HYPERTENSION UPDATE:

Best Practices for Achieving Blood Pressure Targets

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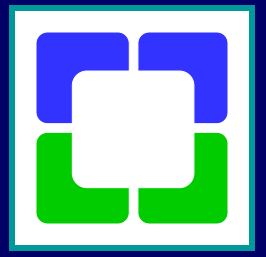


Historical Trends in HTN*

National Health and Nutrition Examination Survey

Trends in awareness, treatment, and control of high blood pressure in adults ages 18-74

	1976-1980	1988-1991	1991-1994	1994-2000
Awareness	51%	73%	68%	70%
Treatment	31%	55%	54%	59%
Control	10%	29%	27%	34%

***Hypertension = SBP >140 mmHg and DBP >90 mmHg**

http://hin.nhlbi.nih.gov/nhbpep_slds/menu.htm

STAGING HYPERTENSION

BP Classification	SBP mmHg		DBP mmHg
Normal	<120	and	<80
Prehypertension	120–139	or	80–89
Stage 1 Hypertension	140–159	or	90–99
Stage 2 Hypertension	≥160	or	≥100

JNC VII Report. *JAMA* 2003;289:2560.

Another View……
ASH Position Paper 2005

"This paradigm expands on the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) definition and classification of hypertension by classifying individuals by blood pressure (BP) level or cardiovascular status; however, **priority is given to cardiovascular status**; **cardiovascular disease (CVD) designation is determined by the constellation of risk factors, early disease markers, and target organ disease"

(J Clin Hypertens. 2005;7:505–512)

ASH Position Paper 2005

Table I. Hypertension Writing Group Definition and Classification of Hypertension*

Classification	Normal	Stage 1 Hypertension	Stage 2 Hypertension	Stage 3 Hypertension
Descriptive category (BP pattern and CVD status)	Normal BP or rare BP elevations AND No identifiable CVD**	Occasional or intermittent BP elevations OR Risk factors or markers suggesting early CVD**	Sustained BP elevations OR Evidence of progressive CVD**	Marked and sustained BP elevations OR Evidence of advanced CVD**
Cardiovascular risk factors (see Table II)	None	≥1 risk factor present	Multiple risk factors present	Multiple risk factors present
Early disease markers (see Table III)	None	0–1	≥2	≥2 present with evidence of CVD
Target organ disease (see Table IV)	None	None	Early signs present	Overtly present with or without CVD events

Developing Risk Scores

- Comprehensive vascular evaluation of hypertensive patients to accurately stratify and manage based on risks

- Framingham Risk Score:
  - Risk Assessment Tool for Estimating 10-year Risk of Developing Hard CHD (Myocardial Infarction and Coronary Death)

- Rasmussen Score:

Rasmussen Score

1. **Small-artery elasticity using pulsewave analysis**
2. **Large-artery elasticity using pulsewave analysis**
3. **Blood pressure at rest**
4. **Blood pressure after three minutes of exercise**
5. **Optic fundus photos taken with a digital camera**
6. **Microalbuminuria**
7. **Carotid artery ultrasound to measure artery wall thickness**
8. **Electrocardiogram**
9. **Left ventricular ultrasound to measure heart size**
10. **Plasma B-type peptide concentration.**

Rasmussen Center for Cardiovascular Disease Prevention

- 0 (normal)
- 1 (borderline)
- 2 (abnormal)
- Patients then receive a composite score known as their Rasmussen score.
- A score of 6 or higher is considered cause for concern

WHICH BP DO WE USE FOR STAGING AND TREATMENT OF HYPERTENSION?

- Office BP
  - Nurse, medical assistant, doctor, machinery (*e.g.,* BP Tru)
- Home BP (self-monitoring)
- 24-hr ambulatory blood pressure monitoring (ABPM)

LABELLING THE PATIENT AS "HYPERTENSIVE"

- Confirm elevated office BP readings
- BP consistently >135-140 / 85-90 at home
- 24-hr ABPM
  - Average awake BP >135/85
  - Average asleep BP >120/75

BP MEASUREMENT IN THE OFFICE

1. Technique of BP measurement:
   - 5 minutes of rest, no conversation, seated comfortably
   - Arm should at the level of the heart
   - No tobacco or caffeine intake in the preceding 30 minutes
2. Two seated readings should be obtained and averaged
3. Two upright readings (after 1 minute of quiet standing) should be obtained and averaged.

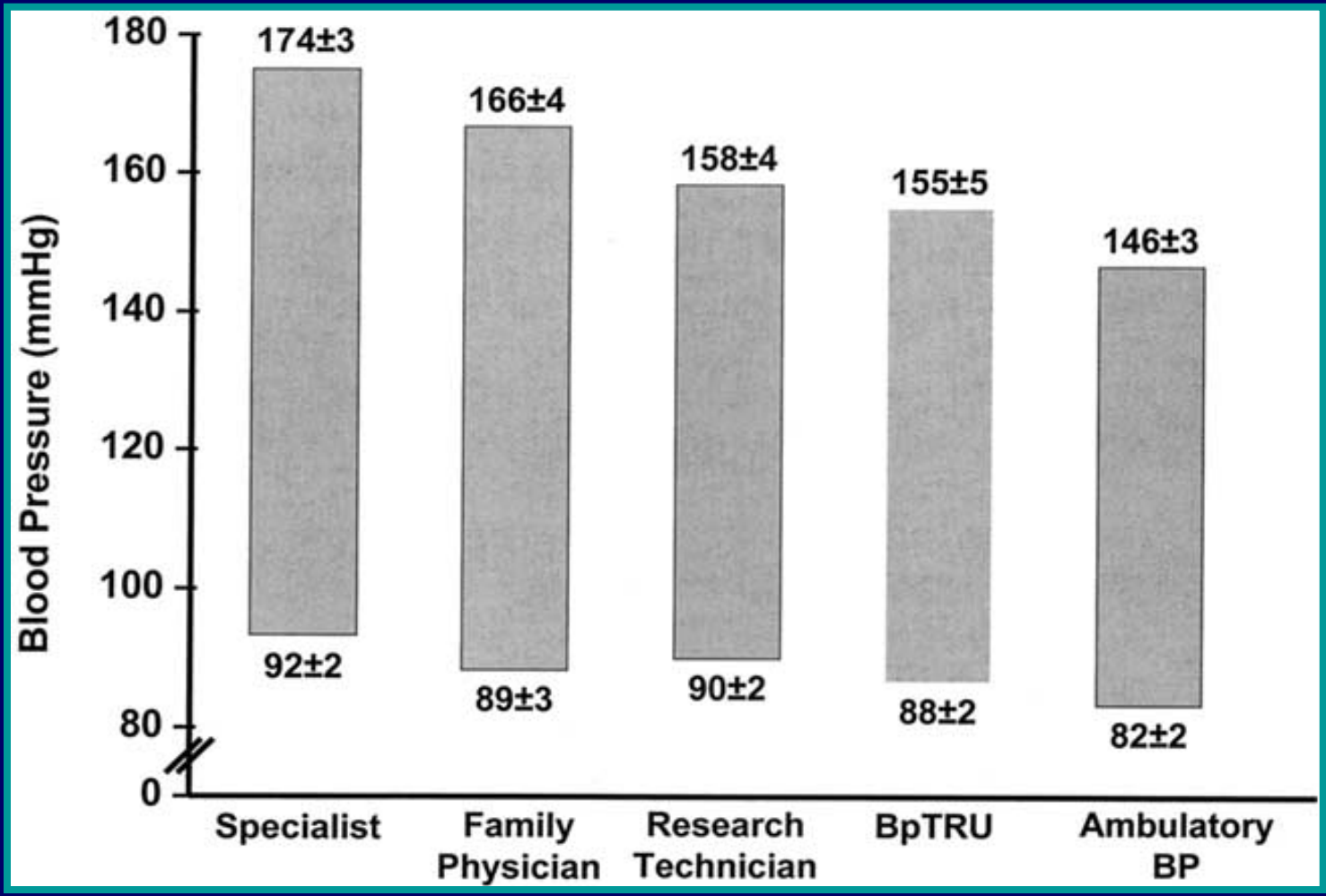
BpTRU

- White coat effect
- Work in progress

BpTRU: Rationale

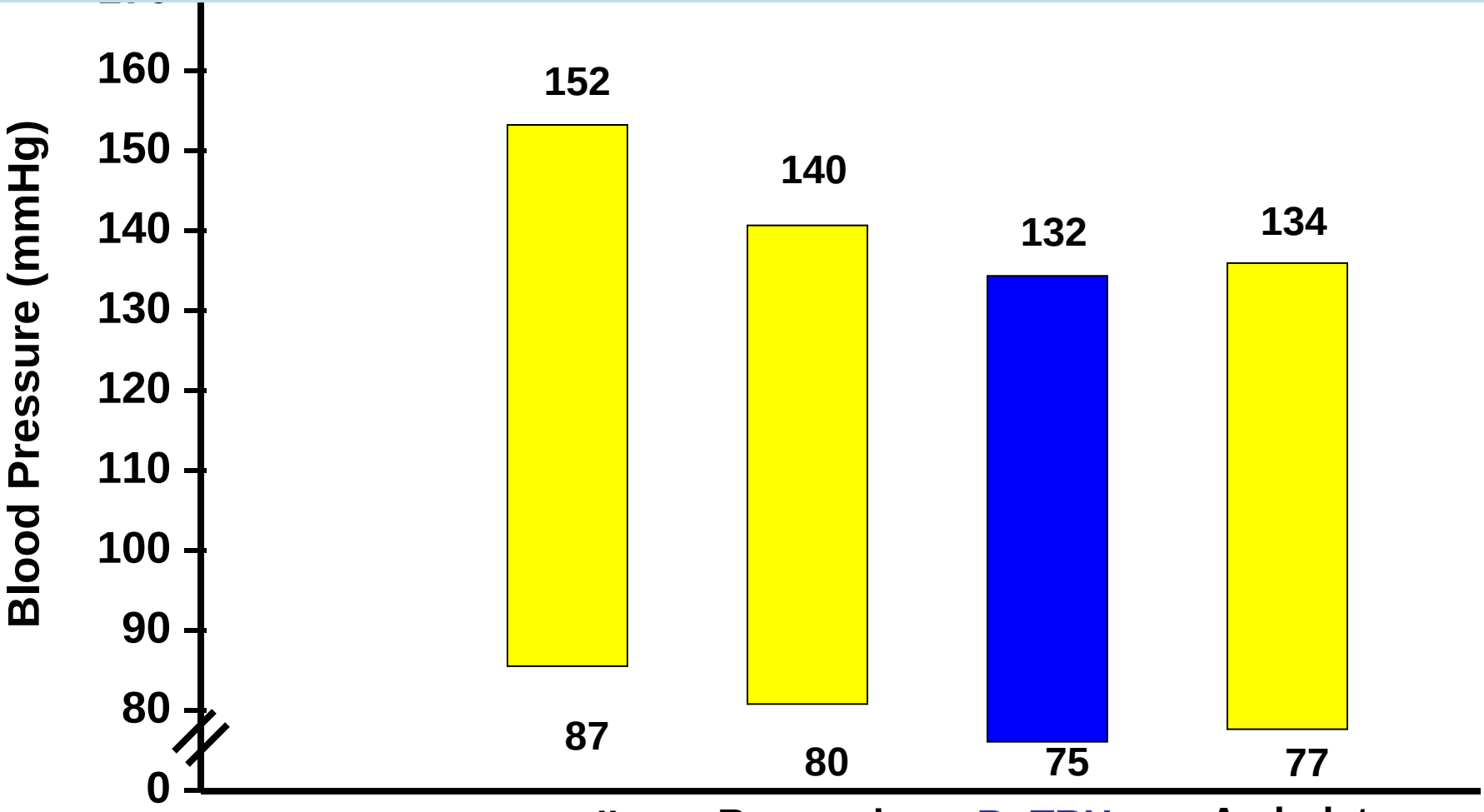
- Oscillometric device
- Tested extensively
- Independently validated device
- Automatically zeroes with each inflation
- Utilized widely over Mayo Clinic
- Average of 6 readings
- Integration to EMR

WHICH BP SHOULD WE BELIEVE?



Myers & Valdivieso. *Am J Hypertens* 2003;16(6):494.

Reduction of WCE in Clinical Practice



n=309

Myers M, et al, Journal of Hypertension 2009 27(2) 280-286

Random Q7 Patient

Vitals - Last Recorded

BP	Pulse	Temp	Ht	Wt
180/76	53	96.8 °F (36 °C)	180.3 cm (5' 11")	90.719 kg (200

Orthostatic Vitals

BP	Pulse	Position	Site	Cuff Size	Time
129/73	51	Sitting	Right Arm	Regular	02:33 PM
Comment: 1					
146/59	56	Standing	Right Arm	Regular	02:41 PM
Comment: 2					
135/62	55	Standing	Right Arm	Regular	02:41 PM
Comment: 1					
134/53	50	Sitting	Right Arm	Regular	02:41 PM
Comment: 2					
124/54	50	Sitting	Right Arm	Regular	02:41 PM
Comment: 3					
126/51	49	Sitting	Right Arm	Regular	02:41 PM
Comment: 4					
112/57	49	Sitting	Right Arm	Regular	02:41 PM
Comment: 5					
121/48	49	Sitting	Right Arm	Regular	02:41 PM
Comment: 6					
123/53	49	Sitting	Right Arm	Regular	02:41 PM
Comment: AVERAGE					

INDICATIONS FOR ABPM

1. Evaluation of disparate office and home BP readings
    a. Elevated office readings – "office" or "white coat" hypertension
    b. Low or normal office readings with target organ damage
2. Assessment of borderline or labile hypertension
3. Assessment of efficacy of therapy
4. Evaluation of episodic hypertension or orthostatic hypotension
5. Clinical pharmacology studies of new drugs/research

ASSOCIATION BETWEEN OFFICE BP AND 24-HR ABPM

	24-Hr Ambulatory BP controlled	**24-Hr Ambulatory BP *NOT* controlled**
Office BP controlled	Normotension	**Masked hypertension**
Office BP *not* controlled	**White coat hypertension**	Hypertension

BREAKING NEWS

Monitors urged for all with high blood pressure

Only 1 in 3 have condition under control; medications could be fine-tuned

Categories
U.S. news
World news
Politics
Business
Tech & science
Entertainment
Health
Diet and nutrition
Women's health
Men's health
Kids and parenting
Sexual health
Mental health
Pet health
Fitness

Associated Press
updated 8:39 p.m. ET, Thurs., May. 22, 2008

Everyone with high blood pressure — some 72 million Americans — should own a home monitor and do regular pressure checks, the American Heart Association and other groups urged Thursday in an unprecedented endorsement of a medical device for consumers.

High blood pressure is a leading cause of heart attacks, strokes and death. Having it checked a few times a year in a doctor's office or at the drugstore is not enough to keep tabs on it, and regular home monitoring is more accurate, the new advice says.

Closer checks would let doctors fine-tune the

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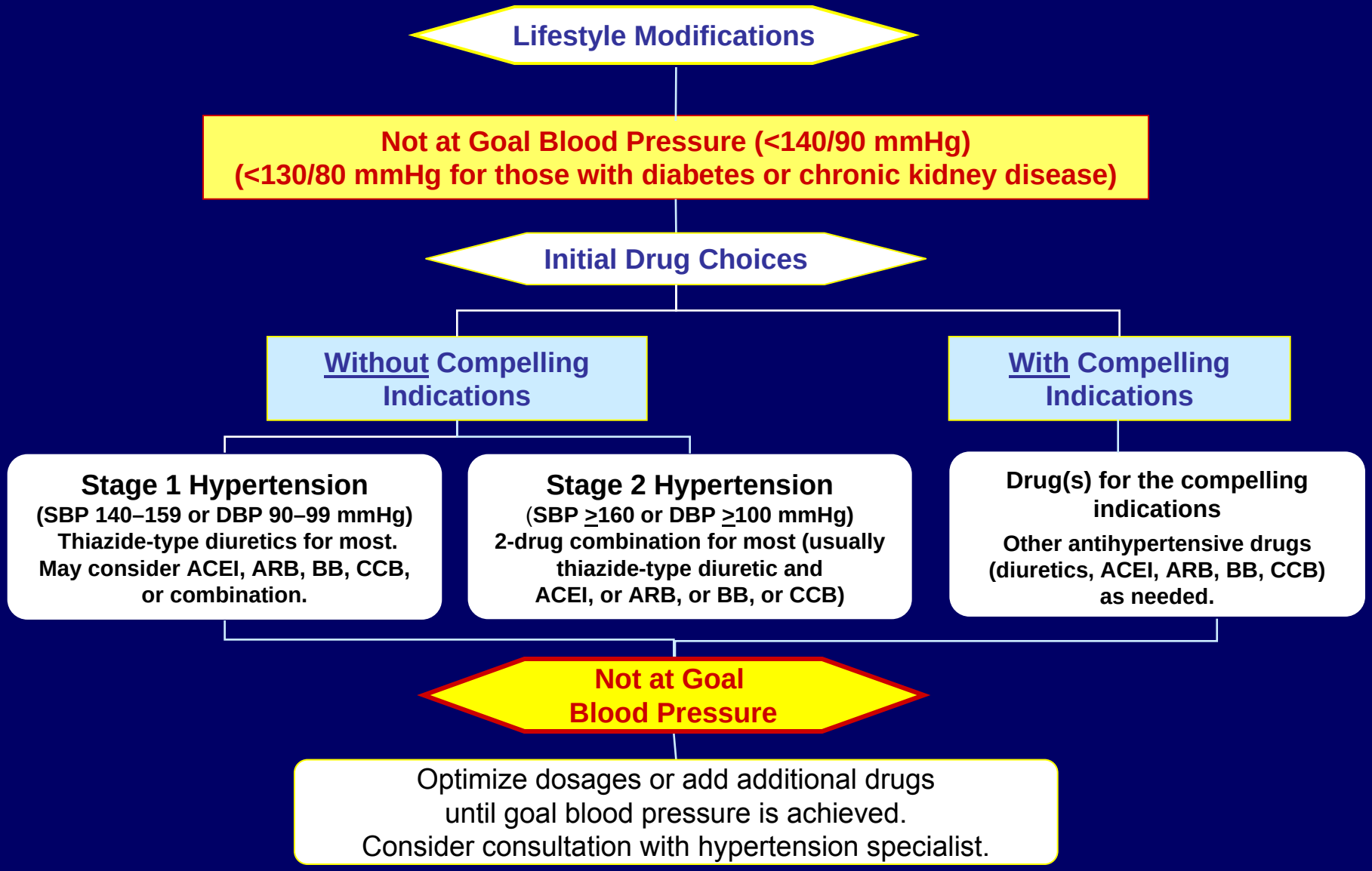
JNC 7 Algorithm for Treatment of Hypertension

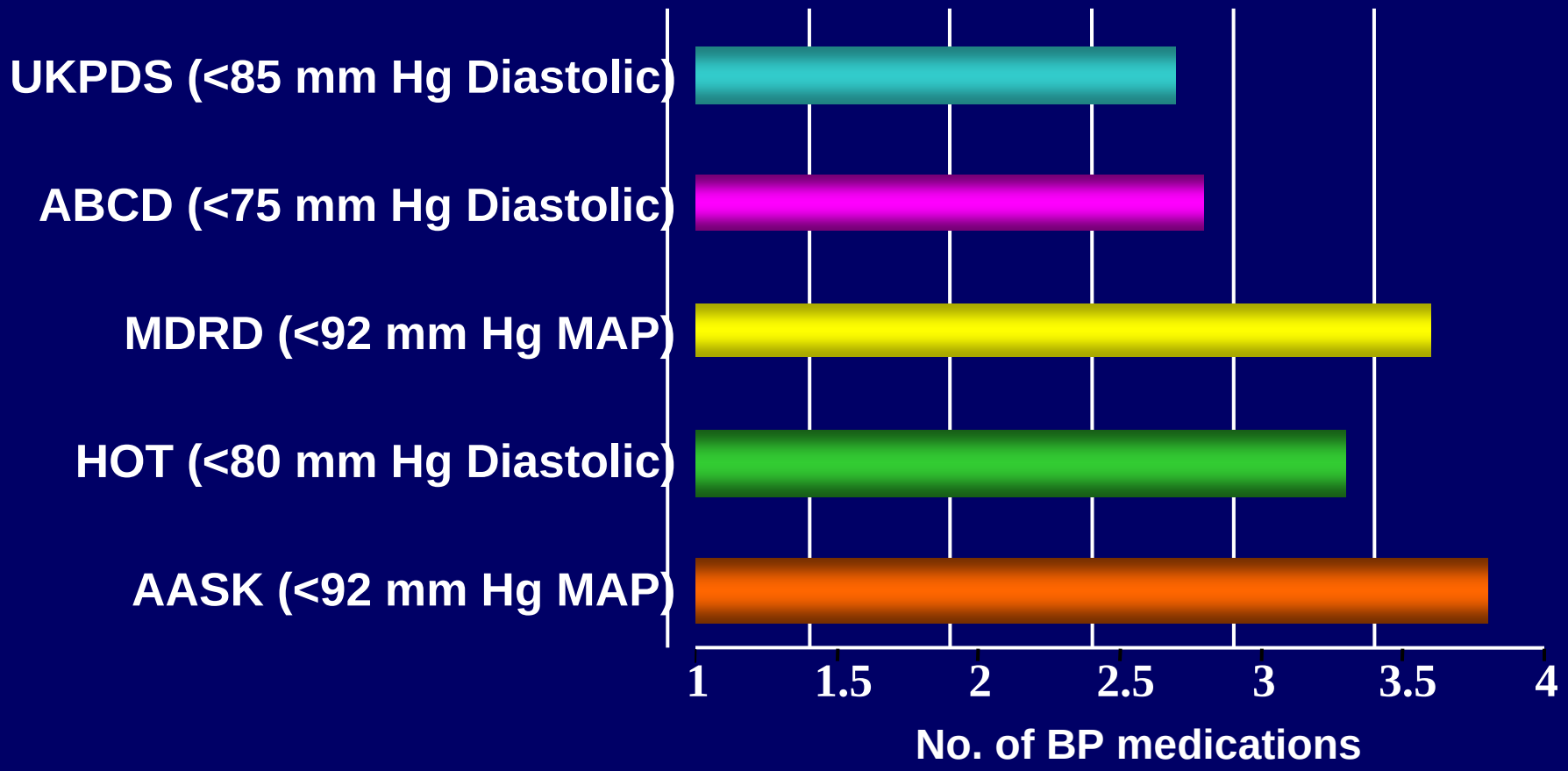


Target Blood Pressure is Achievable

BUT

Usually Requires More Than One Drug

Average Number of Antihypertensive Agents Needed Per Patient to Achieve Diastolic BP Goals*



*** IT IS MORE DIFFICULT TO ACHIEVE *SYSTOLIC* BP GOALS.**

Bakris et al. *Am J Kidney Dis*. 2000;36:646.

Center for BP Disorders Quality Metrics 3rd Q 2008

Physician	<140/90	<130/80	LDL tested	LDL<130	LDL<100	n
A	68.8%	49.4%	90.5%	75.3%	51.9%	77
B	73.3%	45.5%	88.4%	76.2%	56.4%	101
C	65.6%	45.8%	90.8%	66.7%	55.2%	96
D	60.3%	39.7%	87.1%	77.8%	52.4%	63
E	56.6%	28.3%	97.8%	76.8%	57.6%	99

Inclusion criteria:
-Docs in Center for BP Disorders w/ at least 30 cases
-Pt seen at least 2x in department
-last visit between 10/1/07-9/30/08
-ICD9 diagnosis for Htn in Epic encounter or problem list

RESISTANT HYPERTENSION: PROBLEMS WITH DEFINITION

Level of BP? Which BP parameter?

How many antihypertensive drugs?

Which drug combinations?

Drug dosage?

RESISTANT HYPERTENSION: *DEFINITION*

"Failure to control BP adequately (<150/100 mm Hg) with a good regimen, provided that medications are taken as prescribed "

(Gifford & Tarazi, 1978)

JNV-VII DEFINITION OF RESISTANT HYPERTENSION

- “Resistant hypertension is the failure to reach goal BP in patients who are adhering to full doses of an appropriate 3-drug regimen that includes a diuretic.
- Treating SBP and DBP to targets that are <140/90 mm Hg is associated with a decrease in CVD complications. In patients with hypertension and diabetes or renal disease, the BP goal is 130/80 mm Hg.”

POSSIBLE CAUSES OF RESISTANT HYPERTENSION

- Patient resistance
- Physician resistance
  - insufficient dosage
  - infrequent administration
  - irrational combinations
  - inadequate physician education
  - lack of physician motivation
- Drug interactions
- Excessive salt intake
- Office hypertension
- Secondary causes of hypertension
- True drug-resistant hypertension

PATIENT NON-COMPLIANCE

- Inadequate adherence to therapeutic regime
  1. Dietary
     a. Excessive sodium intake
     b. Inability to reduce weight
     c. Excessive alcohol consumption
  2. Pharmacological
     a. **F**ailure to take prescribed drugs
     b. Failure to follow prescribed dosing schedule
- Discontinued medications
- Inadequate follow-up
- Substance abuse (e.g., cocaine, alcohol, amphetamines)

GUIDELINES FOR ESTIMATING A PATIENT'S SODIUM INTAKE

Patient's description of salt intake	Approximate dietary sodium, *(mEq/24 hours)*
Avoids salty foods and adds no salt	90 - 120
Adds salt in moderation	120 – 200
Salts food heavily, often before tasting	>200

CLUES TO NON-COMPLIANCE

- A resting pulse rate $\geq$80 beats per minute in a patient on a β-blocker
- A uric acid level that does not increase or a serum potassium level that does not decrease in a patient on a thiazide diuretic

PHYSICIAN NON-COMPLIANCE

- Inadequate patient education
- Inadequate drug regimen
  - Inappropriate dosing
  - Inappropriate use or omission of diuretics

RATIONAL TRIPLE-DRUG REGIMEN

Diuretic +	Sympathetic Inhibitor +	Vasodilator
	beta blocker	hydralazine
	prazosin	minoxidil
	clonidine	ACEI
	aldomet	CCB
	labetalol	ARB

ACEI = ACE inhibitor
CCB = calcium channel blocker
ARB = angiotensin II receptor blocker

What is NOT Resistant Hypertension

Hypertension with regimen of:

- HCTZ 12.5 mg q.d.
  Hydralazine 25 mg b.i.d.
  Toprol XL 25 mg q.d.

  OR

- Vasotec 5 mg q.d.
  Lasix 40 mg q.d.
  Procardia XL 30 mg q.d.

RESISTANT HYPERTENSION: MINIMAL REGIMENS*

Regimen 1

1. *Oral diuretic* (a dose equivalent to 0.5 g chlorothiazide, 50 mg HCTZ, 10 mg metalozone, 25 mg chlorthalidone, 5 mg indapamide)†
2. *Sympathetic depressant* (Toprol XL 100 mg, atenolol 100 mg, clonidine 0.8 mg, prazosin 15 mg, labetalol 600 mg) *or ACE inhibitor, ARB, or CCB*
3. *Vasodilator* (hydralazine 200 mg, minoxidil 10-20 mg) *or ACE inhibitor, ARB, or CCB*

* Values refer to daily doses.

† Furosemide in cases of at least 160 mg daily must be used when renal failure is present (*e.g.*, creatinine clearance <30 mg/dL).

RESISTANT HYPERTENSION: MINIMAL REGIMENS*

Regimen 2

1. *Oral diuretic* (a dose equivalent to 0.5 g chlorothiazide, 50 mg HCTZ, 10 mg metolazone, 25 mg chlorthalidone, 5 mg indapamide)†
2. *Sympathetic depressant* (Toprol XL 100 mg, atenolol 100 mg,, clonidine 0.8 mg, prazosin 15 mg, labetalol 600 mg), or *ACEI, or ARB*
3. *Calcium channel blocker* (verapamil SR 480 mg, diltiazem 320 mg, Procardia XL 120 mg, amlodipine 10 mg) or *ACEI, or ARB*

* Values refer to daily doses.

† Furosemide in cases of at least 160 mg daily must be used when renal failure is present (*e.g.,* creatinine clearance <30 mg/dL).

RESISTANT HYPERTENSION: MINIMAL REGIMENS*

Regimen 3

1. *Oral diuretic*
2. *Sympathetic depressant, as above*
3. *ACE inhibitor* (ramipril 10 mg, enalapril 40 mg) *or ARB* (losartan 100 mg, irbesartan 300 mg, candesartan 32 mg, valsartan 320 mg)

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* Values refer to daily doses.

† Furosemide in cases of at least 160 mg daily must be used when renal failure is present (*e.g.*, creatinine clearance <30 mg/dL).

CAUSES FOR LACK OF RESPONSIVENESS TO THERAPY

- ***VOLUME OVERLOAD***

  Inadequate diuretic therapy

  Excess sodium intake

  Fluid retention from reduction of BP

  Progressive renal damage

RESISTANT HYPERTENSION: ACTION AND COUNTERACTION OF ANTIHYPERTENSIVE DRUGS

Drug	Action	Counteractions
Diuretic	Negative salt and water balance	Stimulation of RAAS
Sympathetic inhibitors	Sympathetic blockade	Fluid retention
Vasodilators	⬇ total peripheral resistance	• ⬆ cardiac output • Fluid retention • Stimulation of RAAS

RESISTANT HYPERTENSION: TREATMENT OF DRUG-INDUCED SECONDARY PRESSOR MECHANISMS

Mechanism	Effector Drugs	Treatment
Fluid retention	Sympathetic inhibitors Vasodilators	Diuretics
Cardiac stimulation	Vasodilators	Beta blockers
Hyperreninnemia (↑ RAAS)	Diuretics Vasodilators	Sympathetic inhibitors Beta blockers ACE inhibitors ARBs
Reflex total peripheral resistance elevation	Diuretics (early) Beta blockers	Sympathetic inhibitors

DRUG ACTIONS AND INTERACTIONS

- Sympathomimetics
- Nasal decongestants
- Appetite suppressants
- Cocaine and other illicit drugs
- Caffeine
- Oral contraceptives
- Adrenal steroids
- Licorice (as may be found in chewing tobacco)
- Cyclosporine, tacrolimus
- Erythropoietin
- Antidepressants
- NSAIDs

JNC VI

PSEUDORESISTANCE

Suspect in patients with high indirect BP measurements but little or no end-organ damage

1. Pseudohypertension
   - Due to stiff brachial artery
   - Detected by Osler's maneuver
2. Office hypertension
   - Discrepancy between office and home blood pressure or ABPM

SECONDARY CAUSES

- Renal parenchymal disease
- Renovascular hypertension
- Primary aldosteronism
- Pheochromocytoma
- Hypothyroidism and hyperthyroidism

FEATURES OF ATYPICAL HYPERTENSION

1. Age of onset: <20; >50 yrs
2. Level of BP: >180/110 mmHg
3. Target organ damage
   a. Fundi - Grade II or worse
   b. Serum creatinine >1.5 mg/dL
   c. Cardiomegaly or LVH
4. Presence of features suggesting secondary causes
   a. Unprovoked hypokalemia
   b. Abdominal bruit
   c. Variable BP with tachycardia, sweating, tremor
   d. Family history of renal disease, proteinuria
5. Poor response to appropriate drug regimen

ADDITIONAL CAUSES OF RESISTANT HYPERTENSION

- Smoking
- Increasing obesity
- Sleep apnea
- Ethanol intake >1 oz (30 mL) per day
- Anxiety-induced hyperventilation or panic attacks
- Chronic pain

JNC VI

NEUROHUMORAL ABERRATIONS RESPONSIBLE FOR RESISTANT HYPERTENSION

Neurohumoral aberration	Management
↑ Plasma renin activity (increased RAAS)	beta-blocker ACEI, ARB renin inhibitor
↑ Aldosterone production	spironolactone eplerenone
↑ Plasma catecholamines	clonidine methyldopa prazosin

HEMODYNAMIC ABERRATIONS RESPONSIBLE FOR RESISTANT HYPERTENSION

Hemodynamic aberration	Management
↑ Plasma volume	diuretics (loop) sodium restriction
↑ Peripheral resistance	vasodilators ACEI, ARB renin inhibitor calcium antagonist

PLASMA RENIN ACTIVITY-GUIDED DRUG SELECTION*

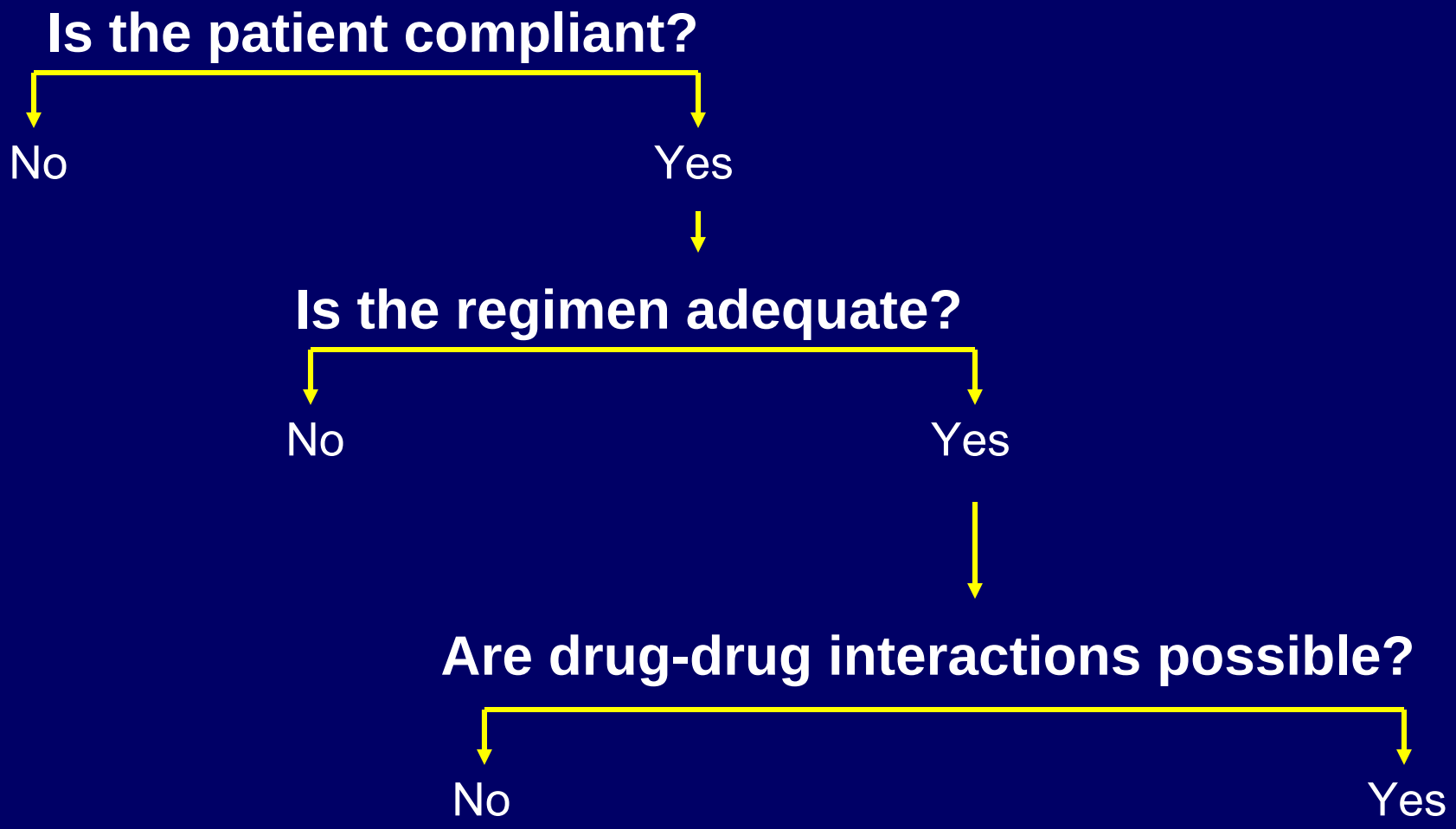
Measure plasma renin activity on present drug regimen

- PRA < 0.65 ng/ml/hr
  - Volume (V)
  - Treat with V drug: DIUR, CCB, α-blocker, spironolactone
- PRA > 0.65 ng/ml/hr
  - Renin (R)
  - Treat with R drug: ACEI, ARB, BB

* Debated for decades, has proponents, has not become standard of care.

Laragh JH, Sealey JE. Am J Hypertens 2003;16(5, Part 1):407-15.

AN ALGORITHM FOR THE MANAGEMENT OF RESISTANT HYPERTENSION



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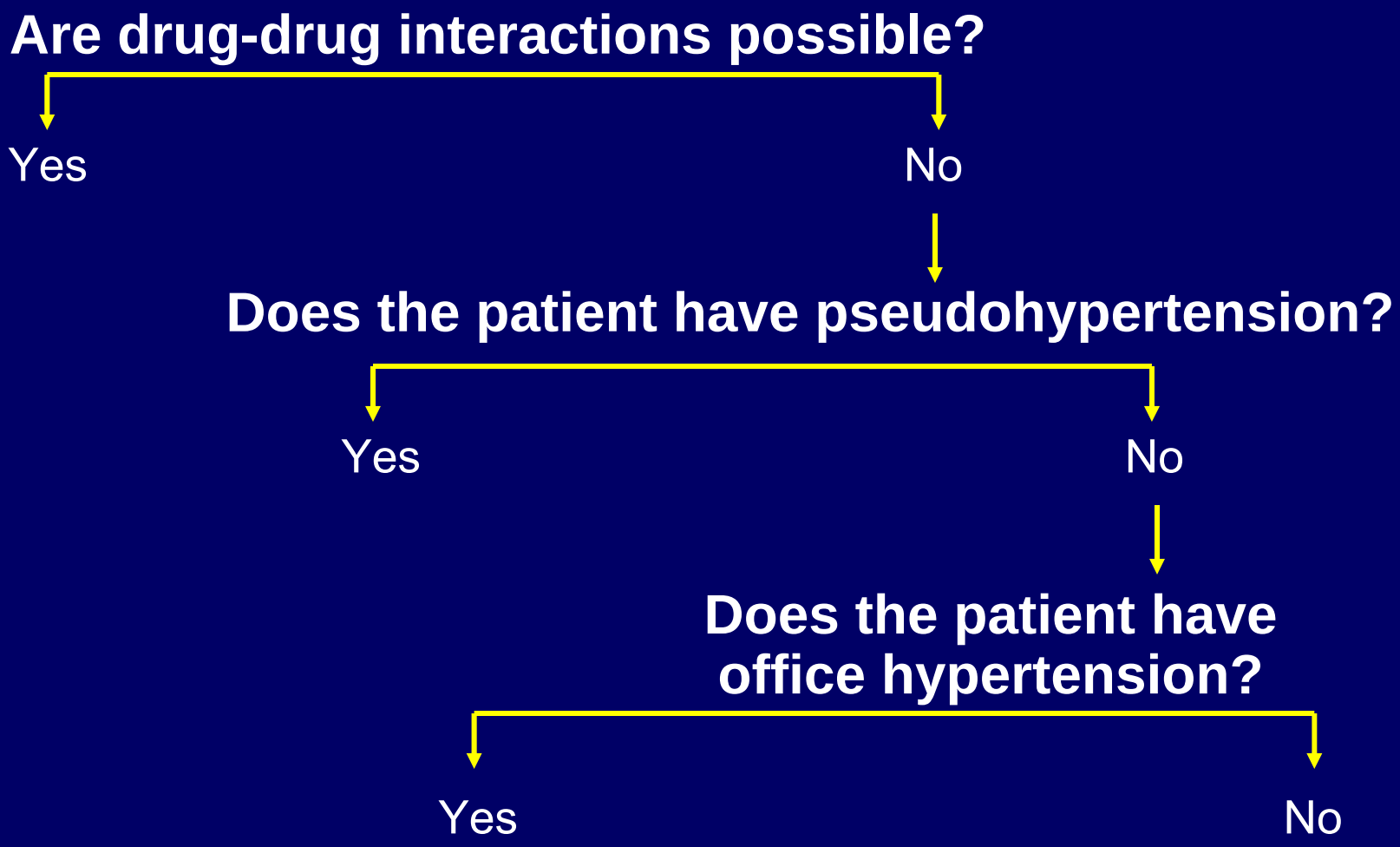

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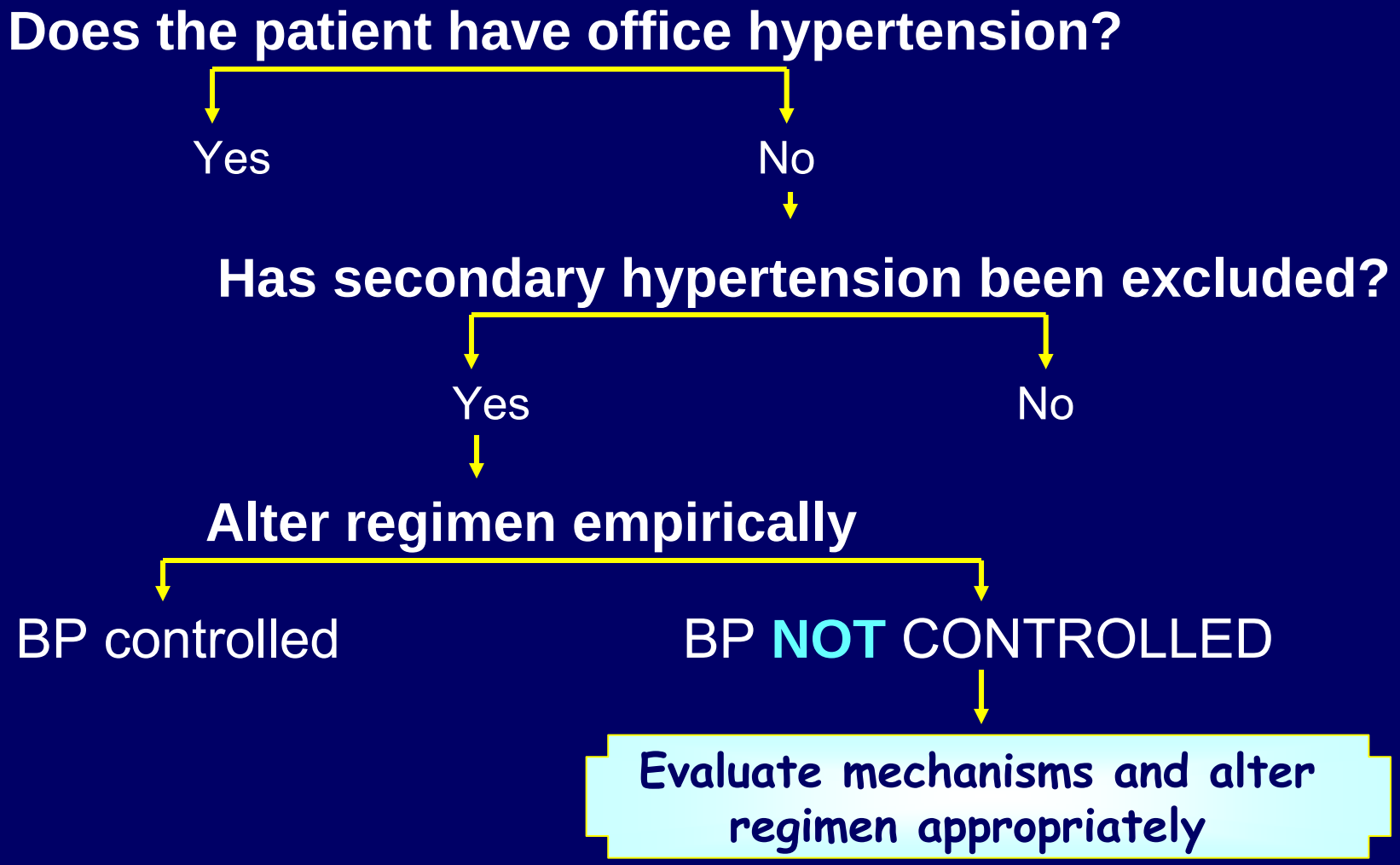

Four Interventions repeatedly linked with improved BP

- Involvement of someone other than the physician
  - (i.e. restructuring care delivery)
- Systematically tracking and improving follow up
- Performance feedback to physicians
- Self-monitoring

Med Care 2006 Jul 44(7): 646-57
Cochrane Database Sys Rev 2006; (2): CD005182

Comprehensive Evaluation of Hypertension