

Hypertension Evaluation and Management

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- Clinical focus: Diabetic Kidney Disease
- Research focus: Medical Education and Implementation Science of Disease Modifying Therapies

DISCLOSURES

None



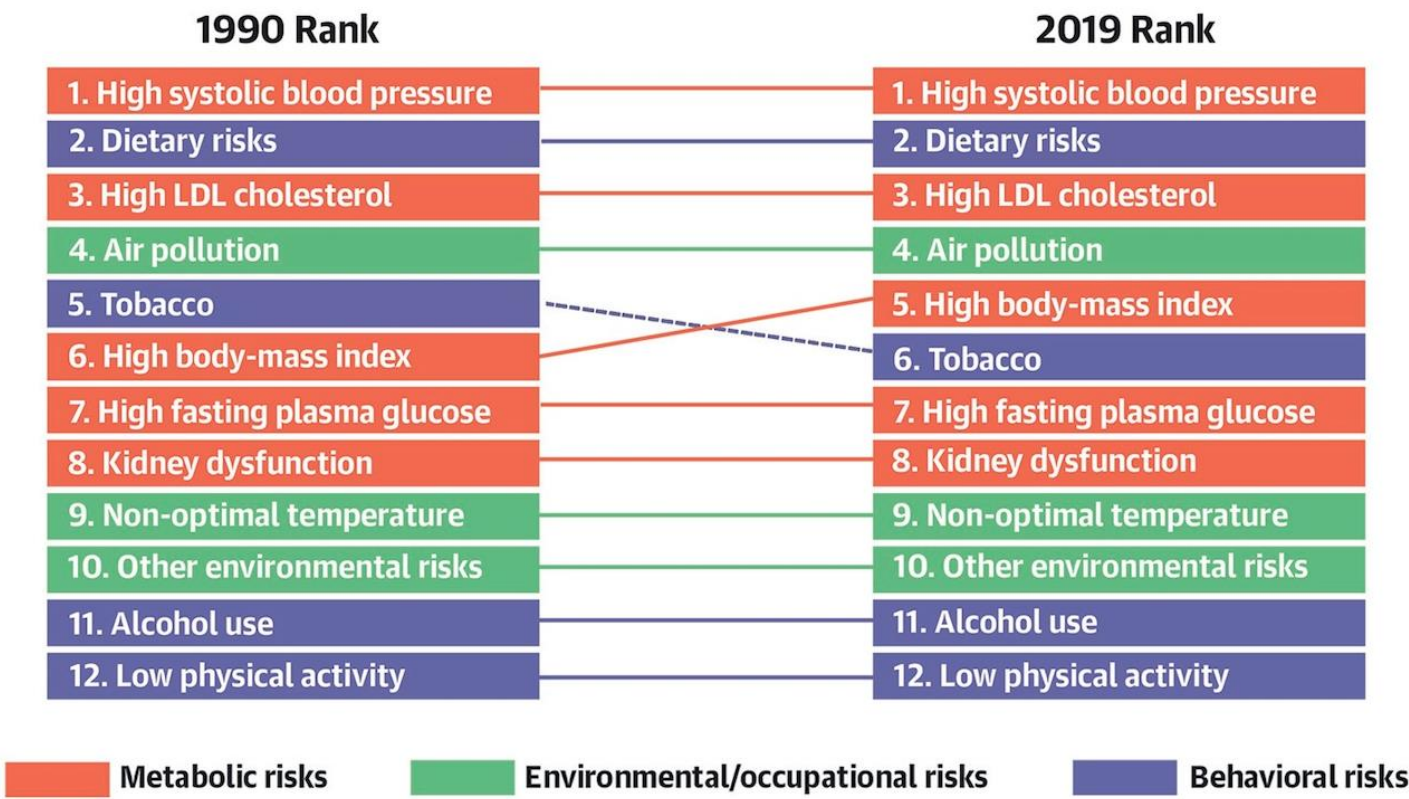
OBJECTIVES

- Understand blood pressure targets and review practical monitoring guidelines
- Review latest guidelines and landmark studies on hypertension care
- Manage hypertension with focus on disease modifying therapies



Hypertension #1 for CVD Burden

CVD Burden Attributable to Modifiable Risk Factors



15 million US adults have a 10-year risk for Heart Failure greater than 10% using the PREVENT equations

Table. Differences in 10-Year Risk Category Classification Comparing HF and ASCVD Risk				
Risk Category	Persons in 10-y HF Risk Category (95% CI), n (millions)*			
	Low Risk (<10.0%)	Intermediate Risk (10.0%-19.9%)	High Risk (≥20.0%)	Total†
Overall	128.22 (117.19-139.25)	12.20 (10.50-13.90)	2.79 (2.20-3.38)	143.21 (131.14-155.27)
By ASCVD 10-y risk category‡				
Low risk (<10.0%)§	126.97 (116.09-137.85)	4.22 (3.44-5.00)	0.06 (0.00-0.13)	131.25 (120.25-142.24)
Intermediate risk (10.0%-19.9%)	1.25 (0.79-1.70)¶	7.95 (6.40-9.50)	2.29 (1.89-2.69)	11.48 (9.63-13.33)
High risk (≥20%)	0.00 (0.00-0.00)¶	0.04 (0.00-0.10)¶	0.44 (0.13-0.75)	0.48 (0.17-0.79)

ASCVD = atherosclerotic cardiovascular disease; HF = heart failure.

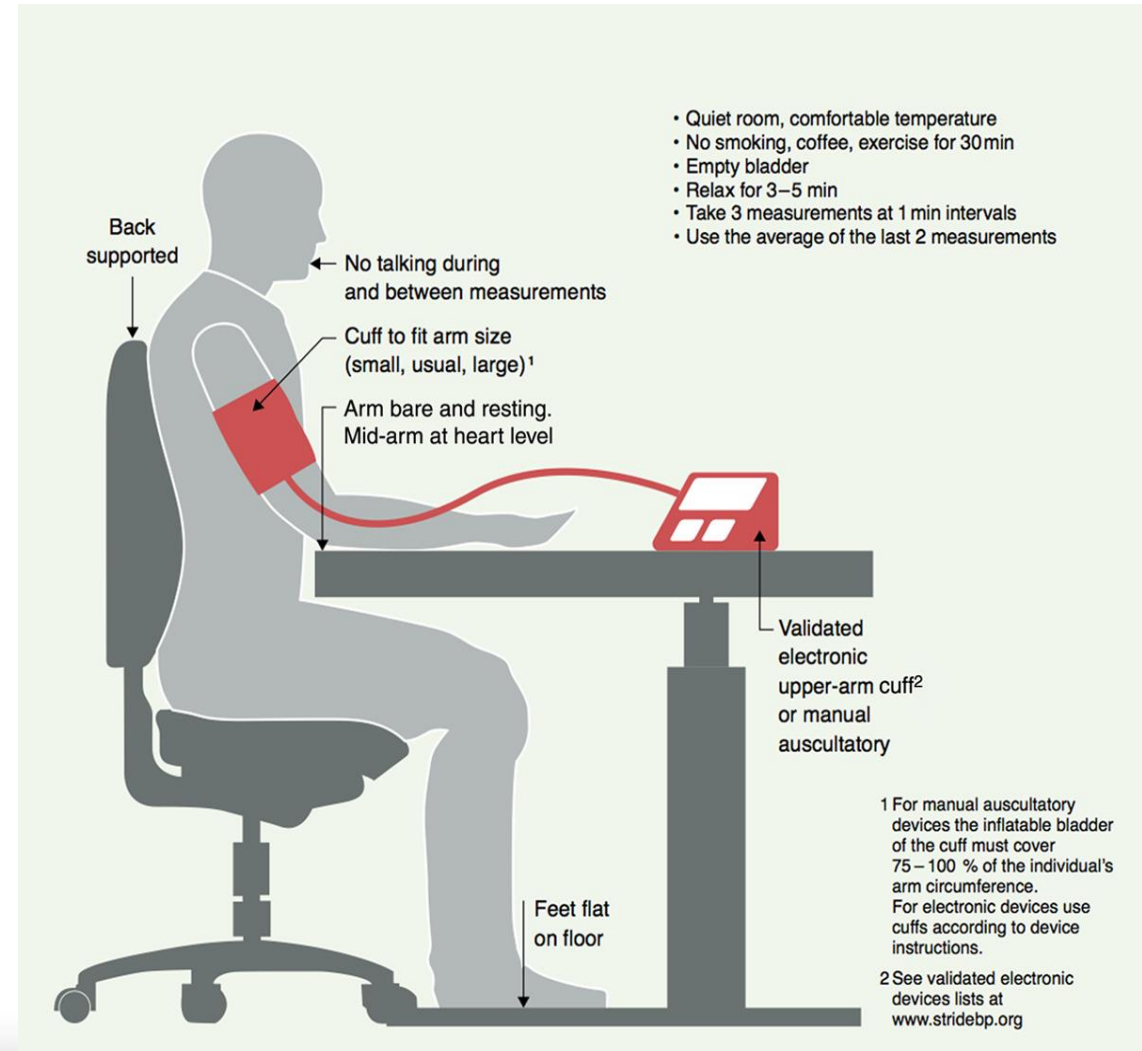
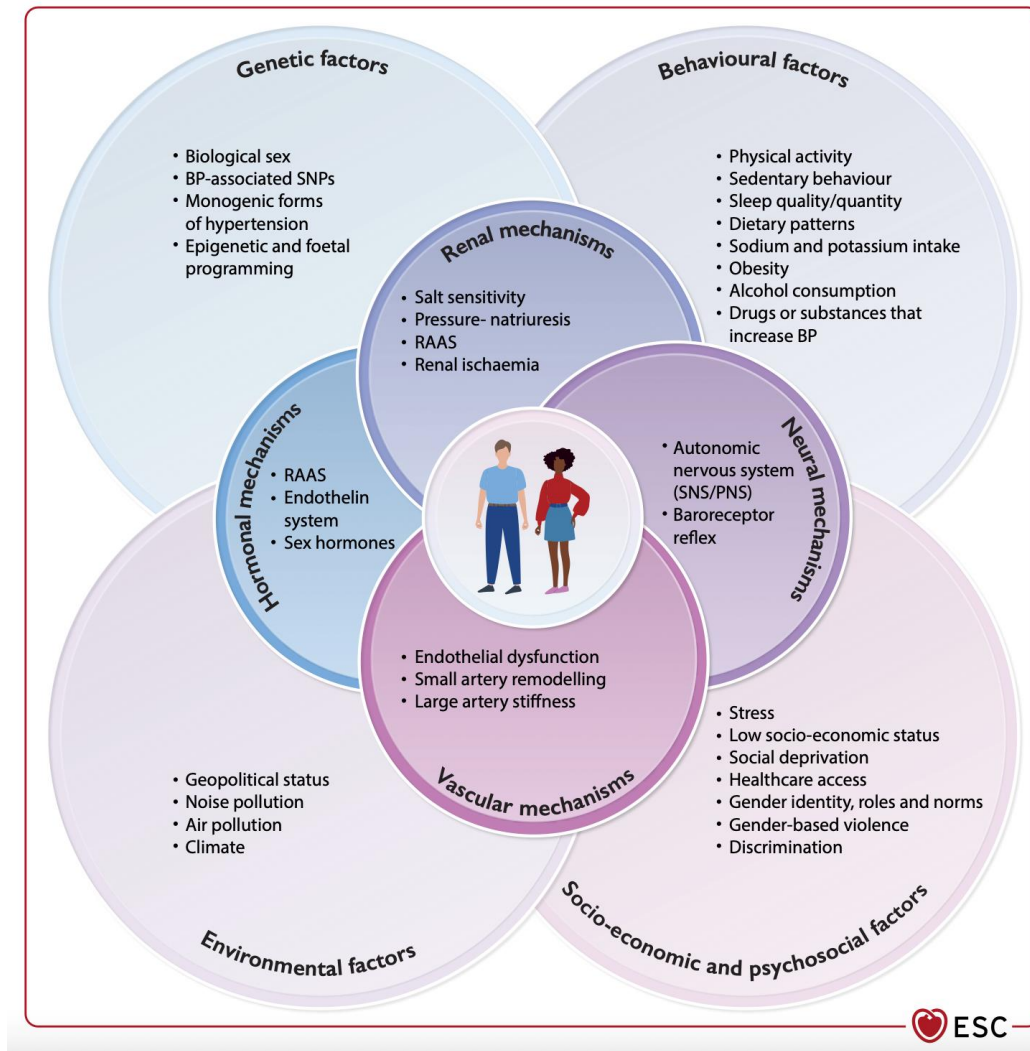
The American Heart Association PREVENT™ Online Calculator

Welcome to the American Heart Association **Predicting Risk of cardiovascular disease EVENTS** (PREVENT™). This app should be used for primary prevention patients (those without atherosclerotic cardiovascular disease or heart failure) only.

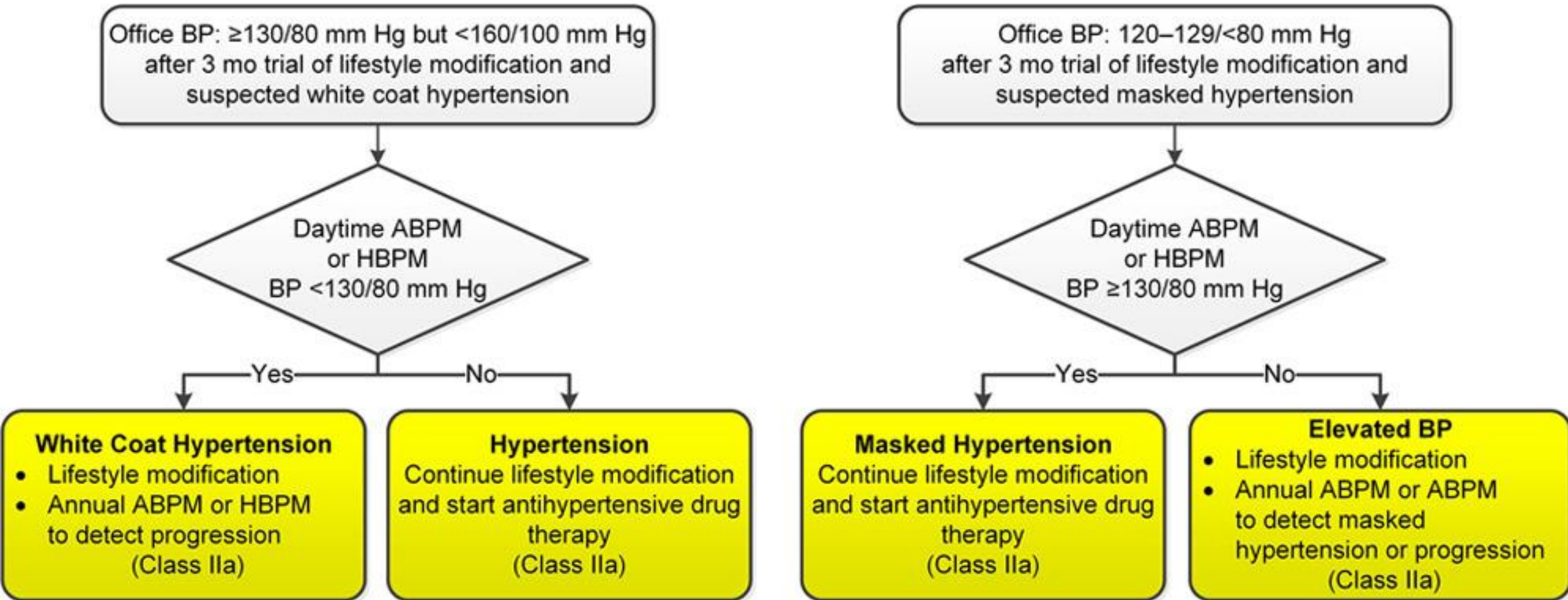
- ☐ Sex
- ☐ Age (30-79)
- ☐ Total Cholesterol
- ☐ HDL Cholesterol
- ☐ SBP
- ☐ BMI
- ☐ eGFR
- ☐ Diabetes?
- ☐ Current Smoking?
- ☐ Anti-HTN meds?
- ☐ Lipid lowering meds?
- ☐ UACR
- ☐ Hgb A1c
- ☐ Zip Code

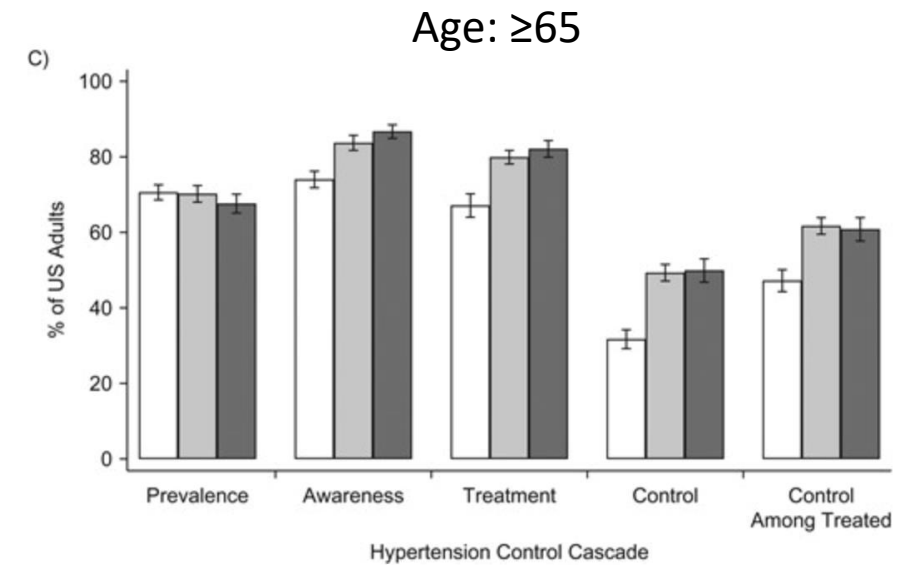
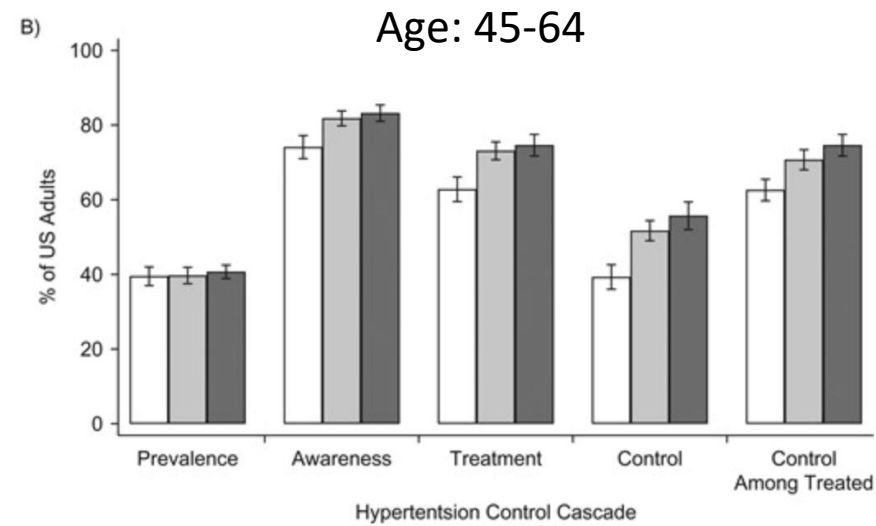
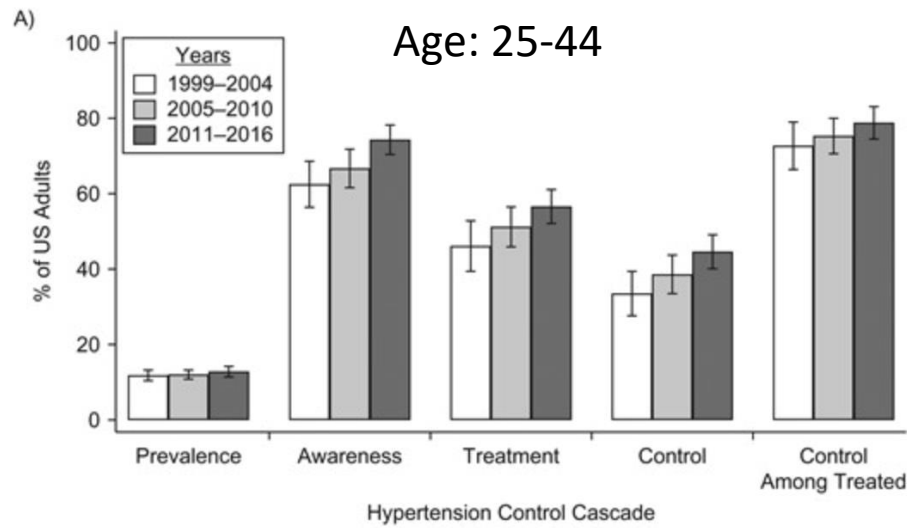


1st Step: Diagnosis



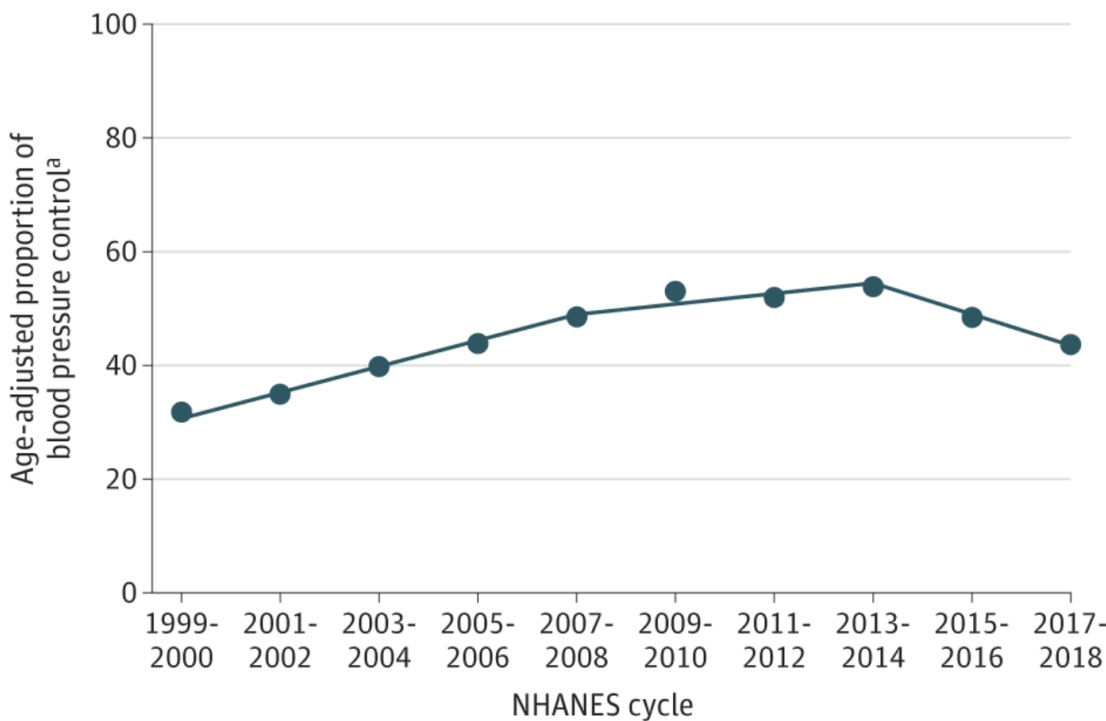
1st Step: Diagnosis



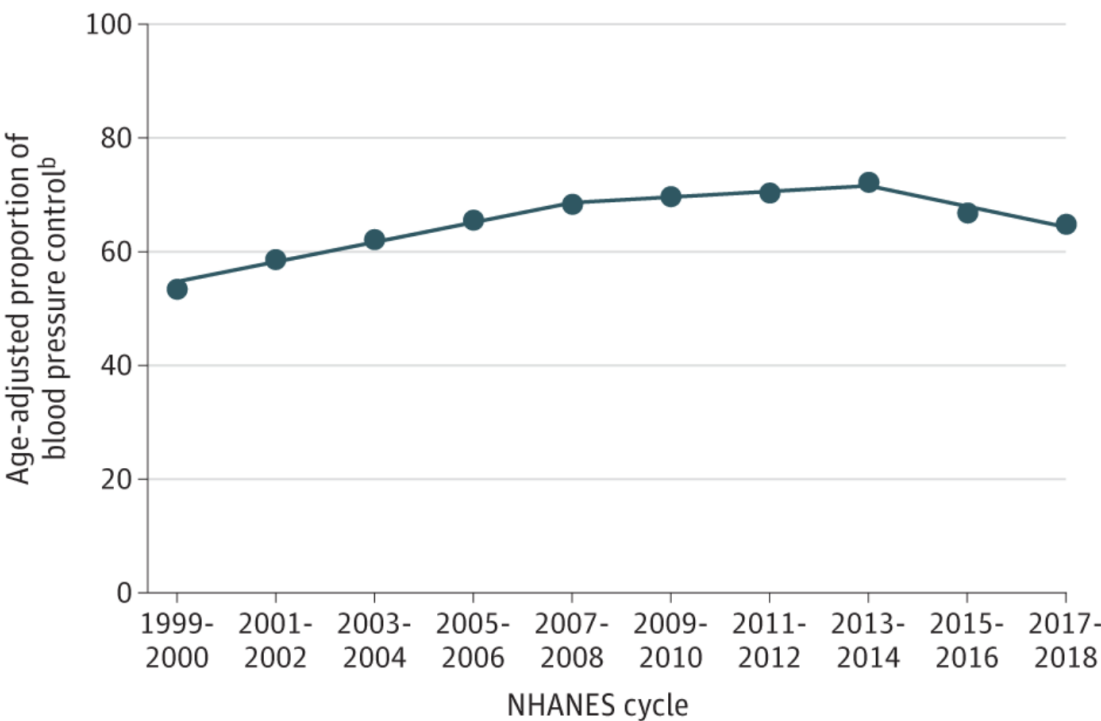


Hypertension and Drug Treatment Thresholds

A Blood pressure control among all adults with hypertension

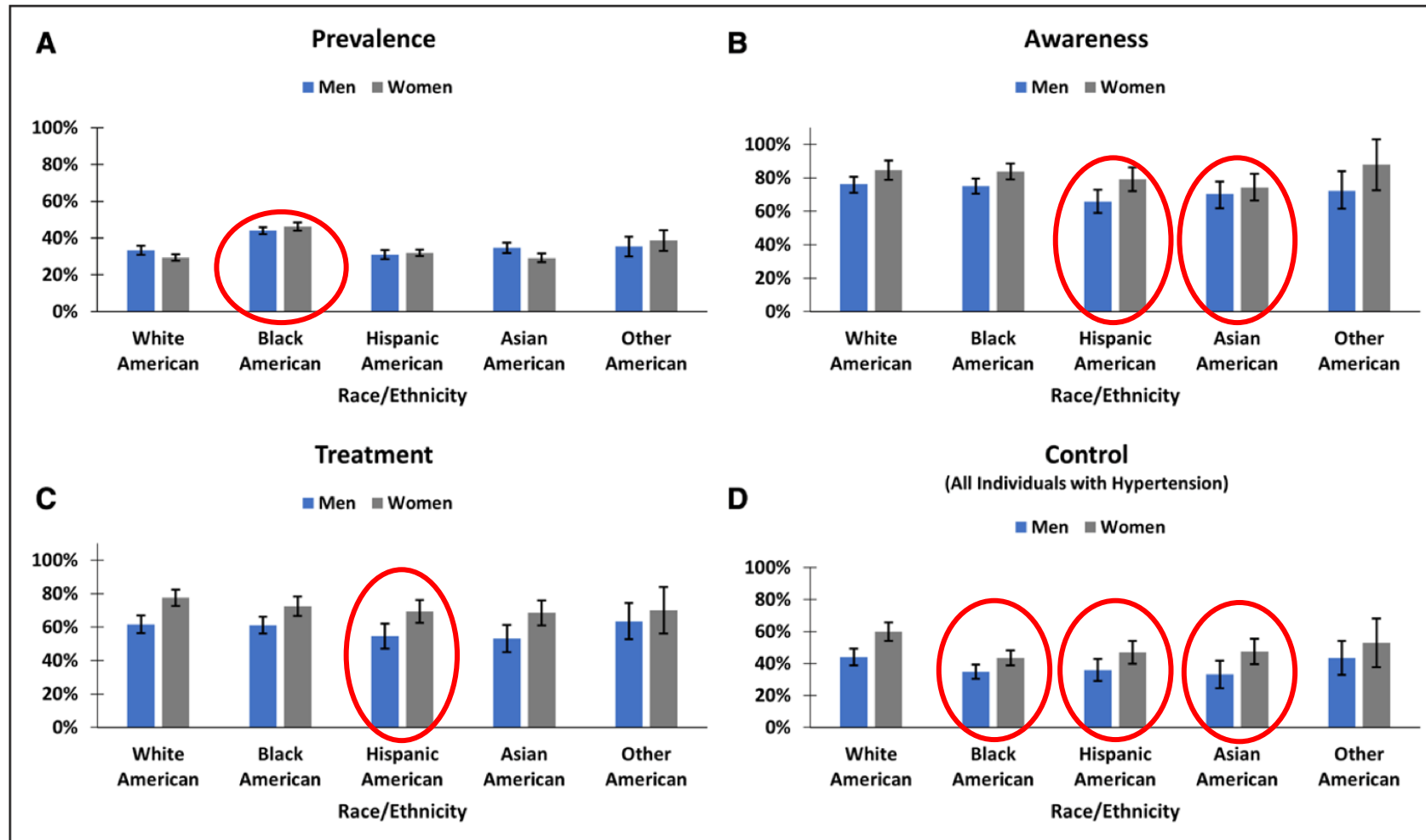


B Blood pressure control among adults taking antihypertensive medication



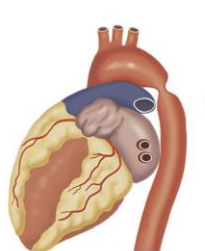
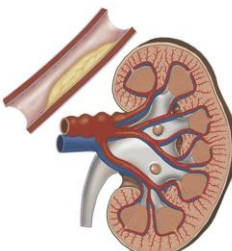
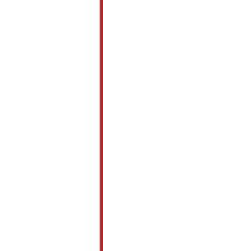
Muntner P, Hardy ST, Fine LJ, Jaeger BC, Wozniak G, Levitan EB, Colantonio LD. Trends in Blood Pressure Control Among US Adults With Hypertension, 1999-2000 to 2017-2018. JAMA. 2020 Sep 22;324(12):1190-1200.

Racial/Ethnic Disparities in Hypertension Prevalence, Awareness, Treatment



Primary or Secondary?

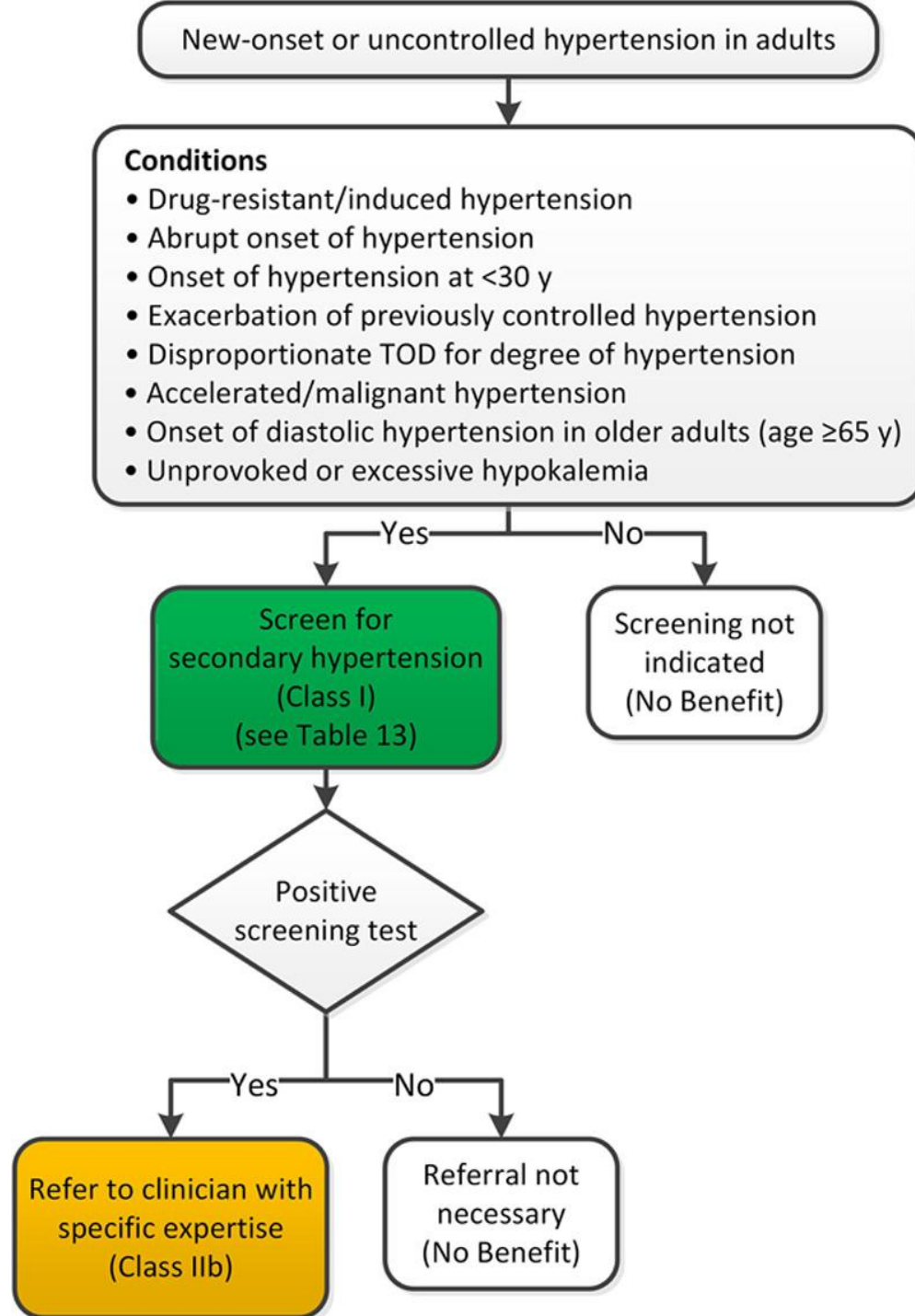
CENTRAL ILLUSTRATION: Cardiac Phenotypes in Secondary Hypertension

					
	Coarctation of Aorta	Renovascular Hypertension	Primary Aldosteronism	Pheochromocytoma /Paraganglioma	Cushing Syndrome
	• Vasculopathy • Sympathetic activity	• Angiotensin II • Aldosterone • Sodium/volume retention	• Aldosterone • Sodium retention	• Catecholamines	• Cortisol
LVH	↑↑	↑ARAS ↔ FMD	↑↑	↑	↑
Diastolic Function	↓	↓ARAS ↔ FMD	↓↓	↔	↓
Systolic Function	↓(advanced)	-	↓↓ strain	↓↓ strain	↓
In CMR	LVH, aortic dilatation	-	LVH, fibrosis, edema	fibrosis, edema	↔ fibrosis
Cardiac Events	CAD, HF	ARAS: CAD, AHF FMD: SCAD	CAD, HF, AF	TTS, hypertrophic/dilated cardiomyopathy, arrhythmias, ACS, AHF	CAD

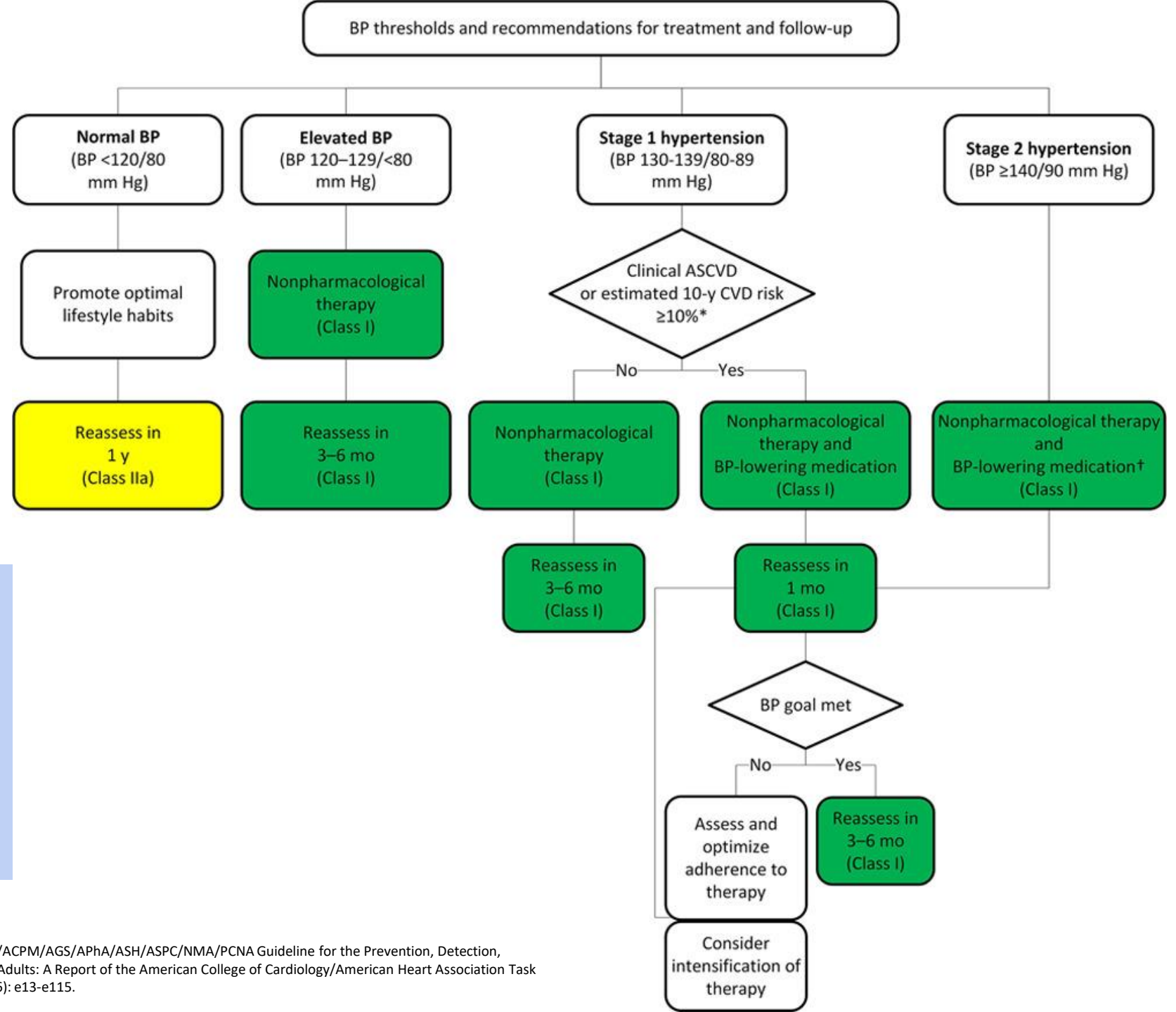
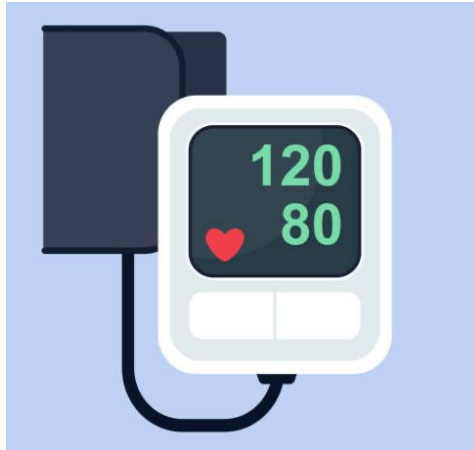
Januszewicz A, et al. J Am Coll Cardiol. 2022;80(15):1480-1497.



Whelton, P. K., et al. (2018). "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." *Hypertension* 71(6): e13-e115.

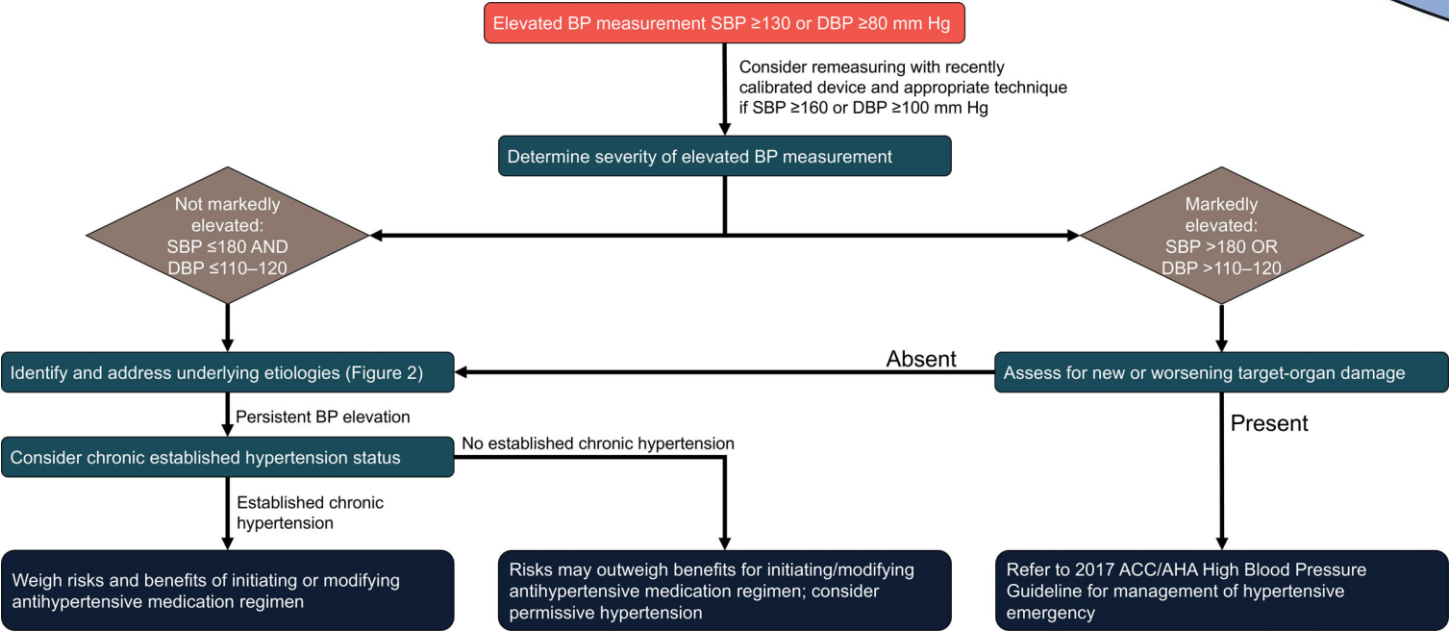
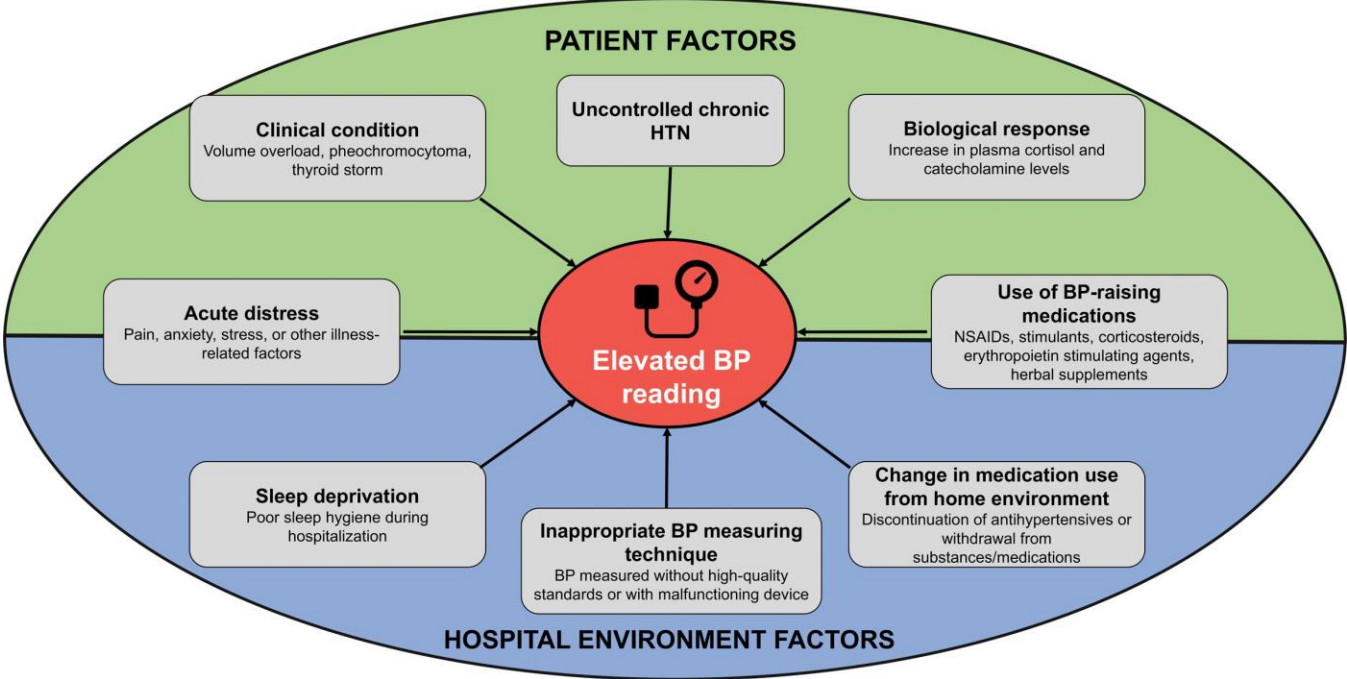


Treat and Reassess



Inpatient Hypertension

To Treat or Not to Treat?



What is the optimal BP goal in most patients with diabetes and hypertension?

A: <140/90 mmHg

B: <135/85 mmHg

C: <130/80 mmHg

D: <140/90, <150/90 age over 60



What is the optimal BP goal in most patients with diabetes and hypertension?

A: <140/90 mmHg

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C: <130/80 mmHg

D: <140/90, <150/90 age over 60



Differences between Guidelines



2003 JNC7 <130/80 mmHg

2013 ADA <140/90 mmHg

2017 AHA/ACC <130/80 mmHg

2017 ADA <140/90 mmHg

2023 ADA <130/80 mmHg

2023 ESH <140/80 mmHg



UKPDS (Lancet 1998)

1,148 hypertensive patients (age 56, mean BP 160/94)

Primary Outcome: Intensive glucose control improved microvascular morbidity but not mortality

BP control tested also:

“Tight control” <150/85 mmHg

Less tight control <180/105 mmHg

Intensive **BP control** improved morbidity (micro- and macro-vascular) and mortality



ADVANCE (Lancet 2007)

11,140 patients: [Perindopril + Indapamide] vs Placebo

SBP fell 6/2 mm Hg with active therapy: 135/75 vs 140/77

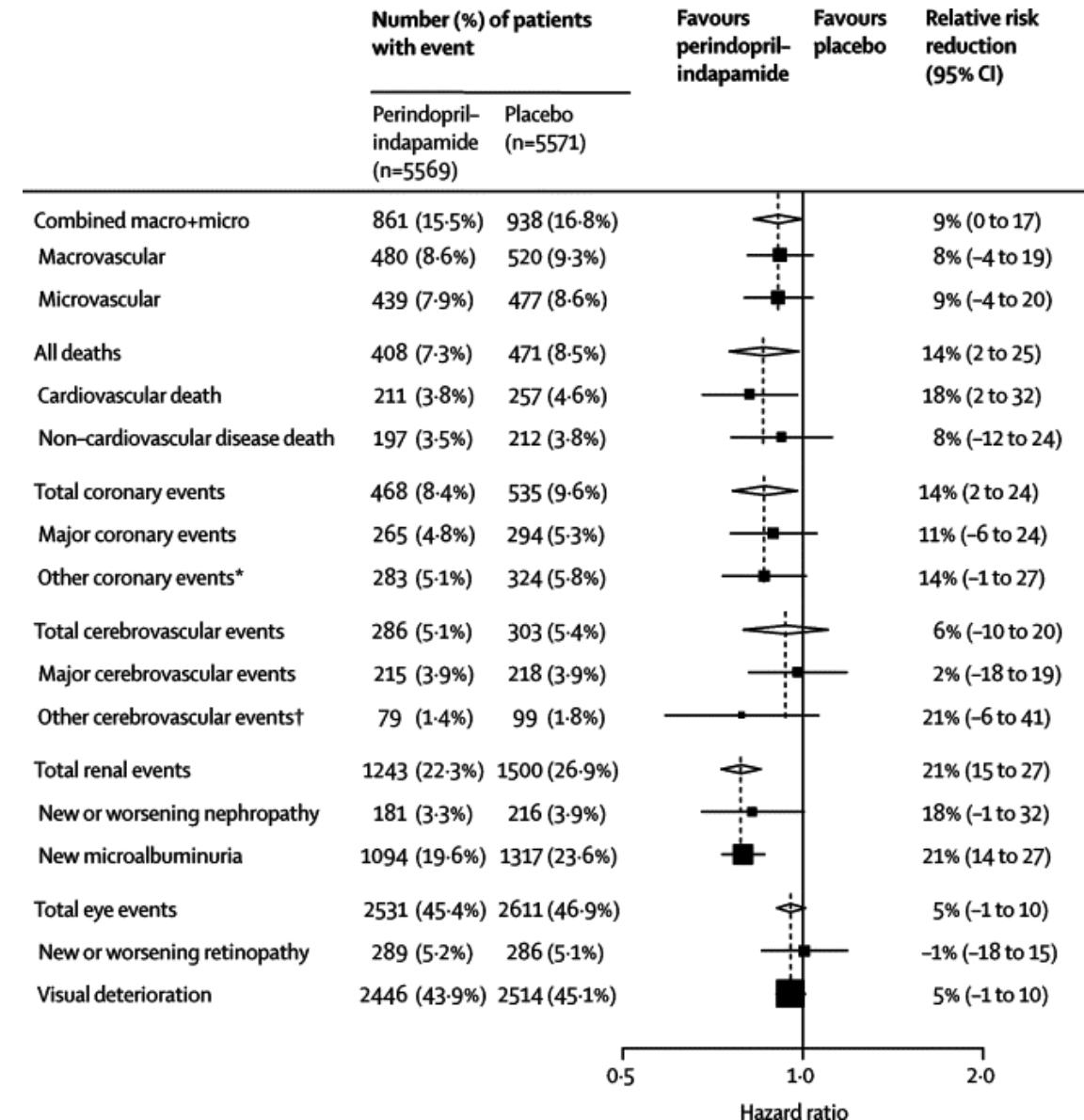
BP lowering led to 9% lower rate of macro- and micro-vascular events

Lower rate of CV and all cause mortality not seen with intensive glucose control

Patients with T2DM benefit from BP < 130/80mm Hg

* regardless of baseline BP or 10-year ASCVD risk

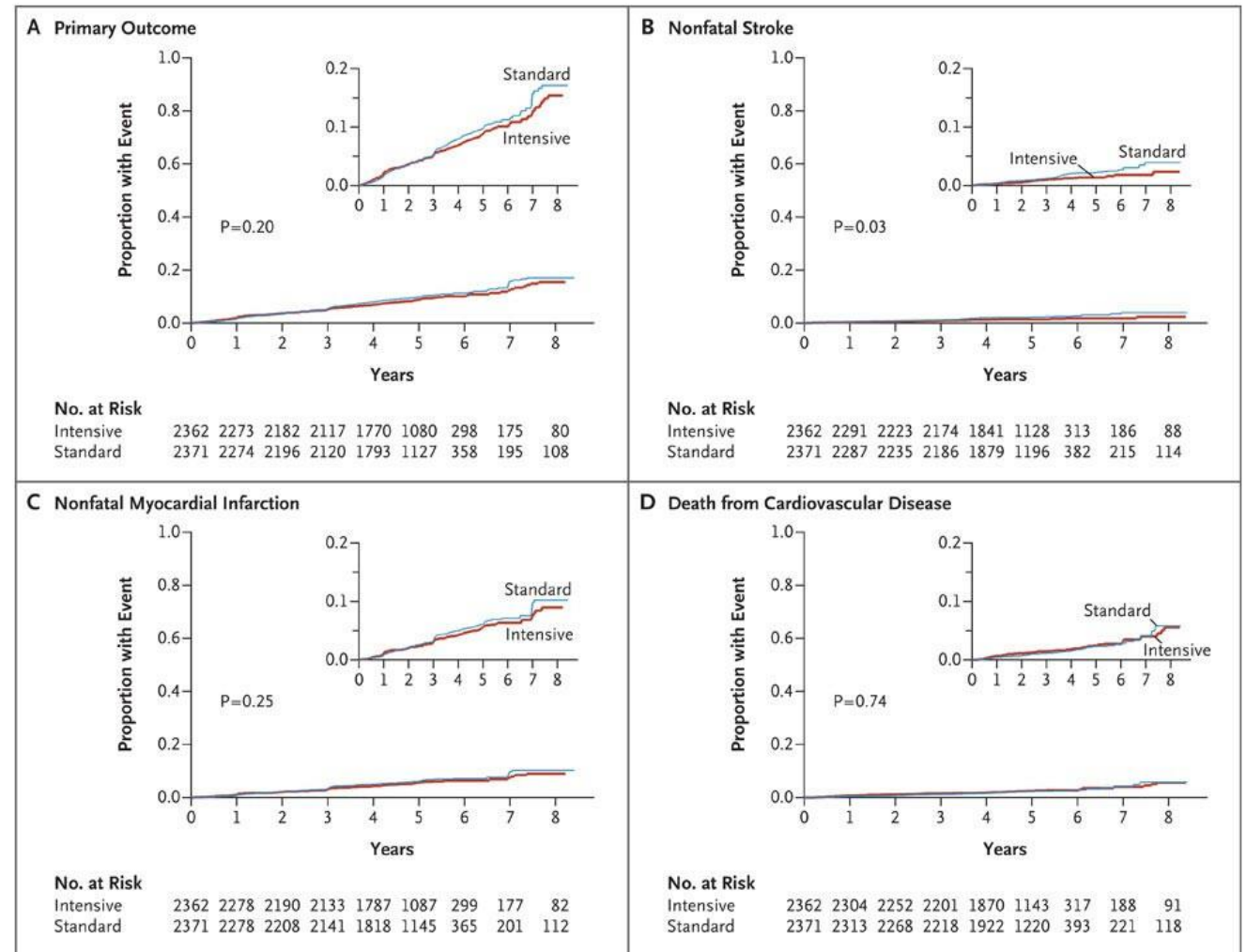
* down to <120/70 mm Hg, benefit persisted



ACCORD (NEJM 2010)

Standard < 140mmHg vs
Intensive <120mmHg

Intensive BP control in DM does
not reduce a composite of
adverse CV events, but does
reduce the rate of stroke



SPRINT (NEJM 2015)

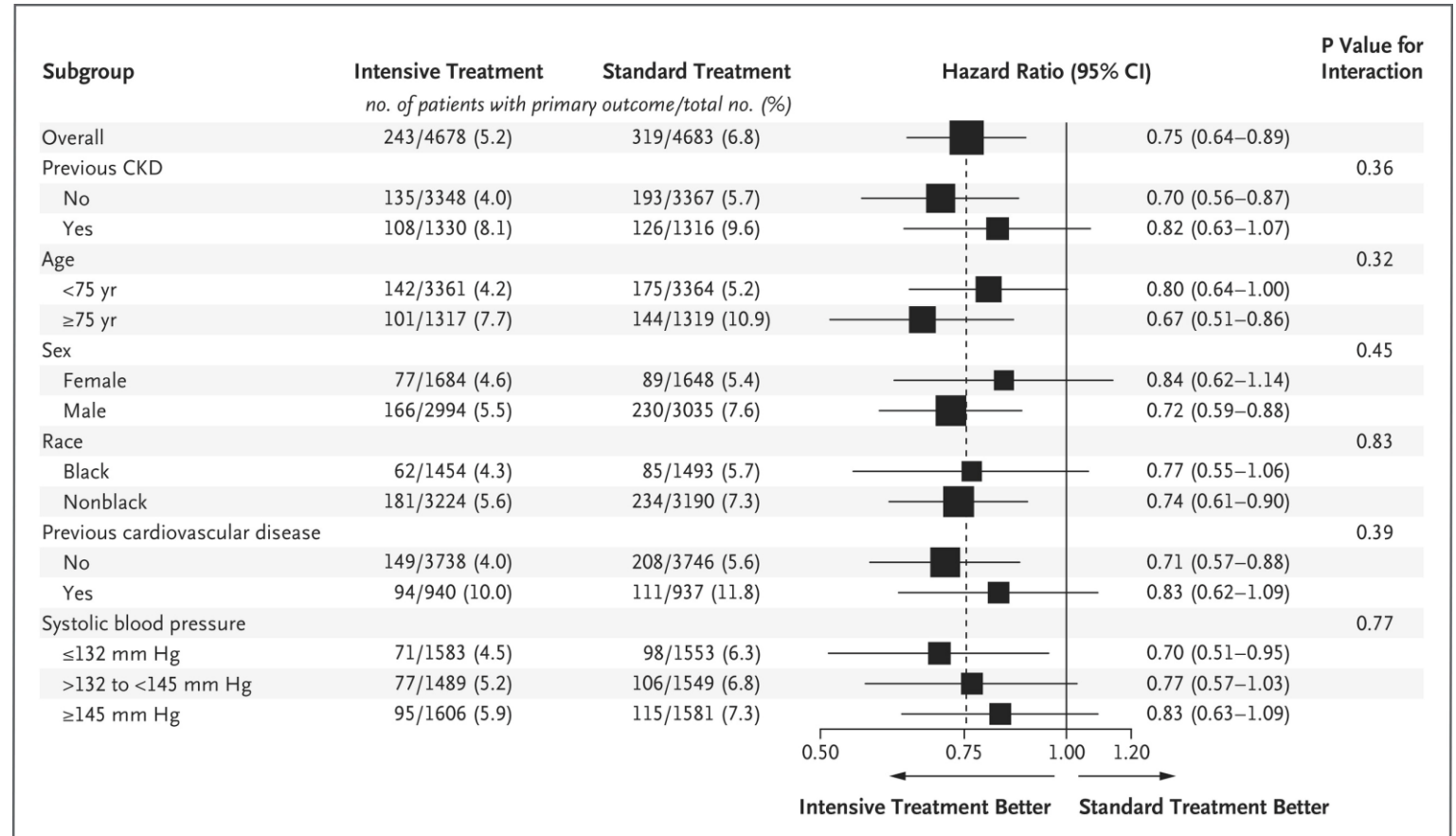
102 clinical sites, 6 year follow up
9,361 patients, >50 years old

- Baseline SBP 130 – 180 mmHg
- Increased risk of CV events
- Excluded DM and prior stroke

Lower target (<120mmHg)
translated to fewer events: fatal and nonfatal CV events and all cause mortality

Intense treatment group

- 25% lower relative risk of primary outcome
- 27% lower relative risk of death from any cause



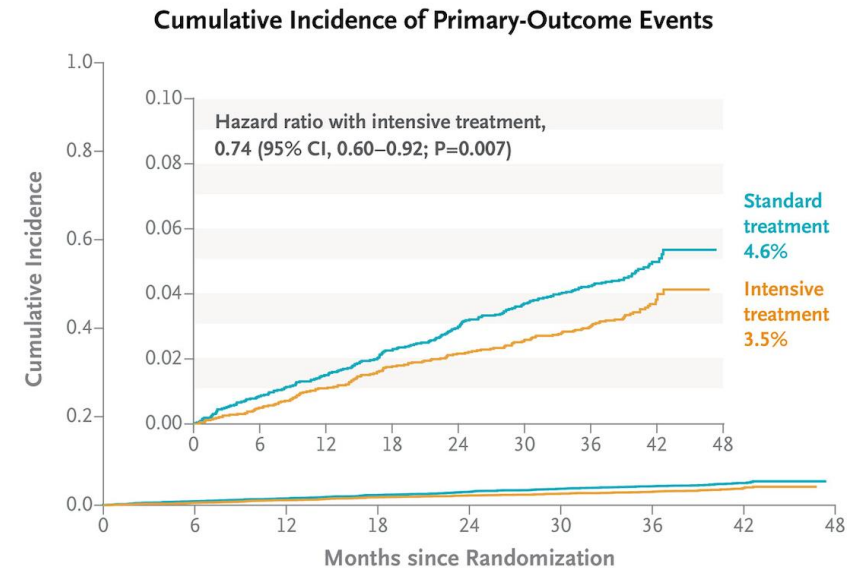
STEP Study (NEJM 2021)

Intensive BP control in older patients (60-80 years of age) with hypertension reduced CV outcomes

N=8,511

20% had diabetes

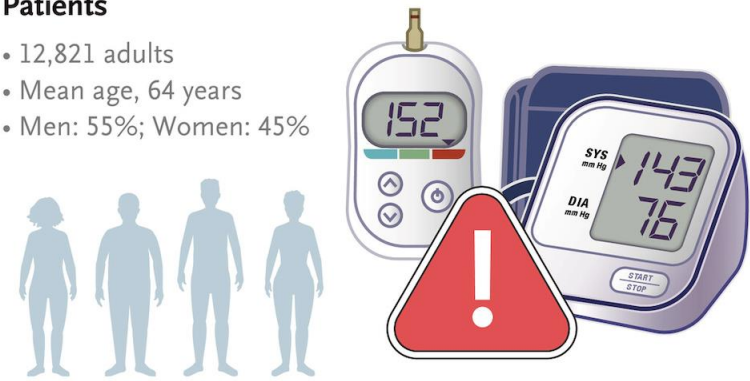
3.34 year follow up



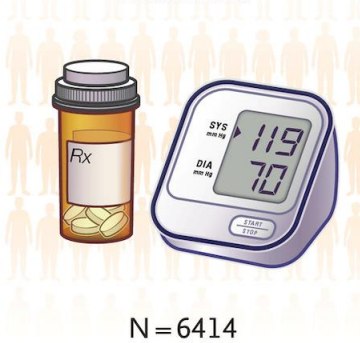
Intensive Blood-Pressure Control in Patients with Type 2 Diabetes (NEJM 2024)

Patients

- 12,821 adults
- Mean age, 64 years
- Men: 55%; Women: 45%

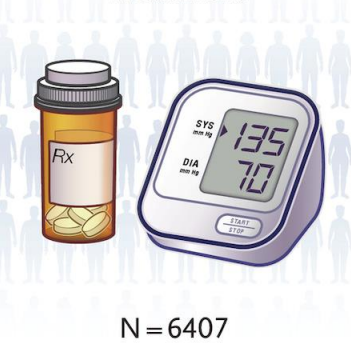


Intensive Antihypertensive Treatment

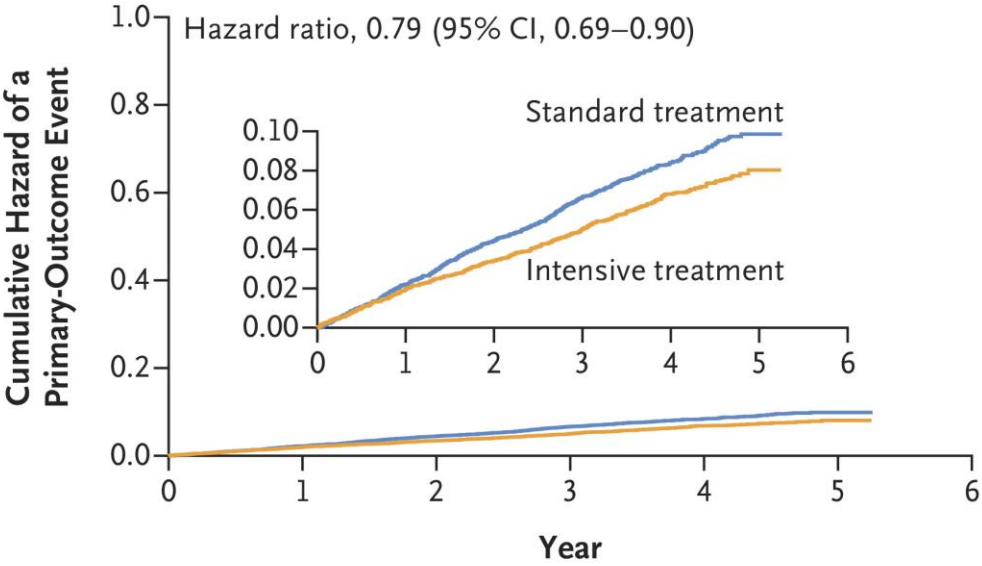


N = 6414

Standard Antihypertensive Treatment



N = 6407



No. at Risk

Standard treatment	6407	6087	5814	4626	3674	132
Intensive treatment	6414	6092	5871	4692	3738	112

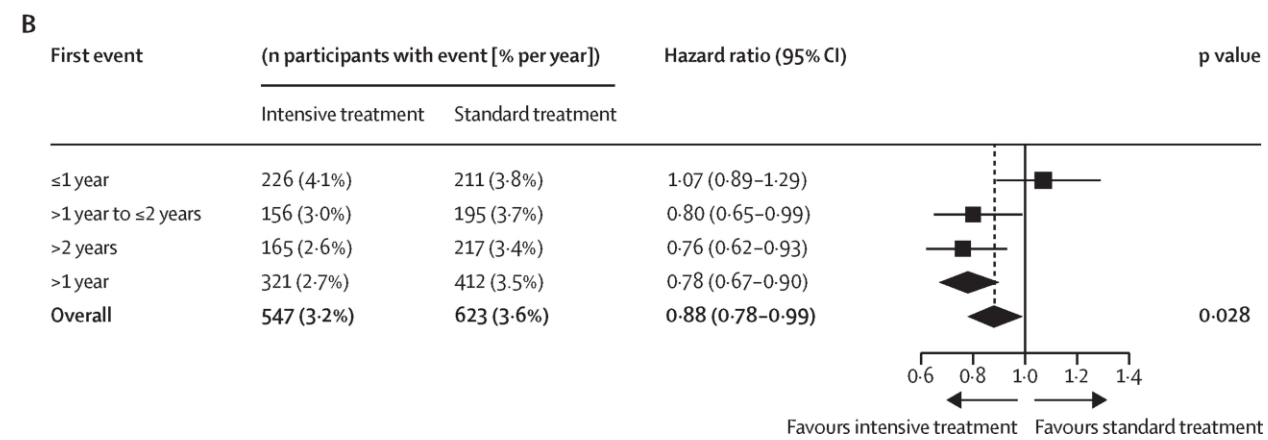
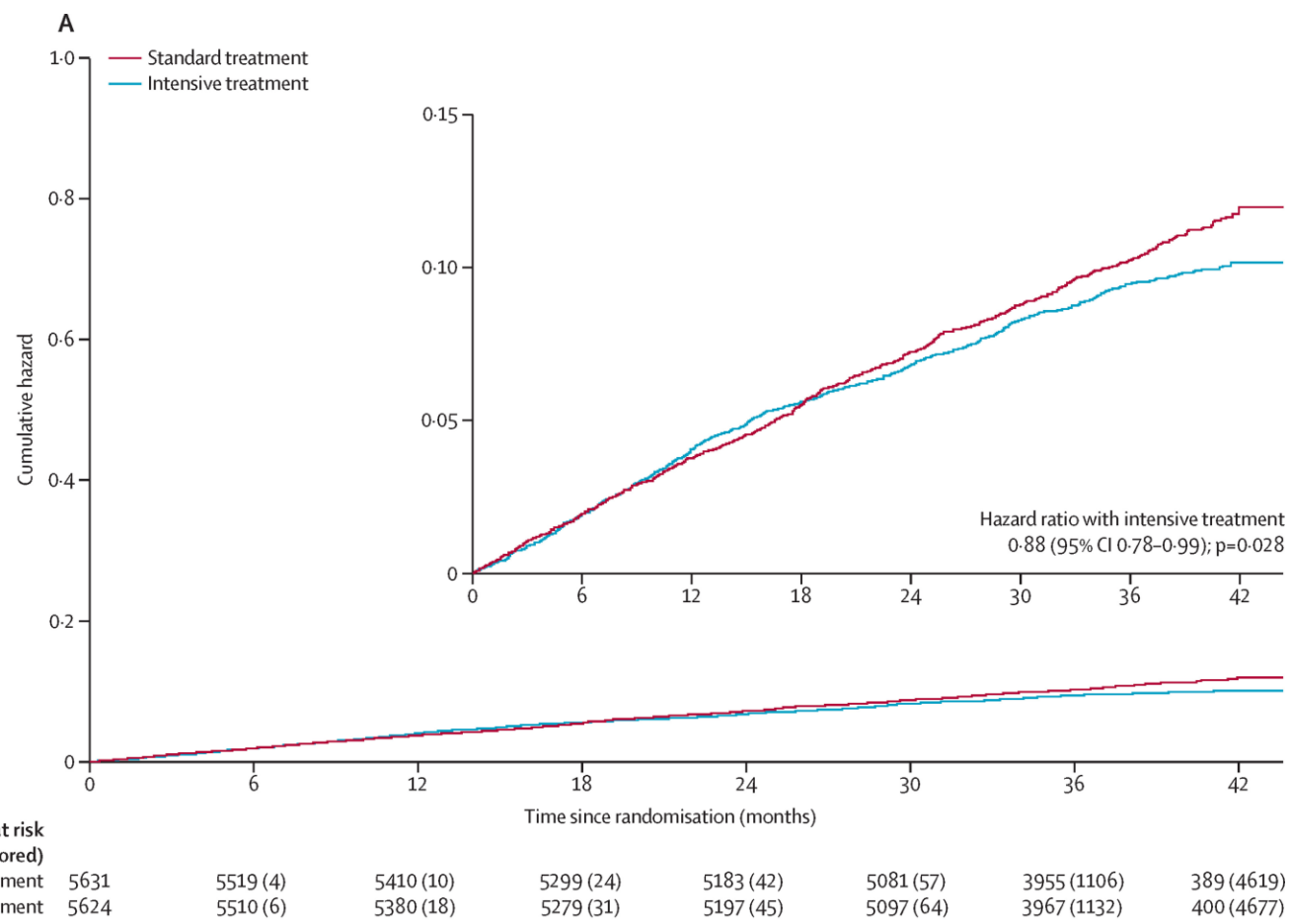
Intensive-treatment group: mean SBP 121.6 mm Hg (median, 118.3 mm Hg)

Standard-treatment group: mean SBP 133.2 mm Hg (median, 135.0 mm Hg)



Lowering SBP to <120 mm Hg vs <140 mm Hg in patients with **high cardiovascular risk** with and without diabetes or previous stroke (Lancet 2024)

Death from cardiovascular causes occurred in 59 (1.1%) from the intensive treatment group and in 97 (1.7%) from the standard treatment group (HR 0.61; 95% CI 0.44–0.84).

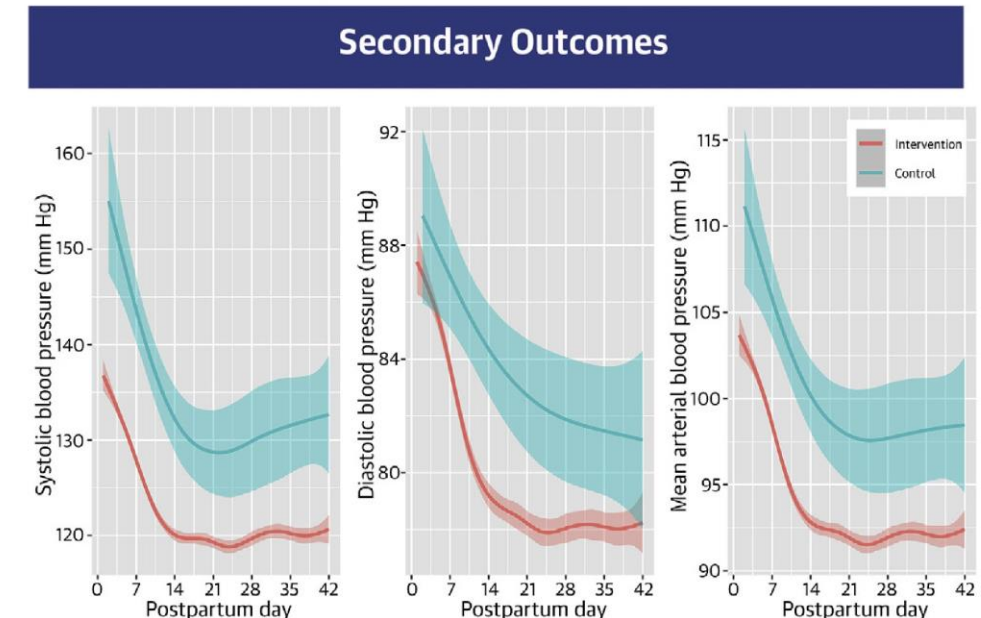
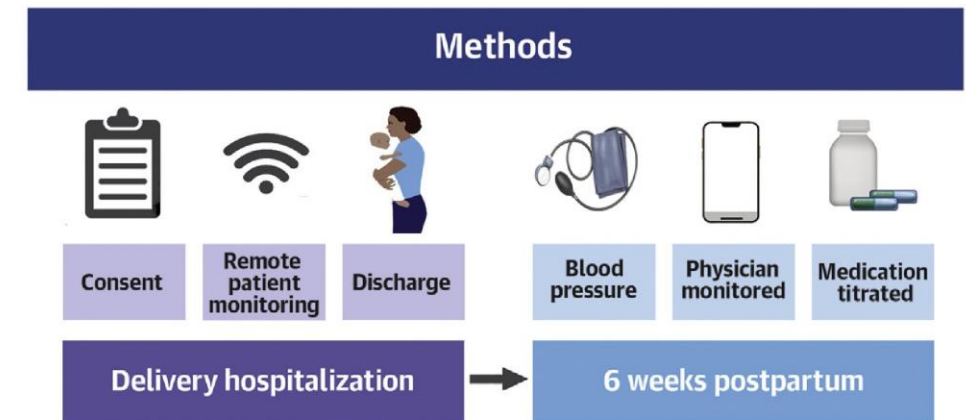
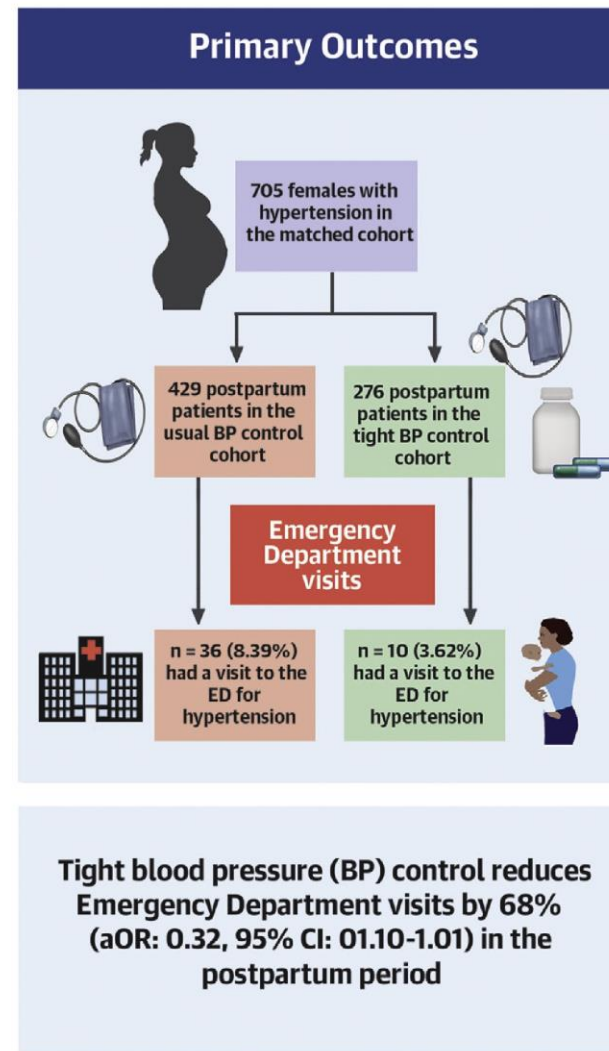


Post-Partum?

ED visits for hypertension:

- 3.6% of the intervention group (<130/80)
- 8.4% of the control group (<150/100)

CENTRAL ILLUSTRATION: Management of Postpartum Preeclampsia and Hypertensive Disorders (MOPP): Postpartum Tight vs Standard Blood Pressure Control



Out-of-Office and Self-Monitored BPs are Recommended

COR	LOE	ACC/AHA 2017
I	A	Out-of-office BP measurements recommended to confirm diagnosis of hypertension and for titration of BP-lowering medication, in conjunction with telehealth counseling or clinical interventions.



validatebp.org
medaval.ie

 STRIDE BP.org

We Need Standardized Education

Home blood pressure measurements (HBPM) are not performed according to guidelines and standardized education is urgently needed

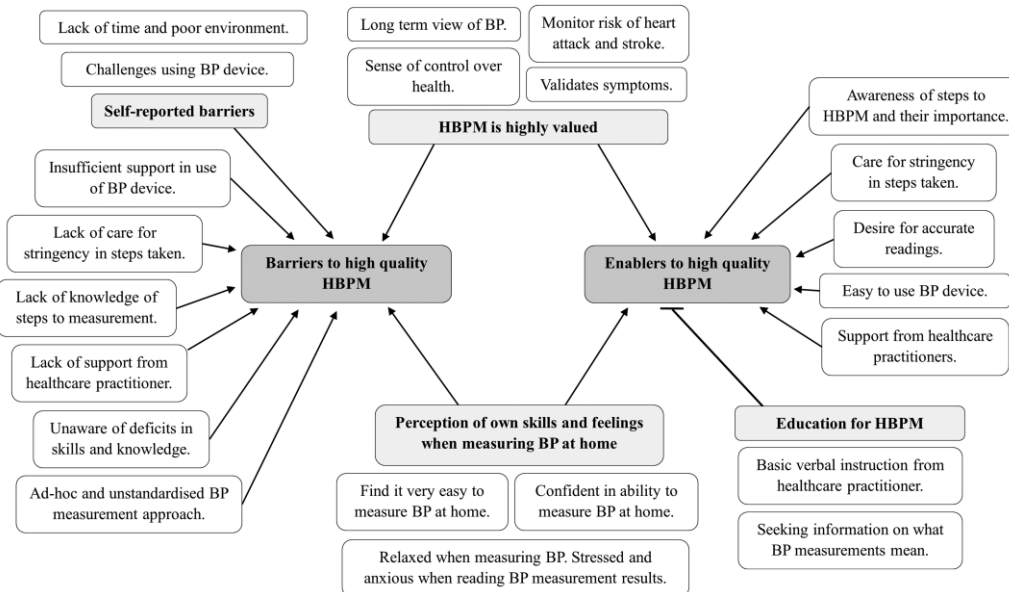


n=350

Aged 58±16 years, 54% women



n=34



HBPM practice

"I measure blood pressure at different times of the day after doing different things".

Recommendations performed by adults:



90% measured BP seated



77% with cuff fitted to a bare arm



78% reported BP to doctor



26% averaged BP readings taken over 7 days



15% measured BP in the morning and evening

HBPM education & training

Education was *"ad-hoc"*



37% received education for HBPM



93% sought information online or from health providers

"I'm pretty confident on how to use a machine, the information was more understanding what it [BP] meant"

Participants that received education **did not perform higher quality HBPM** than those that did not receive education.

Adults should be supported for HBPM by delivering patient education that provides accurate, appropriate and actionable information.



Clapham E, Picone DS, Carmichael S, Stergiou GS, Campbell NRC, Stevens J, Batt C, Schutte AE, Chapman N. Home Blood Pressure Measurements Are Not Performed According to Guidelines and Standardized Education Is Urgently Needed. Hypertension. 2025 Jan;82(1):149-159.

Wally Monster

Name:

Tel Number:

BWH ID#:

Medications: labetolol 300 bid

	AM before pills	Repeat AM	Eve before pills	Repeat
Day 1	123/79	123/82	111/72	126/75
Day 2	126/78	123/86	128/84	134/84
Day 3	132/84	138/84	134/99	157/101 Soar throat run down
Day 4	134/87	133/84	125/82	129/78
Day 5	134/88	126/86	117/76	115/69
Day 6	127/82	126/81	132/89	133/87
Day 7	135/77	122/75	120/72	109/70

Average BP from days 2-7:

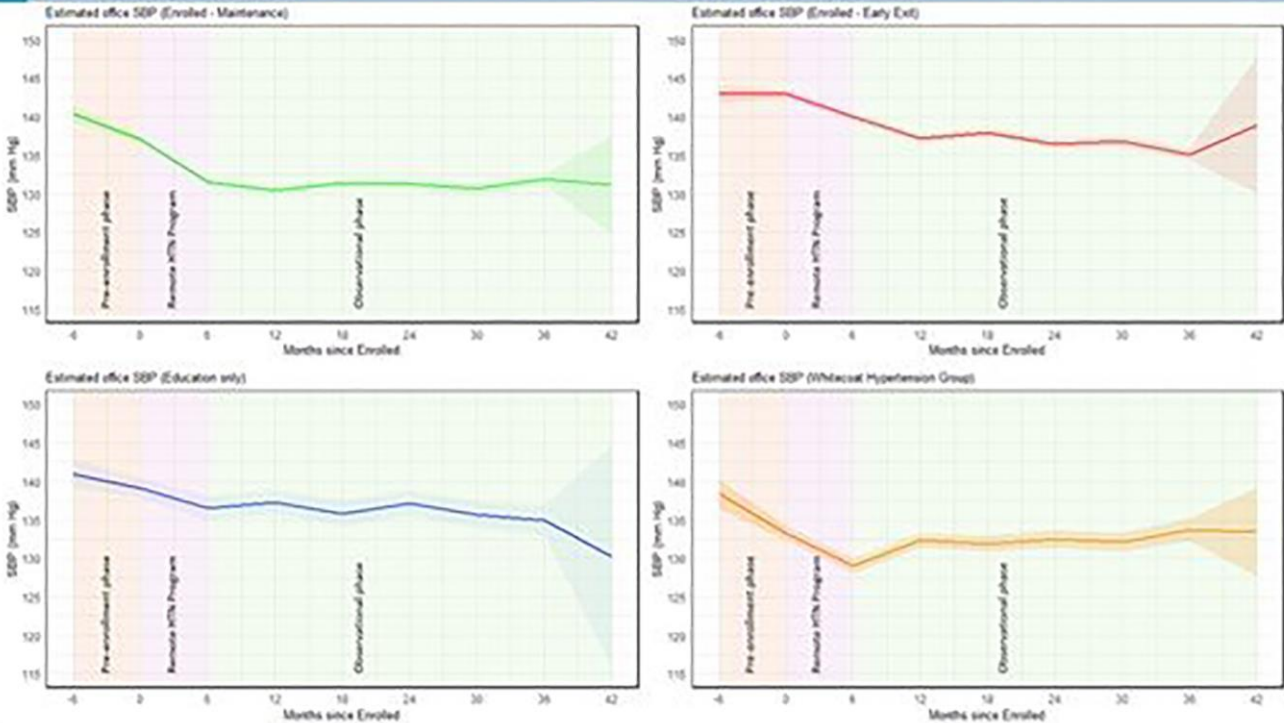
First Morning	131/82.7	First Night	129.3/83.7
Second Morning	128/82.7	Second Night	129.5/81.5

Do not smoke, drink caffeinated beverages or exercise 30 minutes before measuring your pressure.



Remote Hypertension Management is Effective

Long-Term Blood Pressure Trends Following A Remote Hypertension Intervention				
Secondary Analysis of a Remote Hypertension Management Program				
A navigator-driven, pharmacist-led, algorithm-based remote program that managed the blood pressure of 3,658 participants within the Mass General Brigham healthcare system.				
Design	Retrospective Cohort	Data from 3,601 participants	57,475 office BP readings from EHR	From enrollment to 42-months post-enrollment
Results	All groups sustained mean office SBP reductions below qualifying values up to 42-months post-enrollment. In the maintenance group, 90% participants maintained their mean office SBP ≤ 140 mm Hg, up to 42-months. Age ≥ 50 y was significantly associated with higher likelihood of above-goal SBP in the maintenance group.			



Conclusion

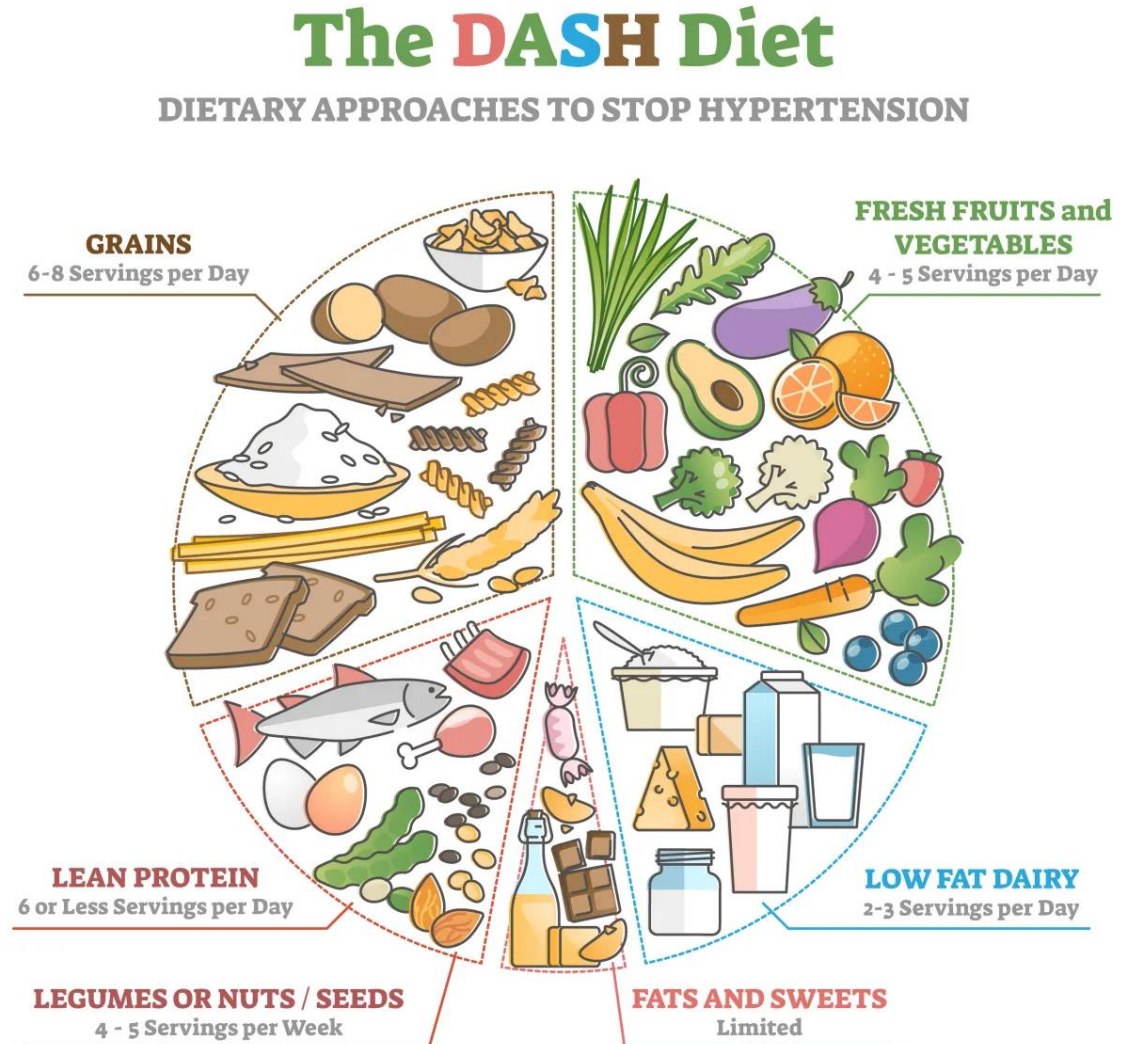
A time limited remote hypertension management program effectively achieved and sustained BP control at the population level, demonstrating its scalability for broader implementation. Tailored approaches are needed to ensure equitable access and engagement, especially in older and underserved populations.



Lifestyle Modifications Come First

For patients with BP>120/80 mmHg, lifestyle intervention is recommended:

- Weight loss if overweight or obese
- DASH-style diet
- Reduced sodium intake
 - AHA 1500mg
 - FDA 2300mg unless higher risk profile
 - Americans consume: 3,500-4,000mg/day
- Moderation of alcohol intake
- Increased physical activity



Lifestyle Modification: Patient's Work

Modification	~SBP Reduction
Weight reduction	10 mmHg/10kg
DASH diet	11 mmHg
Sodium reduction	5-6 mmHg
Potassium rich diet	4-5 mmHg
Physical activity	5-8 mmHg
Moderation of alcohol	4 mmHg



Which drug classes have been proven to reduce cardiovascular risk in patients with Type II DM?

A: ACE-I and ARBs

B: ACE-I, ARBs, Beta Blockers, calcium channel blockers, and diuretics

C: ACE-I, ARBs, CCB, and diuretics

D: ACE-I and CCB



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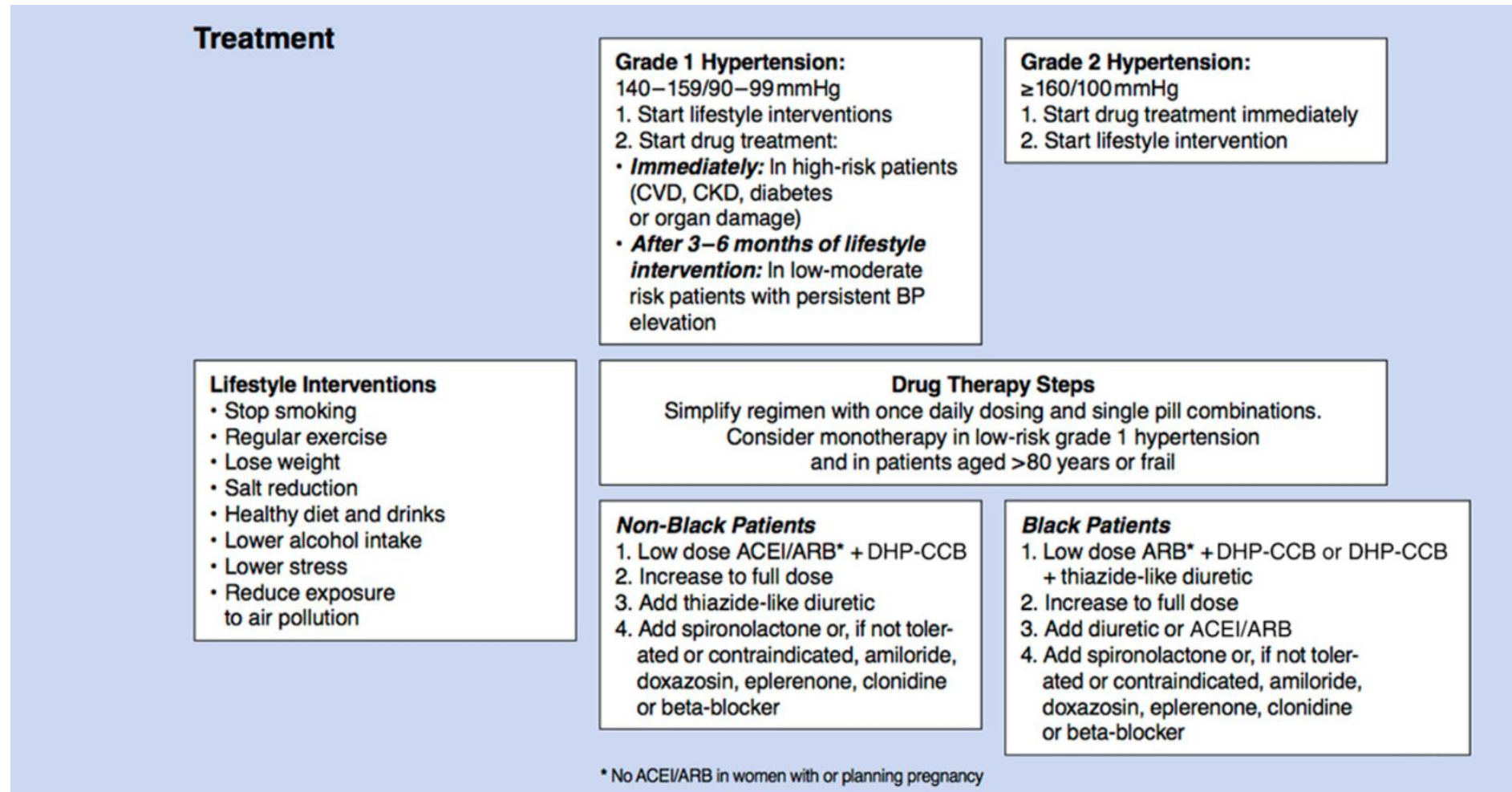


A B C D of Hypertension Management

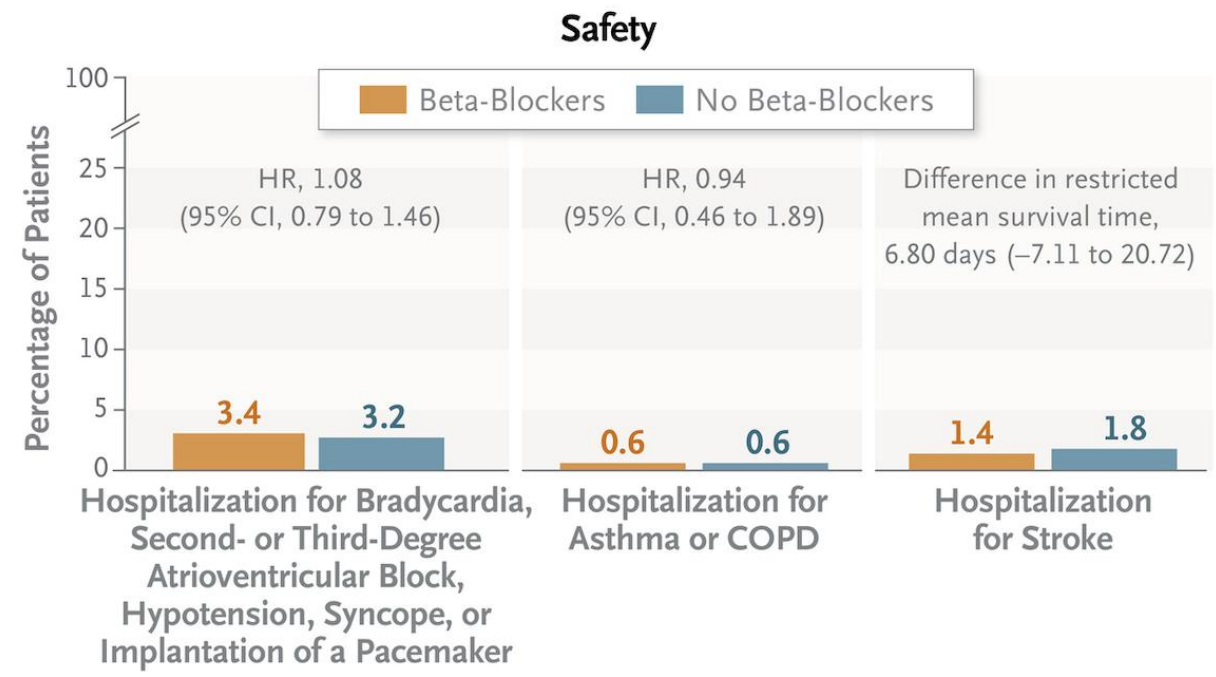
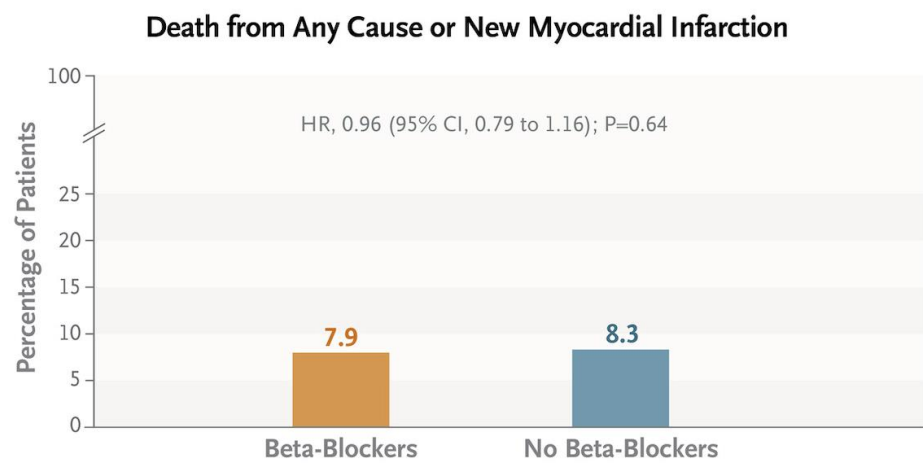
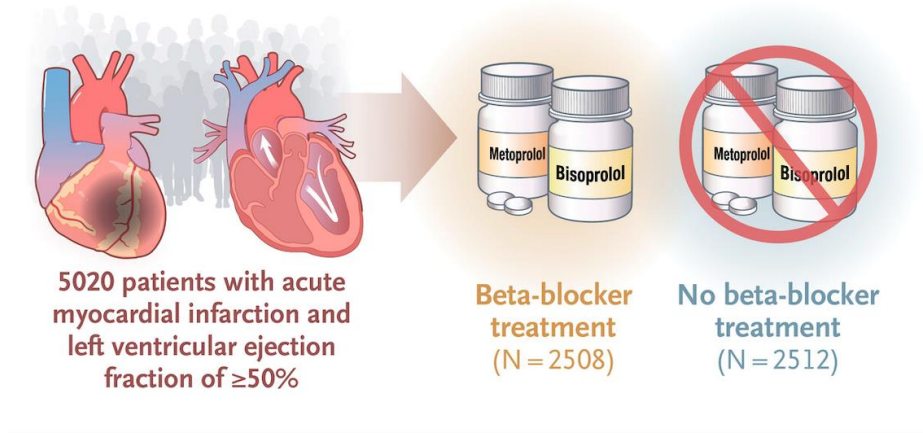
A	ACE inhibitors ARB (do not combine)	May improve glucose metabolism, lipid neutral Recommended 1 st line treatment in patients with DM and UACR $\geq 300\text{mg/g}$ Use maximum tolerated dose
B	Beta Blockers	Worsen glucose control (not vasodilating BB: carvedilol, nebivolol, labetalol)
C	Calcium Channel Blockers	Lipid and glucose neutral No labs needed
D	Thiazide-like Diuretics	Reduces CHF Worsens glucose metabolism, lipids



2020 International Society of Hypertension Global Practice Guidelines



Beta Blockers after acute MI?

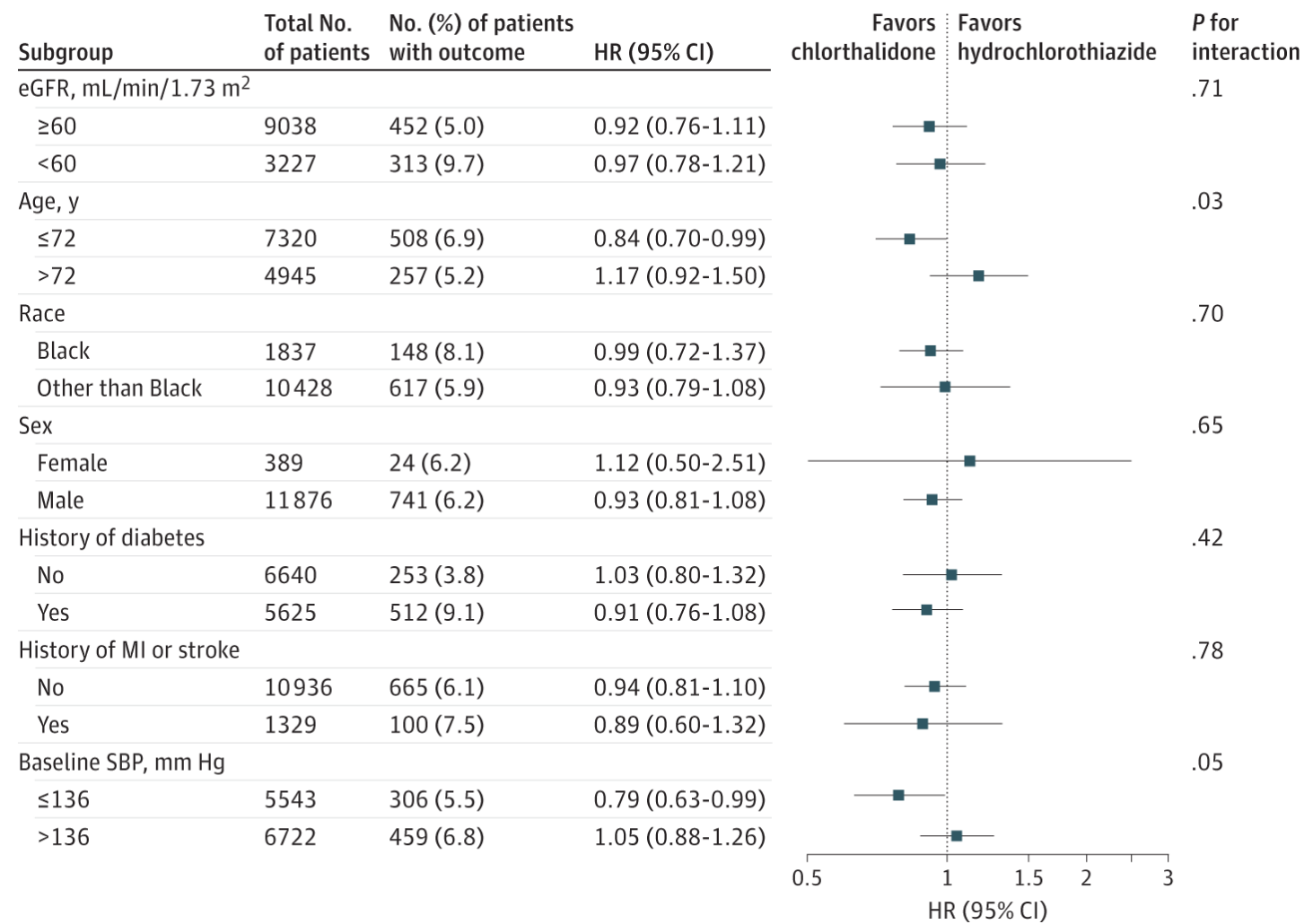


Following acute MI, patient who underwent early coronary angiography and had a preserved LVEF ($\geq 50\%$), long-term beta-blocker treatment **did not** lead to a **lower risk of death from any cause or new myocardial infarction than no beta-blocker use.**



Which Thiazide? HCTZ versus Chlorthalidone

Chlorthalidone is **not superior** to hydrochlorothiazide in the incidence of the primary or secondary composite kidney outcome.

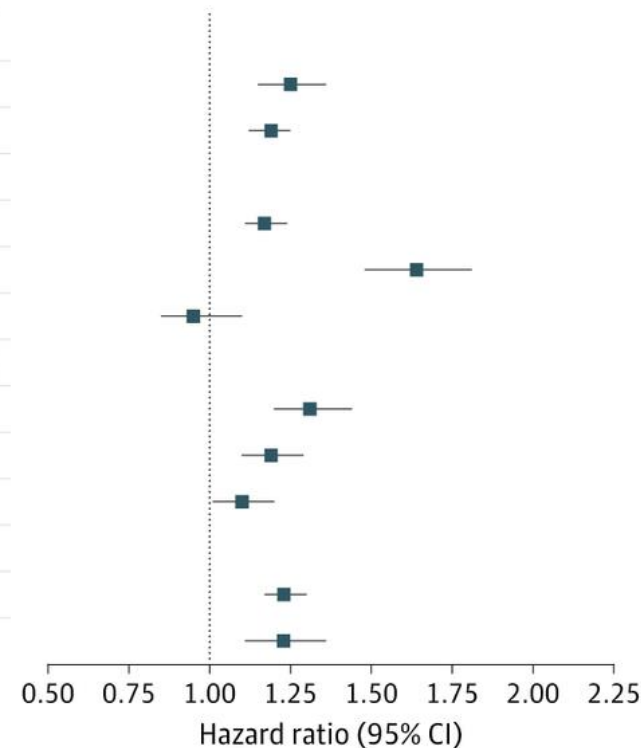


PRN?

133,760 patients
hospitalized in Veterans
Affairs hospitals

Use of PRN BP medication
use associated with **greater
risk** of AKI, rapid drop in
blood pressure, and the
composite outcome of
stroke, myocardial
infarction, or death.

	Total, No.	Hazard ratio (95% CI)
Type of as-needed BP medication given		
β-Blocker	15 234	1.25 (1.15-1.36)
Non-β-blocker	18 277	1.19 (1.12-1.25)
Route of as-needed BP medication administration		
Orally only	34 680	1.17 (1.11-1.24)
IV only	9482	1.64 (1.48-1.81)
Orally and IV	7896	0.95 (0.85-1.10)
Maximum systolic BP before as-needed BP medication administration, mm Hg		
140-159	11 870	1.31 (1.20-1.44)
160-179	17 894	1.19 (1.10-1.29)
≥180	12 602	1.10 (1.01-1.20)
As-needed BP medication order type		
One-time	40 008	1.23 (1.17-1.30)
Recurring (pro re nata)	12 070	1.23 (1.11-1.36)



Polypill Simulation

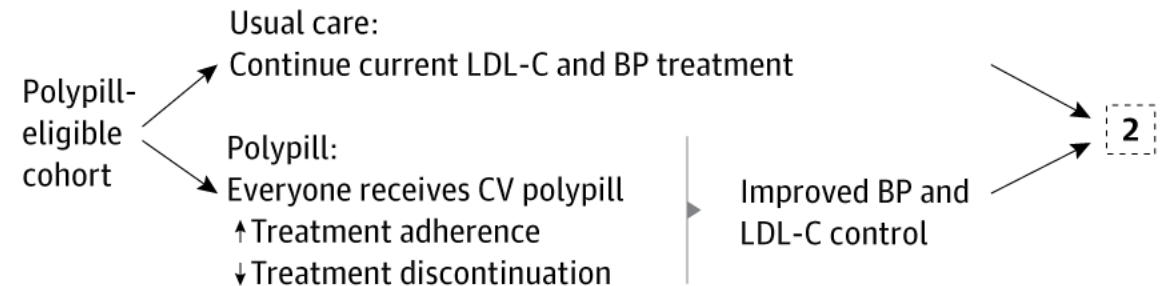
Adherence and price: largest impact on cost-effectiveness of polypill treatment

Polypill treatment would be

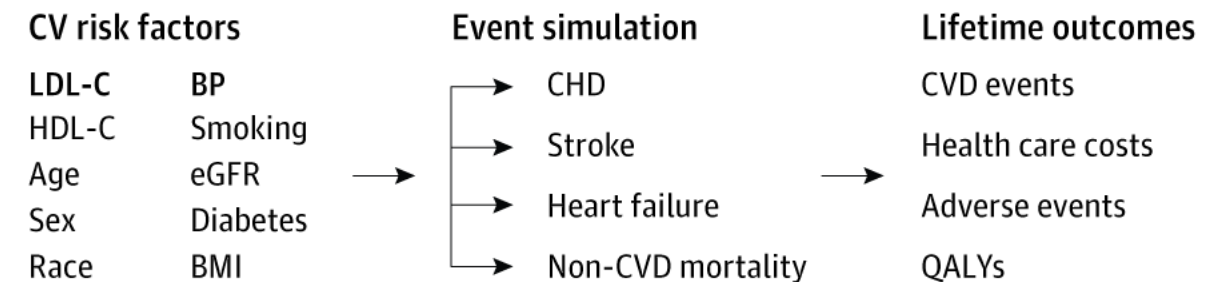
- cost saving at annual prices below \$443
- high value at prices below \$559

Over a lifetime, polypill treatment increased average life expectancy by over 3 months and remained highly cost-effective

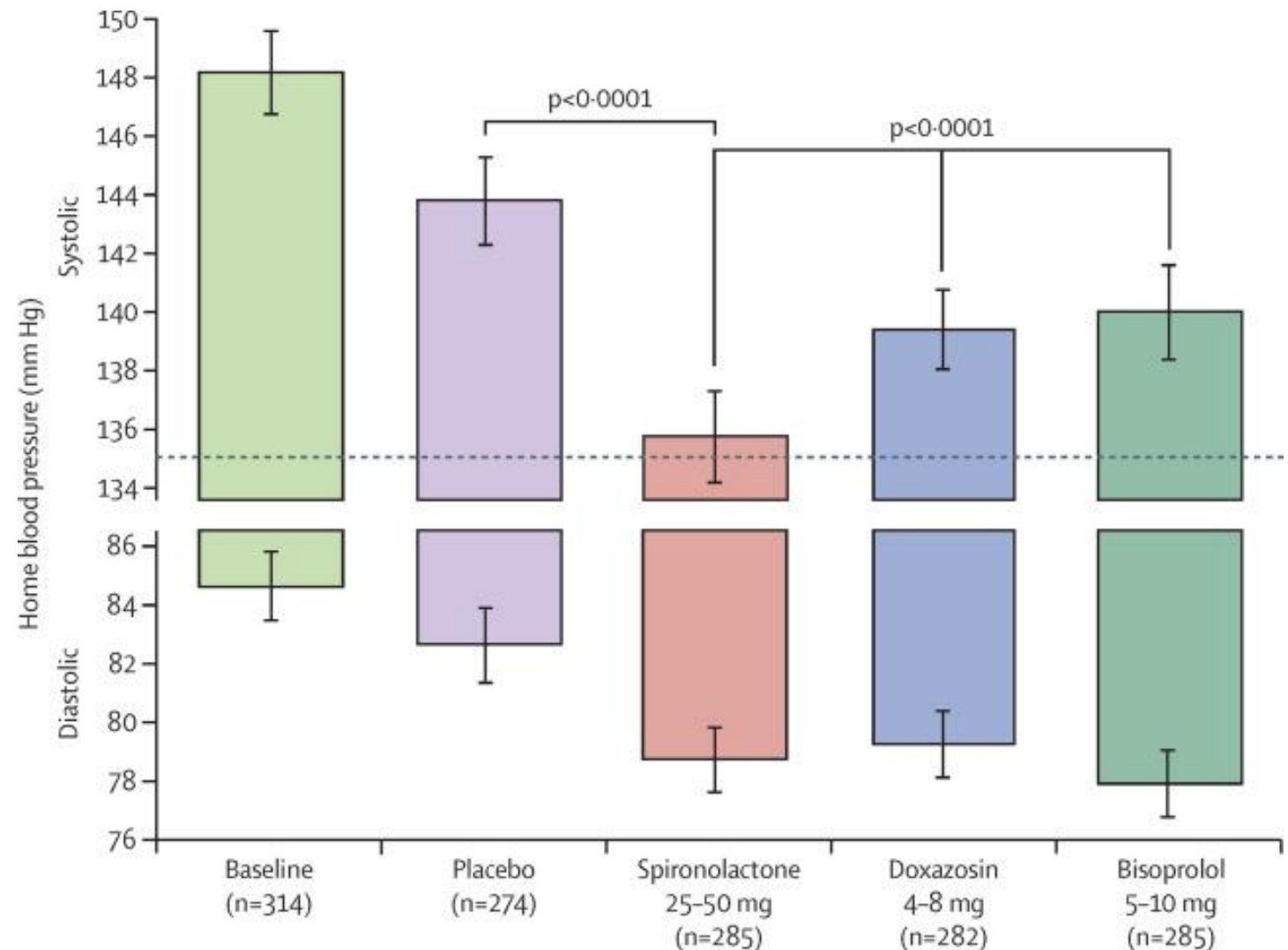
1 Simulating SCCS polypill trial



2 Simulating individual-level health and cost outcomes



Spironolactone is the best 4th drug for Resistant Hypertension



Comparison of MRA inhibitors: Steroidal and Non-steriodal

	Steroidal MRAs		Finerenone
			
	Spironolactone	Eplerenone	Finerenone
Structural properties	Flat (steroidal)	Flat (steroidal)	Bulky (nonsteroidal)
Potency to MR	+++	+	+++
Selectivity to MR	+	++	+++
CNS penetration	+	+	-
Sexual side effects	++	(+)	-
Half-life	> 20 hours	4-6 hours	2-3 hours
Active metabolites	++	-	-
Effect on BP	+++	++	+

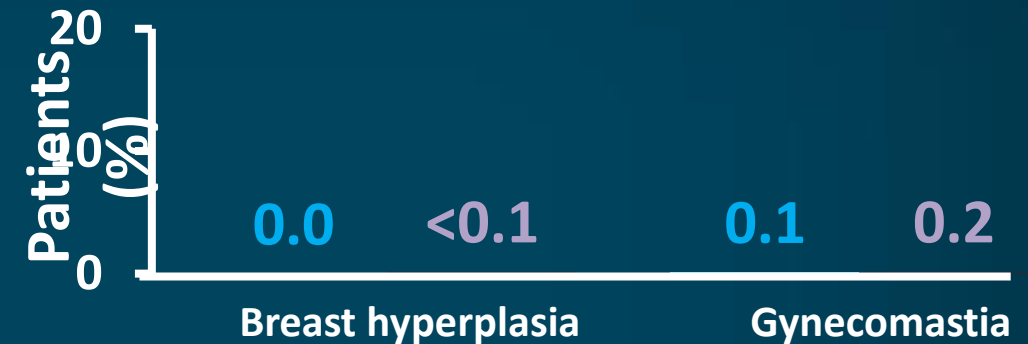
Finerenone Showed Modest Effects on SBP and No Sexual Side Effects—Hyperkalemia Was Increased But Clinical Impact Was Low

Modest effect on systolic blood pressure

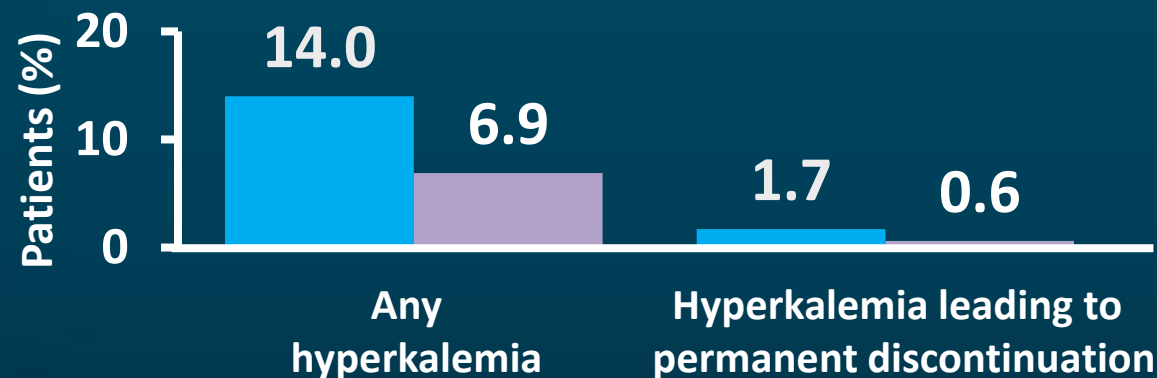


Placebo-corrected change
in mean SBP of
−3.7 mmHg at 4 months

No sexual side-effects



Increased hyperkalemia with minimal impact

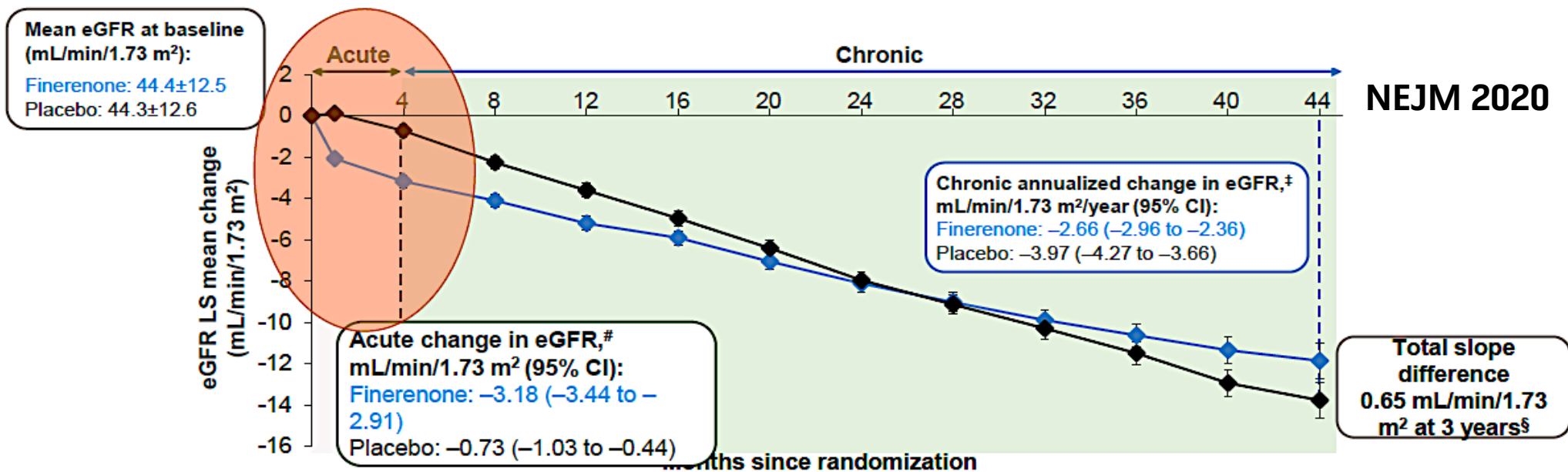
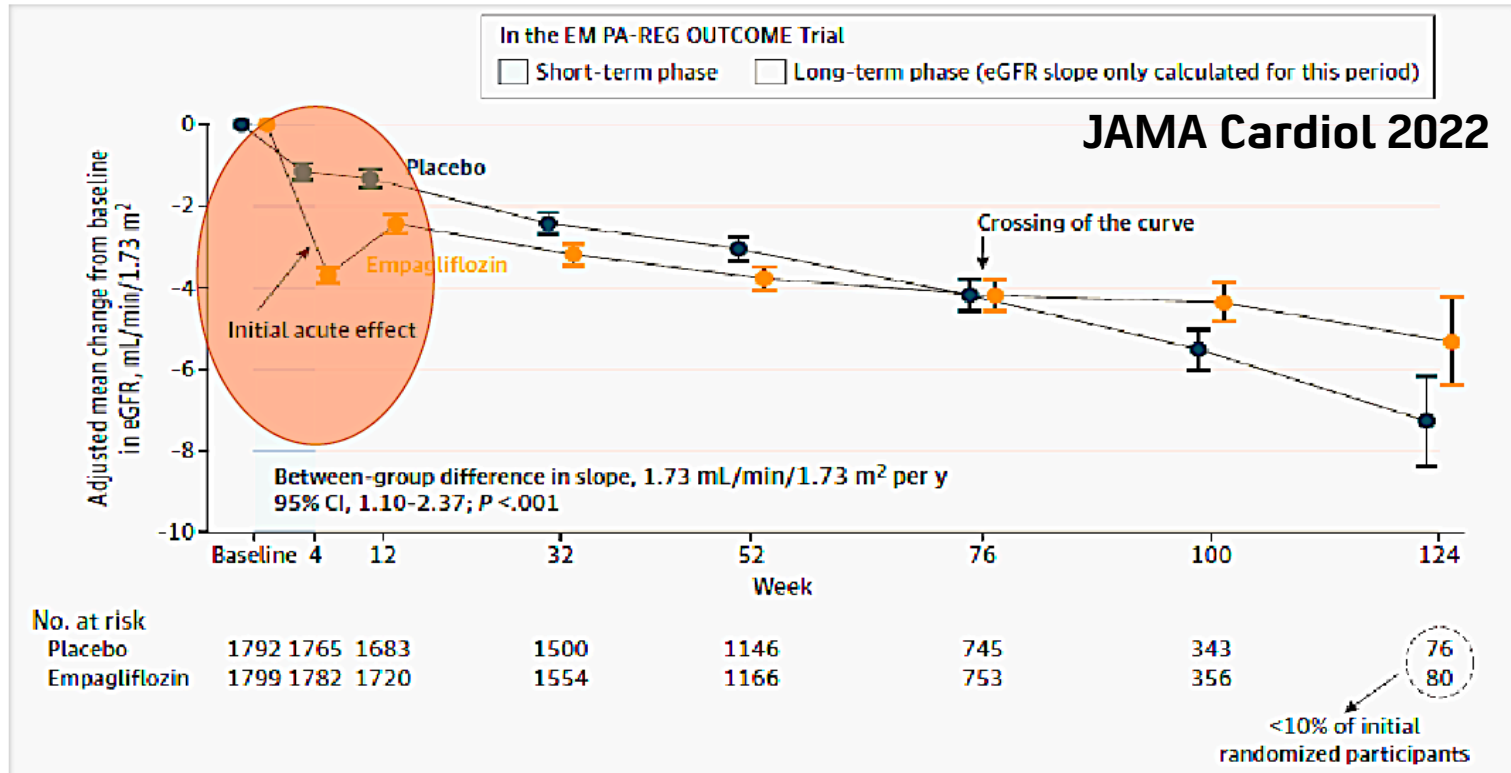
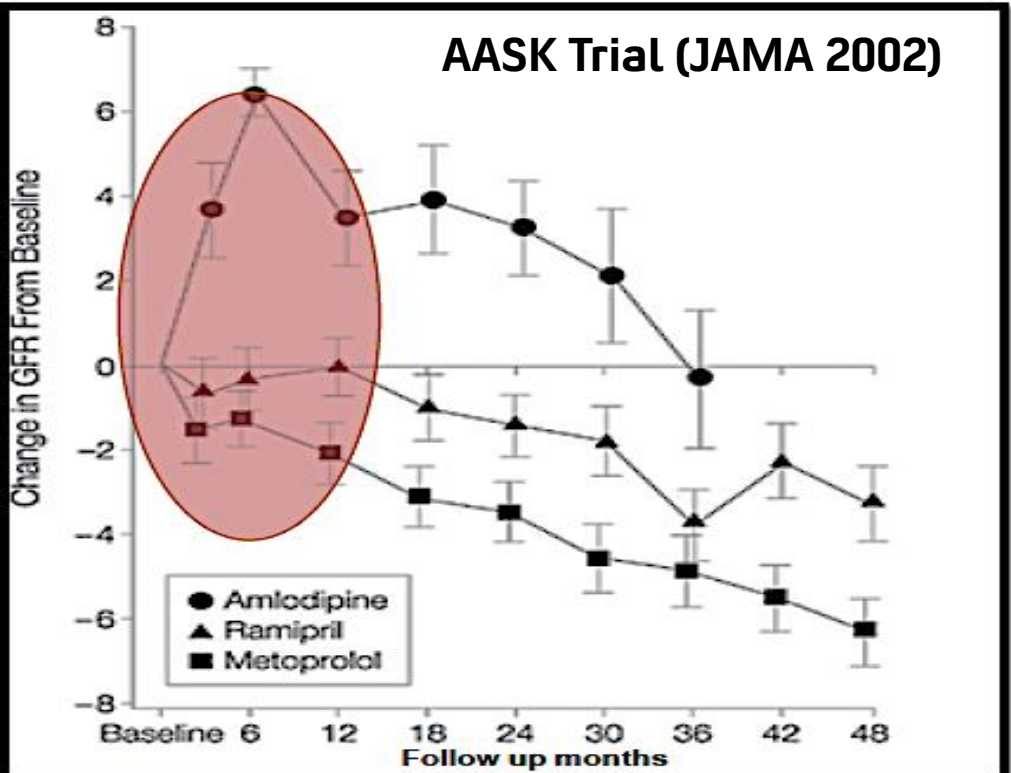


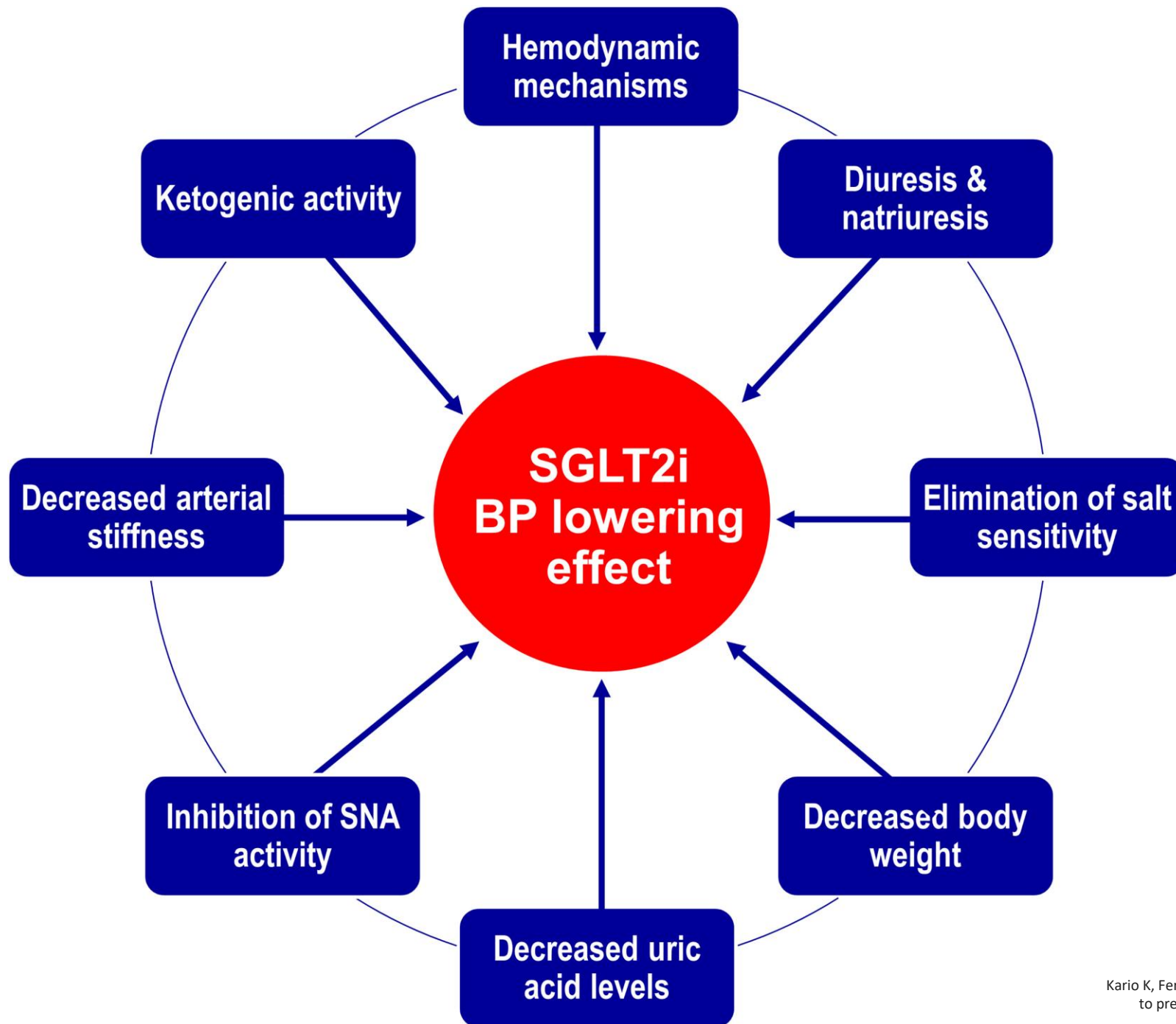
Finerenone (n = 6510)

PBO (n = 6489)

SBP = systolic blood pressure.

Agarwal R, et al. *Eur Heart J*. 2022;43:474-484 and supplement.





Modest BP reduction with SGLT-2 inhibitor

SBP ↓ 2.5-5 mmHg

Take Home Points

- Target BP <130/80 mmHg for most patients
- Order a 24-hour ABPM, if possible, to augment home BPs
- Incorporate systematic home BPs into your practice
- Lifestyle Modification always first
- Use A (ACE-i/ARB), C (CCB), D (Thiazide Diuretic) therapy
- Consider SGLT-2 inhibitors for BP management





Brigham and Women's Hospital
Founding Member, Mass General Brigham

THANK YOU!