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ORLANDO HEALTH®

Primary Care Guide to Hypertension

October 5, 2019

Objectives

- BP cuffs
  - Upper-arm
  - Wrist
- Home BP measurements
- ACC/AHA Guidelines
- Treatment
  - Lifestyle Modifications
  - Antihypertensives

53 y/o obese male with hyperlipidemia comes to you for first time clinic visit. BP 155/95, HR 85. In addition to lifestyle modifications, which of the following would you recommend?

A. Start antihypertensive

B. Have patient follow-up in 2-8 weeks and if clinic BP still elevated, start antihypertensive

C. Home BP log for 1-3 weeks and if average BP still elevated, start antihypertensive

D. 24-hour Ambulatory BP monitor and if average BP still elevated, start antihypertensive

E. Lifestyle modifications for 3-6 months and and if BP still elevated, start antihypertensive

BP Cuffs

- What cuff should I get?

Upper-arm Cuff

- Appropriately sized upper arm cuff is the standard

Cuff Size

- Too small cuff: overestimation of BP
- Too large cuff: underestimation of BP

Arm Circumference		Recommended Cuff Size (width x length in cm)
cm	in	
22 – 26	8.7 – 10.2	12 x 22 **(small adult)***
27 – 34	10.6 – 13.4	16 x 30 **(adult)***
35 – 44	13.8 – 17.3	16 x 36 **(large adult)***
45 – 52	17.7 – 20.5	16 x 42 **(extra-large adult)**

Wrist Cuffs

- 30-50% of market share
- BP accuracy depends on difference in height between the wrist and the heart
  - Wrists at a higher level than heart lead to falsely lower BP
  - Wrists at a lower level than heart lead to falsely higher BP
- Few models have a position sensor to verify that the wrist is placed properly at heart level

Population-based study

- Office: SBP 2.5% lower at wrist than upper-arm
- Home: SBP 5.6% higher and DBP 5.4% higher than upper-arm
  - 621/721 subjects had home measurement error of at least ±5 mm Hg and 455/721 of at least ±10 mm Hg
- Falsely elevated BP values from incorrect arm position during measurement
  - Magnified in longer forearms: more pronounced for SBP than DBP

Casiglia et al. Poor reliability of wrist blood pressure self-measurement at home: A population-based study. *Hypertension*.

Correct forearm position

for wrist blood pressure measurement

1. **Apply the wrist device**
2. **Keep elbow on table or desk with forearm bent**
3. **Place the wrist at heart level**
4. **Keep arm relaxed and hand resting against your body**
5. **Measure wrist blood pressure without moving arm from seated position**

Incorrect forearm position[2]

Wrist higher than heart level

Forearm in horizontal position

Forearm vertical and close to the body

Medaval™ Certified Accuracy

Accurate Upper-Arm Blood Pressure Monitors for Self-Measurement and Home Use.

These monitors have been Clinically Validated in a general population

Certified 4-Star and 5-Star Blood Pressure Monitors

NAME & MODEL	NAME & MODEL	NAME & MODEL
A&D UA-651	iHealth Feel BP5	Omron HEM-7500F
Andon KD-5851	**Omron BP760N (HEM-7320-Z)**	**PangaO PG-800B11**
Andon KD-5917	Omron BP765 (HEM-7311-ZSA)	PangaO PG-800B5-1
Andon KD-5965	**Omron HEM-7130**	**PangaO PG-800B68**
Avita BPM63S	Omron HEM-7251G	Rossmax CF-175F
BIOS Precision 8.0 (BD215)	**Omron HEM-7252G-HP**	**Visomat Double Comfort**
iHealth BP3 (KD-931)	Omron HEM-7320F	

3-Star Blood Pressure Monitors

NAME & MODEL	NAME & MODEL	NAME & MODEL
Andon KD-5031	Omron 705IT (HEM-759-E)	Omron M3 Intellisense (HEM-7051-E)
Andon KD-556	**Omron BP760 (HEM-7220-Z)**	**Omron M4-I (HEM-752-E)**
Andon KD-5913	Omron BP785 (HEM-7222-Z)	Omron M6 (HEM-7001-E)
Andon KD-5915	**Omron Evolv (HEM-7600T-E)**	**Omron M6 (HEM-7211-E)**
Andon KD-5963	Omron HEM-7051 (HEM-7051-SH)	Omron M6 (HEM-7211-E8)
Andon KD-5971	**Omron HEM-7080IC**	**Omron M6 Comfort (HEM-7000-E)**
Beurer BM-44	Omron i-C10 (HEM-7070-E)	Omron M6 Comfort (HEM-7221-E)
Beurer BM-47	**Omron IA2**	**Omron M6 Comfort (HEM-7221-EB)**
Beurer BM-58	Omron M10-IT (HEM-7080IT-E)	Omron M6 Comfort (HEM-7223-E)
Beurer BM-65	**Omron M2 (HEM-7117-E)**	**Omron M6 Comfort (HEM-7321-E)**
Beurer SBM-43	Omron M2 (HEM-7119-E(V))	Omron M6 Comfort IT (HEM-7322U-E)
Grandway G LAB MD2680	**Omron M2 Basic (HEM-7116-E)**	**Omron M7 (HEM-780-E)**
Grandway MD2301	Omron M2 Basic (HEM-7116-E2(V))	PangaO PG-800B26
Medel Check (V1)	**Omron M2 Basic (HEM-7116-E8(V))**	**Pic Solution Digit Extra**
Medel Elite	Omron M3 (HEM-7200-E)	Pic Solution Digit Smart
Microlife BP 3AS1-2	**Omron M3 (HEM-7200-EB)**	**Visomat Comfort E (v2)**
Omron 705CP-11 (HEM-759-E2)	Omron M3 Comfort (HEM-7134-E)	

2-Star Blood Pressure Monitors

NAME & MODEL	NAME & MODEL	NAME & MODEL
A&D UA-1020	Microlife BP 3BT0-A (2)	Omron M400 (HEM-7131-D)
A&D UA-1200BLE	**Microlife BP 3BTO-AP**	**Omron M500 (HEM-7321-D)**
Accutension BP Kit (XYZ-110)	Microlife BP A1 Easy (BP 3GR1-1P)	Omron MX3 Plus (HEM-742-E)
Andon KD-595	**Microlife BP A100**	**Panasonic EW-3106**
Avita BPM-64	Microlife BP A100 Plus	Polygreen KP-7670
Avita BPM-17	**Microlife BP A2 Basic (BP 3GQ1-3P)**	**Qardio QardioArm A100**
Beurer BM-60	Microlife BP A6 PC	Rising Sun RS-651
Bpump BF-1112	**Microlife WatchBP Home (BP 3MX1-1)**	**Rossmax Medicare 100F**
Hartmann Tensoval Due Control 11	Microlife WatchBP Home A (BP 3MX1-3)	Sejoy BP-1307
Konsung QD-217A	**Microlife WatchBP Home N (BP 3MX1-4)**	**Transtek LS-808-B**
Medipro MC-100F	Nissei DS-400	Transtek TMB-1491
Medisana MTP Plus (51043)	**Nissei DS-500**	**Withings BP-800**
Microlife BP 3AG1	Omron HEM-7250-IT	Yuwell YE-690A
Microlife BP 3BT0-1	**Omron HEM-7420**	
Microlife BP 3BT0-A	Omron HEM-9210T	

Visit www.medaval.ie - for more information on

- Best / Top rated devices
- Devices for Home BP Monitoring
- Devices that have not been validated
- Device Manuals
- Professional Devices
- Patient Monitors
- Blood Glucose Meters
- Pulse Oximeters
- Validation and Certification details

BEST UPA Blood Pressure Monitors - 1st Jan 2019

Medaval™ Certified Accuracy

Accurate Upper-Arm Blood Pressure Monitors for Self-Measurement and Home Use.

These monitors have been Clinically Validated in a general population

1-Star Blood Pressure Monitors

NAME & MODEL	NAME & MODEL	NAME & MODEL
Andon KD-391	Medisana MTD	Omron MIT Elite Plus (HEM-7301-ITKE7)
BIOS Precision 4.0 (BD204)	**Medisana MTX (51083)**	**Omron MX2 Basic (HEM-742-E2)**
Braun ExactFit 3 (BP-6000)	Microlife BP 3AC1-1	Panasonic EW-3109
Braun ExactFit 3 (BP-6100)	**Microlife BP 3AC1-1 PC**	**Panasonic EW-BU15**
Braun ExactFit 5 (BP-6200)	Microlife BP 3AC1-2	Pic Solution Classic Check
Citizen CH-461C	**Omron Elite 7300W (HEM-7300-EZ)**	**Pic Solution Comfort Check**
Citizen CH-463E	Omron HEM-705CP (V2)	Pic Solution Daily Check
H&L HL888HA	**Omron HEM-706**	**Pic Solution Help Check**
Hartmann Tensoval Comfort	Omron HEM-7101 (HEM-7101-SH)	Pic Solution My Check
Hartmann Tensoval Due Control	**Omron HEM-742**	**Pic Solution One Check**
HoMedics BPA-540	Omron i-Q132 SpotArm (HEM-1010-E)	Pic Solution Personal Check
Honsun Scian LD-578	**Omron M2 Compact (HEM-7102-E)**	**Transtek TMB-986**
IEM Tel-O-Graph BT	Omron M3 Basic 11	Visomat Comfort Eco (v2)
IEM Tel-O-Graph GSM	**Omron M300 (HEM-7121-D)**	**Visomat Comfort Form (v1)**
Kingyield BP-101H	Omron M4 Plus 11	
Lloyds BP11	**Omron M5-1 (HEM-757-E)**	

Other Clinically Validated Blood Pressure Monitors

NAME & MODEL	NAME & MODEL	NAME & MODEL
A&D UA-631	BoSo Medicus Control	Nissei DS-1902
A&D UA-704	**BoSo Medicus Family**	**Omron HEM Solar (HEM-4500-Sole)**
A&D UA-705	BoSo Medicus Prestige	Omron HEM-711
A&D UA-767	**BoSo Medicus Smart**	**Omron HEM-711DLX**
A&D UA-767 Plus	BoSo Medicus Uno	Omron M1 (HEM-4030-E)
A&D UA-774	**Braun BP-4900**	**Omron M1 (HEM-422C2-E)**
A&D UA-779	Braun BP-5900	Omron M1 Classic (HEM-442C-E)
A&D UA-787	**Braun Easy Click (BP-3000)**	**Omron M1 Compact (HEM-4022-E)**
A&D UA-851	Citizen CH-432B	Omron M1 Plus (HEM-4011C-E)
A&D UA-852	**Citizen CH-452**	**Oregon BPU330**
A&D UA-853	Colson MAM BP 3AA1-2	Panasonic EW-3152W
A&D UA-854	**H&L HL868BA**	**PMS Mandaus**
A&D UA-854	Hartmann Digital HG160 Comfort	Rossmax ME701
Artsana (Pic Solution) CS-410	**Heine Gamma G5**	**Scala DB-61M**
Artsana (Pic Solution) CSI-610	Heine Gamma G7	SensaCare SAA-102
Beurer BM-20	**HoMedics BPA-300**	**Spengler KP7500 D**
Beurer BM-35	K-jump KP-7770	Tensiomed Tensioday
Beurer DC-50	**Medel Idea**	**Visomat Comfort 20-40 (v2)**

Medaval CERTIFIED ACCURATE DEVICE ★★★★★

Blood Pressure Monitors with a Star rating are the best devices you can buy.
In addition devices certified by Medaval have been awarded a Medaval Certification of Accuracy and can use this logo, on its packaging, in its literature and in advertisements for that device.

Visit www.medaval.ie - for more information on

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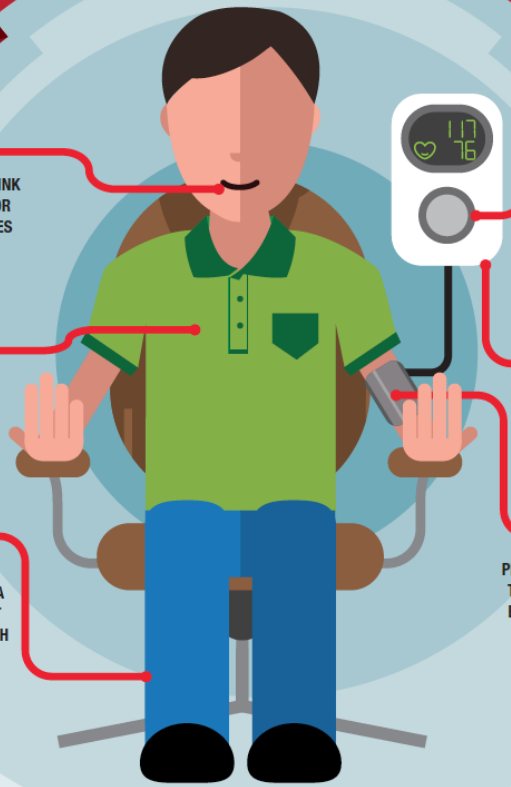
- Device Manuals
- Professional Devices
- Patient Monitors
- Blood Glucose Meters
- Pulse Oximeters
- Validation and Certification details

Home BP measurements

BLOOD PRESSURE MEASUREMENT INSTRUCTIONS

American Heart Association | American Stroke Association
life is why*



DON'T SMOKE, EXERCISE, DRINK CAFFEINATED BEVERAGES OR ALCOHOL WITHIN 30 MINUTES OF MEASUREMENT.

REST IN A CHAIR FOR AT LEAST 5 MINUTES WITH YOUR LEFT ARM RESTING COMFORTABLY ON A FLAT SURFACE AT HEART LEVEL. SIT CALMLY AND DON'T TALK.

MAKE SURE YOU'RE RELAXED. SIT STILL IN A CHAIR WITH YOUR FEET FLAT ON THE FLOOR WITH YOUR BACK STRAIGHT AND SUPPORTED.

TAKE AT LEAST TWO READINGS 1 MIN. APART IN MORNING BEFORE TAKING MEDICATIONS, AND IN EVENING BEFORE DINNER. RECORD ALL RESULTS.

USE PROPERLY CALIBRATED AND VALIDATED INSTRUMENT. CHECK THE CUFF SIZE AND FIT.

PLACE THE BOTTOM OF THE CUFF ABOVE THE BEND OF THE ELBOW.

American Heart Association recommended blood pressure levels

BLOOD PRESSURE CATEGORY	SYSTOLIC mm Hg (upper number)		DIASTOLIC mm Hg (lower number)
NORMAL	LESS THAN 120	and	LESS THAN 80
ELEVATED	120-129	and	LESS THAN 80
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 1	130-139	or	80-89
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 2	140 OR HIGHER	or	90 OR HIGHER
HYPERTENSIVE CRISIS (consult your doctor immediately)	HIGHER THAN 180	and/or	HIGHER THAN 120

BLOOD PRESSURE HIGHER THAN 180/120 mm Hg IS A CRISIS.*

* Wait a few minutes and take blood pressure again. If it's still high, contact your doctor immediately.

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Monitoring Schedule and Interpretation

- 2 measurements 1 minute apart
  - Morning: before medications
  - Evening: before dinner
- 7 routine work days (minimum 3 days)
  - Weekends preferably excluded: BP usually lower
- Decision making
  - Exclude 1st day readings: usually higher and more variable
  - Average 6 days home BP readings (minimum 3 days)

Normal	Prehypertension	Hypertension
<130/80	130-134/80-84	≥135/85

Home BP measurements

- Casual, isolated home measurements can be very misleading
  - Not constitute basis for clinical decisions
- Educate patients that BP can vary between measurements and not to be alarmed by high or low BP on a single occasion, unless an important elevation or reduction persists or is associated with clinically relevant symptoms

53 y/o obese male with hyperlipidemia comes to you for first time clinic visit. BP 155/95, HR 85.

In addition to lifestyle modifications, you decide to start him on Amlodipine 5 mg daily. What goal BP do you target?

A. <140/90

B. <140/80

C. <135/85

D. <130/80

E. <120/80

ACC/AHA Guidelines

Hypertension
Journal of the American Heart Association

American Heart Association®

2017 ACC/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

Paul K. Whelton, Robert M. Carey, Wilbert S. Aronow, Donald E. Casey, Jr, Karen J. Collins, Cheryl Dennison Himmelfarb, Sondra M. DePalma, Samuel Gidding, Kenneth A. Jamerson, Daniel W. Jones, Eric J. MacLaughlin, Paul Muntner, Bruce Ovbiagele, Sidney C. Smith, Jr, Crystal C. Spencer, Randall S. Stafford, Sandra J. Taler, Randal J. Thomas, Kim A. Williams, Sr, Jeff D. Williamson and Jackson T. Wright, Jr

2017 ACC/AHA Guidelines

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

Average of ≥2 careful readings obtained on ≥2 occasions

Out-of-office BPs recommended to confirm diagnosis

Systolic vs. Diastolic HTN

- Isolated systolic HTN: ≥130/<80 mmHg
- Isolated diastolic HTN: <130/≥80 mmHg
- Mixed systolic/diastolic HTN: ≥130/≥80 mmHg

2017 ACC/AHA Guidelines

Clinical CVD: CAD, CHF, and stroke

Clinical Condition(s)	BP Threshold, mm Hg	BP Goal, mm Hg
General		
Clinical CVD or 10-year ASCVD risk ≥10%	≥130/80	<130/80
No clinical CVD and 10-year ASCVD risk <10%	≥140/90	<130/80
Older persons (≥65 years of age; noninstitutionalized, ambulatory, community-living adults)	≥130 (SBP)	<130 (SBP)
Specific comorbidities		
Diabetes mellitus	≥130/80	<130/80
Chronic kidney disease	≥130/80	<130/80
Chronic kidney disease after renal transplantation	≥130/80	<130/80
Heart failure	≥130/80	<130/80
Stable ischemic heart disease	≥130/80	<130/80
Secondary stroke prevention	≥140/90	<130/80
Peripheral artery disease	≥130/80	<130/80

ASCVD Risk Estimator*

All fields are required to compute ASCVD risk.

Gender: **M** | **F**

Age: 20-79

Race

- **White**
- **African American**
- **Other**

Total Cholesterol (mg/dL): 130-320

HDL - Cholesterol (mg/dL): 20-100

Systolic Blood Pressure: 90-200

Treatment for Hypertension: **Y** | **N**

Diabetes: **Y** | **N**

Smoker: **Y** | **N**

ASCVD Risk Estimator*

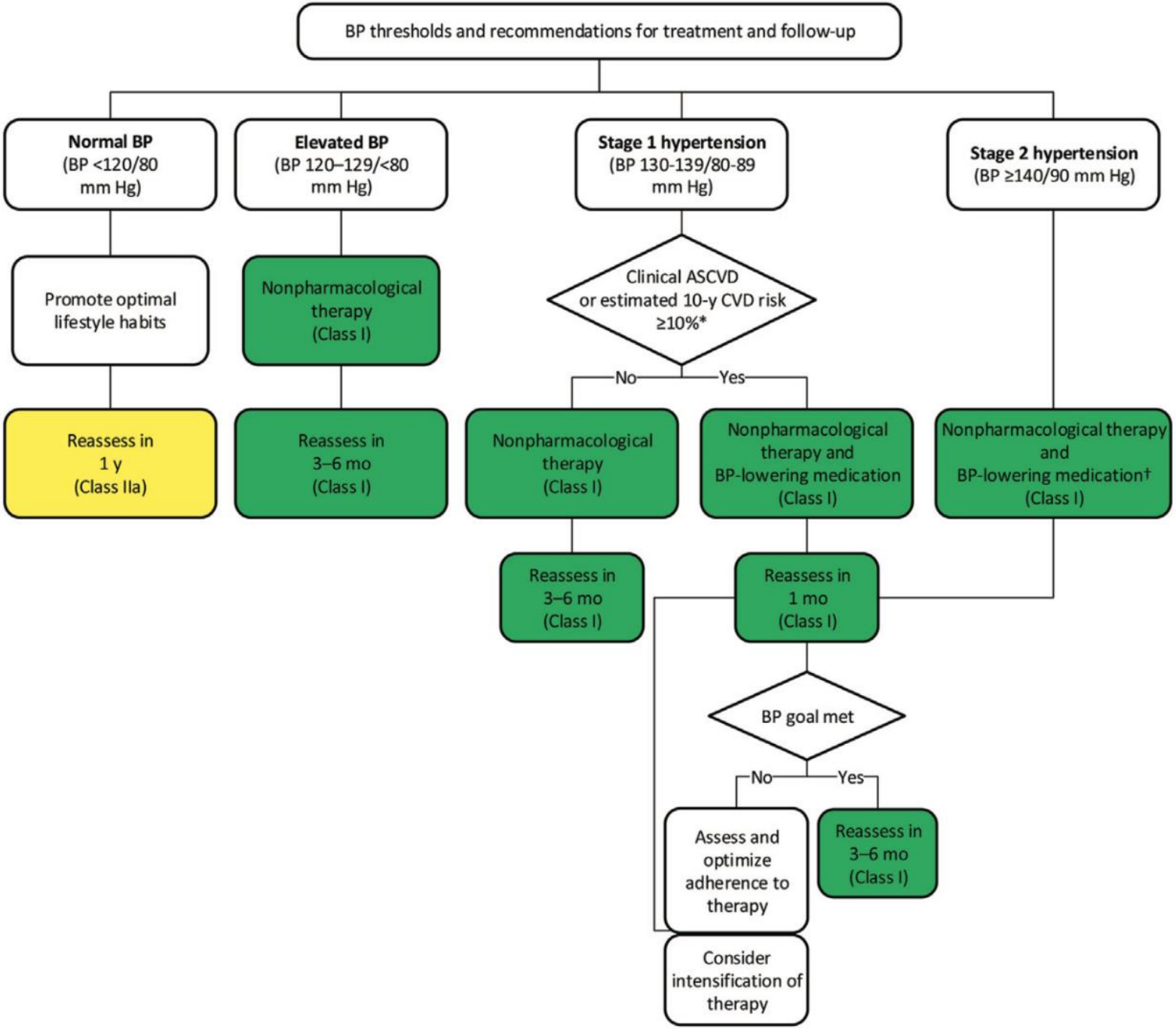
10-Year ASCVD Risk: 20.4 % calculated risk

Lifetime ASCVD Risk: 69 % calculated risk

Recommendation Based On Calcul...

Less aggressive BP Goal

- <140/90 mmHg (office) or <135/85 mmHg (home)
  - Labile BP or postural hypotension
  - Side effects to multiple antihypertensives
- ≥75 y/o w/ high comorbidity burden
- DBP <55 mmHg


BP thresholds and recommendations for treatment and follow-up
Normal BP (BP <120/80 mm Hg)
Elevated BP (BP 120–129/<80 mm Hg)
Stage 1 hypertension (BP 130-139/80-89 mm Hg)
Stage 2 hypertension (BP ≥140/90 mm Hg)
Promote optimal lifestyle habits
Nonpharmacological therapy (Class I)
Clinical ASCVD or estimated 10-y CVD risk ≥10%*
No
Yes
Reassess in 1 y (Class IIa)
Reassess in 3–6 mo (Class I)
Nonpharmacological therapy (Class I)
Nonpharmacological therapy and BP-lowering medication (Class I)
Nonpharmacological therapy and BP-lowering medication† (Class I)
Reassess in 3–6 mo (Class I)
Reassess in 1 mo (Class I)
BP goal met
No
Yes
Assess and optimize adherence to therapy
Reassess in 3–6 mo (Class I)
Consider intensification of therapy

53 y/o obese male with hyperlipidemia comes to you for first time clinic visit. BP 155/95, HR 85. In addition to lifestyle modifications, you decide to start him on Amlodipine 5 mg daily.

4 weeks after starting him on Amlodipine 5 mg daily, he returns to clinic with home BP log showing an average BP of 142/90 and office BP of 145/90. Now what would you recommend?

A. Increase Amlodipine

B. Start another antihypertensive

C. Increase Amlodipine and start another antihypertensive

D. Stop Amlodipine and switch to another antihypertensive

E. No change in medication

Treatment

- Remove causative or exacerbating agents
- Lifestyle Modifications
- Antihypertensives

Treatment

- Remove causative or exacerbating agents, if possible
- Nonpharmacologic
- Pharmacologic

Agent	Possible Management Strategy
Alcohol	■ Limit alcohol to ≤1 drink daily for women and ≤2 drinks for men (S5.4.1-7)
Amphetamines (e.g., amphetamine, methylphenidate dexmethylphenidate, dextroamphetamine)	■ Discontinue or decrease dose (S5.4.1-8) ■ Consider behavioral therapies for ADHD (S5.4.1-9)
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) (S5.4.1-10,S5.4.1-11)
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 (S5.4.1-12)
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 [ephedra], St. John's wort [with MAO inhibitors, yohimbine])	■ Avoid use
Immunosuppressants (e.g., cyclosporine)	■ Consider converting to tacrolimus, which may be associated with fewer effects on BP (S5.4.1-13–S5.4.1-15)
Oral contraceptives	■ Use low-dose (e.g., 20–30 mcg ethinyl estradiol) agents (S5.4.1-16) 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 (S5.4.1-16)
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, sorafenib)	■ Initiate or intensify antihypertensive therapy

Nonpharmacologic

- Lifestyle modification: **all patients**

Lifestyle Modifications

Elevated BP or Stage 1 hypertension with <10% ASCVD risk: 3-6 months

Risk Factor	Intervention	Duration/Type/Dose	Δ ↓BP (mmHg)
Physical Activity	Aerobic	90-150 min/week	4-6/3
Diet	DASH	Fruits, Vegetables, Whole grains, etc.	6/4
Weight	↓	1 kg	0.5-2 per 1 kg
Na	↓	<1500 mg/day	4.8/2.5
K	↑	3500-5000 mg/day	4
EtOH	↓	M ≤2, F ≤1 per day*	4
OSA	CPAP	Nightly	2-3

*1 “standard” drink contains roughly 14 g of pure alcohol: 12 oz of regular beer (usually about 5% alcohol), 5 oz of wine (usually about 12% alcohol), or 1.5 oz of distilled spirits (usually about 40% alcohol)

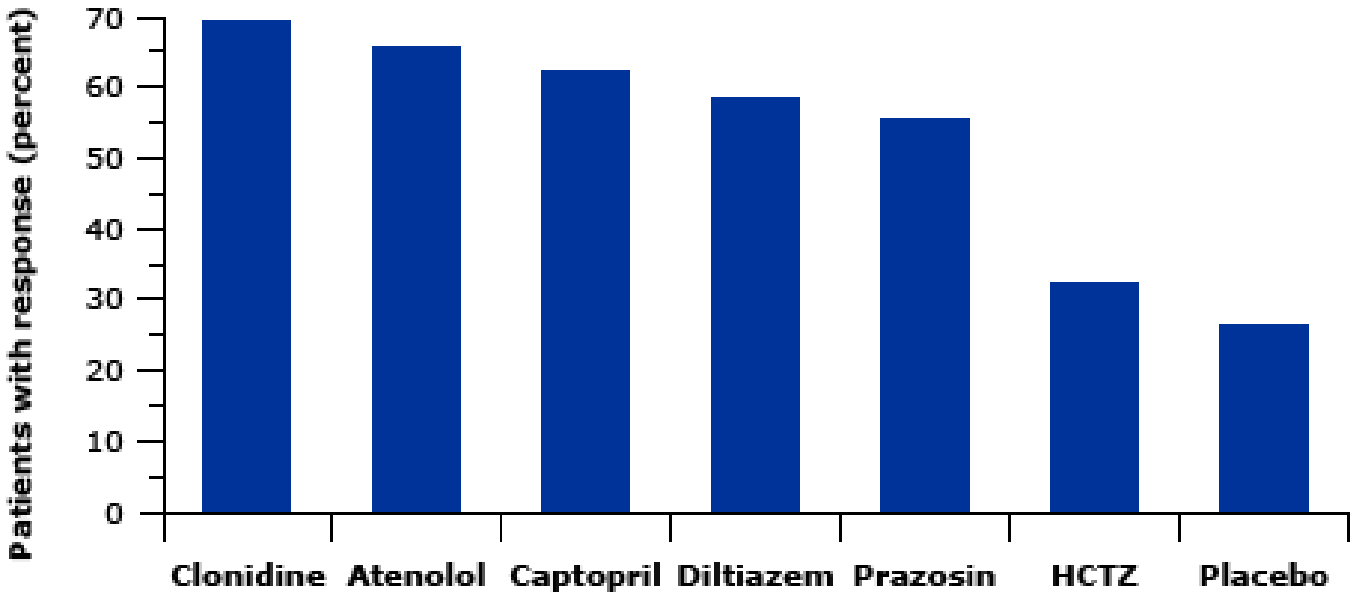
Antihypertensives

Class	Drug	Usual Dose, Range (mg/d)*	Daily Frequency	Comments
Primary agents				
Thiazide or thiazide-type diuretics	Chlorthalidone	12.5–25	1	■ Chlorthalidone is preferred on the basis of prolonged half-life and proven trial reduction of CVD. ■ Monitor for hyponatremia and hypokalemia, uric acid and calcium levels. ■ Use with caution in patients with history of acute gout unless patient is on uric acid–lowering therapy.
	Hydrochlorothiazide	25–50	1	
	Indapamide	1.25–2.5	1	
	Metolazone	2.5–5	1	
ACE inhibitors	Benazepril	10–40	1 or 2	■ Do not use in combination with ARBs or direct renin inhibitor. ■ There is an increased risk of hyperkalemia, especially in patients with CKD or in those on K^+ supplements or K^+-sparing drugs. ■ There is a risk of acute renal failure in patients with severe bilateral renal artery stenosis. ■ Do not use if patient has history of angioedema with ACE inhibitors. ■ Avoid in pregnancy.
	Captopril	12.5–150	2 or 3	
	Enalapril	5–40	1 or 2	
	Fosinopril	10–40	1	
	Lisinopril	10–40	1	
	Moexipril	7.5–30	1 or 2	
	Perindopril	4–16	1	
	Quinapril	10–80	1 or 2	
	Ramipril	2.5–20	1 or 2	
	Trandolapril	1–4	1	
ARBs	Azilsartan	40–80	1	■ Do not use in combination with ACE inhibitors or direct renin inhibitor. ■ There is an increased risk of hyperkalemia in CKD or in those on K^+ supplements or K^+-sparing drugs. ■ There is a risk of acute renal failure in patients with severe bilateral renal artery stenosis. ■ Do not use if patient has history of angioedema with ARBs. Patients with a history of angioedema with an ACE inhibitor can receive an ARB beginning 6 weeks after ACE inhibitor is discontinued. ■ Avoid in pregnancy.
	Candesartan	8–32	1	
	Eprosartan	600–800	1 or 2	
	Irbesartan	150–300	1	
	Losartan	50–100	1 or 2	
	Olmesartan	20–40	1	
	Telmisartan	20–80	1	
	Valsartan	80–320	1	
CCB—dihydropyridines	Amlodipine	2.5–10	1	■ Avoid use in patients with HFrEF; amlodipine or felodipine may be used if required. ■ They are associated with dose-related pedal edema, which is more common in women than men.
	Felodipine	2.5–10	1	
	Isradipine	5–10	2	
	Nicardipine SR	60–120	2	
	Nifedipine LA	30–90	1	
	Nisoldipine	17–34	1	
CCB—nondihydropyridines	Diltiazem ER	120–360	1	■ Avoid routine use with beta blockers because of increased risk of bradycardia and heart block. ■ Do not use in patients with HFrEF. ■ There are drug interactions with diltiazem and verapamil (*CYP3A4* major substrate and moderate inhibitor).
	Verapamil IR	120–360	3	
	Verapamil SR	120–360	1 or 2	
	Verapamil-delayed onset ER	100–300	1 (in the evening)	
Secondary agents				
Diuretics—loop	Bumetanide	0.5–2	2	■ These are preferred diuretics in patients with symptomatic HF. They are preferred over thiazides in patients with moderate-to-severe CKD (e.g., GFR <30 mL/min).
	Furosemide	20–80	2	
	Torsemide	5–10	1	
Diuretics—potassium sparing	Amiloride	5–10	1 or 2	■ These are monotherapy agents and minimally effective antihypertensive agents. ■ Combination therapy of potassium-sparing diuretic with a thiazide can be considered in patients with hypokalemia on thiazide monotherapy. ■ Avoid in patients with significant CKD (e.g., GFR <45 mL/min).
	Triamterene	50–100	1 or 2	

Class	Drug	Usual Dose, Range (mg/d)*	Daily Frequency	Comments
Diuretics—aldosterone antagonists	Eplerenone	50–100	1 or 2	■ These are preferred agents in primary aldosteronism and resistant hypertension. ■ Spironolactone is associated with greater risk of gynecomastia and impotence as compared with eplerenone. ■ This is common add-on therapy in resistant hypertension. ■ Avoid use with K^+ supplements, other K^+-sparing diuretics, or significant renal dysfunction. ■ Eplerenone often requires twice-daily dosing for adequate BP lowering.
	Spironolactone	25–100	1	
Beta blockers—cardioselective	Atenolol	25–100	2	■ Beta blockers are not recommended as first-line agents unless the patient has IHD or HF. ■ These are preferred in patients with bronchospastic airway disease requiring a beta blocker. ■ Bisoprolol and metoprolol succinate are preferred in patients with HFrEF. ■ Avoid abrupt cessation.
	Betaxolol	5–20	1	
	Bisoprolol	2.5–10	1	
	Metoprolol tartrate	100–200	2	
	Metoprolol succinate	50–200	1	
Beta blockers—cardioselective and vasodilatory	Nebivolol	5–40	1	■ Nebivolol induces nitric oxide–induced vasodilation. ■ Avoid abrupt cessation.
Beta blockers—noncardioselective	Nadolol	40–120	1	■ Avoid in patients with reactive airways disease. ■ Avoid abrupt cessation.
	Propranolol IR	80–160	2	
	Propranolol LA	80–160	1	
Beta blockers—intrinsic sympathomimetic activity	Acebutolol	200–800	2	■ Generally avoid, especially in patients with IHD or HF. ■ Avoid abrupt cessation.
	Penbutolol	10–40	1	
	Pindolol	10–60	2	
Beta blockers—combined alpha- and beta-receptor	Carvedilol	12.5–50	2	■ Carvedilol is preferred in patients with HFrEF. ■ Avoid abrupt cessation.
	Carvedilol phosphate	20–80	1	
	Labetalol	200–800	2	
Direct renin inhibitor	Aliskiren	150–300	1	■ Do not use in combination with ACE inhibitors or ARBs. ■ Aliskiren is very long acting. ■ There is an increased risk of hyperkalemia in CKD or in those on K^+ supplements or K^+-sparing drugs. ■ Aliskiren may cause acute renal failure in patients with severe bilateral renal artery stenosis. ■ Avoid in pregnancy.
Alpha-1 blockers	Doxazosin	1–16	1	■ These are associated with orthostatic hypotension, especially in older adults. ■ They may be considered as second-line agent in patients with concomitant BPH.
	Prazosin	2–20	2 or 3	
	Terazosin	1–20	1 or 2	
Central alpha$_2$-agonist and other centrally acting drugs	Clonidine oral	0.1–0.8	2	■ These are generally reserved as last-line because of significant CNS adverse effects, especially in older adults. ■ Avoid abrupt discontinuation of clonidine, which may induce hypertensive crisis; clonidine must be tapered to avoid rebound hypertension.
	Clonidine patch	0.1–0.3	1 weekly	
	Methyldopa	250–1000	2	
	Guanfacine	0.5–2	1	
Direct vasodilators	Hydralazine	100–200	2 or 3	■ These are associated with sodium and water retention and reflex tachycardia; use with a diuretic and beta blocker. ■ Hydralazine is associated with drug-induced lupus-like syndrome at higher doses. ■ Minoxidil is associated with hirsutism and requires a loop diuretic. Minoxidil can induce pericardial effusion.
	Minoxidil	5–100	1 -3	

Antihypertensives

- Each of the antihypertensive agents is roughly equally effective in lowering BP
- However, wide interpatient variability as many patients will respond well to one drug but not to another



Materson, BJ, Reda, DJ, Cushman, WC, et al, N Engl J Med 1993; 328:914. Correction and additional data: Am J Hypertens 1995; 8:189

Which antihypertensive?

- Most patients will require >1 antihypertensive
- The degree of BP ↓, *not* the choice of antihypertensive, is the major determinant of ↓ in cardiovascular risk
  - Multiple guidelines and meta-analyses
- Recommendations for specific classes are based upon clinical trial evidence
  - ↓ cardiovascular risk
  - BP lowering efficacy
  - Safety and tolerability
- Individualize therapy based upon patient characteristics and preferences

“Compelling” Indications

- Specific drug(s) has major improvement in outcome independent of BP

Disease	Medications
Angina	BB, CCB
MI	ACEi or ARB, BB, aldosterone antagonist
Systolic CHF	ACEi or ARB, BB, diuretic, aldosterone antagonist
Atrial Fib/Flutter	BB, nondihydropyridine CCB
Diabetic nephropathy or Proteinuric CKD*	ACEi or ARB

*Stage 3 or higher CKD or Stage 1 or 2 CKD with albuminuria (>300 mg/day): ACEi/ARB to slow progression of kidney disease

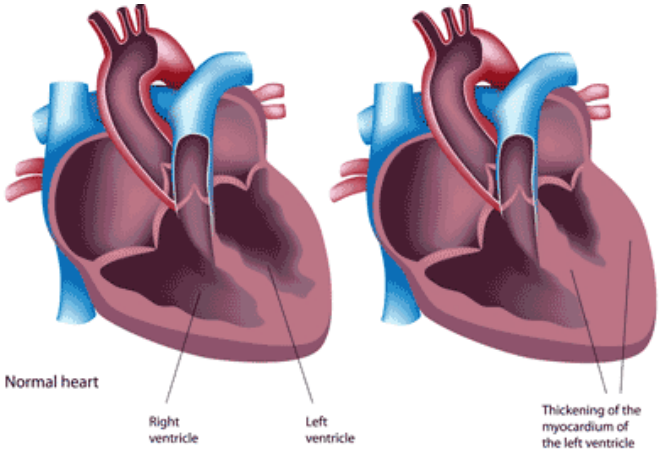
“Non-compelling” indications

- Likely to have a favorable effect on symptoms

Disease	Medication(s)
BPH	Alpha blocker
Essential tremor	BB (Noncardioselective)
Hyperthyroidism	BB
Migraine	BB, CCB
Osteoporosis	Thiazide
Raynaud phenomenon	Dihydropyridine CCB
LVH	ACEi/ARBs, CCB, some diuretics (chlorthalidone, indapamide), some sympatholytics (methyldopa, alpha-blockers), direct renin inhibitor (aliskiren)

Left Ventricular Hypertrophy (LVH)

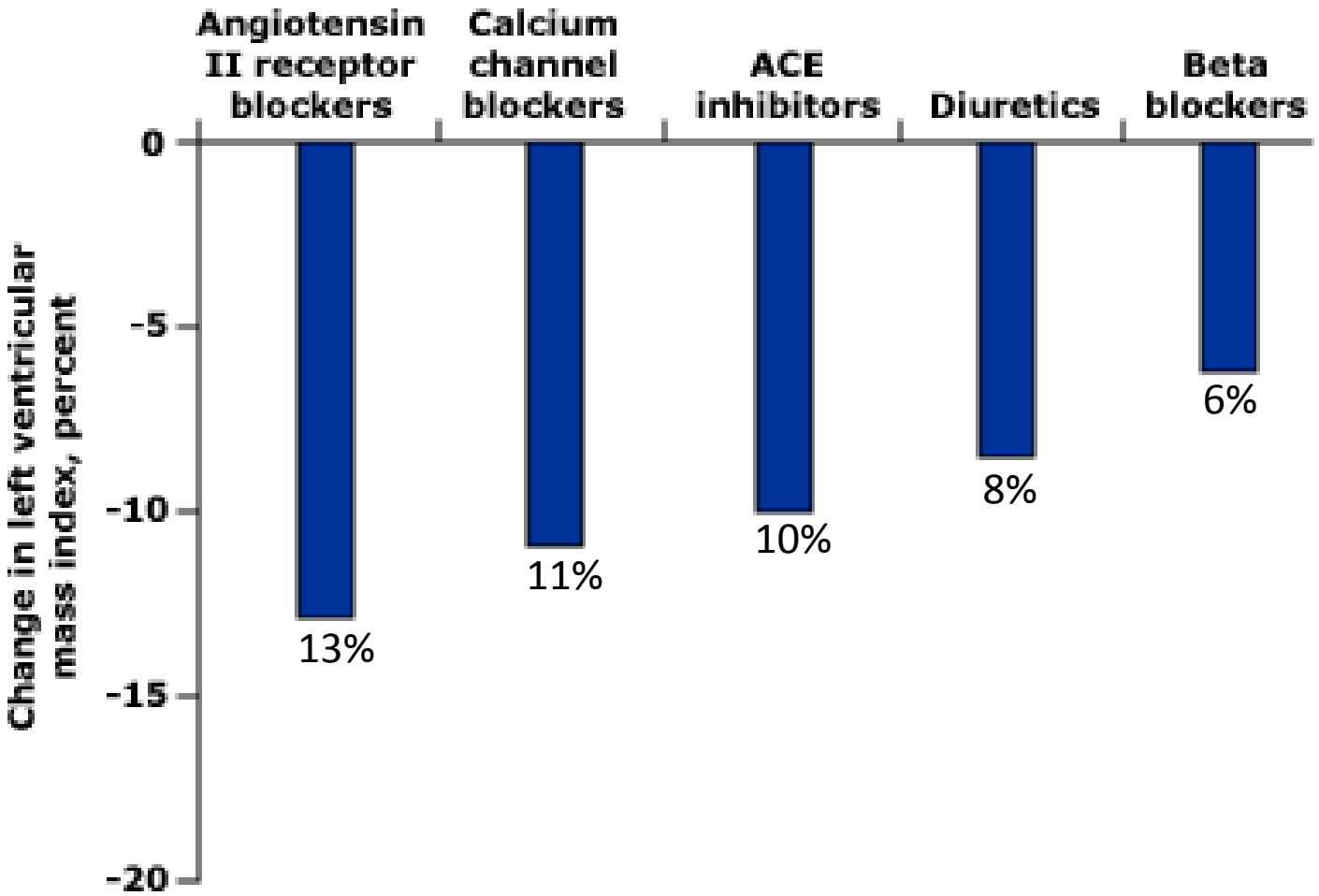
- Early sign of end-organ damage
- ↑ CHF, ventricular arrhythmias, death following MI, decreased EF, sudden cardiac death, aortic root dilation, AF, and CVA
  - In part due to myocardial ischemia: reduced density of capillaries, enlarged muscle mass limits the ability of the coronary arteries to dilate in response to decreased perfusion or during vasodilatory stress, directly compress endocardial capillaries



LVH regression

- ↓ CV risk
  - Improved systolic performance, ↑ stroke volume, no increase in the risk of decompensation if BP rises, ↓ PVCs, ↓ inducible VF, ↓ AF
- ↓ by antihypertensives, weight loss, or dietary sodium restriction
- Starts at few months and continues gradually over 3 years or more
- May be associated with complete reversal of LVH, left atrial enlargement, and diastolic dysfunction

Antihypertensives for LVH regression



Klingbeil AU, Schneider M, Martus P, et al.

Initial Antihypertensive if no "compelling" indications

- Thiazide diuretics
  - Thiazide-like: Chlorthalidone
  - Thiazide-type: HCTZ
- CCB
- ACEi or ARBs

- Systematic Review
  - No significant difference in CV mortality between these drug classes

Thiazide diuretics

- Thiazide-like: Chlorthalidone
- Thiazide-type: HCTZ, Indapamide, Metolazone

Chlorthalidone vs. HCTZ

- Meta-analysis of 14 trials: Chlorthalidone is 1.5-3x more potent than HCTZ: 3.6 mmHg
- Longer duration of action: ≥24 hrs versus 6-12 hrs with HCTZ

Chlorthalidone

- Multiple-treatment (network) meta-analysis of 21 trials including ~120,000 patients
  - Chlorthalidone ↓ CV events by 12% and HF by 21%
- ALLHAT: Chlorthalidone was superior to amlodipine and lisinopril in preventing HF

Should I switch patients from HCTZ to Chlorthalidone?

- Optimal approach has not been defined
- Is home BP below goal at the end of the drug's dosing period?

Thiazides

- Result in initial volume depletion which then stimulates the renin, aldosterone, angiotensin system (RAAS)
- Diuretics are more effective when given first in a regimen rather than second
  - They prime the RAAS.
  - These effects make the addition of a RAAS blocker an attractive combination to improve BP control

CCB

- Dihydropyridine: Amlodipine, Nifedipine
- Non-dihydropyridine: Diltiazem, Verapamil
- Potency: dihydropyridines > diltiazem > verapamil
- What about combining dihydropyridine and non-dihydropyridine CCBs?
  - Dual CCB therapy lowers BP significantly better than CCB monotherapy, without an increase in adverse events
    - However, given the lack of long-term outcome data on efficacy and safety, dual CCB therapy should be used with restraint, if at all

CCB induced leg swelling

- Edema not from increased plasma volume
  - Not improve with diuretics
- More common with dihydropyridines than with non-dihydropyridines
- Dose dependent: 2-3x higher with higher doses
- Options
  - Non-dihydropyridine CCB: Diltiazem or Verapamil
  - Reduce dose
  - Add ACEi or ARB: reduce incidence and severity of edema

What about Amlodipine BID?

- Not associated with increased trough plasma amlodipine concentrations, reduced arterial stiffness, or improved BP control over a 24-hour period

Effects of Dividing Amlodipine Daily Doses on Trough Drug Concentrations and Blood Pressure Control Over a 24-Hour Period
Miyoshi, Ken-ichi et al. Clinical Therapeutics , Volume 35 , Issue 9 , 1418 - 1422

Amlodipine vs. Nifedipine XL

- Multicenter, randomized trial
- After 8 weeks, BP was similarly reduced in the Amlodipine (n = 257) and Nifedipine XL groups (n = 248)
  - 24-hour systolic/diastolic BP: 10.3/6.5 vs 10.9/6.3 mm Hg ($P \geq 0.24$)

Huang QF, Sheng CS, Li Y, Dou Y, Zheng MS, Zhu ZM, Wang JG; Amlodipine Morning Blood Pressure Surge Study (ARMORS) Investigators. A randomized controlled trial on the blood pressure-lowering effect of amlodipine and nifedipine-GITS in sustained hypertension. J Clin Hypertens (Greenwich). 2019 Apr 11.

Lisinopril BID?

- Elimination half-life ~12 hrs
- Retrospective cohort study
  - Only 90 patients
  - 20 mg BID vs. 40 mg qday
  - BID: 10.2/4.3 mm Hg greater reduction
- Further studies needed to validate

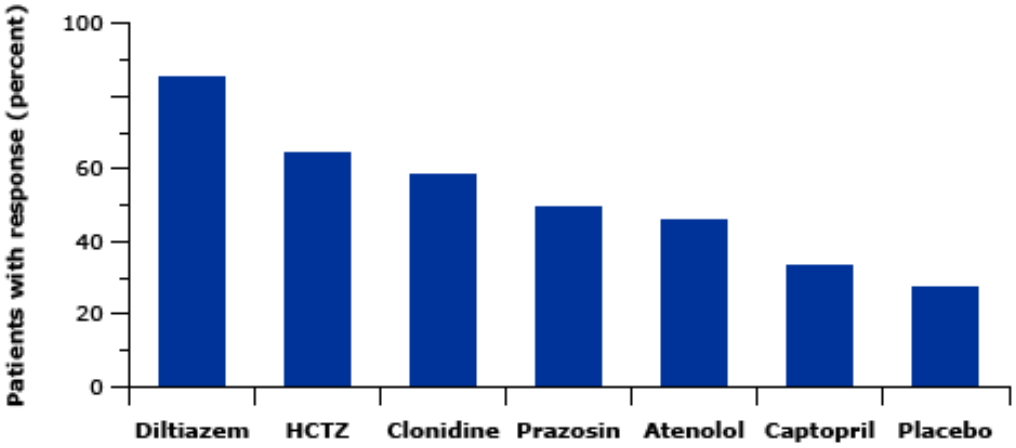
J Clin Hypertens (Greenwich). 2017 Sep;19(9):868-873

Beta blockers

- Not initial monotherapy unless “compelling” indications
- Avoid beta blockers and non-dihydropyridine CCB, unless “compelling” indication
- Atenolol is not as effective as other antihypertensives

African Americans

- If no “compelling” indications
- Thiazide-like diuretic or long-acting dihydropyridine CCB
  - Amlodipine as effective as chlorthalidone in ↓ BP, CV disease, and stroke but less effective in preventing HF
- If 3rd agent needed, ARBs may be better tolerated than ACEi with less cough and angioedema
  - ACEi/ARB less effective in preventing HF and stroke
  - No advantage over diuretics or CCBs in DM without nephropathy or HF



Materson BJ, Reda DJ, Cushman WC. Am J Hypertens 1995; 8:189

Combination Therapy

- Single-agent therapy will not adequately control BP if SBP ≥15 mmHg above goal
- Combination therapy with drugs from different classes has substantially greater BP lowering than doubling dose of a single agent
  - Using higher doses generally produces lesser BP response and more toxicity than switching to an initial dose of a second drug
- Initial combination antihypertensive therapy with two first-line agents of different classes
  - SBP >20 mmHg or DBP >10 mmHg above goal

Side Effects

- With thiazides, CCB, and beta blockers, the rate of symptomatic and metabolic adverse effects increase significantly with standard or twice-standard doses compared to half-standard doses
- Very low rate of side effects with ACEi and ARBs with no dose dependence

Fixed-dose, single-pill combination

- Use whenever feasible
  - Reduce pill burden and improve medication adherence

Class	Drug	Dosage Strengths (mg/mg)	Daily Frequency*
2-drug combinations			
ACE Inhibitors + Thiazide	Benazepril/Hydrochlorothiazide	10/12.5, 20/12.5, 20/25	1
	Captopril/Hydrochlorothiazide	25/15, 50/15, 25/25, 50/25	2
	Enalapril/Hydrochlorothiazide	5/12.5, 10/25	1 or 2
	Fosinopril/Hydrochlorothiazide	10/12.5, 20/12.5	1
	Lisinopril/Hydrochlorothiazide	10/12.5, 20/12.5, 20/25	1
	Moexipril/Hydrochlorothiazide	7.5/12.5, 15/12.5, 15/25	1 or 2
	Quinapril/Hydrochlorothiazide	10/12.5, 20/12.5, 20/25	1 or 2
ARBs + Thiazide	Azilsartan/Chlorthalidone	40/12.5, 40/25	1
	Candesartan/Hydrochlorothiazide	16/12.5, 32/12.5, 32/25	1
	Eprosartan/Hydrochlorothiazide	600/12.5, 600/25	1
	Irbesartan/Hydrochlorothiazide	150/12.5, 300/12.5, 300/25	1
	Losartan/Hydrochlorothiazide	50/12.5, 100/12.5, 100/25	1 or 2
	Olmesartan/Hydrochlorothiazide	20/12.5, 40/12.5, 40/25	1
	Telmisartan/Hydrochlorothiazide	40/12.5, 80/12.5, 80/25	1
	Valsartan/Hydrochlorothiazide	80/12.5, 160/12.5, 320/12.5, 160/25, 320/25	1
CCB – dihydropyridine + ACEIs	Amlodipine/Benazepril	2.5/10, 5/10, 5/20, 10/20, 5/40, 10/40	1
	Enalapril/Felodipine	5/5	1
	Perindopril/Amlodipine	3.5/2.5, 7/5, 14/10	1
CCB – dihydropyridine + ARB	Amlodipine/Olmesartan	5/20, 10/20, 4/40	1
	Amlodipine/Valsartan	5/160, 10/160, 5/320, 10/320	1
	Telmisartan/Amlodipine	40/5, 80/5, 40/10, 80/10	1
CCB – nondihydropyridine + ACEIs	Trandolapril/Verapamil	2/180, 1/250, 2/240, 4/240	1
Beta blocker + Thiazide	Atenolol/Chlorthalidone	50/25, 100/25	1
	Bisoprolol/Hydrochlorothiazide	2.5/6.25, 5/6.25, 10/6.25	1
	Metoprolol succinate/Hydrochlorothiazide	25/12.5, 50/12.5, 100/12.5	1
	Metoprolol tartrate/ Hydrochlorothiazide	50/25, 100/25, 100/50	1 or 2
	Nadolol/Bendroflumethiazide	40/5, 80/5	1
	Propranolol/Hydrochlorothiazide	40/25, 80/25	1 or 2
Direct renin inhibitor + CCB – dihydropyridine	Aliskiren/amlodipine	150/5, 150/10, 300/5, 300/10	1
Direct renin inhibitor + Thiazide	Aliskiren/ Hydrochlorothiazide	150/12.5, 150/25, 300/12.5, 300/25	1
Direct renin inhibitor + CCB – dihydropyridine	Aliskiren/Amlodipine	150/5, 150/10, 300/5, 300/10	1
Direct renin inhibitor + Thiazide	Aliskiren/Hydrochlorothiazide	150/12.5, 150/25, 300/12.5, 300/25	1
Central acting agent + Thiazide	Clonidine/Chlorthalidone	0.1/15, 0.2/15, 0.3/15	1 or 2
	Methyldopa/Hydrochlorothiazide	250/15, 250/25	2
Diuretic- potassium sparing + Thiazide	Amiloride/Hydrochlorothiazide	5/50	1
	Triamterene/Hydrochlorothiazide	37.5/25, 75/50	1
Diuretic- aldosterone antagonist + Thiazide	Spironolactone/ Hydrochlorothiazide	25/25	1 or 2
3-drug combinations			
ARB + CCB – dihydropyridine + Thiazide	Amlodipine/Valsartan/ Hydrochlorothiazide	5/160/12.5, 10/160/12.5, 5/160/25, 10/160/25, 10/320/25	1
	Olmesartan/Amlodipine/ Hydrochlorothiazide	20/5/12.5, 40/5/12.5, 40/5/25, 40/10/12.5, 40/10/25	1
Direct renin inhibitor + CCB – dihydropyridine + Thiazide	Aliskiren/Amlodipine/Hydrochlorothiazide	150/5/12.5, 300/5/12.5, 300/5/25, 300/10/12.5, 300/10/25	1

When to add a 3rd medication?

- If BP uncontrolled w/ 2 antihypertensive medications at max or max tolerated dose, then add 3rd
  - ACEi or ARB, long-acting dihydropyridine CCB, and thiazide-like diuretic

Conclusions

- Home BP monitoring
- Lifestyle modification: **all patients**
- Decision to initiate drug therapy should be individualized
- The degree of BP ↓, *not* the choice of antihypertensive, is the major determinant of ↓ in cardiovascular risk
- “Compelling” indications