Hypertension Updates and Pediatric Pearls

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JNC 8

- 60 yo treat to <150/90
- Everyone else treat to <140/90
- Non black use thiazide, CCB, ACE or ARB, Black population use thiazide or CCB initially
- 18 yo or older with CKD, initially use ACE or ARB

2017 ACC/AHA Guidlines

- Updated terminology (no “pre-hypertension”)
- More stringent thresholds
- Inclusion of ASCVD risk score in treatment decisions and RF screening
- Significant focus on non-pharmacologic interventions at all stages

Measurement

Key Steps for Proper BP Measurements	Specific Instructions
Step 1: Properly prepare the patient	1. Have the patient relax, sitting in a chair (feet on floor, back supported) for >5 min. 2. The patient should avoid caffeine, exercise, and smoking for at least 30 min before measurement. 3. Ensure patient has emptied his/her bladder. 4. Neither the patient nor the observer should talk during the rest period or during the measurement. 5. Remove all clothing covering the location of cuff placement. 6. Measurements made while the patient is sitting or lying on an examining table do not fulfill these criteria.
Step 2: Use proper technique for BP measurements	1. Use a BP measurement device that has been validated, and ensure that the device is calibrated periodically.* 2. Support the patient’s arm (e.g., resting on a desk). 3. Position the middle of the cuff on the patient’s upper arm at the level of the right atrium (the midpoint of the sternum). 4. Use the correct cuff size, such that the bladder encircles 80% of the arm, and note if a larger- or smaller-than-normal cuff size is used (Table 9). 5. Either the stethoscope diaphragm or bell may be used for auscultatory readings (5, 6).
Step 3: Take the proper measurements needed for diagnosis and treatment of elevated BP/hypertension	1. At the first visit, record BP in both arms. Use the arm that gives the higher reading for subsequent readings. 2. Separate repeated measurements by 1–2 min. 3. For auscultatory determinations, use a palpated estimate of radial pulse obliteration pressure to estimate SBP. Inflate the cuff 20–30 mm Hg above this level for an auscultatory determination of the BP level. 4. For auscultatory readings, deflate the cuff pressure 2 mm Hg per second, and listen for Korotkoff sounds.
Step 4: Properly document accurate BP readings	1. Record SBP and DBP. If using the auscultatory technique, record SBP and DBP as onset of the first Korotkoff sound and disappearance of all Korotkoff sounds, respectively, using the nearest even number. 2. Note the time of most recent BP medication taken before measurements.
Step 5: Average the readings	Use an average of ≥2 readings obtained on ≥2 occasions to estimate the individual’s level of BP.
Step 6: Provide BP readings to patient	Provide patients the SBP/DBP readings both verbally and in writing.

Risk factor stratification

Modifiable Risk Factors*	Relatively Fixed Risk Factors†
• Current cigarette smoking, secondhand smoking • Diabetes mellitus • Dyslipidemia/hypercholesterolemia • Overweight/obesity • Physical inactivity/low fitness • Unhealthy diet	• CKD • Family history • Increased age • Low socioeconomic/educational status • Male sex • Obstructive sleep apnea • Psychosocial stress

Defining new categories

BP Category	SBP		DBP
Normal	<120 mm Hg	and	<80 mm Hg
Elevated	120–129 mm Hg	and	<80 mm Hg
Hypertension			
Stage 1	130–139 mm Hg	or	80–89 mm Hg
Stage 2	≥140 mm Hg	or	≥90 mm Hg

What about home readings?

- Suggests that home readings very useful in diagnosis and titration of medication
- Push towards using ABPM, especially if suspected “white coat”
- Costs associated with ABPM and insurance approval

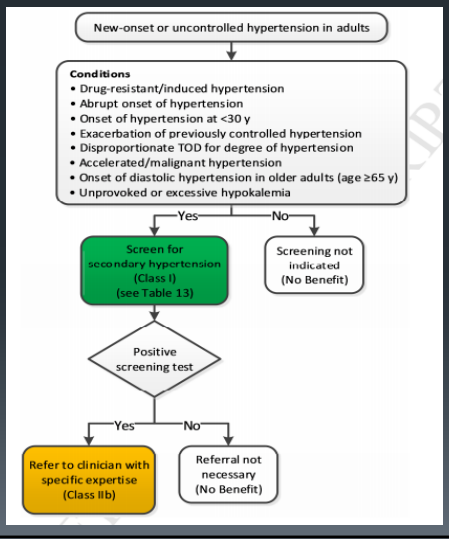
Home monitoring

- Automated
- Storage of readings
- Appropriate size (encircles arm)
- Specify which arm
- AM before medications and PM before supper
- Bring device to visits and compare to office equipment

White Coat Hypertension

- Prevalence 13-35% across populations
- ABPM and HBPM better predictor of CVD due to HTN
- Slightly increased CVD risk with white coat
- ABPM preferred in diagnosis

Screening for secondary HTN



Secondary

	Prevalence	Clinical Indications	Physical Examination	Screening Tests	Additional/ Confirmatory Tests
Common causes					
Renal parenchymal disease (1, 3)	1%–2%	Urinary tract infections; obstruction, hematuria; urinary frequency and nocturia; analgesic abuse; family history of polycystic kidney disease; elevated serum creatinine; abnormal urinalysis	Abdominal mass (polycystic kidney disease); skin pallor	Renal ultrasound	Tests to evaluate cause of renal disease
Renovascular disease (4)	5%–34%*	Resistant hypertension; hypertension of abrupt onset or worsening or increasingly difficult to control; flash pulmonary edema (atherosclerotic); early-onset hypertension, especially in women (fibromuscular hyperplasia)	Abdominal systolic-diastolic bruit; bruits over other arteries (carotid – atherosclerotic or fibromuscular dysplasia), femoral	Renal Duplex Doppler ultrasound; MRA; abdominal CT	Bilateral selective renal intra-arterial angiography
Primary aldosteronism (5, 6)	8%–20%†	Resistant hypertension; hypertension with hypokalemia (spontaneous or diuretic induced); hypertension and muscle cramps or weakness; hypertension and incidentally discovered adrenal mass; hypertension and obstructive sleep apnea; hypertension and family history of early-onset hypertension or stroke	Arrhythmias (with hypokalemia); especially atrial fibrillation	Plasma aldosterone/ renin ratio under standardized conditions (correction of hypokalemia and withdrawal of aldosterone antagonists for 4–6 wk)	Oral sodium loading test (with 24-h urine aldosterone) or IV saline infusion test with plasma aldosterone at 4 h of infusion Adrenal CT scan, adrenal vein sampling.
Obstructive sleep apnea (7)‡	25%–50%	Resistant hypertension; snoring; fitful sleep; breathing pauses during sleep; daytime sleepiness	Obesity, Mallampati class III–IV; loss of normal nocturnal BP fall	Berlin Questionnaire (8); Epworth Sleepiness Score (9); overnight oximetry	Polysomnography
Drug or alcohol induced (10)§	2%–4%	Sodium-containing antacids; caffeine; nicotine (smoking); alcohol; NSAIDs; oral	Fine tremor, tachycardia, sweating (cocaine, ephedrine, MAO	Urinary drug screen (illicit drugs)	Response to withdrawal of suspected agent

Uncommon Secondary

	Prevalence	Clinical Indications	Physical Examination	Screening Tests	Additional/ Confirmatory Tests
Pheochromocytoma/ paraganglioma (11)	0.1%–0.6%	Resistant hypertension; paroxysmal hypertension or crisis superimposed on sustained hypertension; "spells," BP lability, headache, sweating, palpitations, pallor; positive family history of pheochromocytoma/ paraganglioma; adrenal incidentaloma	Skin stigmata of neurofibromatosis (café-au-lait spots; neurofibromas); Orthostatic hypotension	24-h urinary fractionated metanephrines or plasma metanephrines under standard conditions (supine position with indwelling IV cannula)	CT or MRI scan of abdomen/pelvis
Cushing's syndrome (12)	<0.1%	Rapid weight gain, especially with central distribution; proximal muscle weakness; depression; hyperglycemia	Central obesity, "moon" face, dorsal and supraclavicular fat pads, wide (1-cm) violaceous striae, hirsutism	Overnight 1-mg dexamethasone suppression test	24-h urinary free cortisol excretion (preferably multiple); midnight salivary cortisol
Hypothyroidism (10)	<1%	Dry skin; cold intolerance; constipation; hoarseness; weight gain	Delayed ankle reflex; periorbital puffiness; coarse skin; cold skin; slow movement; goiter	Thyroid-stimulating hormone; free thyroxine	None
Hyperthyroidism (10)	<1%	Warm, moist skin; heat intolerance; nervousness; tremulousness; insomnia; weight loss; diarrhea; proximal muscle weakness	Lid lag; fine tremor of the outstretched hands; warm, moist skin	Thyroid-stimulating hormone; free thyroxine	Radioactive iodine uptake and scan
Aortic coarctation (undiagnosed or repaired) (13)	0.1%	Young patient with hypertension (<30 y of age)	BP higher in upper extremities than in lower extremities; absent femoral pulses; continuous murmur over patient's back, chest, or abdominal bruit; left thoracotomy scar (postoperative)	Echocardiogram	Thoracic and abdominal CT angiogram or MRA

Uncommon secondary

	Prevalence	Clinical Indications	Physical Examination	Screening Tests	Additional/ Confirmatory Tests
Primary hyperparathyroidism (14)	Rare	Hypercalcemia	Usually none	Serum calcium	Serum parathyroid hormone
Congenital adrenal hyperplasia (15)	Rare	Hypertension and hypokalemia; virilization (11-beta-hydroxylase deficiency [11-beta-OH]); incomplete masculinization in males and primary amenorrhea in females (17-alpha-hydroxylase deficiency [17-alpha-OH])	Signs of virilization (11-beta-OH) or incomplete masculinization (17-alpha-OH)	Hypertension and hypokalemia with low or normal aldosterone and renin	11-beta-OH: elevated deoxycorticosterone (DOC), 11-deoxycortisol, and androgens17-alpha-OH; decreased androgens and estrogen; elevated deoxycorticosterone and corticosterone
Mineralocorticoid excess syndromes other than primary aldosteronism (15)	Rare	Early-onset hypertension; resistant hypertension; hypokalemia or hyperkalemia	Arrhythmias (with hypokalemia)	Low aldosterone and renin	Urinary cortisol metabolites; genetic testing
Acromegaly (16)	Rare	Acral features, enlarging shoe, glove, or hat size; headache, visual disturbances; diabetes mellitus	Acral features; large hands and feet; frontal bossing	Serum growth hormone ≥1 ng/mL during oral glucose load	Elevated age- and sex-matched IGF-1 level; MRI scan of the pituitary

Primary vs. Secondary Summary

Primary Hypertension	Secondary Hypertension
• Gradual increase in BP, with slow rate of rise in BP • Lifestyle factors that favor higher BP (e.g., weight gain, high-sodium diet, decreased physical activity, job change entailing increased travel, excessive consumption of alcohol) • Family history of hypertension	• BP lability, episodic pallor and dizziness (pheochromocytoma) • Snoring, hypersomnolence (obstructive sleep apnea) • Prostatism (chronic kidney disease due to post-renal urinary tract obstruction) • Muscle cramps, weakness (hypokalemia from primary aldosteronism or secondary aldosteronism due to renovascular disease) • Weight loss, palpitations, heat intolerance (hyperthyroidism) • Edema, fatigue, frequent urination (kidney disease or failure) • History of coarctation repair (residual hypertension associated with coarctation) • Central obesity, facial rounding, easy bruisability (Cushing's syndrome) • Medication or substance use (e.g., alcohol, NSAIDS, cocaine, amphetamines) • Absence of family history of hypertension

Medications

Agent	Possible Management Strategy
Alcohol	• Limit alcohol to ≤1 drink daily for women and ≤2 drinks for men (7)
Amphetamines (e.g., amphetamine, methylphenidate dexmethylphenidate, dextroamphetamine)	• Discontinue or decrease dose (8) • Consider behavioral therapies for ADHD (9)
Antidepressants (e.g., MAOIs, SNRIs, TCAs)	• Consider alternative agents (e.g., SSRIs) depending on indication • Avoid tyramine-containing foods with MAOIs
Atypical antipsychotics (e.g., clozapine, olanzapine)	• Discontinue or limit use when possible • Consider behavior therapy where appropriate • Recommend lifestyle modification (see Section 6.2) • Consider alternative agents associated with lower risk of weight gain, diabetes mellitus, and dyslipidemia (e.g., aripiprazole, ziprasidone) (10, 11)
Caffeine	• Generally limit caffeine intake to <300 mg/d • Avoid use in patients with uncontrolled hypertension • Coffee use in patients with hypertension is associated with acute increases in BP; long-term use is not associated with increased BP or CVD (12)
Decongestants (e.g., phenylephrine, pseudoephedrine)	• Use for shortest duration possible, and avoid in severe or uncontrolled hypertension • Consider alternative therapies (e.g., nasal saline, intranasal corticosteroids, antihistamines) as appropriate
Herbal supplements (e.g., Ma Huang	• Avoid use

Medications continued…

[ephedra], St. John's wort [with MAO inhibitors, yohimbine])	
Immunosuppressants (e.g., cyclosporine)	• Consider converting to tacrolimus, which may be associated with fewer effects on BP (13-15)
Oral contraceptives	• Use low-dose (e.g., 20–30 mcg ethinyl estradiol) agents (16) or a progestin-only form of contraception, or consider alternative forms of birth control where appropriate (e.g., barrier, abstinence, IUD) • Avoid use in women with uncontrolled hypertension (16)
NSAIDs	• Avoid systemic NSAIDs when possible • Consider alternative analgesics (e.g., acetaminophen, tramadol, topical NSAIDs), depending on indication and risk
Recreational drugs (e.g., "bath salts" [MDPV], cocaine, methamphetamine, etc.)	• Discontinue or avoid use
Systemic corticosteroids (e.g., dexamethasone, fludrocortisone, methylprednisolone, prednisone, prednisolone)	• Avoid or limit use when possible • Consider alternative modes of administration (e.g., inhaled, topical) when feasible
Angiogenesis inhibitor (e.g., bevacizumab) and tyrosine kinase inhibitors (e.g., sunitinib, sorafenif)	• Initiate or intensify antihypertensive therapy

Non Pharmacologic Tx

- Best proven interventions include the following…
- Weight loss
- DASH diet
- Sodium restriction
- Physical activity
- Moderate alcohol intake

Nonpharmacologic Tx

	Nonpharmacological Intervention	Dose	Approximate Impact on SBP		
			Hypertension	Normotension	Reference
Weight loss	Weight/body fat	Best goal is ideal body weight, but aim for at least a 1-kg reduction in body weight for most adults who are overweight. Expect about 1 mm Hg for every 1-kg reduction in body weight.	-5 mm Hg	-2/3 mm Hg	(1)
Healthy diet	DASH dietary pattern	Consume a diet rich in fruits, vegetables, whole grains, and low-fat dairy products, with reduced content of saturated and total fat.	-11 mm Hg	-3 mm Hg	(6, 7)
Reduced intake of dietary sodium	Dietary sodium	Optimal goal is <1500 mg/d, but aim for at least a 1000-mg/d reduction in most adults.	-5/6 mm Hg	-2/3 mm Hg	(9, 10)
Enhanced intake of dietary potassium	Dietary potassium	Aim for 3500–5000 mg/d, preferably by consumption of a diet rich in potassium.	-4/5 mm Hg	-2 mm Hg	(13)
Physical activity	Aerobic	● 90–150 min/wk ● 65%–75% heart rate reserve	-5/8 mm Hg	-2/4 mm Hg	(18, 22)
	Dynamic resistance	● 90–150 min/wk ● 50%–80% 1 rep maximum ● 6 exercises, 3 sets/exercise, 10 repetitions/set	-4 mm Hg	-2 mm Hg	(18)

Nonpharmacologic Tx

	Isometric resistance	• 4 × 2 min (hand grip), 1 min rest between exercises, 30%–40% maximum voluntary contraction, 3 sessions/wk • 8–10 wk	-5 mm Hg	-4 mm Hg	(19, 31)
Moderation in alcohol intake	Alcohol consumption	In individuals who drink alcohol, reduce alcohol† to: • Men: ≤2 drinks daily • Women: ≤1 drink	-4 mm Hg	-3 mm Hg	(22-24)

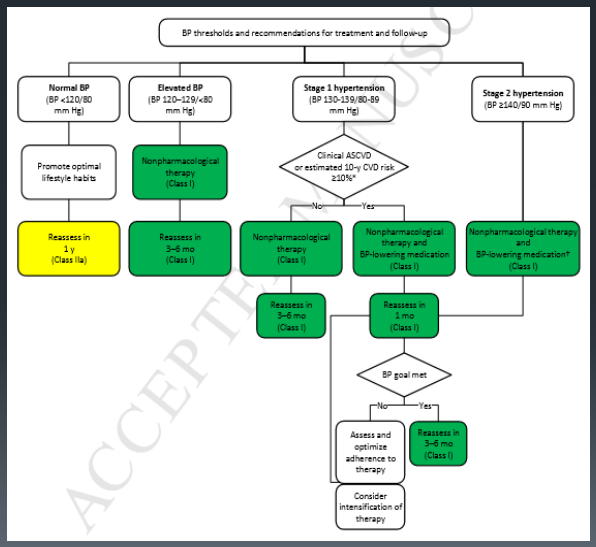
Laboratory Testing

- BMP
- CBC
- Lipid panel
- UA
- EKG
- Optional (Echo, Uric acid, Urine albumin/Cr)

Treatment!

- Use medication for secondary prevention in those with…
- Clinical evidence of CVD and BP >130/80
- Primary prevention in individuals with 10 year ASCVD score >10% and BP >130/80
- Primary prevention in those <10% ASCVD score and BP >140/90

Treatment Algorithm



Treatment Summary

Recommendations for Follow-Up After Initial BP Elevation References that support recommendations are summarized in Online Data Supplement 24.		
COR	LOE	Recommendations
I	B-R	1. Adults with an elevated BP or stage 1 hypertension who have an estimated 10-year ASCVD risk less than 10% should be managed with nonpharmacological therapy and have a repeat BP evaluation within 3 to 6 months (1, 2).
I	B-R	2. Adults with stage 1 hypertension who have an estimated 10-year ASCVD risk of 10% or higher should be managed initially with a combination of nonpharmacological and antihypertensive drug therapy and have a repeat BP evaluation in 1 month (1, 2).
I	B-R	3. Adults with stage 2 hypertension should be evaluated by or referred to a primary care provider within 1 month of the initial diagnosis, have a combination of nonpharmacological and antihypertensive drug therapy (with 2 agents of different classes) initiated, and have a repeat BP evaluation in 1 month (1, 2).
I	B-R	4. For adults with a very high average BP (e.g., SBP ≥180 mm Hg or DBP ≥110 mm Hg), evaluation followed by prompt antihypertensive drug treatment is recommended (1, 2).
IIa	C-EO	5. For adults with a normal BP, repeat evaluation every year is reasonable.

Preferred Medication

- Thiazide, CCB, ACE or ARB still first-line
- Thiazide: Chlorthalidone preferred (half-life CVD reduction)
- CCB: Try to avoid in HFrEf (Amlodipine of Felodipine if need to)
- Loop: Especially if CKD (GFR < 30mL/min)
- K+ sparing: resistant HTN

Treatment approach

- Use first-line agents
- Also appropriate to use agents to treat comorbidities regardless of first-line recommendations
- F/U at monthly intervals until goals met
- Treatment goal is <130/80

Treatment scenarios

- IHD, Angina, HFrEF
- Diabetes
- Aortic disease
- Ethnicity
- Gender
- Age

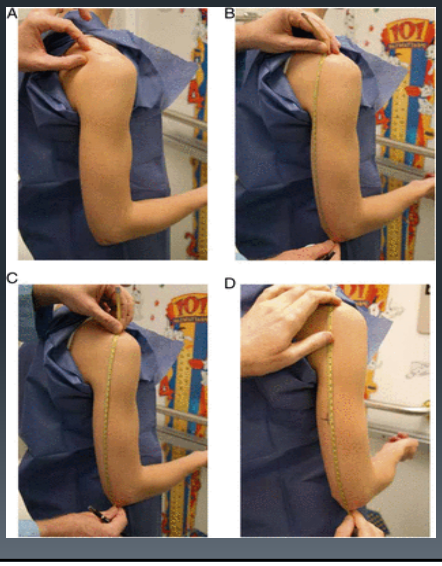
Pediatric Hypertension

- Updated in 2017 (update from 2004)
- Aligns with terminology used in AHA/ACC in those 13 and older
- Based on children with normal weight
- Provides screening tables to identify children who need further monitoring and assessment

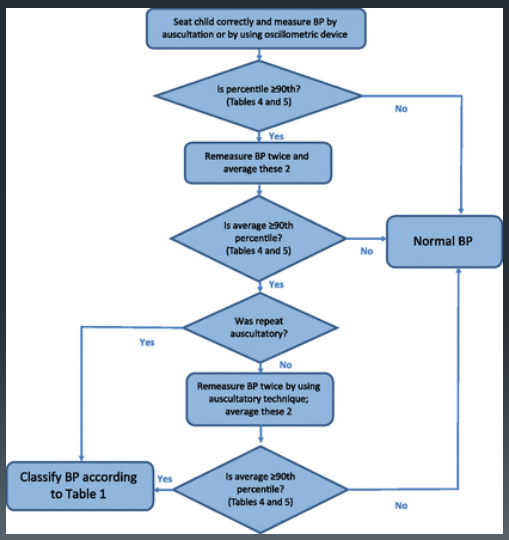
Screening

- New tables are meant to be a tool to screen and identify pediatric patients who need further monitoring (repeat measurements)
- Not meant to diagnose
- 13 years of age and older the threshold is 120/80
- Tables arranged by age, gender, and height
- Start monitoring in office by 3 years of age

Measurement



Measurement



Approach to workup and treatment

- Normal BP <90% continue with annual screening
- Elevated BP 90>95%
- Dietary and lifestyle interventions
- 6 month F/U
- 12 month F/U

Stage I interventions

- >95% - 95% + 12mm Hg
- If asymptomatic F/U.
- If symptomatic send to ED
- Upper and LE readings at 2nd visit
- If still sustained at 3rd visit start diagnostic evaluation and treatment

Stage II interventions

- >95% + 12mm HG
- Check upper and lower extremity at initial visit. F/U 1 week. Can refer as well
- If still sustained start workup and treatment
- ABPM
- If symptomatic send to ED (or if BP > 30mm/HG above 95%
- >180/120 in adolescent

Updated Definitions

TABLE 3 Updated Definitions of BP Categories and Stages

For Children Aged 1–13 y	For Children Aged ≥13 y
Normal BP: <90th percentile	Normal BP: <120/<80 mm Hg
Elevated BP: ≥90th percentile to <95th percentile or 120/80 mm Hg to <95th percentile (whichever is lower)	Elevated BP: 120/<80 to 129/<80 mm Hg
Stage 1 HTN: ≥95th percentile to <95th percentile + 12 mmHg, or 130/80 to 139/89 mm Hg (whichever is lower)	Stage 1 HTN: 130/80 to 139/89 mm Hg
Stage 2 HTN: ≥95th percentile + 12 mm Hg, or ≥140/90 mm Hg (whichever is lower)	Stage 2 HTN: ≥140/90 mm Hg

Diagnosis

- Auscultatory BP readings confirmed greater or equal 95% at 3 separate visits
- Greater or equal to 130/80 in adolescents 13 or older

New BP tables

- Can be confusing and difficult to find BP categories
- Due to this a simplified table is provided
- Recognize those that need further monitoring
- Simplified provides 90% BP values at 5% height

Simplified table

TABLE 6 Screening BP Values Requiring Further Evaluation

Age, y	BP, mm Hg			
	Boys		Girls	
	Systolic	DBP	Systolic	DBP
1	98	52	98	54
2	100	55	101	58
3	101	58	102	60
4	102	60	103	62
5	103	63	104	64
6	105	66	105	67
7	106	68	106	68
8	107	69	107	69
9	107	70	108	71
10	108	72	109	72
11	110	74	111	74
12	113	75	114	75
≥13	120	80	120	80

Putting it all together

- Identify those who need monitoring and schedule appropriate F/U
- Identify combordities and risk stratify
- Provide appropriate counseling
- Distinguish Primary vs. Secondary
- Start treatment if indicated

Primary vs. Secondary

- Primary: Older (>6), family history, overweight or obese
- Secondary: Thin, negative family history. Acute rise. UA abnormalities
- Severity of HTN

Secondary

- Renal disease most common secondary
  - History of UTI's (especially pyelo)
  - Congenital kidney or urolgic abnormalities
- Cardiac: Coarctation
- Exogenous: Medication, drugs
  - Steroids
  - Stimulants
  - Decongestants
  - OCP's

RF stratification

- Overweight/obese
- Sedentary
- Dietary
- Family Hx
- Tobacco
- CKD or DM
- OSA

Diagnostic work up

- Labs
  - All: UA, BMP or CMP, Lipid panel
  - Obese: HgbA1c, LFT's, Lipids
  - Additional: Fasting glucose, TSH, UDS, CBC,
- Imaging
  - Renal US: if <6 or abnormal UA, renal function (regardless of age)
  - Echo: recommended when considering treatment
  - Sleep study

Action Plan

- Physical activity
- DASH diet
- All to aid weight loss or maintenance over time
- In line with AHA/ACC continue all non pharmacolgic along with pharmacologic treatment
- Update recommendation in 2022 likely

Pharmacolgic treatment

- Treat
  - sustained hypertensive individuals failed lifestyle interventions
  - Symptomatic HTN
  - Stage II without modifiable RF
  - Stage I or II associated with renal disease or DM
  - Goal: <90% or <130/80 if 13 or older

Preferred medications

- ACE/ARB, CCB, Thiazide
- AA: Consider thiazide or CCB
- CKD, DM, Proteinuria: ACE/ARB
- Sexually active female, pregnant: ACE/ARB contraindicated
- BB: Not recommended first line, especially not athletes

Follow up

- F/U every 4-6 weeks if treated with medication. Continue until BP goal reached
- Every 3-4 months when goal reached
- F/U every 3-6 months if only treating with lifestyle changes

Resources

- Flynn JT, Kaelber DC, Baker-Smith CM, et al; SUBCOMMITTEE ON SCREENING AND MANAGEMENT OF HIGH BLOOD PRESSURE IN CHILDREN. Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents. *Pediatrics*. 2017; 140(3):e20171904
- 2017ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol* 2017;Nov 13
- Up to Date

Resources

- https://solutions.aap.org/DocumentLibrary/pcowebinars/2017%20Hypertension%20Webinar.pdf