modified no. : 2

CVS

PBL

Writer: Insaf Alammouri

Corrected by: Shahed Atiyat

Doctor: Hanna Makhamreh

HYPERTENSION

Hanna K. Al-Makhamreh,

MD FACC Associate Professor of Cardiology University Of Jordan

Blood pressure = Cardiac Output X Systemic Vascular Resistance

FACTORS INFLUENCING BP

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

controlled by

(regulated by hormones)

HYPERTENSION DIAGNOSIS

- Diagnosis requires two reading at two different clinic visits → in one week
- BP measurement in both arms (2 readings for both arms each visit)
    - Use arm with higher reading for subsequent measurements
- Measure BP following 5min of rest in the sitting position with good back support → & arm

→ we take the higher reading
ex: rt arm Systolic BP = 140 , lt arm Systolic = 130
lt arm may have atherosclerosis → ↓ BP

Office BP Readings: Checklist for Accurate Measurements

Key Points	Specific Instructions
Step 1: Prepare patient	***-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	***-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	***-At first visit, record BP in both arms. Subsequently, use arm with higherBP.*** ***-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	***-Note time of most recent BP medication before measurements.*** ***-Record SBP and DBP.***
Step 5: Average readings	***-Use average of ≥2 readings obtained on ≥2 occasions to estimate level of BP.***

Whelton PK et al. Hypertension/J Am Coll Cardiol. 2017;Epub ahead of print

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 (treatment of cause resolves HTN)
  - 5% to 10% in adults

RISK FACTORS FOR PRIMARY HYPERTENSION

- Age (> 55 for men; > 65 for women)
- Alcohol
- Cigarette smoking
- Diabetes mellitus
- Elevated serum lipids
- Excess dietary sodium
- Gender (♂)
- Family history
- Obesity (BMI > 30)
- Ethnicity (African Americans)
- Sedentary lifestyle
- Socioeconomic status
- Stress

CLINICAL MANIFESTATIONS

- Asymptomatic (Silent Killer)

- Non-specific symptoms: (if symptomatic)
  - -Fatigue
  - -Reduced activity tolerance
  - -Dizziness
  - -Palpitations

- End organ damage (ex: ophthalmic)

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.**

Whelton PK et al. Hypertension/J Am Coll Cardiol. 2017 [Epub ahead of print].

(look if there is albuminuria)

BP Classification (JNC 7 and ACC/AHA Guidelines)

↳ now used

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

In adults not taking antihypertensive medication

- Confirmed (Sustained) Hypertension (always ↑: at home, work, clinic)
  - Elevated office and out of office average BP
  - Substantially higher risk of CVD compared to adults with normal office and out of office BPs
  - Require therapy (nonpharmacological or combined nonpharmacological and antihypertensive drug therapy)

- White Coat Hypertension (WCH)
  - Office Hypertension not confirmed by out of office BP readings (only ↑ at clinic)
  - 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) → good prognosis, no end organ damage

- Masked Hypertension (MH)
  - Normal office BP but out of office BP hypertension (Stressed more out of clinic)
  - 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 (like confirmed HTN)

HYPERTENSION COMPLICATIONS

End organ damage involves:

- Heart
- Brain
- Kidney
- Eyes

HYPERTENSION COMPLICATIONS

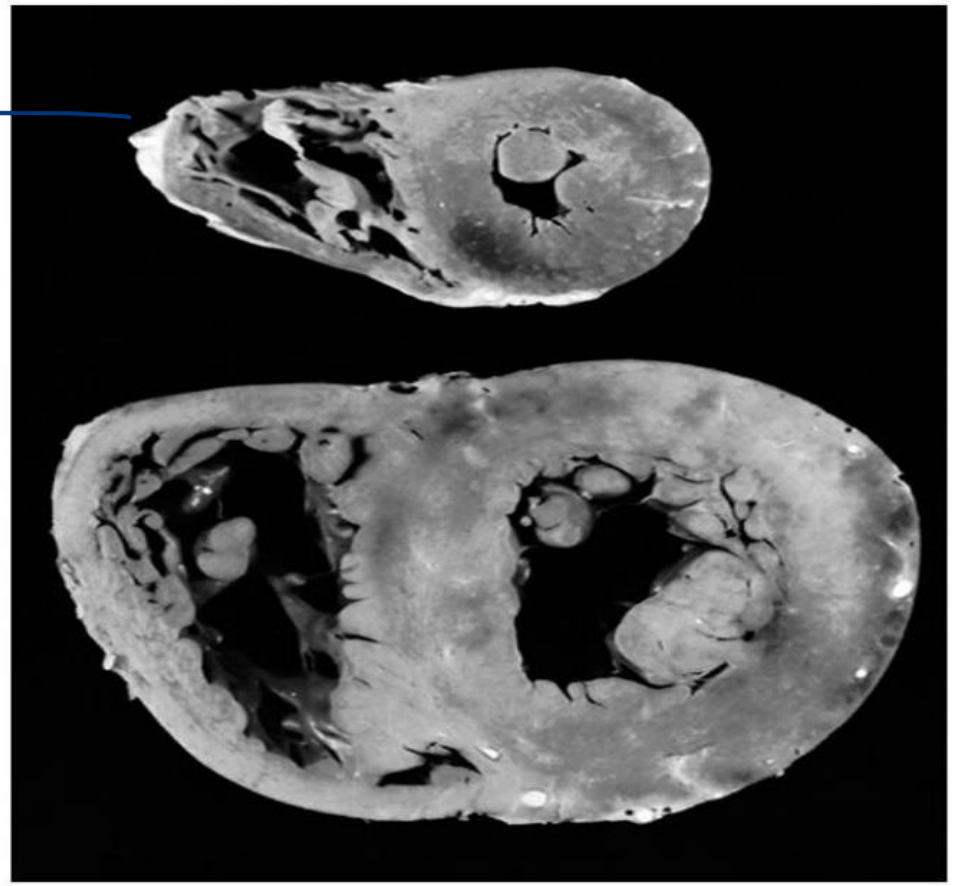
Cardiovascular Disease:

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

muscle hypertrophy (most lumen is obliterated)

Ventricular hypertrophy happens because there is ↑ afterload

Left ventricular hypertrophy



From Kissane JM: *Anderson's pathology*, ed 9, St. Louis, 1990, Mosby.

HYPERTENSION COMPLICATIONS

CNS :

- Ischemic stroke
- Hemrrhagic stroke
- Hypertensive Encephalopathy

Kidney :

- Nephrosclerosis
- Major cause for End stage Renal Failure

Ophthalmic :

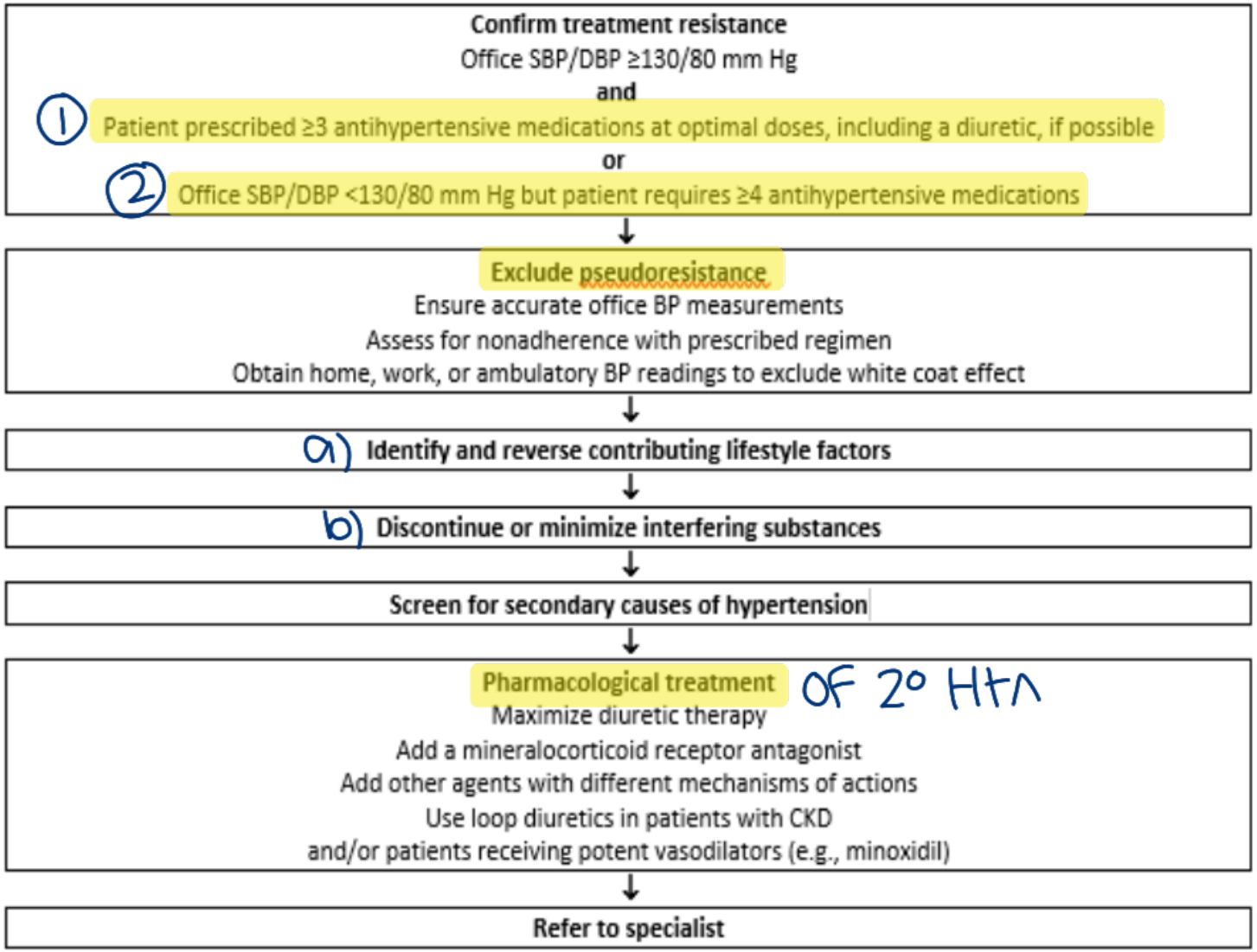
- Retinal complication including bleeding

Stages 1-4

worst: intracranial bleeding

RESISTANT HYPERTENSION: DIAGNOSIS, EVALUATION, AND TREATMENT

↳ usually 2° HTN



Whelton PK et al. Hypertension/J Am Coll Cardiol. 2017 [Epub ahead of print].

resistant Htn: persistance of Htn despite medications

* conditions: ① ≥3 different classes of antihypertensives at max dose including a diuretic
② ≥4 antihypertensives needed to control office Htn
* Usally 2° Htn if pseudo Htn is excluded
* Pharmacological treatment:
① maximize diuretic
② add mineralocorticoid agonist
③ add agents with different MOA
④ use loop diuretics for CKD patients & patients that take potent vasodilators (ex: minoxidil)

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pseudo Htn: is Htn affected by:

① lifestyle (ex: ↑ salt intake)
② if the patient isn't taking perscribed doses
③ if the patient takes medications that interfere with perscribed antihypertensives (ex: NSAIDs, steroids, decongestants)

SECONDARY HTN

- " 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

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

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SCREENING

General principles: (when to screen)

- New onset HTN if 50 years of age (very young/very old)
- HTN refractory to medical Rx (>3 meds) (resistant HTN)
- Specific clinical/lab features typical for certain disease entity:
  - -Hypokalemia, → ex: renal A stenosis
  - -Epigastric bruit (turbulance blood flow caused by stenosis)
  - -Differential BP between arm and leg (ex: coarchtation of aorta)
  - -Episodic HTN/flushing/palp, etc
    - → ex: pheochromocytoma

RENAL PARENCHYMAL DISEASE

- Common cause of secondary HTN
- HTN is both a cause and consequence of renal disease (مين أول: البيضة ولا الدجاجة؟ 😅)
- Multifactorial cause for HTN including disturbances in Na/water balance (1), depletion of vasodilators leading to highTPR (2)
- Renal disease from multiple etiologies, treat underlying disease, dialysis/ transplant if necessary (reversible kidney impairment ↳ reversible HTN)

* if we know that this patient has renal disease & used to have normal BP & now has HTN & creatinine = 2.5 then we know that HTN is 2° to renal disease
* BP is harder to control in patients with parenchymal disease

RENOVASCULAR HTN

Incidence 1-30%

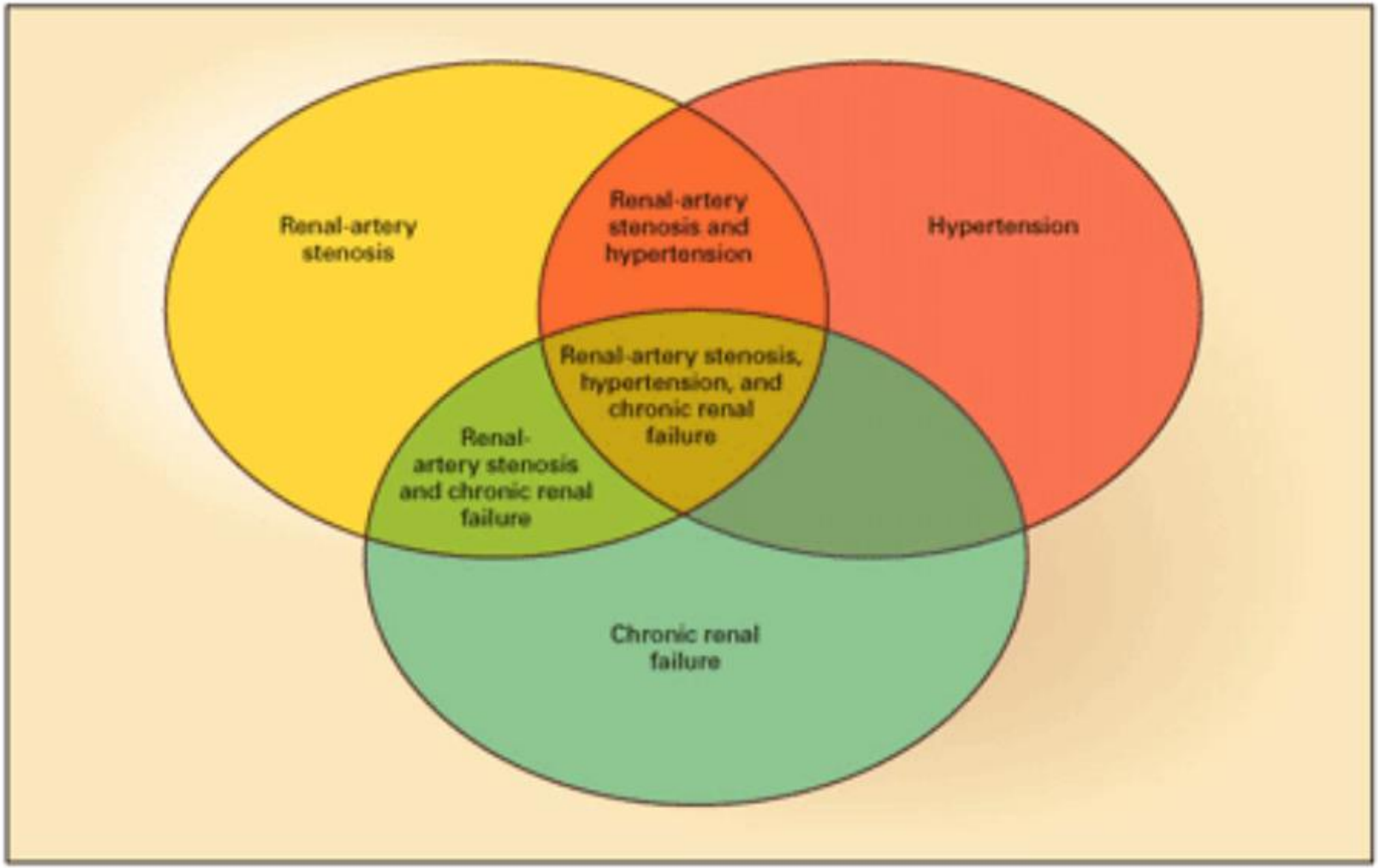
Etiology

- Atherosclerosis 75-90% → older ♂
- Fibromuscular dysplasia 10-25% (FMD) → younger ♀
- Other
  - -Aortic/renal dissection
  - -Takayasu's arteritis
  - -Thrombotic/cholesterol emboli
  - -CVD
  - -Post transplantation stenosis
  - -Post radiation

* atheroSclerosis: usually in the proximal segment of renal A (vessel ostium)

* FMD: usually in middle to distal segment of renal A, some lesions develop thicker tunica media (beading pattern)

(في العصبة: توسع تضيق توسع تضيق ...)


Renal-artery stenosis
Renal-artery stenosis and hypertension
Hypertension
Renal-artery stenosis, hypertension, and chronic renal failure
Renal-artery stenosis and chronic renal failure
Chronic renal failure

RENOVASCULAR HTN - PATHOPHYSIOLOGY

renal A stenosis → ↓ blood flow to juxtaglumerular cells → ↑ renin release

- 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

→ bilateral renal A stenosis → pulmonary edema (but echo & EF is normal → not a cardial etiology)

RENOVASCULAR HTN - CLINICAL

History (presentation)

- onset HTN age 55
- Sudden onset uncontrolled HTN in previously well controlled pt (resistant)
- Accelerated/malignant HTN
- Intermittent pulm edema with nl LV fxn

PE/Lab

- Epigastric bruit, particulary systolic/diastolic
- Azotemia induced by ACEI (Azotemia = acute kidney injury) → sudden creatinine elevation after use of ACEI
- Unilateral small kidney
  ↳ (ischemic nephropathy)

RENOVASCULAR HTN - DIAGNOSIS

- Physical findings (bruit)
- Duplex U/S (ultrasound)
- Captopril renography (nuclear scan)
- CTA (CT scan with angiography)
- MRA (MR scan " ")
- Renal Angiography (cath)

* 2D echo → shows size of structure
* duplex echo → shows velocity (turbulence indicates stenosis)

CT & renal angiography are risky because they have contrast media (if creatinine was ↑ this may cause end stage renal failure)

FIBROMUSCULAR DYSPLASIA

- 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%

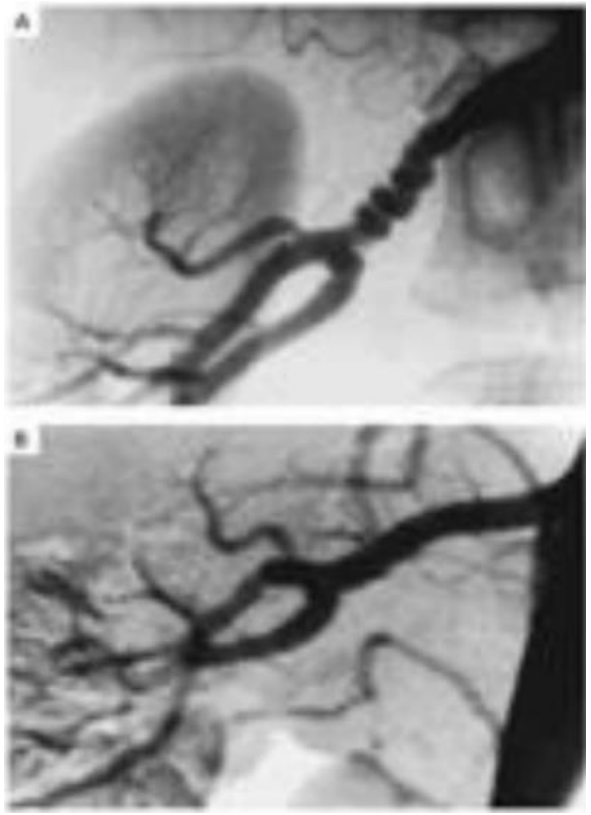
  -“Cure” of HTN in ~60%

ATHEROSCLEROTIC RAS

- 75-90% of RAS
- Usually men, age>55
- Treatment

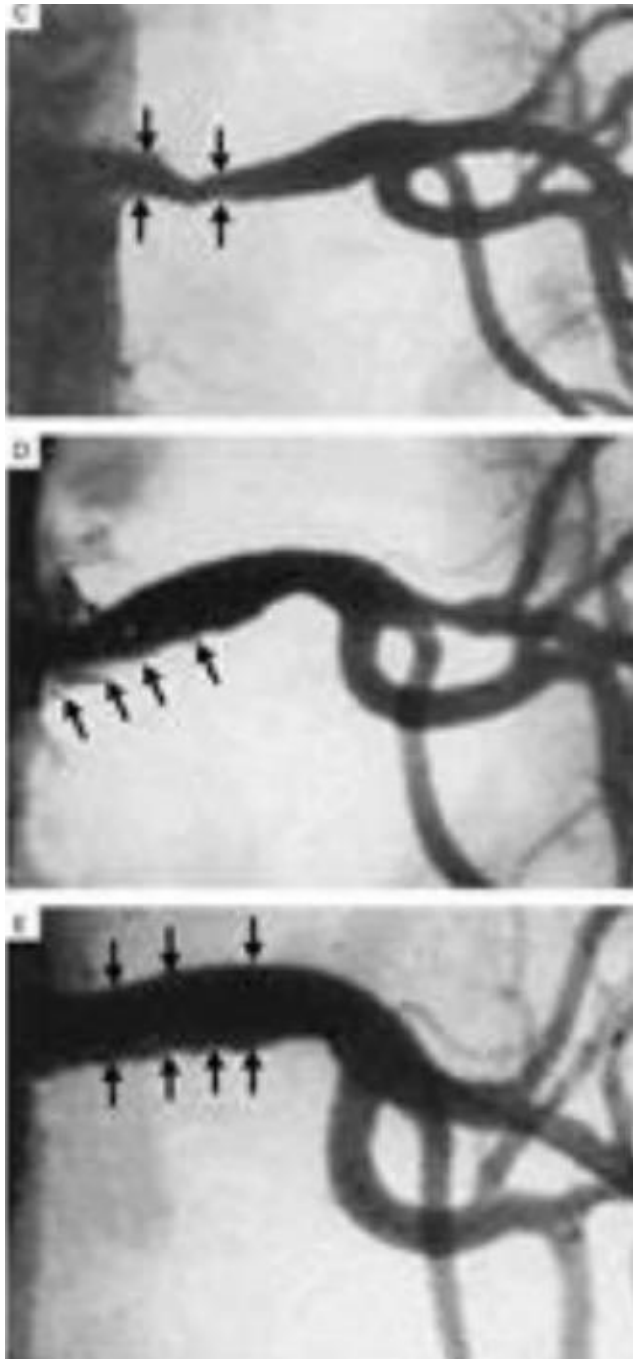
  -Stent success 94-100%

PROCEDURES TO TREAT ATHEROSCLEROSIS & FMD



Fibromuscular Dysplasia, before and after PTCA

baloon angiography (blow baloon in vessel to dilate it)



Atherosclerotic RAS before and after stent

(inserting a metal mesh inside vessel to keep it open)

RENOVASCULAR HTN – MEDICAL RX

- Aggressive risk fx modification (lipid, tobacco, etc)

- ACEI/ARB safe in unilateral RAS if careful titration and close monitoring

→ not recommended in bilateral

(↑creatinine 1-2 weeks after starting medication → stop drug because there might be renal A stenosis)

PRIMARY HYPERALDOSTERONISM

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

Caused by hypokalemia

PRIMARY ALDOSTERONISM- DX

- Aldosterone / Plasma Renin Activity ratio

  Ratio >20 (ratio > 30 if patient is on diuretic)

- Confirmatory/physiologic testing
  - Withold 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 → bilateral hyperplasia or adenoma appear

Suppression test

→ with Na^+

PRIMARY ALDOSTERONISM - TREATMENT

- Surgical removal of adrenal tumor, can be done laparoscopically

(gradually inhibits aldosterone)

- 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

OBSTRUCTIVE SLEEP APNEA (obese, short neck)

↳ may be associated with resistant HTN, atrial fibrillation, HF

- 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 somnolescence, am headaches, snoring or witnessed apneic episodes, interrupted sleep
- Dx – Sleep studies (sleep lab, apnea hypopnea index)
- Rx – wt loss, CPAP, surgical

↳ cont. + airway pressure (for severe OSP)

PHEOCHROMOCYTOMA

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

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%

PHEOCHROMOCYTOMA - TREATMENT

- 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

hypertensive crisis

- Caution with BB- can cause unopposed alpha stimulation/ pheo crisis
- BP control with alpha blockers (phentolamine, phenoxybenzamine, and prazosin)

CUSHING'S SYNDROME/ HYPERCORTISOLISM

- 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

CUSHINGS SYNDROME

pit = pituitary

DX:

Screen:

- 24 Hr Urine free cortisol

Confirm

- Low dose dexamethasone suppression test
- 1mg dexameth. midnight, then measure am plasma cortisol
  ↳ in the morning

Imaging

- CT/MRI head (pit) chest (ectopic ACTH tumor)

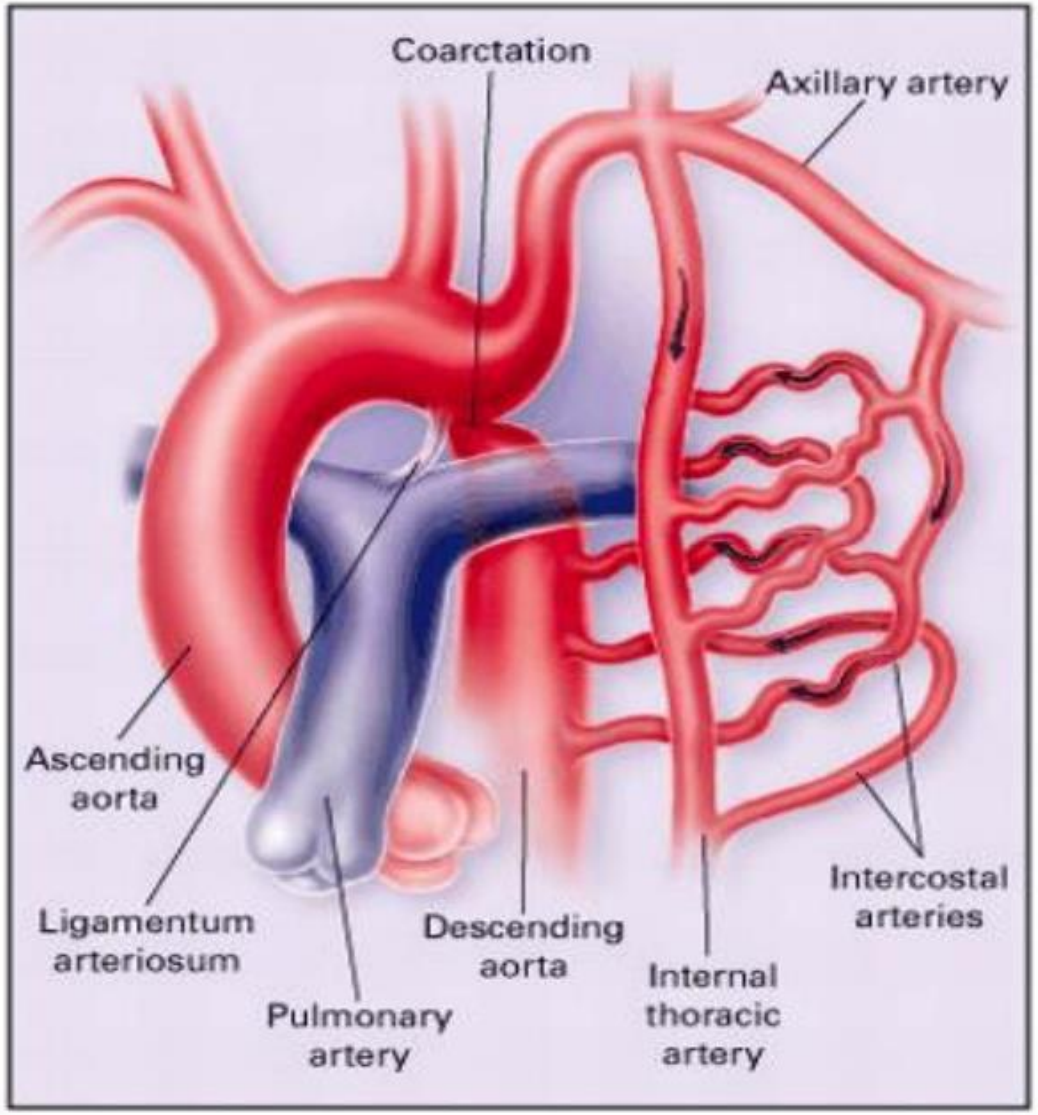
RX: (removal of tumor by:)

- Cushings dz/ pit adenoma
- Transphenoidal resection
  -Pituitary irradiation
  -Bromocriptine, octreotide
- Adrenal tumors - adrenalectomy
- Removal of ACTH tumor
  (extra adrenal)

COARCTATION OF AORTA

- 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
  (repair of aorta or stenting)

*poor prognosis



HYPERTHYROIDISM

- 33% of thyrotoxic pt develop HTN
- Usually obvious signs of thyrotoxicosis
- Dx: TSH, Free T4/3, thyroid RAIU
- Rx: radioactive ablation, propanolol

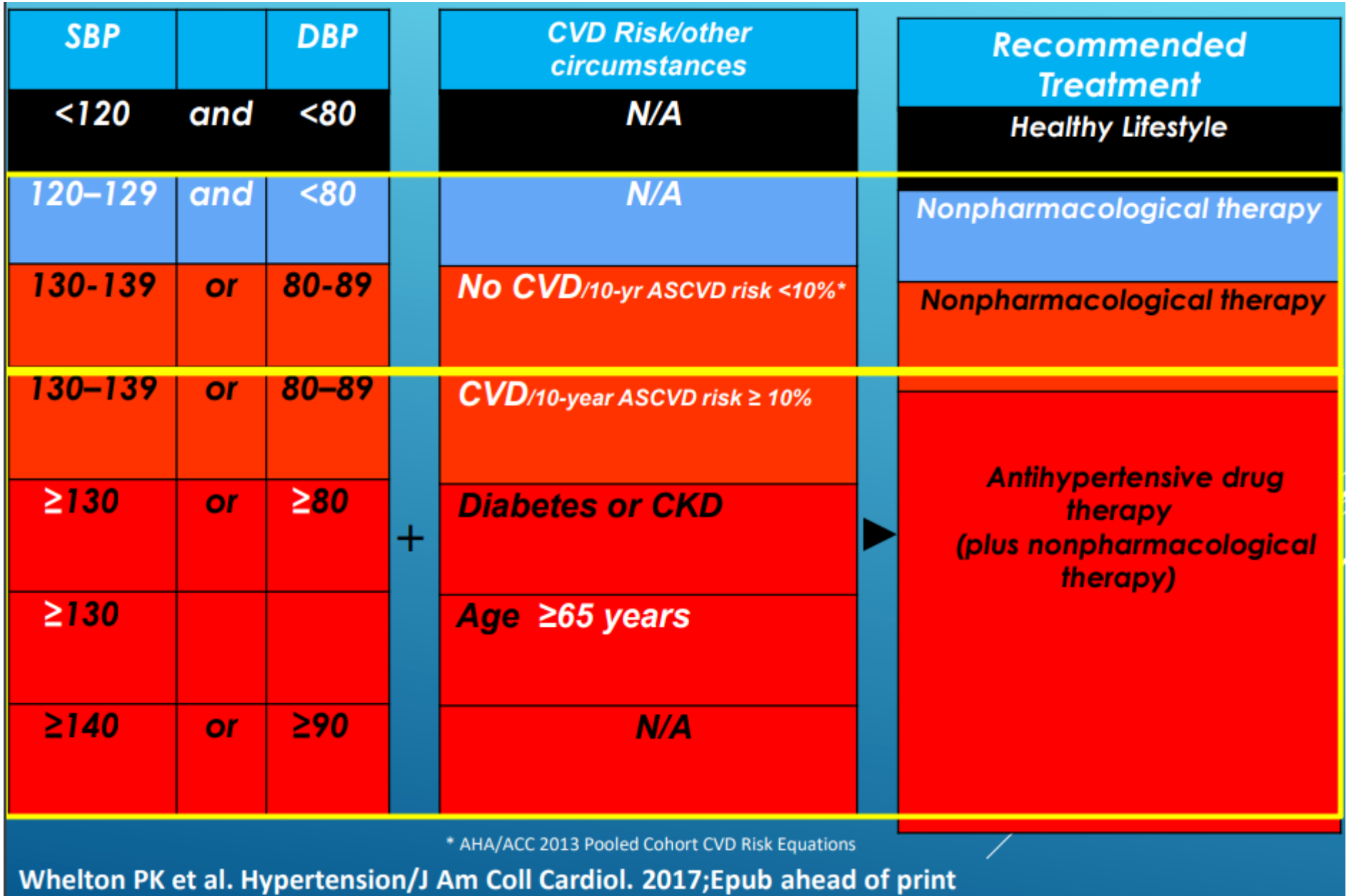
HYPOTHYROIDISM

- 25% hypothyroid pt develop HTN
- Mechanism mediated by local control, as basal metabolism falls so does accumulation of local metabolites; relative vasoconstriction ensues

CONCLUSIONS

- Remember clinical/diagnostic features of common forms of secondary HTN
- Important to appropriately screen pt suspected of having potentially correctable causes of HTN
- Understand limitations of screening/treatment (atherosclerotic RAS)

2017 ACC/AHA BP GUIDELINE: THRESHOLDS FOR TREATMENT



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* Stage 1 Htn patients need pharmacological therapy if they are at >10% risk of ASCVD (atherosclerotic Cardiovascular disease)

* we don't calculate ASCVD risk if the patient is:
  >65 yo or diabetic or has CKD (they are automatically given therapy because they have >10% risk)

* Stage 2 Htn patients always need pharmacological therapy (they require 2 drugs)

2017 ACC/AHA BP GUIDELINE: TREATMENT TARGETS

SBP		DBP	CVD Risk	Recommended Treatment
<120	and	<80	N/A	N/A
120–129	and	<80	N/A	N/A
130-139	or	80-89	No CVD and 10-year ASCVD risk <10%	SBP <130 and DBP <80 mm Hg
130–139	or	80–89	Clinical CVD or 10-year ASCVD risk ≥ 10%	
≥130	or	≥80	Diabetes or CKD	
≥140	or	≥90	N/A	
≥130			Age ≥65 years	SBP <130 mm Hg

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BENEFITS OF LOWERING BP

goal BP < 130/80

	Average percent reduction
Stroke incidence	35-40%
Myocardial infarction	20-25%
Heart failure	50%

HYPERTENSION

Lifestyle Modifications:

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

Nutritional Therapy: DASH Diet = Dietary Approahes 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:

1. **Compelling indication**

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

2. **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 (4 main classes)
  - Diuretic (esp. long-acting thiazide-type agent such as chlorthalidone)
  - Calcium channel blocker (CCB)
  - Angiotensin converting enzyme inhibitor (ACEI)
  - Angiotensin receptor blocker (ARB)

*Others: nitrates (vasodilators), hydralazine (afterload reducing agent), minoxidil, centrally acting, α blockers

Choice of Drug Therapy in Treatment of Hypertension

Combination drug therapy:

1. Initial treatment with two drugs in most patients
   - esp. in blacks and adults with stage 2 hypertension with BP ≥20/10 above target
2. Use agents with complimentary modes of action
   - e.g. diuretic or CCB with ACEI or ARB
3. Use combination pill when feasible
4. In blacks with hypertension but without HF or CKD (including those with DM):
   - Initial treatment should include thiazide-type diuretic or CCB
5. Simultaneous use of ACEI and ARB not recommended (don't combine ACEI & ARB)
   - Potentially harmful

(acute renal impairment, hyperkalemia)

* now we have pills of 3 medications (ex: ARB + CCK + thiazide diuretic) to make compliance easier

ANTIHYPERTENSIVE DRUG TREATMENT: DIABETES MELLITUS

- In adults with hypertension and DM,
- If average BP ≥130/80 mm Hg, initiate antihypertensive drug therapy and treat to <130/80mm 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 (contraindicated)
- BP goal: <130/80 mm Hg

Spironolactone

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 & CCBs
- 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

* coronary A disease patient → BB, nitrates, CCBs
→ ACEI & ARBs have shown endothelial function benifits

ANTIHYPERTENSIVE DRUG TREATMENT: CKD

Adults with hypertension and CKD

- Treatment with ACE inhibitors reasonable to slow kidney disease progression:
  - Stage 3 (eGFR 30 - 59 mL/min/1.73 M2) or higher
  - Stage 1 or 2 with albuminuria ≥300 mg/d
- Use of ARBs reasonable if ACE inhibitors not tolerated
- BP goal: SBP <130/80 mm Hg

* Stage 1 or 2 CKD (GFR >60) + proteinuria → we prefer ACEI or ARBs