

HYPERTENSION

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$$\text{Blood Pressure} = \text{Cardiac Output} \times \text{Systemic Vascular Resistance}$$



- ▶ Hear rate
- ▶ Sympathatic/Parasympathatic
- ▶ Vasoconstriction/vasodilation
- ▶ Fluid volume
 - ▶ Renin-angiotensin
 - ▶ Aldosterone
 - ▶ ADH

FACTORS INFLUENCING BP



HYPERTENSION DIAGNOSIS

- Diagnosis requires two readings at two different clinic visits
- BP measurement in both arms
 - Use arm with higher reading for subsequent measurements

Measure BP following 5min of rest in the sitting position with good back support



Office BP Readings: Checklist for Accurate Measurements

<i>Key Points</i>	<i>Specific Instructions</i>
Step 1: Prepare patient	<ul style="list-style-type: none">-Have patient relax, sitting in a chair (feet on floor, back supported) for >5 min.-Avoid caffeine, exercise, and smoking for ≥ 30 min before measurement.-Ensure bladder emptied.-No talking during rest period or measurement.-Remove clothing covering location of cuff placement.-Measurements while patient sitting/lying on exam table do not fulfill criteria.
Step 2: Use proper technique	<ul style="list-style-type: none">-Use validated BP measurement device that is calibrated periodically.-Support patient's arm (e.g., resting on a desk).-Position middle of cuff on patient's upper arm at mid-sternum (right atrium).-Use correct cuff size, such that the bladder encircles 80% of the arm.-Either stethoscope diaphragm or bell may be used for auscultatory readings.
Step 3: Take proper measurements	<ul style="list-style-type: none">-At first visit, record BP in both arms. Subsequently, use arm with higher BP.-Separate repeated measurements by 1–2 min.-For auscultatory readings, estimate SBP by palpation and inflate cuff 20–30 mm Hg above. Deflate 2 mm Hg per second and listen for Korotkoff sounds.
Step 4: Document BP readings	<ul style="list-style-type: none">-Note time of most recent BP medication before measurements.-Record SBP and DBP.
Step 5: Average readings	<ul style="list-style-type: none">-Use average of ≥ 2 readings obtained on ≥ 2 occasions to estimate level of BP.



CLASSIFICATION OF HYPERTENSION

- **Primary (Essential) Hypertension**
 - Elevated BP with unknown cause
 - 90% to 95% of all cases
- **Secondary Hypertension**
 - Elevated BP with a specific cause
 - 5% to 10% in adults



- Age (> 55 for men; > 65 for women)
- Alcohol
- Cigarette smoking
- Diabetes mellitus
- Elevated serum lipids
- Excess dietary sodium
- Gender

RISK FACTORS FOR PRIMARY HYPERTENSION



- ▶ **Family history**
- ▶ **Obesity (BMI \geq 30)**
- ▶ **Ethnicity (African Americans)**
- ▶ **Sedentary lifestyle**
- ▶ **Socioeconomic status**
- ▶ **Stress**



CLINICAL MANIFESTATIONS

- ▶ **Asymptomatic**
- ▶ **Non-specific symptoms**
 - Fatigue
 - Reduced activity tolerance
 - Dizziness
 - Palpitations
- ▶ **End organ damage**



BASIC AND OPTIONAL LABORATORY TESTS FOR PRIMARY HYPERTENSION

Basic testing	Fasting blood glucose*
	Complete blood count
	Lipid profile
	Serum creatinine with eGFR*
	Serum sodium, potassium, calcium*
	Thyroid-stimulating hormone
	Urinalysis
	Electrocardiogram
Optional testing	Echocardiogram
	Uric acid
	Urinary albumin to creatinine ratio

*May be included in metabolic panel. eGFR indicates estimated glomerular filtration rate.



BP Classification (JNC 7 and ACC/AHA Guidelines)

<i>SBP</i>		<i>DBP</i>	<i>2003 JNC7</i>	<i>2017 ACC/AHA</i>
<120	<i>and</i>	<80	Normal BP	Normal BP
120–129	<i>and</i>	<80	Prehypertension	Elevated BP
130–139	<i>or</i>	80–89		Stage 1 hypertension
140–159	<i>or</i>	90–99	Stage 1 hypertension	Stage 2 hypertension
≥160	<i>or</i>	≥100	Stage 2 hypertension	Stage 2 hypertension

Major area of difference

- Blood Pressure should be based on an average of ≥ 2 careful readings on ≥ 2 occasions
- Adults with SBP or DBP in two categories should be designated to the higher BP category



Out of Office BP Readings

Greater use of out of office BP measurements (ABPM or HBPM) for confirmation of office hypertension and recognition of White Coat/Masked Hypertension

Confirmed (Sustained) Hypertension

- Elevated office and out of office average BP
- Require therapy (nonpharmacological or combined nonpharmacological and antihypertensive drug therapy)

White Coat Hypertension (WCH)

- Office Hypertension not confirmed by out of office BP readings
- Present in about 10-25% of adults with office hypertension
- CVD risk profile more like adults with normal BP than adults with sustained hypertension
- May not need treatment for hypertension (should be monitored for development of sustained hypertension)

Masked Hypertension (MH)

- Normal office BP but out of office BP hypertension
- Present in about 10-25% of adults with normal office BP
- CVD risk profile more like adults with sustained hypertension than adults without hypertension
- Should be considered for antihypertensive drug therapy



HYPERTENSION

COMPLICATIONS

End organ damage involves:

- **Heart**
- **Brain**
- **Kidney**
- **Eyes**



HYPERTENSION

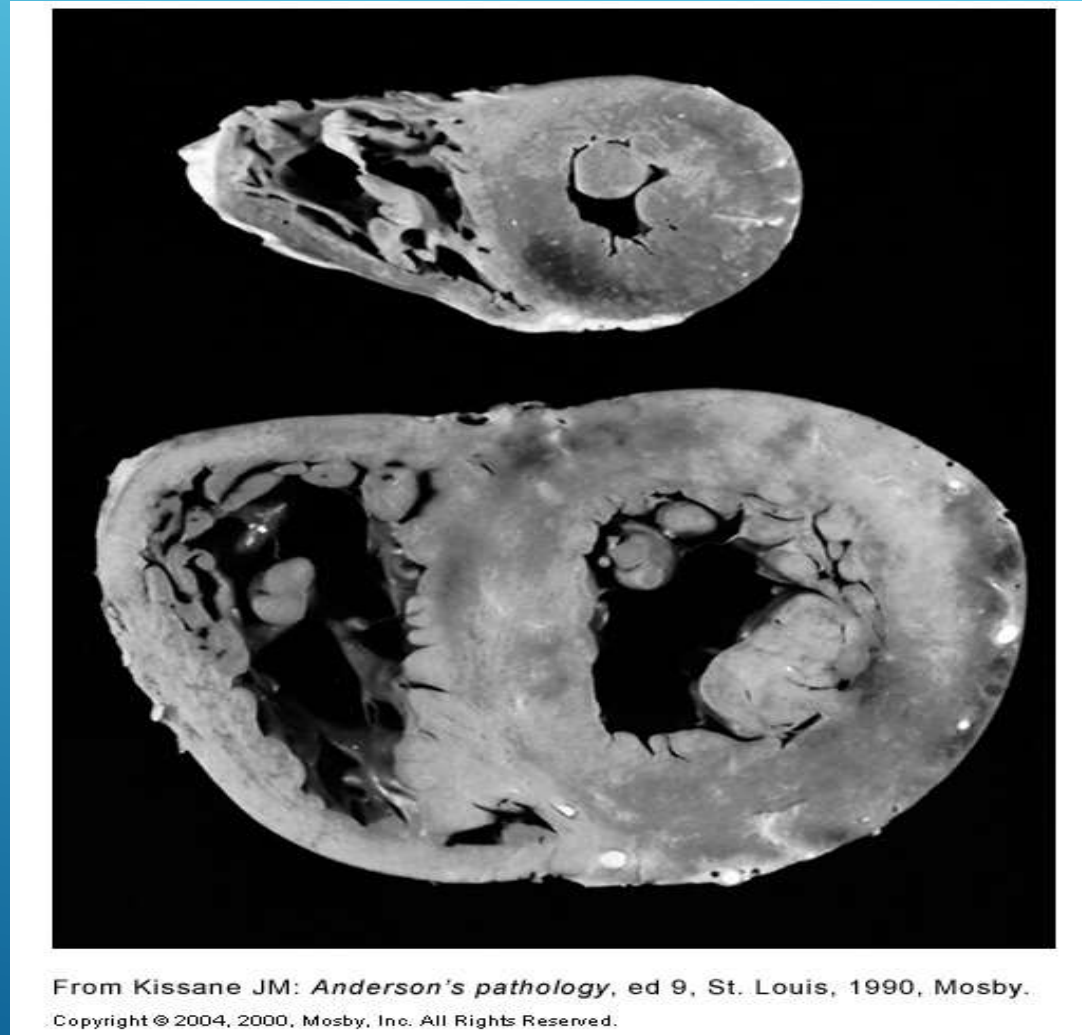
COMPLICATIONS

▪ Cardiovascular Disease

- Coronary artery disease**
- Left ventricular hypertrophy**
- Diastolic dysfunction**
- Heart failure**
- Peripheral arterial disease**
- Aneurysm and dissection**



LEFT VENTRICULAR HYPERTROPHY



HYPERTENSION

COMPLICATIONS

- **CNS**

Ischemic stroke

Hemorrhagic stroke

Hypertensive Encephalopathy



- ▶ Kidney:

Nephrosclerosis

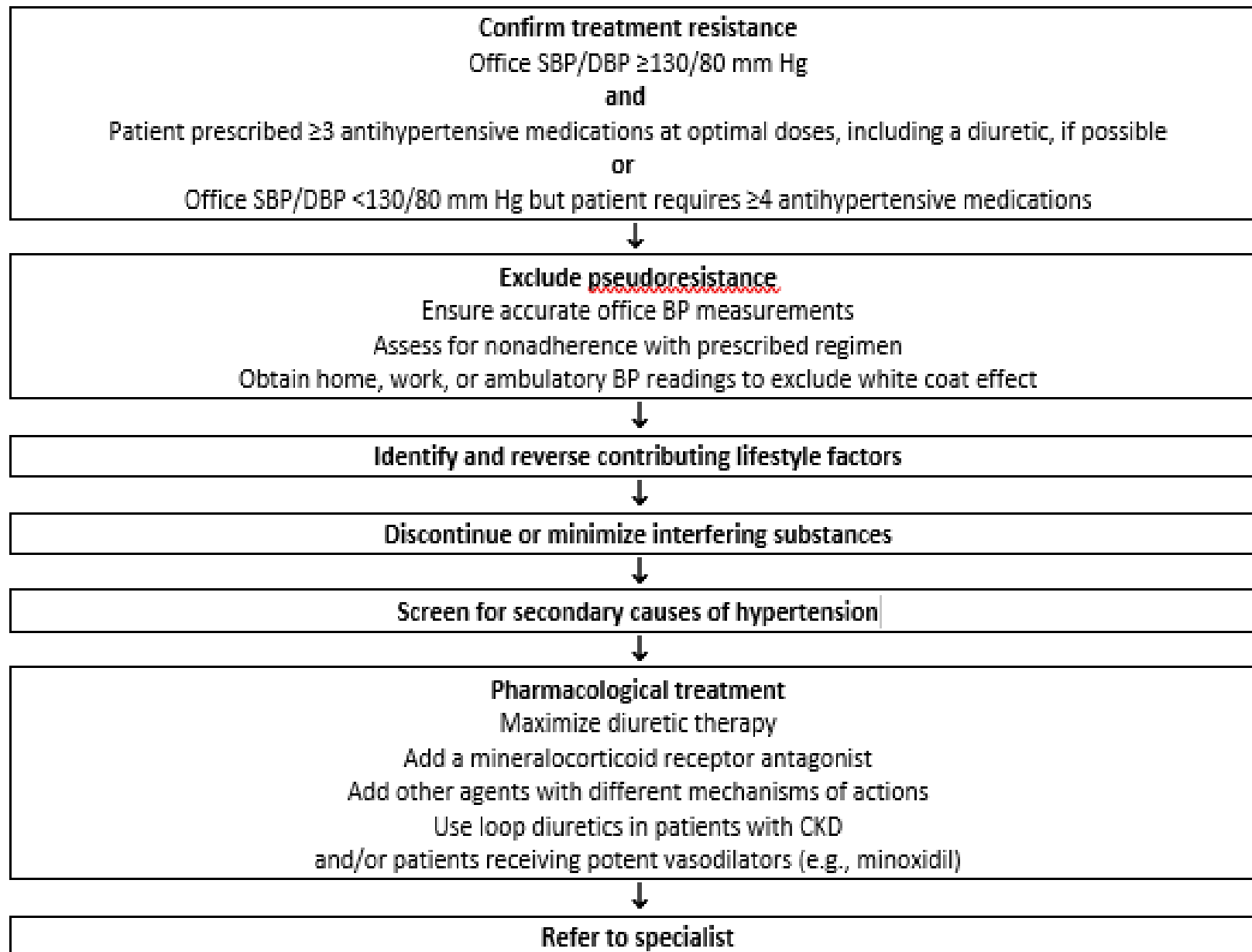
Major cause for End stage Renal Failure

- ▶ Ophthalmic:

Retinal complication including bleeding



RESISTANT HYPERTENSION: DIAGNOSIS, EVALUATION, AND TREATMENT



- ▶ “Secondary” HTN accounts for ~5-10% of other cases and represents potentially curable disease
- ▶ Often overlooked and underscreened
- ▶ Controversy over screening and treatment in some cases

SECONDARY HTN



Secondary Hypertension

Underlying cause of high BP in about 10% of adults with hypertension

Common causes

Renal parenchymal disease

Renovascular disease

Primary aldosteronism

Obstructive sleep apnea

Drug or alcohol induced

Uncommon causes

Pheochromocytoma/paraganglioma

Cushing's syndrome

Hypothyroidism

Hyperthyroidism

Aortic coarctation (undiagnosed or repaired)

Primary hyperparathyroidism

Congenital adrenal hyperplasia

Mineralocorticoid excess syndromes other than primary aldosteronism

Acromegaly



- ▶ General principles:
 - ▶ New onset HTN if <30 or >50 years of age
 - ▶ HTN refractory to medical Rx (>3 meds)
 - ▶ Specific clinical/lab features typical for certain disease entity:
 - ▶ Hypokalemia,
 - ▶ Epigastric bruit
 - ▶ Differential BP between arm and leg
 - ▶ Episodic HTN/flushing/palp, etc

SCREENING



- ▶ Common cause of secondary HTN
- ▶ HTN is both a cause and consequence of renal disease
- ▶ Multifactorial cause for HTN including disturbances in Na/water balance, depletion of vasodilators leading to highTPR
- ▶ Renal disease from multiple etiologies, treat underlying disease, dialysis/ transplant if necessary

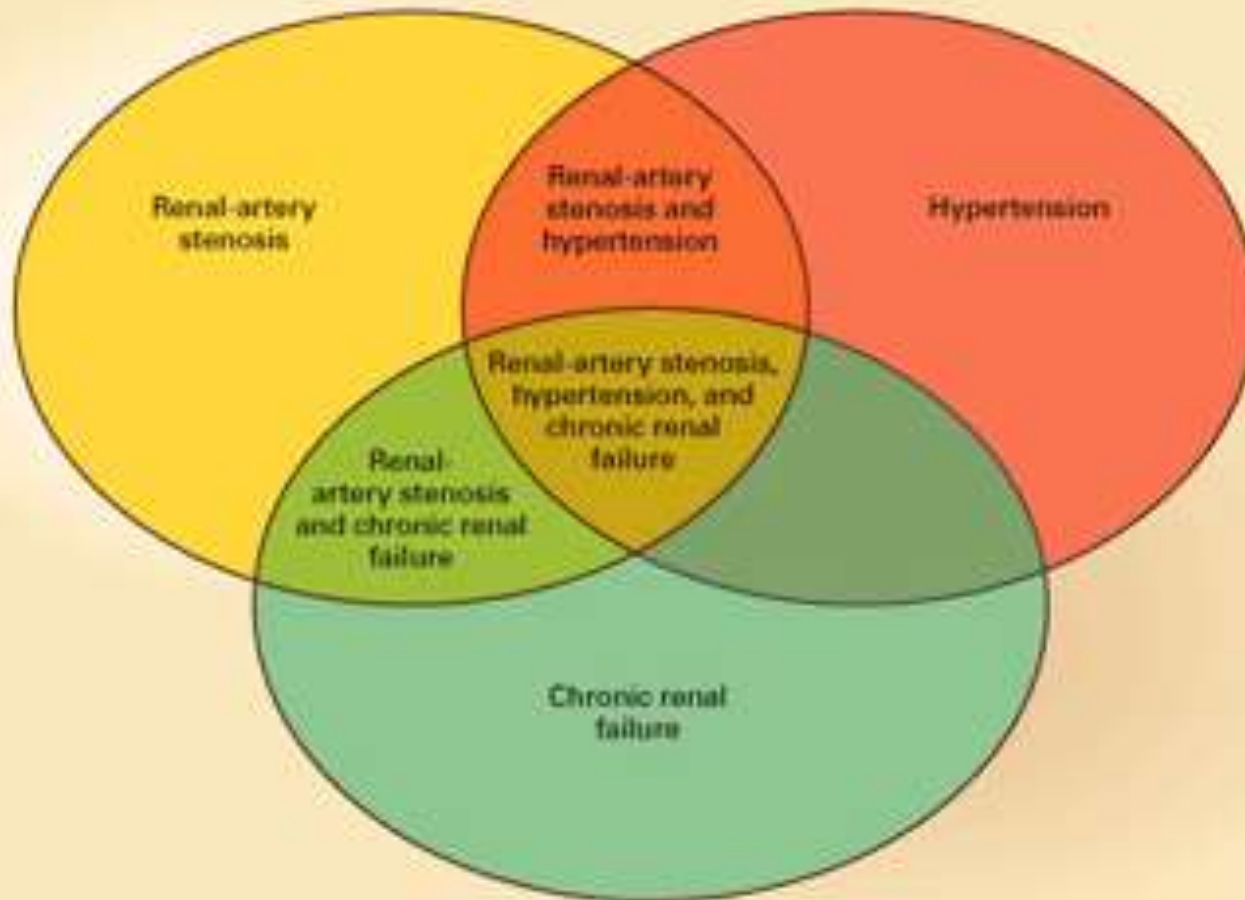
RENAL PARENCHYMAL DISEASE



- ▶ Incidence 1-30%
- ▶ Etiology
 - ▶ Atherosclerosis 75-90%
 - ▶ Fibromuscular dysplasia 10-25%
 - ▶ Other
 - ▶ Aortic/renal dissection
 - ▶ Takayasu's arteritis
 - ▶ Thrombotic/cholesterol emboli
 - ▶ CVD
 - ▶ Post transplantation stenosis
 - ▶ Post radiation

RENOVASCULAR HTN





- ▶ Decrease in renal perfusion pressure activates RAAS, renin release converts angiotensinogen → Ang I; ACE converts Ang I → Ang II
- ▶ Ang II causes vasoconstriction which causes HTN and enhances adrenal release of aldosterone; leads to sodium and fluid retention
- ▶ Contralateral kidney (if unilateral RAS) responds with diuresis/ Na, H₂O excretion which can return plasma volume to normal
- ▶ Bilateral RAS or solitary kidney RAS leads to rapid volume expansion and ultimate decline in renin secretion

RENOVASCULAR HTN - PATHOPHYSIOLOGY



- ▶ History
 - ▶ onset HTN age <30 or >55
 - ▶ Sudden onset uncontrolled HTN in previously well controlled pt
 - ▶ Accelerated/malignant HTN
 - ▶ Intermittent pulm edema with nl LV fxn
- ▶ PE/Lab
 - ▶ Epigastric bruit, particularly systolic/diastolic
 - ▶ Azotemia induced by ACEI
 - ▶ Unilateral small kidney

RENOVASCULAR HTN - CLINICAL



- ▶ Physical findings (bruit)
- ▶ Duplex U/S
- ▶ Captopril renography
- ▶ CTA
- ▶ MRA
- ▶ Renal Angiography

RENOVASCULAR HTN - DIAGNOSIS



- ▶ 10-25% of all RAS
- ▶ Young female, age 15-40
- ▶ Medial disease 90%, often involves distal RA
- ▶ Treatment – PTCA
 - ▶ Successful in 82-100% of patients
 - ▶ Restenosis in 5-11%
 - ▶ “Cure” of HTN in ~60%

FIBROMUSCULAR DYSPLASIA



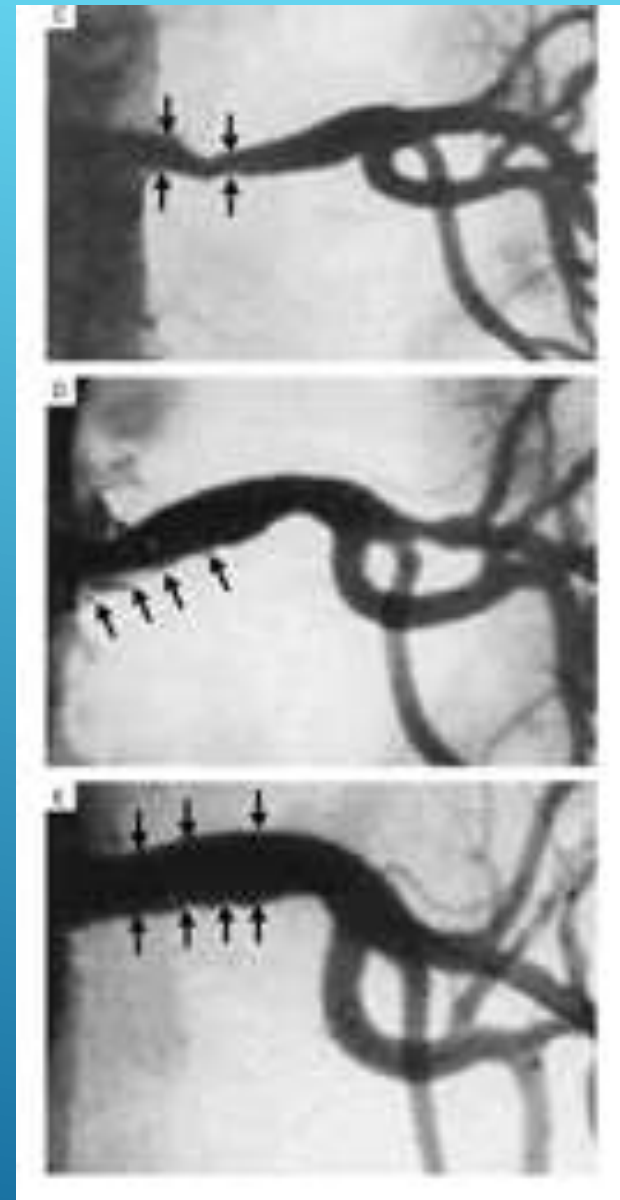
- ▶ 75-90% of RAS
- ▶ Usually men, age>55
- ▶ Treatment
 - Stent success 94-100%

ATHEROSCLEROTIC RAS





Fibromuscular Dysplasia, before and after PTCA



Atherosclerotic RAS before and after stent



- ▶ Aggressive risk fx modification (lipid, tobacco, etc)
- ▶ ACEI/ARB safe in unilateral RAS if careful titration and close monitoring

RENOVASCULAR HTN – MEDICAL RX



- ▶ Prevalence .5- 2.0%
- ▶ Etiology
 - ▶ Adrenal adenoma 33%
 - ▶ bilat adrenal hyperplasia 66%
- ▶ Clinical:
 - ▶ May be asymptomatic; headache, muscle cramps, polyuria
 - ▶ Hypokalemia (K normal in 40%-70%), metabolic alkalosis, high Na

PRIMARY HYPERALDOSTERONISM



- ▶ Aldosterone / Plasma Renin Activity ratio
Ratio >20
- ▶ Confirmatory/physiologic testing
 - ▶ Withhold BP meds 2wks
 - ▶ High serum aldo after IV saline (1.25L x 2hr) load
 - ▶ serum aldo <8.5 ng/dL after IV saline rules out primary aldosteronism
 - ▶ Imaging – CT

PRIMARY ALDOSTERONISM- DX



- ▶ Surgical removal of adrenal tumor, can be done laparoscopically
- ▶ Pretreatment for 3-4 wks with spironolactone minimizes postoperative hypoaldosteronism and restores K to normal levels, response of BP to spiro treatment is predictor of surgical outcome

PRIMARY ALDOSTERONISM - TREATMENT



- ▶ Published reports estimate incidence of 30-80% of pt with essential HTN have OSA and 50% pt with OSA have HTN¹
- ▶ Prospective studies show link between OSA (apneic-hyponeic index) and development of HTN independent of other risk fx²
- ▶ Clinical
 - ▶ Daytime somnolence, am headaches, snoring or witnessed apneic episodes
- ▶ Dx – Sleep studies
- ▶ Rx – wt loss, CPAP, surgical

OBSTRUCTIVE SLEEP APNEA



- ▶ Rare cause of HTN (.1-1.0%)
- ▶ Tumor containing chromaffin cells which secrete catecholamines
- ▶ Young-middle age with female predominance
- ▶ Clinical
 - ▶ Intermittent HTN, palpitations, sweating, anxiety “spells”
 - ▶ May be provoked by triggers such as tyramine-containing foods (beer,cheese,wine), pain, trauma, drugs (clonidine, TCA, opiates)

PHEOCHROMOCYTOMA



PHEOCHROMOCYTOMA - SCREEN

- ▶ Best detected during or immediately after episodes

	Sensitivity	Specificity
Plasma free metanephrine >.66nmol/L	99%	89%
24hr urine metanephrine (>3.7nmol/d)	77%	93%
24 urine VMA	64%	95%



PHEOCHROMOCYTOMA - DIAGNOSIS

- ▶ Imaging for localization of tumor

	Sens	Spec	PPV	NPV
(MIBG) scintigraphy	78%	100%	100%	87%
CT	98%	70%	69%	98%
MRI	100%	67%	83%	100%



- ▶ Surgical removal of tumor
 - ▶ Anesthesia- avoid benzo, barbiturates or demerol which can trigger catechol release
 - ▶ Complications include ligation of renal artery, post op hypoglycemia, hemorrhage and volume loss
 - ▶ Mort 2%, 5 yr survival 95% with <10% recurrence
- ▶ Caution with BB – can cause unopposed alpha stimulation/pheo crisis
- ▶ BP control with alpha blockers (phentolamine, phenoxybenzamine, and prazosin)

PHEOCHROMOCYTOMA - TREATMENT



- ▶ Rare cause of secondary HTN (.1-.6%)
- ▶ Etiology: pituitary microadenoma, iatrogenic (steroid use), ectopic ACTH, adrenal adenoma
- ▶ Clinical
 - ▶ Sudden weight gain, truncal obesity, moon facies, abdominal striae, DM/glucose intolerance, HTN, prox muscle weakness, skin atrophy, hirsutism/acne

CUSHING'S SYNDROME/ HYPERCORTISOLISM



- Screen:
 - 24 Hr Urine free cortisol
- Confirm
 - Low dose dexamethasone suppression test
 - 1mg dexameth. midnight, measure am plasma cortisol
- Imaging
 - CT/MRI head (pit) chest (ectopic ACTH tumor)

CUSHINGS SYNDROME - DX



- ▶ Cushing's dz/ pit adenoma
 - ▶ Transphenoidal resection
 - ▶ Pituitary irradiation
 - ▶ Bromocriptine, octreotide
- ▶ Adrenal tumors - adrenalectomy
- ▶ Removal of ACTH tumor

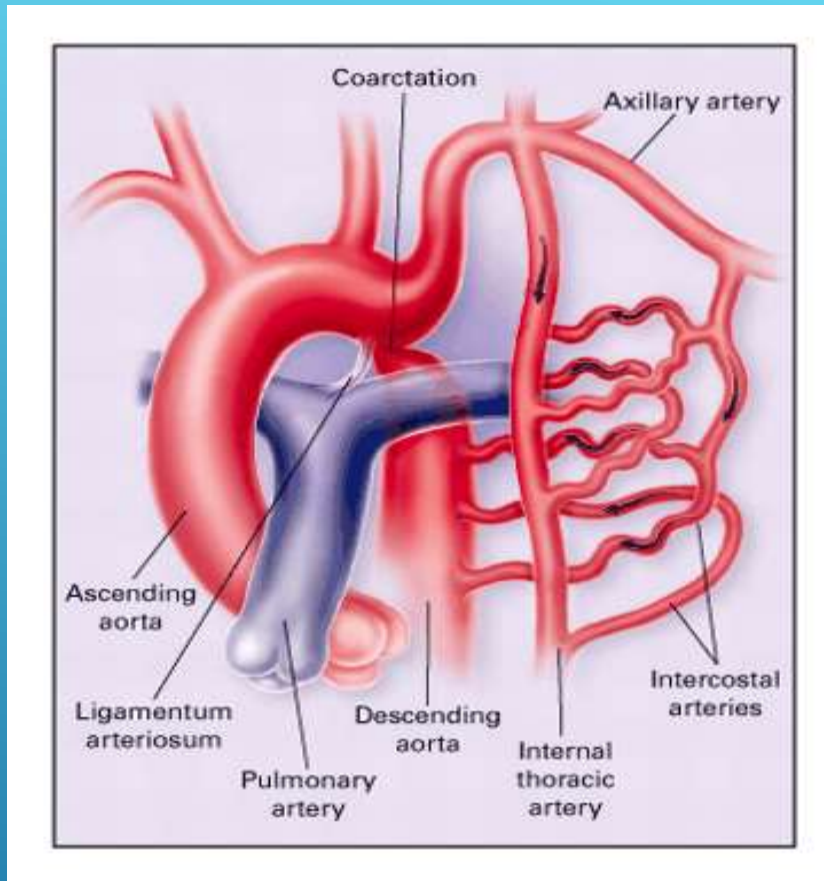
CUSHINGS SYNDROME - RX



- ▶ Congenital defect, male>female
- ▶ Clinical
 - ▶ Differential systolic BP arms vs legs
 - ▶ Diminished/absent femoral art pulse
 - ▶ Often asymptomatic
 - ▶ Assoc with Turners, bicuspid AV
- ▶ If uncorrected 67% will develop LV failure by age 40 and 75% will die by age 50
- ▶ Surgical Rx, long term survival better if corrected early

COARCTATION OF AORTA





COARCTATION OF AORTA

Brickner, et al. NEJM 2000;342:256-263



HYPERTENSION

- **Lifestyle Modifications**
 - Weight reduction
 - Limitation of alcohol intake
 - Regular physical activity
 - Avoidance of tobacco use
 - Stress management



HYPERTENSION

- **Nutritional Therapy: DASH Diet = Dietary Approaches to Stop HTN**
 - Sodium restriction
 - Rich in vegetables, fruit, and nonfat dairy products
 - Calorie restriction if overweight



Choice of Drug Therapy in Treatment of Hypertension

▶ *First-step agents:*

▶ *Compelling indication*

- ▶ *Use agent(s) that concurrently lower BP (e.g. post-MI, SIHD, HF)*

▶ *No compelling indication*

- ▶ *Achieving BP goal more important than choice of drug therapy*

▶ *Diuretic or CCB often good choice, but*

▶ *Drugs from following classes acceptable*

- ▶ *Diuretic (esp. long-acting thiazide-type agent such as chlorthalidone)*
- ▶ *Calcium channel blocker (CCB)*
- ▶ *Angiotensin converting enzyme inhibitor (ACEI)*
- ▶ *Angiotensin receptor blocker (ARB)*



ANTIHYPERTENSIVE DRUG TREATMENT: DIABETES MELLITUS

- **In adults with hypertension and DM,**
- **If average BP $\geq 130/80$ mm Hg, initiate antihypertensive drug therapy and treat to $< 130/80$ mm Hg**
- **All first-line classes of antihypertensives (i.e., diuretics, ACE inhibitors, ARBs, and CCBs) useful and effective**
- **Consider ACEI or ARBs in presence of albuminuria**



ANTIHYPERTENSIVE DRUG TREATMENT: HEART FAILURE

Hypertension and heart failure with reduced ejection factor (HFrEF)

- ▶ *Prescribe guideline directed medical therapy (GDMT)*

ACEI, ARB, BB, MRA

- ▶ *Nondihydropyridine CCBs not recommended*

- ▶ *BP goal: <130/80 mm Hg*

Hypertension and heart failure with preserved ejection factor (HFpEF)

- ▶ *If symptoms of volume overload, prescribe diuretics*

- ▶ *If high BP persists, prescribe ACE inhibitors or ARBs and beta blockers*

- ▶ *BP goal: <130 /80 mm Hg*



ANTIHYPERTENSIVE DRUG TREATMENT: ISCHEMIC HEART DISEASE

- **Adults with hypertension and stable ischemic heart disease (SIHD)**
 - Use GDMT medications (e.g., beta blockers, ACE inhibitors, or ARBs) for compelling indications (e.g., previous MI, stable angina)
 - Add other drugs (e.g. dihydropyridine CCBs, thiazide diuretics, and/or mineralocorticoid receptor antagonists) as needed to control hypertension
 - BP target: <130/80 mm Hg



- ▶ A 22 year old medical student presented to the E/D with epistaxis, his BP in the right arm is 190/110mmHg and left arm 200/115mmHg.
- ▶ On exam he was found to have radio-femoral delay.
- ▶ What is the next step in your evaluation and what is the diagnosis ?

CASE 1

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- ▶ A 30 year old female presents with muscle fatigue and was found to be hypertensive.
- ▶ Her BP 170/100mmHg, K=2.8meq
- ▶ What is the next step in your evaluation?
- ▶ What is your diagnosis?

CASE 2

52



- ▶ A 27 year old female presents with palpitation, headache and hypertension.
- ▶ These episodes come in paroxysmal pattern.
- ▶ What is your clinical diagnosis?
- ▶ How do you confirm it?

CASE 3

53



- ▶ A 65 year old hypertensive gentleman, treated with amlodipine 5mg .Recently he noticed his BP readings to be out of control. Today on exam his BP is 190/105mmHG and there is a paraumbilical bruit.
- ▶ What is the next step in your evaluation?
- ▶ What is your diagnosis?

CASE 4

54



- ▶ A 50 year old non-compliant male patient who is to be hypertensive but doesn't follow appropriate life style neither he takes his medications presents to the ED with chest pain, and was found to be hypertensive with BP 200/110 mmHG in the right arm and 140/80mmHG in the left arm.
- ▶ What is your clinical diagnosis?
- ▶ How to confirm ?

CASE 5

55



THANK YOU

