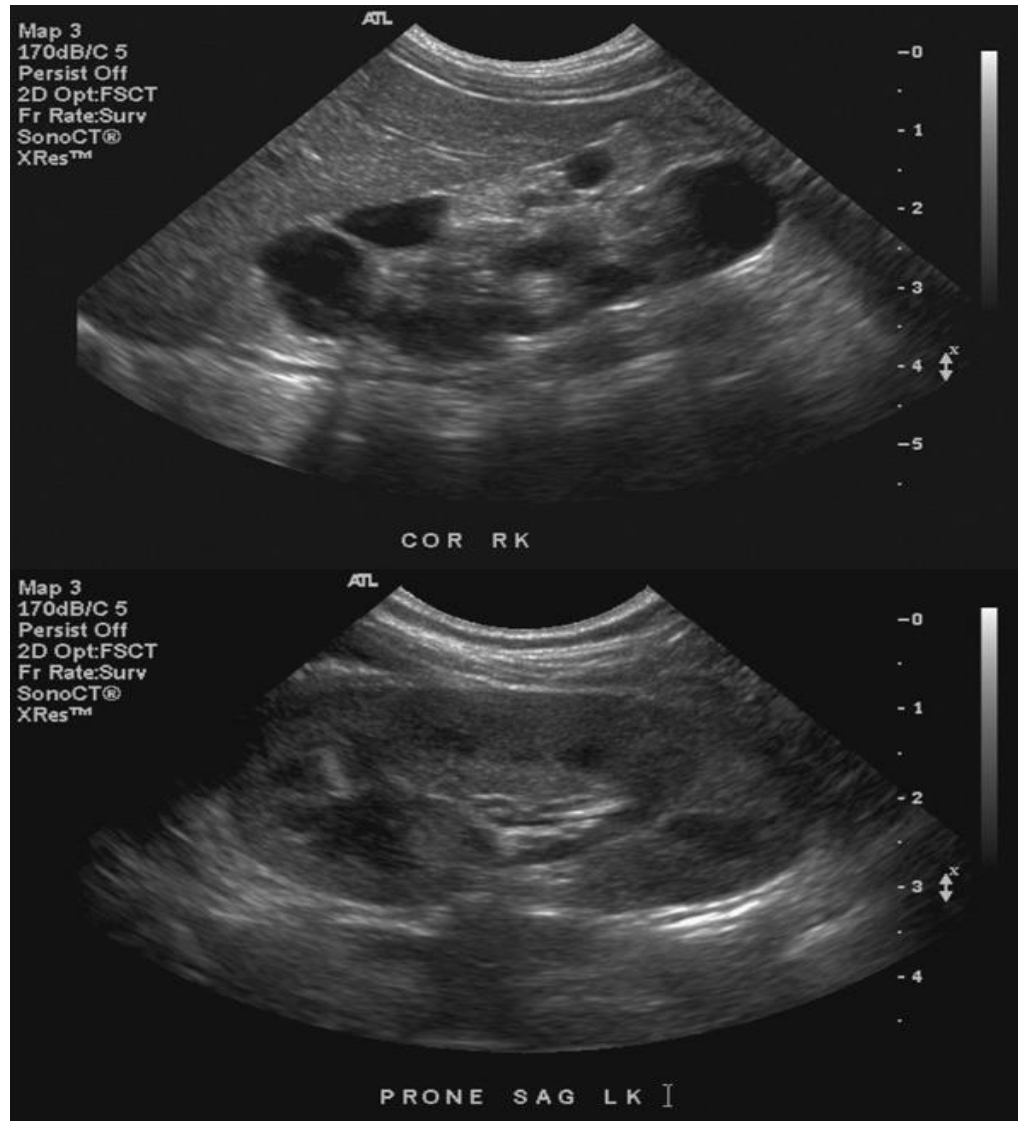
ARPKD



ADPKD

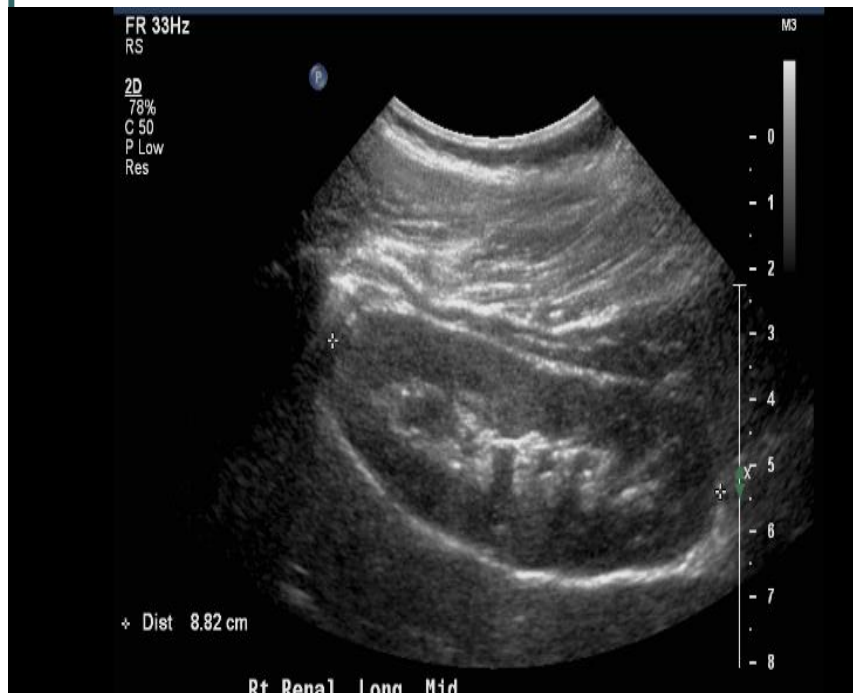


Multicystic Dysplastic Kidney

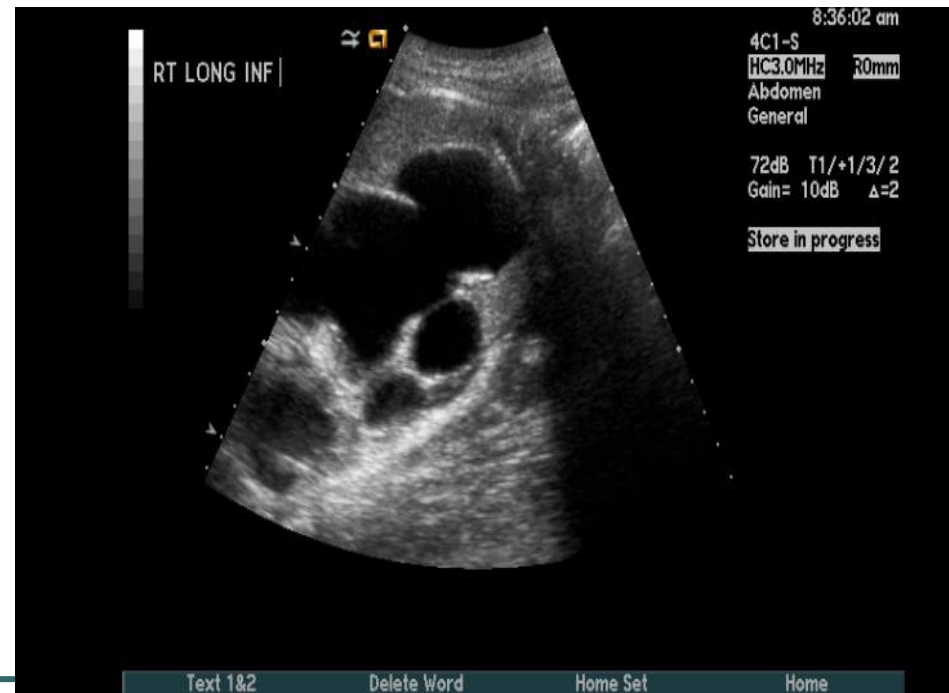


UPJ Obstruction

Normal



Obstructed



When to suspect secondary HTN

- A very young child (<10 years)
- Higher BP readings
- No family history of HTN
- Poor response to treatment (suspect non-compliance!)

Case 1

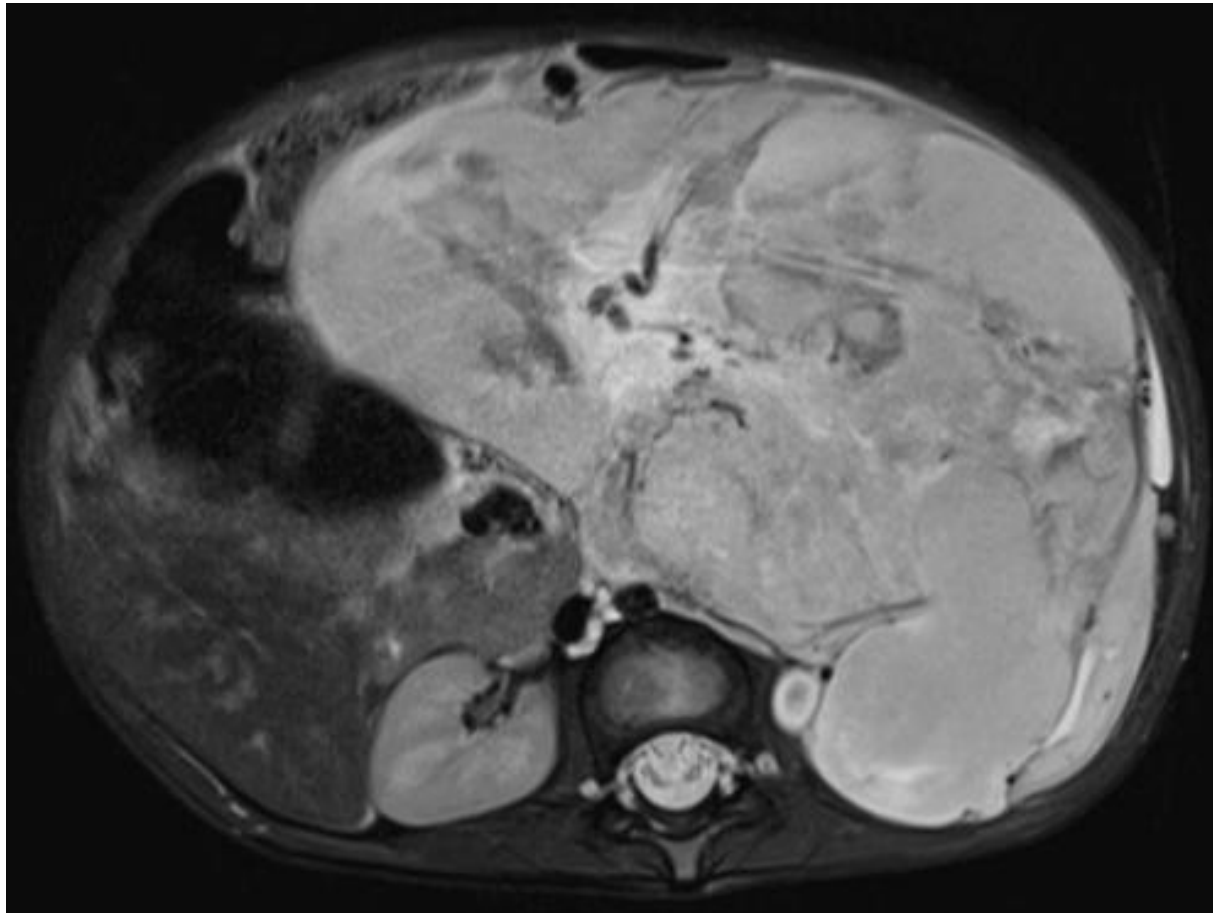
- 13yo old male noticed to have elevated blood pressure at pediatrician's office 5 months ago. Initial BP was 140/85. Several subsequent readings similar. No symptoms associated with elevated blood pressures.
- Patient's PMHx and PSHx unremarkable.
- **Physical exam:** Comfortable. Weight 72kg, height 125cm. BP 138/80. Rest of exam unremarkable

Case 2

Hem/onc Consult:

2yo male with high blood pressures. Patient newly diagnosed with wilm's tumor and admitted 2 days ago for surgery. Most recent blood pressures in the 130s/70s. There is no family history of hypertension. Patient with normal renal function and good urine output.

Wilms tumor with compression of renal artery



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Case 3

- 10yo female with hypertension. Most recent blood pressures in the 130s/90s. She has a history of recurrent febrile urinary tract infections. Patient diagnosed with grade 4 VUR at 3 years of age. She is currently followed by nephrology and urology. Energy level and appetite are normal.

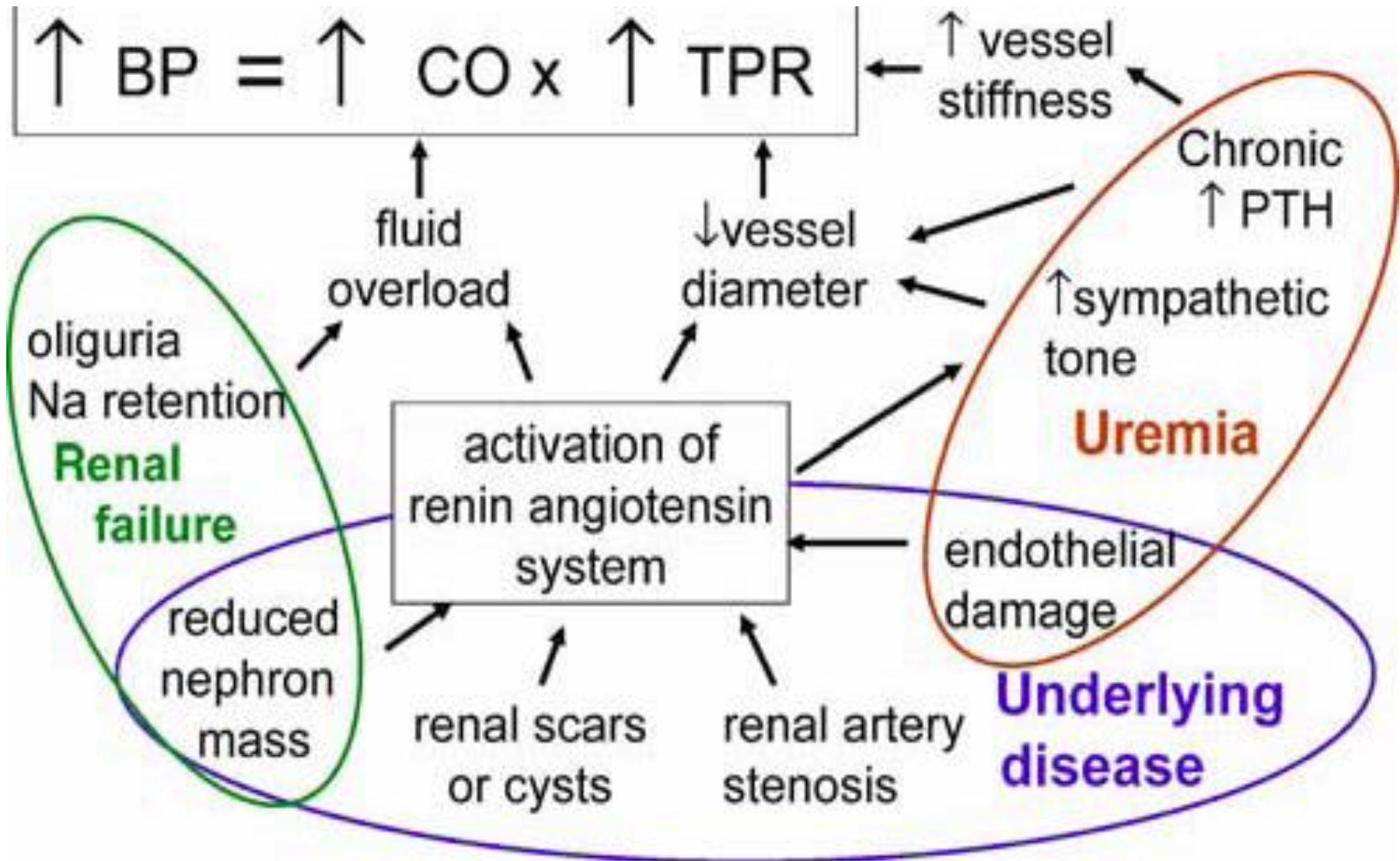
Case 4

NICU consult:

- 1mo old 28 week ex-premie. In the last one week, blood pressures have been high, 120s/70s-80s.
- What additional history would you obtain?

HTN in Chronic Kidney Disease

Generation of HTN in CKD



Evaluation of HTN in Children and Adolescents

Must begin with:

- thorough history (including hx of sleep disorder), physical examination
- laboratory evaluation
- assessment of cardiovascular risk factors:
 - ❖ overweight
 - ❖ low plasma HDL cholesterol
 - ❖ high plasma triglycerides
 - ❖ abnormal glucose tolerance

Laboratory evaluation of HTN

Basic:

- Serum chemistries, BUN, Cr, PRA, Aldosterone level
- CBC
- Urinalysis and Urine culture
- Renal ultrasound with doppler

Evaluation for comorbidity:

- Fasting Lipid profile
- Fasting glucose
- Drug screen (if hx of drug use)
- Polysomnography (if hx of sleep disorder)

Evaluation for end-organ damage:

- Echocardiogram
- Retinal exam

Additional Evaluation

- 24hr ABPM
- Renovascular imaging
 - Renal scan
 - Duplex Doppler flow studies
 - MRA, CTA
 - Arteriogram
- Other labs
 - Plasma and urine metanephrines
 - Plasma and urine steroids

Non-pharmacologic Therapy of HTN in children

- Weight reduction
- Regular physical activity
- Dietary modifications:
 - consumption of more fruits, vegetables, fiber, nonfat dairy, reduced sodium intake (1.2g/day in younger kids and 1.5g/day in older kids)

Pharmacologic Therapy of HTN in Children

Indications:

1. Symptomatic hypertension
 2. Secondary hypertension
 3. Target-organ damage
 4. Poor response to non pharmacologic therapy
 5. Diabetes mellitus
- Goal is to reduce BP <95th percentile (<90th percentile if concurrent conditions or LVH present)
 - Treat severe symptomatic BP with IV antihypertensives

Acceptable antihypertensives in children and adolescents

- Adrenergic blockers (e.g. labetolol, atenolol, metoprolol)
- Calcium channel blockers (e.g amlodipine)
- Vasodilators (e.g Hydralazine, minoxidil)
- ACEI/ARB (single or in combination)
- Diuretics (e.g. HCTZ)
- Central alpha blocker (clonidine)

Monitor for side effects!

Guidelines for use of antihypertensive agents in children

- Start with a single drug
- Start at lowest recommended dose
- Increase dose until desired effect
- Once highest recommended dose is reached (or side effect develops), may introduce second agent

Case 5

- 16yo male referred from the pediatrician's office to the emergency room for severe headache and high blood pressures. No episodes of vomiting. No visual changes. No significant past medical history. Urine output normal. Family history unremarkable.

Systolic blood pressure in the ER 190/105.

The rest of physical examination unremarkable.

Question

How do you manage hypertensive urgency/emergency?

Hypertensive Urgency/emergency

- Admit to the ICU!
- Goal is to safely lower BP
- Use titratable short-acting IV antihypertensive for BP management
- Reduce BP by 25% of goal reduction in first 2 hrs and then down to normal in next 3-4 days

Guidelines for BP management

TABLE 5. Classification of Hypertension in Children and Adolescents, With Measurement Frequency and Therapy Recommendations

	SBP or DBP Percentile*	Frequency of BP Measurement	Therapeutic Lifestyle Changes	Pharmacologic Therapy
Normal	<90th	Recheck at next scheduled physical examination	Encourage healthy diet, sleep, and physical activity	—
Prehypertension	90th to <95th or if BP exceeds 120/80 even if <90th percentile up to <95th percentile†	Recheck in 6 mo	Weight-management counseling if overweight; introduce physical activity and diet management‡	None unless compelling indications such as chronic kidney disease, diabetes mellitus, heart failure, or LVH exist
Stage 1 hypertension	95th–99th percentile plus 5 mm Hg	Recheck in 1–2 wk or sooner if the patient is symptomatic; if persistently elevated on 2 additional occasions, evaluate or refer to source of care within 1 mo	Weight-management counseling if overweight; introduce physical activity and diet management‡	Initiate therapy based on indications in Table 6 or if compelling indications (as shown above) exist
Stage 2 hypertension	>99th percentile plus 5 mm Hg	Evaluate or refer to source of care within 1 wk or immediately if the patient is symptomatic	Weight-management counseling if overweight; introduce physical activity and diet management‡	Initiate therapy§

* For gender, age, and height measured on at least 3 separate occasions; if systolic and diastolic categories are different, categorize by the higher value.

† This occurs typically at 12 years old for SBP and at 16 years old for DBP.

‡ Parents and children trying to modify the eating plan to the Dietary Approaches to Stop Hypertension Study eating plan could benefit from consultation with a registered or licensed nutritionist to get them started.

Summary for the pediatrician

- Thorough P &E
- Monitor BPs initially, confirm HTN with at least 3 separate readings
- Get basic labs, fasting lipid profile and glucose, Echo
- Institute TLC as indicated
- If symptomatic, may initiate therapy (with med of choice) and refer to Nephrologist within a week

References

- National High Blood Pressure Education Program (NHBPEP)
www.nhlbi.nih.gov/about/nhbpep/index.htm
- Constantine and Linakis (2005) The assessment and management of Hypertensive Emergencies and Urgencies in Children. Pediatric Emergency Care 21:391-399