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Author: Alan Weder, M.D., 2008

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Hypertension

M2 Cardiovascular Sequence

Dr. Alan Weder

Fall 2008

University of Michigan
Medical School

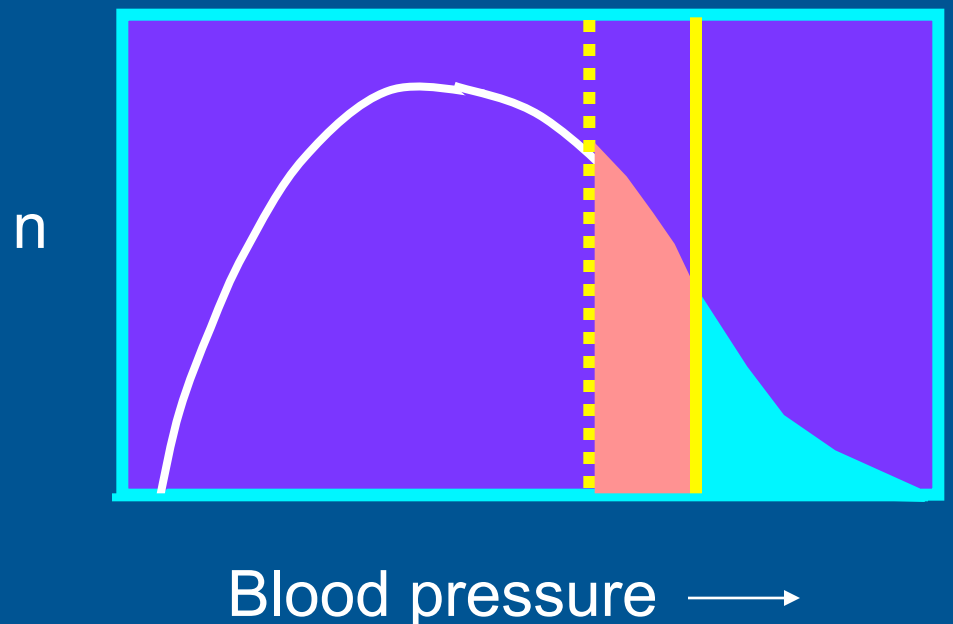
Key Points

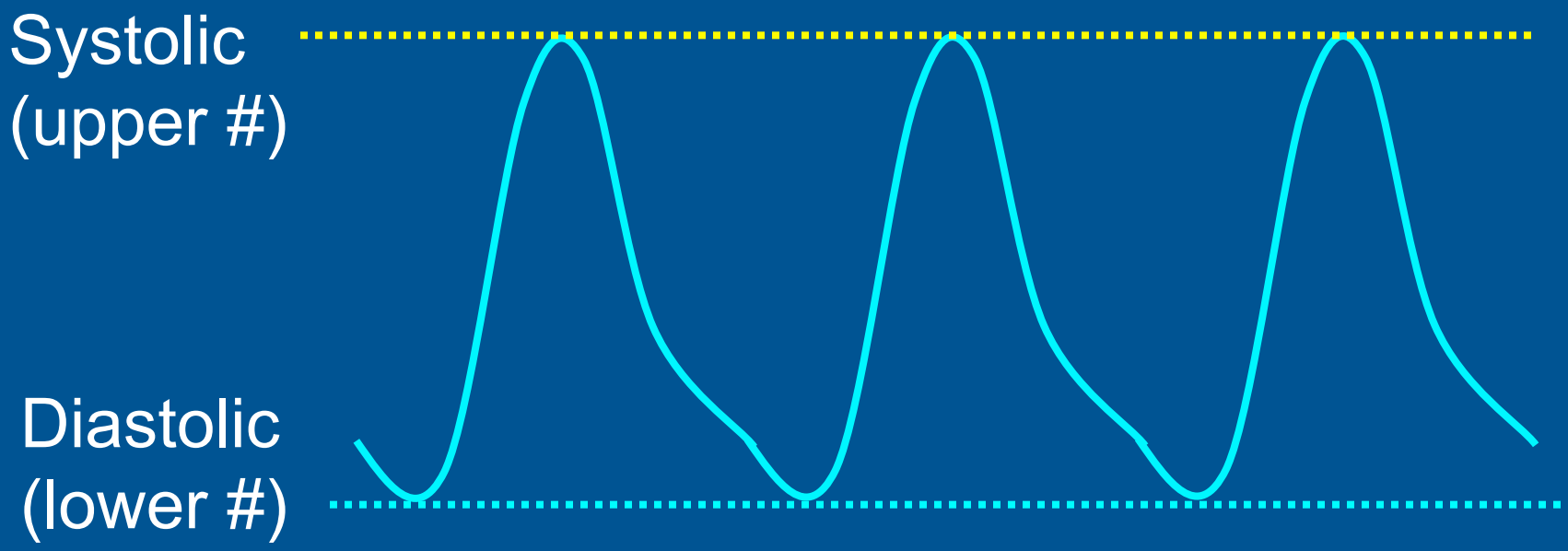
- Hypertension is a disease of blood pressure regulation
- Hypertension is a risk factor for atherosclerosis.
- Blood pressure measurement is important and requires attention to technique.
- Treatment decisions made in the context of overall risk factor burden.
- Secondary forms of hypertension are infrequently encountered and are usually recognized by resistance to treatment and distinctive biochemical features.

Hypertension

= high blood pressure

≠ being “hyper”, anxious





"Normal" is less than 140/90 mmHg

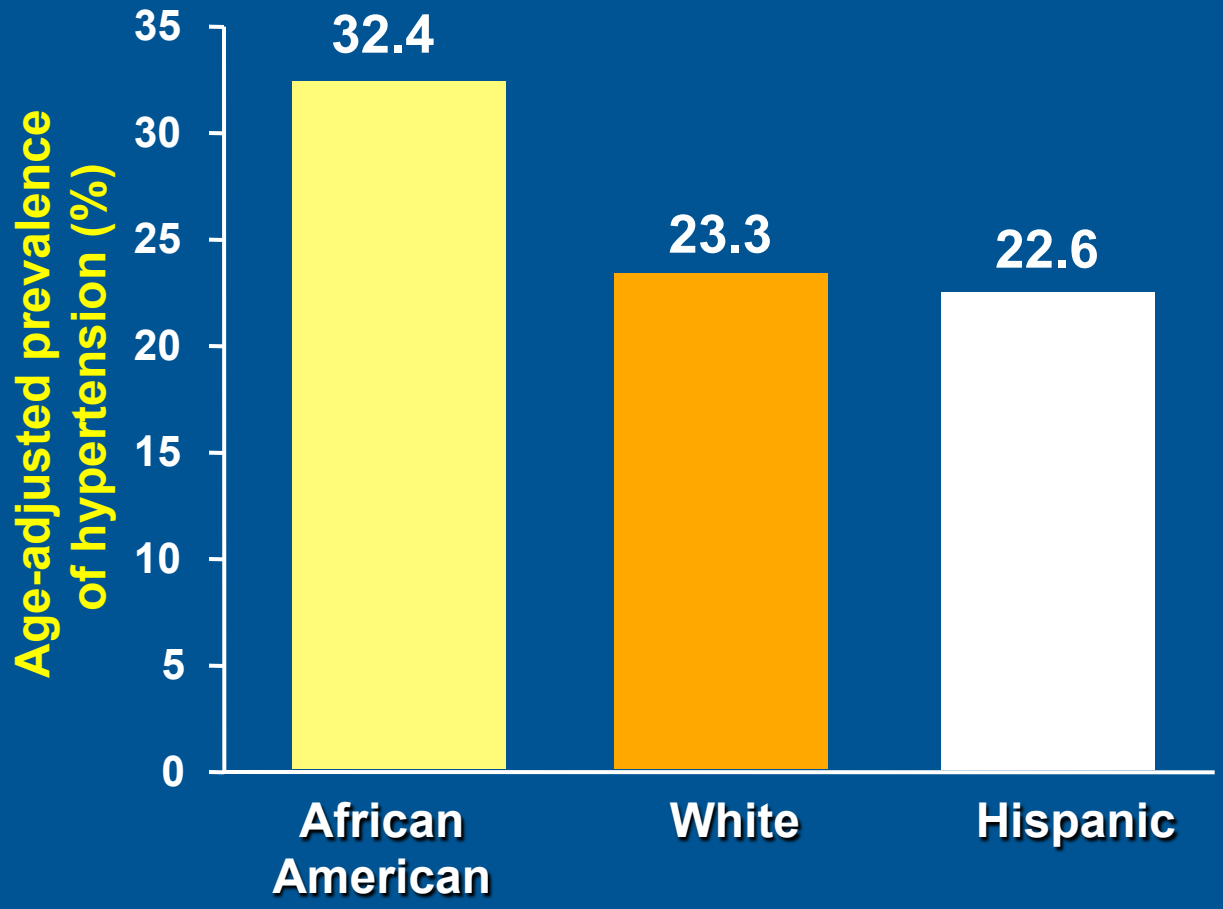
JNC-7* Blood Pressure Classification

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

Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and treatment of High Blood Pressure JAMA 289:2560, 2003.

Hypertension: Ethnic Variation (United States)

40% greater relative prevalence in African-Americans



 Burt et al. *Hypertension*. 1995;25:305

Blood pressure regulation

- Hemodynamic (descriptive)
- Sympathetic nervous system (short-term)
- Renal pressure natriuresis (long-term)

Blood pressure regulation
Hemodynamic

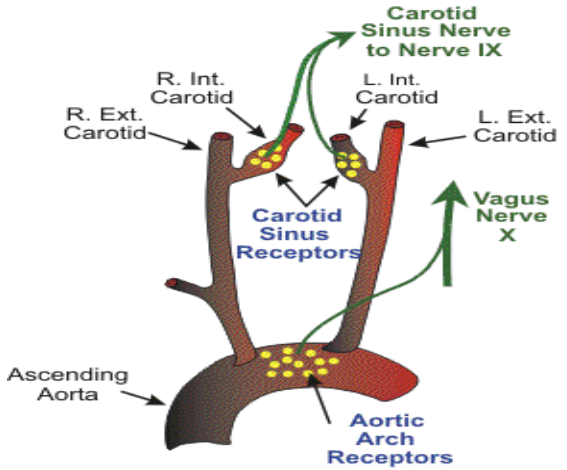
Mean arterial blood pressure =
Cardiac output X Peripheral vascular resistance

MAP = C.O. X TPR

See discussion in Lilly hypertension chapter

Blood pressure regulation

Sympathetic nervous system



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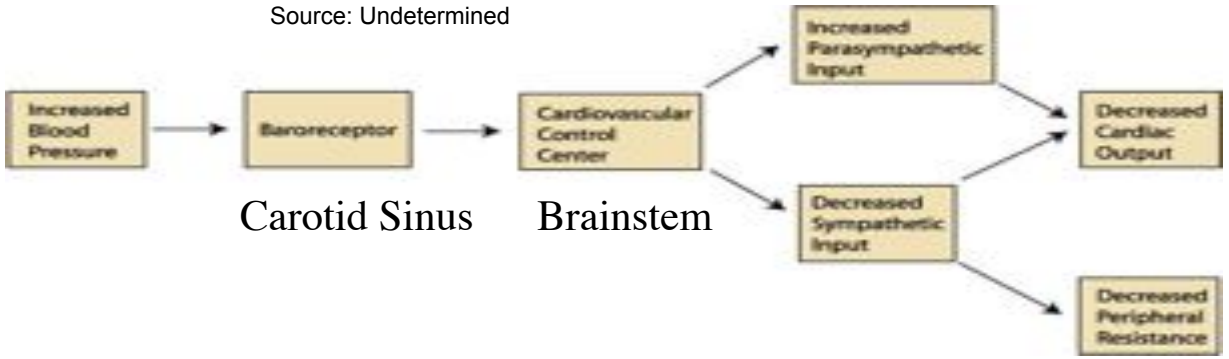
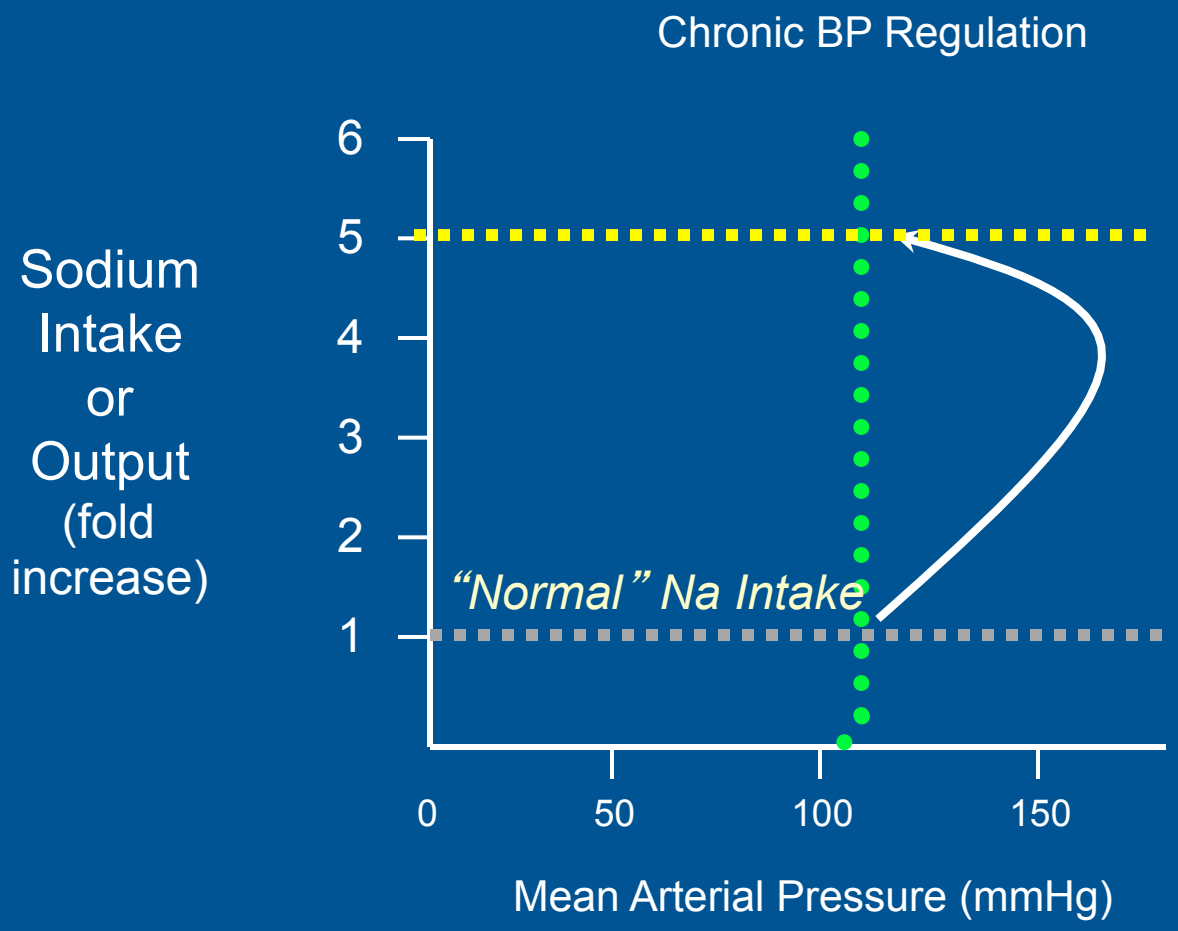
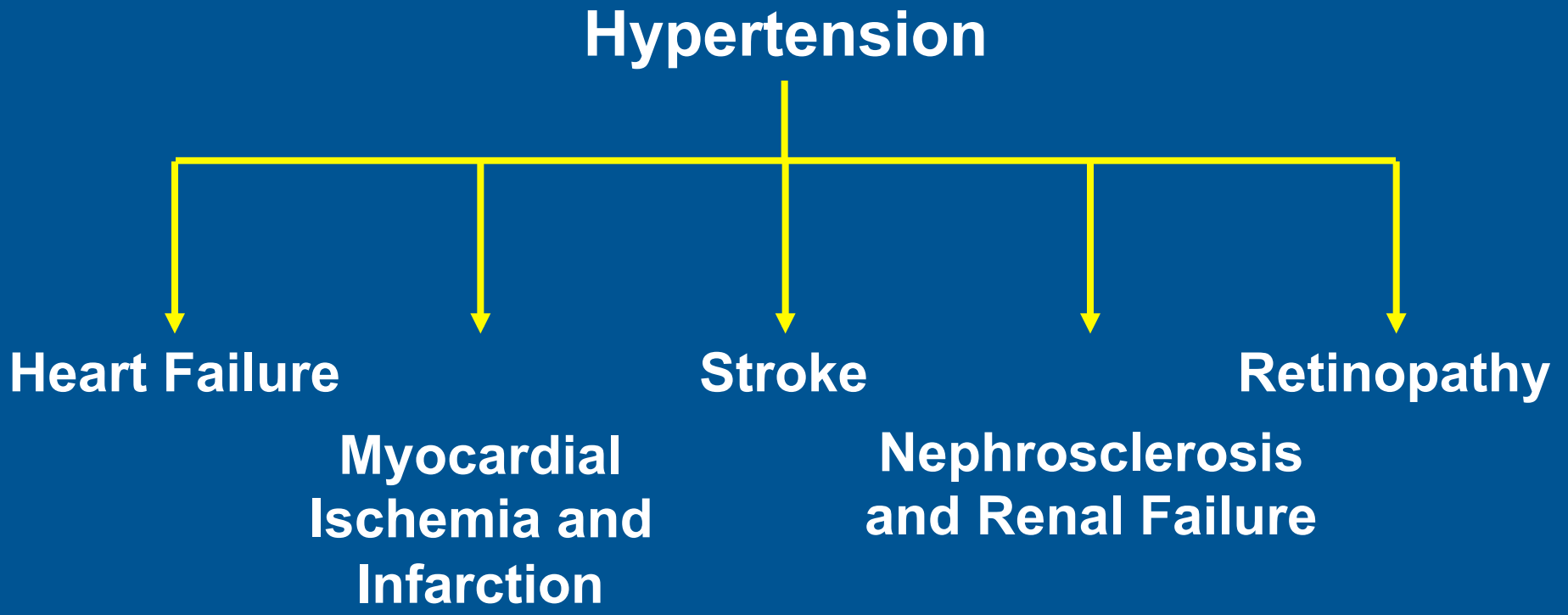


Blood pressure regulation
Renal pressure natriuresis

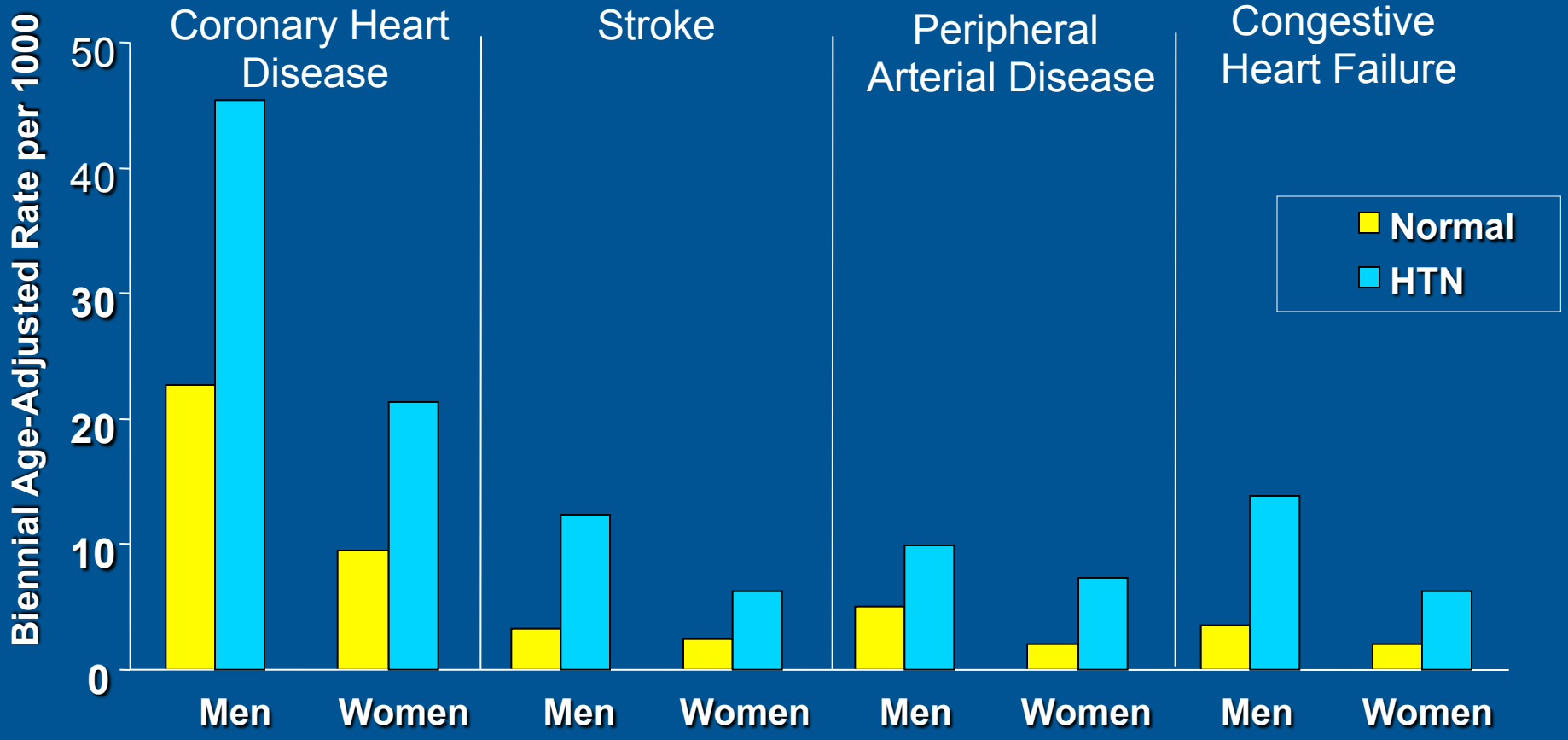


Sequelae of Essential Hypertension



Cardiovascular Disease Risk by BP Status in Persons Aged 35–64 Years

Framingham Heart Study 36-Year Follow–Up



	Coronary Heart Disease		Stroke		Peripheral Arterial Disease		Congestive Heart Failure	
	Men	Women	Men	Women	Men	Women	Men	Women
Risk ratio	2	2	4	3	2	4	4	3
Excess risk	23	12	9	4	5	5	10	4

Risk ratio: Rate in HTN/Rate in Normals Excess risk: Rate in HTN - Rate in Normals

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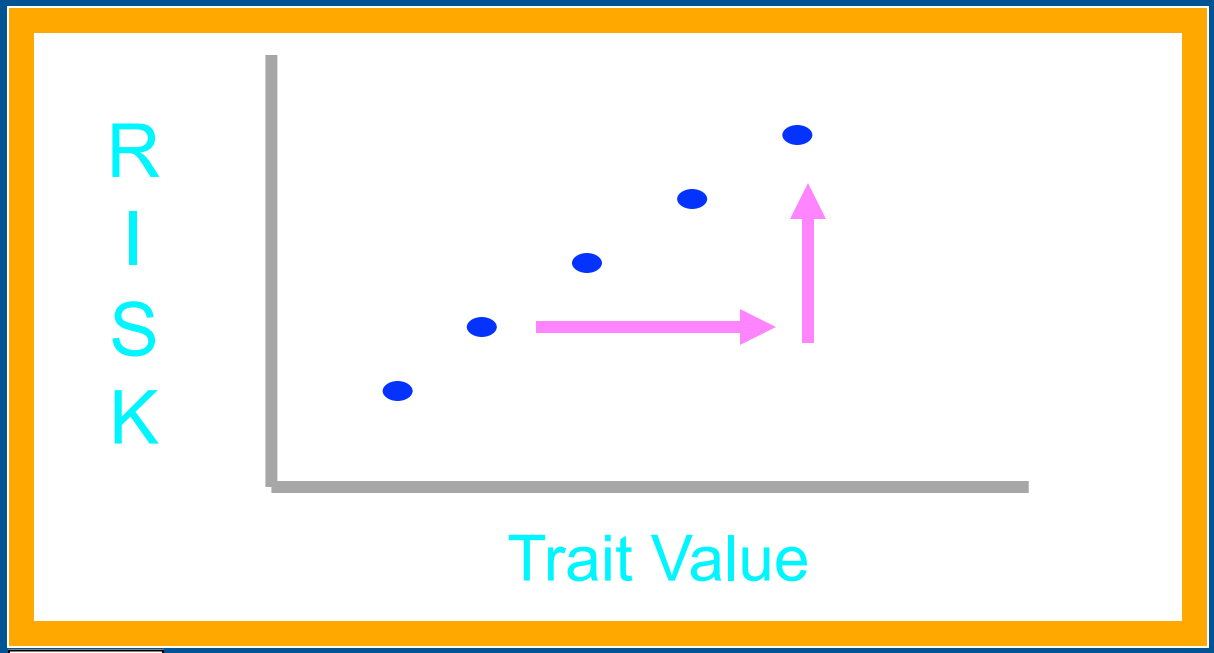
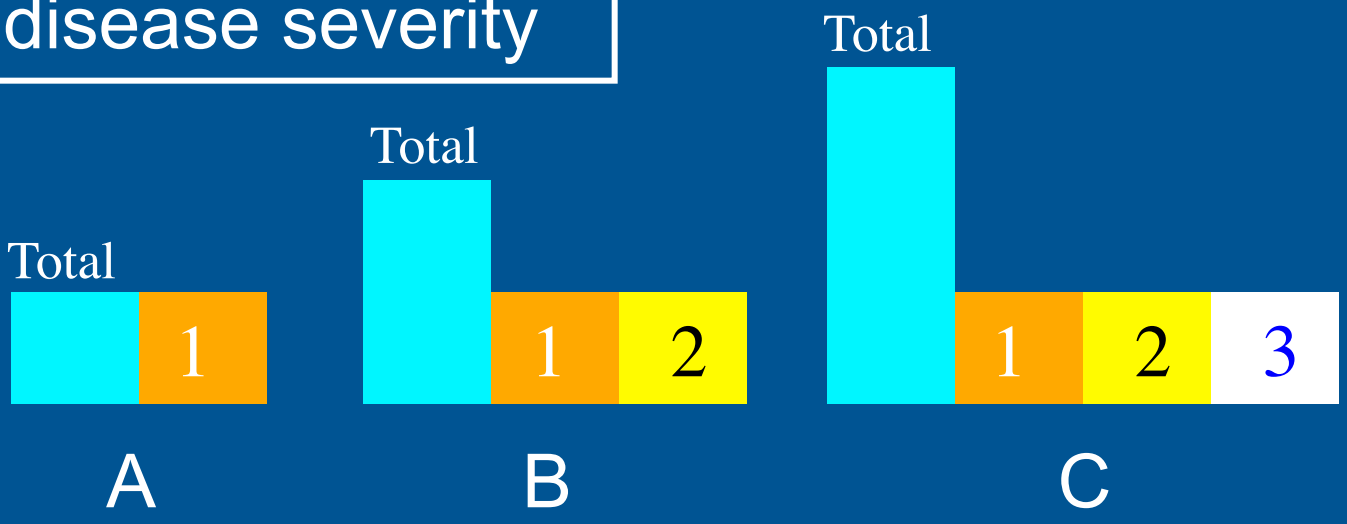
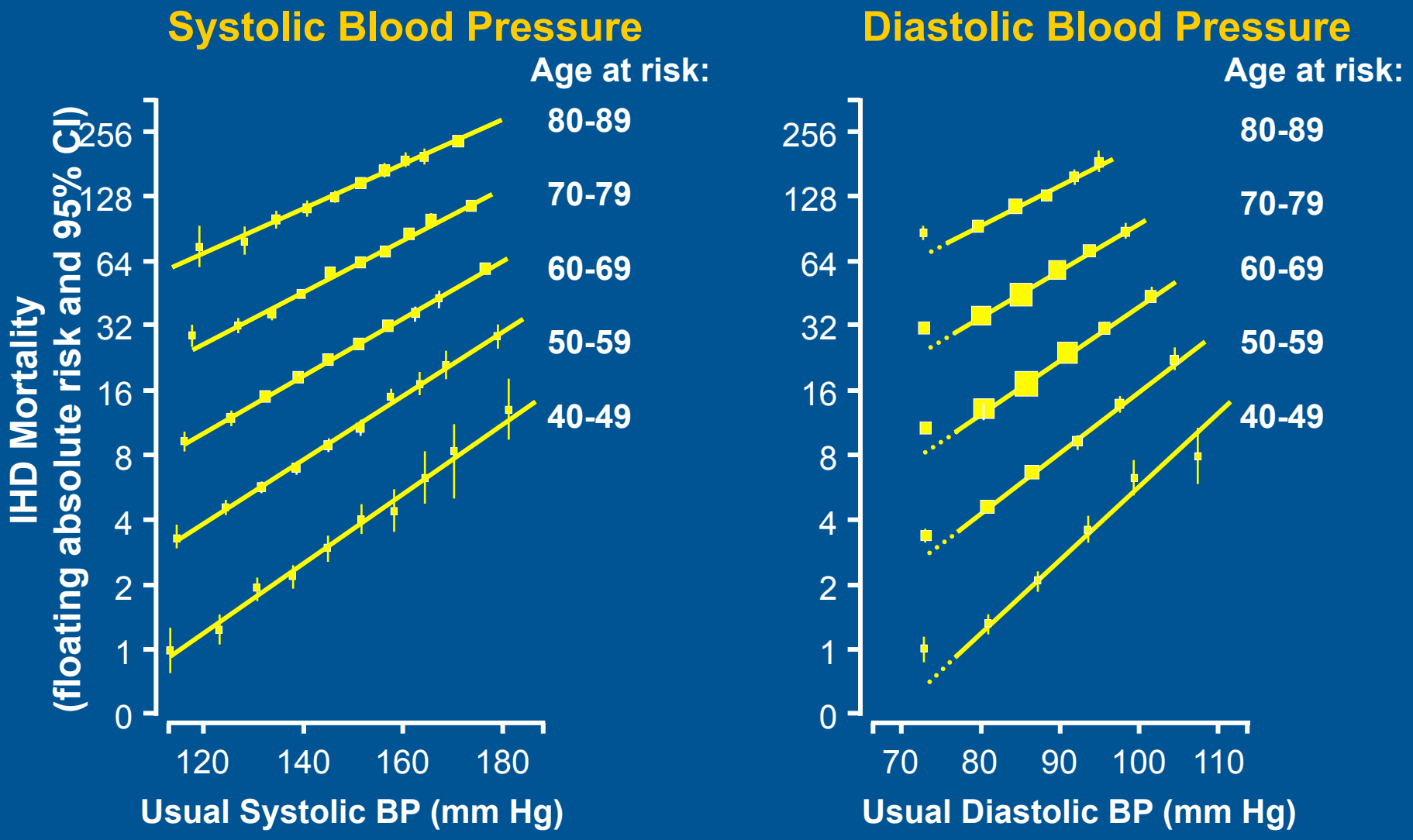
Trait level affects risk of disease (risk factor)



Total burden of risk factors affects disease severity



Cornary Heart Disease Mortality vs Usual BP by Age



 Prospective Studies Collaboration. *Lancet*. 2002;360:1903-1913.

Components of CVD Risk Stratification in Patients With Hypertension

Major Risk Factors

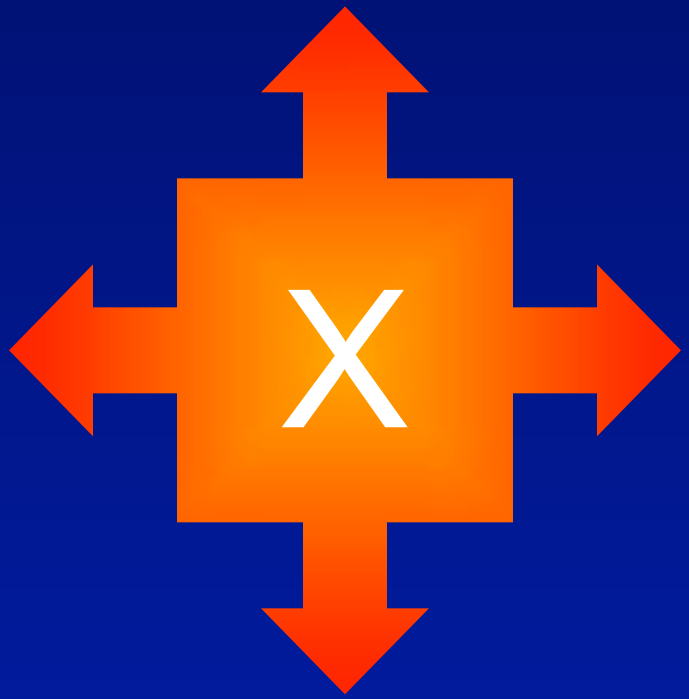
- Smoking
- Dyslipidemia
- Diabetes Mellitus
- Age >60 years
- Gender (men and postmenopausal women)
- Family history of early onset Coronary Heart Disease:
  - women <65 years
  - men <55 years

Source: JNC VI. *Arch Intern Med.* 1997;157:2413

The "Metabolic Syndrome" is a Cluster of "Diseases of Civilization"

Hyperlipidemia

Diabetes Mellitus



Hypertension

Obesity

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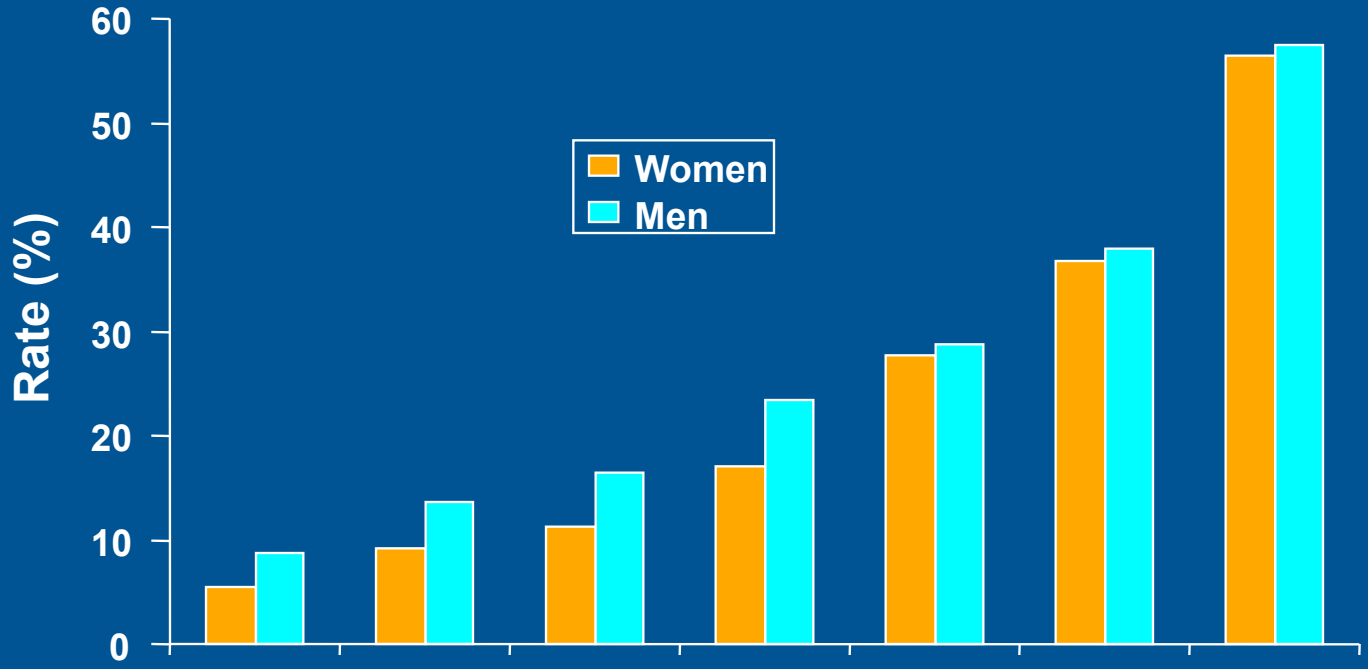
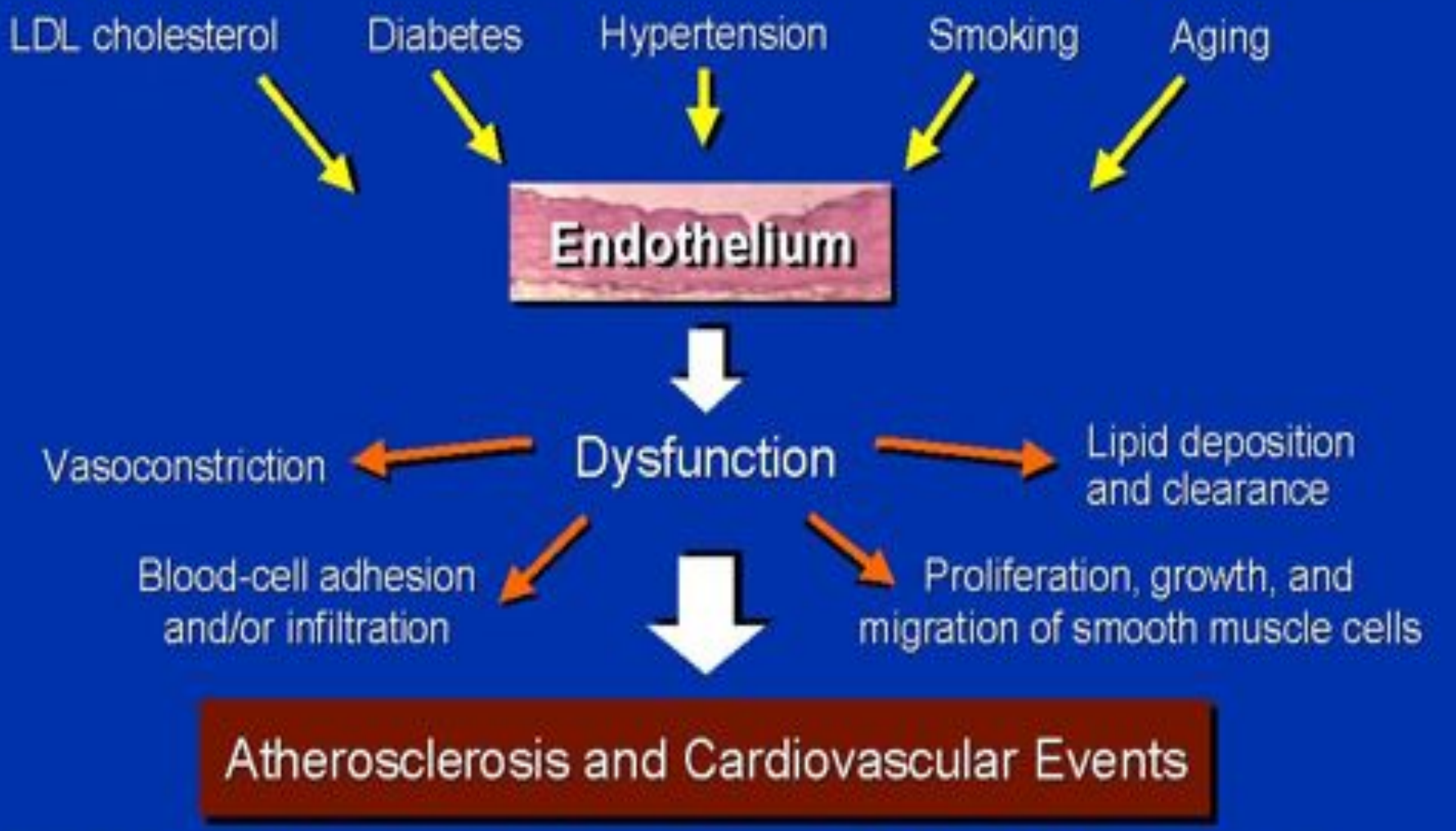
Rate of CHD in Hypertension According to Risk Factors



SBP (mm Hg)	120	160	160	160	160	160	160
Cholesterol (mg/dL)	220	220	259	259	259	259	259
HDL (mg/dL)	50	50	50	35	35	35	35
DM	–	–	–	–	+	+	+
Cigarette smoking	–	–	–	–	–	+	+
LVH by ECG	–	–	–	–	–	+	+

 Adapted with permission from Kannel WB. *JAMA.* 1996;275:1571

Injury to Endothelium Causes Endothelial Dysfunction

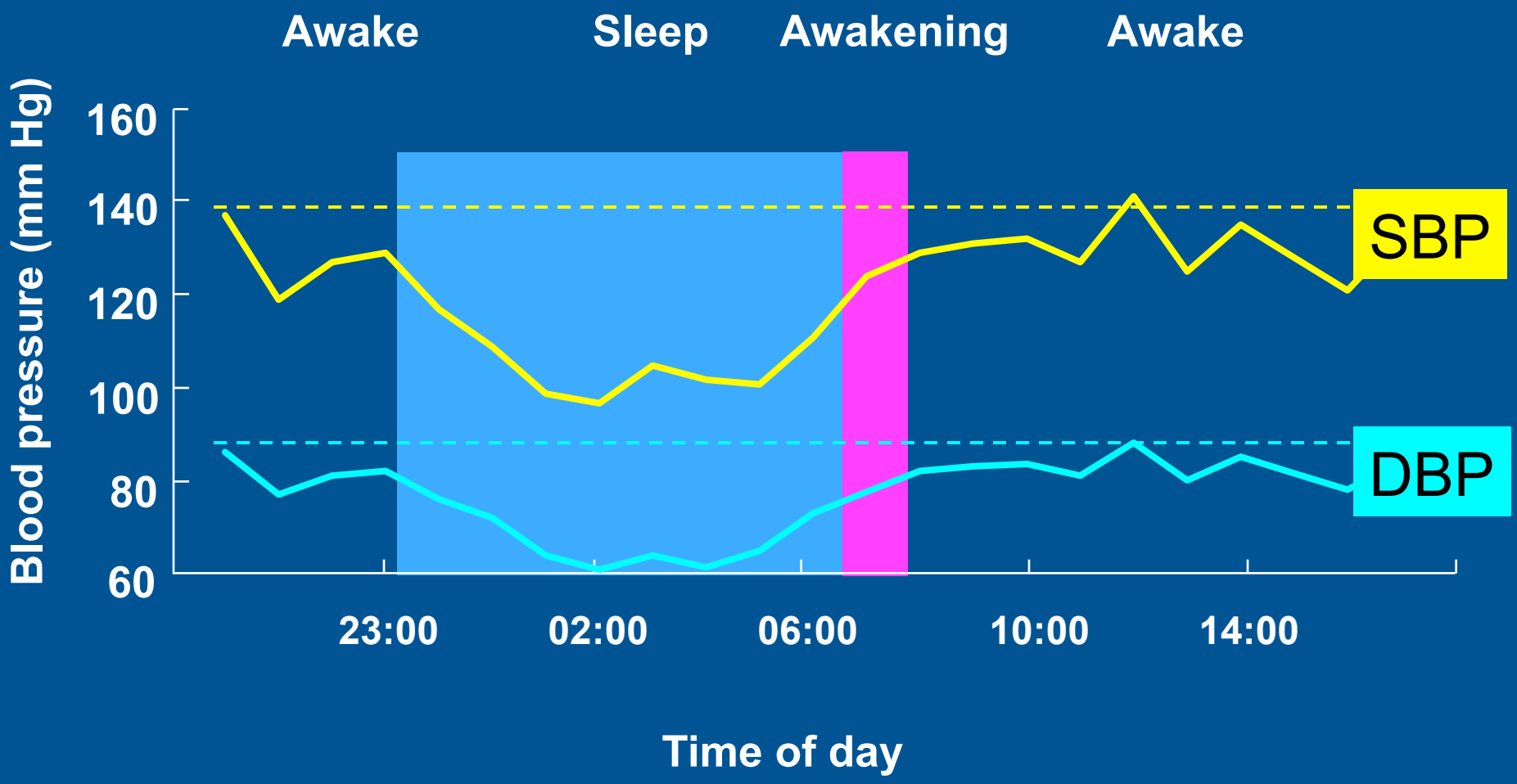


Modified from Dzau VJ. *J Cardiovasc Pharmacol*. 1990;15(suppl 5):S59-S64. Cohn JN. *J Hypertens*. 1998; 16:2117-2124. Glasser SP et al. *Am Heart J*. 1996;131:379-384. Zhuo JL et al. *Circulation*. 1997;96:174-182.

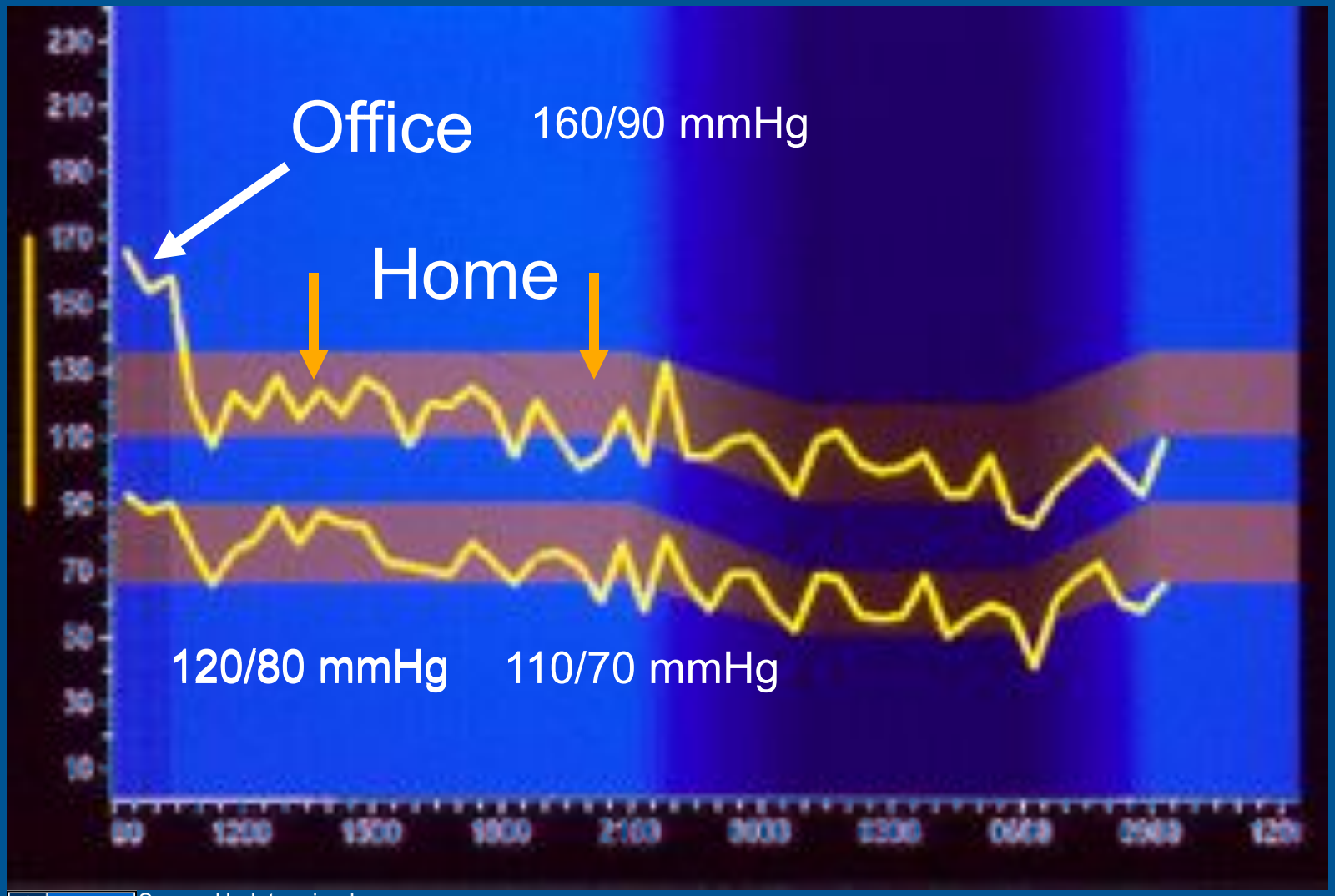
Blood Pressure Measurement

- Patients should be seated with back supported and arm bared and supported at heart level.
- Patients should refrain from smoking or ingesting caffeine for 30 minutes before measurement.
- Measurement should begin after at least 5 minutes of rest.
- Appropriate cuff size and calibrated equipment should be used.
- Both SBP and DBP should be recorded.
- Two or more readings should be averaged.

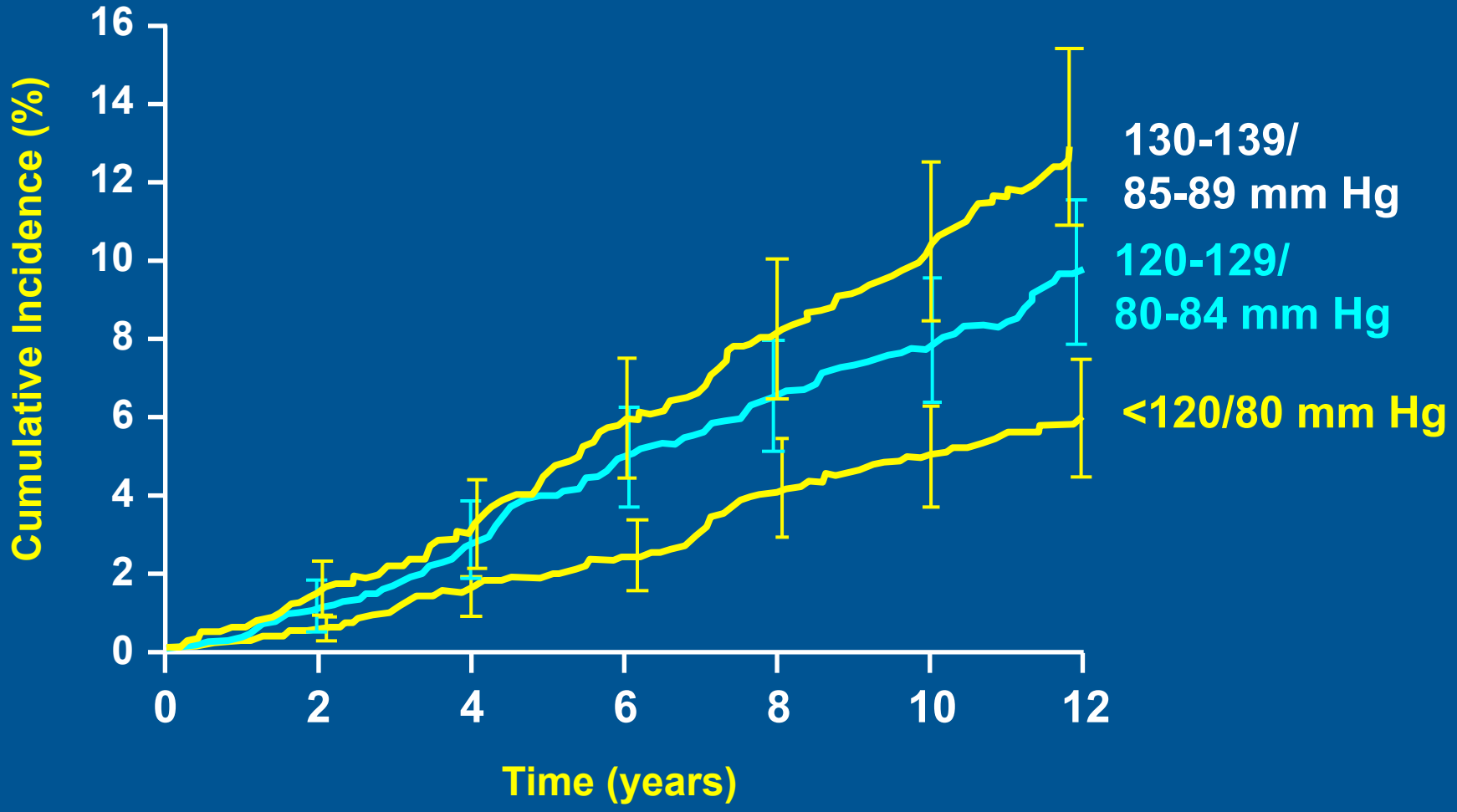
24-h BP Profile
Typical Medical Student



“White Coat” or “Office” Hypertension



Impact of "Normal" BP on CV Disease Risk In Men



Vasan, et al. *N Engl J Med*. 2001;345:1291-97.

Objectives of the Initial Evaluation of Hypertensives

- To identify other risk factors or disorders that might guide treatment
- To assess presence or absence of target organ damage and cardiovascular disease
- To identify known causes

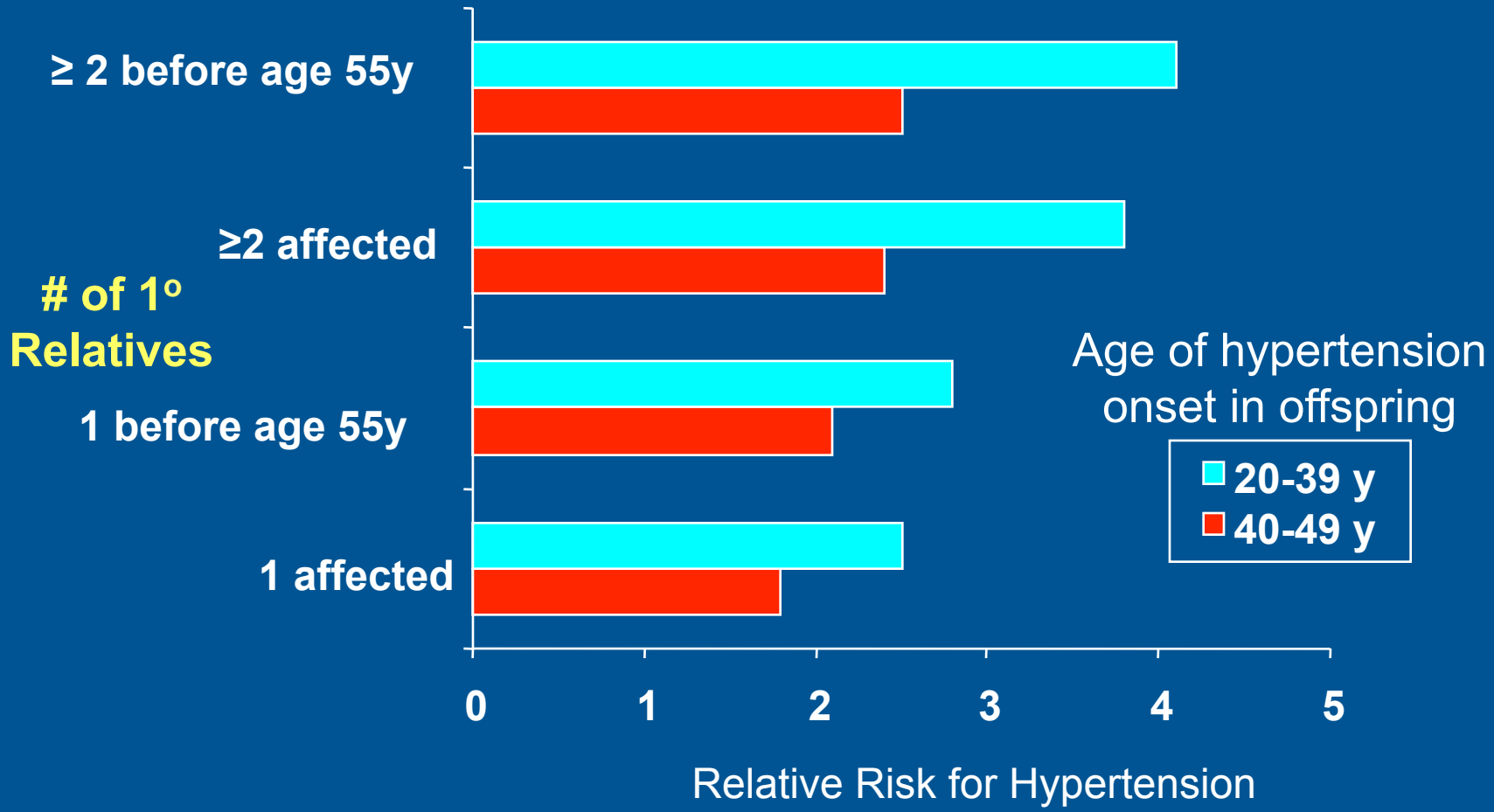
Evaluation Components

- Medical history
- Physical examination
- Routine laboratory tests
- Optional tests

Medical History

- Duration and classification (stage)
- Patient history of cardiovascular disease
- Family history
- Symptoms suggesting causes of hypertension
- Lifestyle factors
- Current and previous medications

Hypertension Runs in Families



Physical Examination

- Blood pressure readings (two or more).
- Verification in contralateral arm.
- Height, weight, and waist circumference.
- Fundiscopic examination.
- Examination of the neck, heart, lungs, abdomen, and extremities.
- Neurological assessment.

Objectives of the Initial Evaluation of Hypertensives

- To identify other risk factors or disorders that might guide treatment
- To assess presence or absence of target organ damage and cardiovascular disease
- To identify known causes (secondary HTN)

Causes of Hypertension

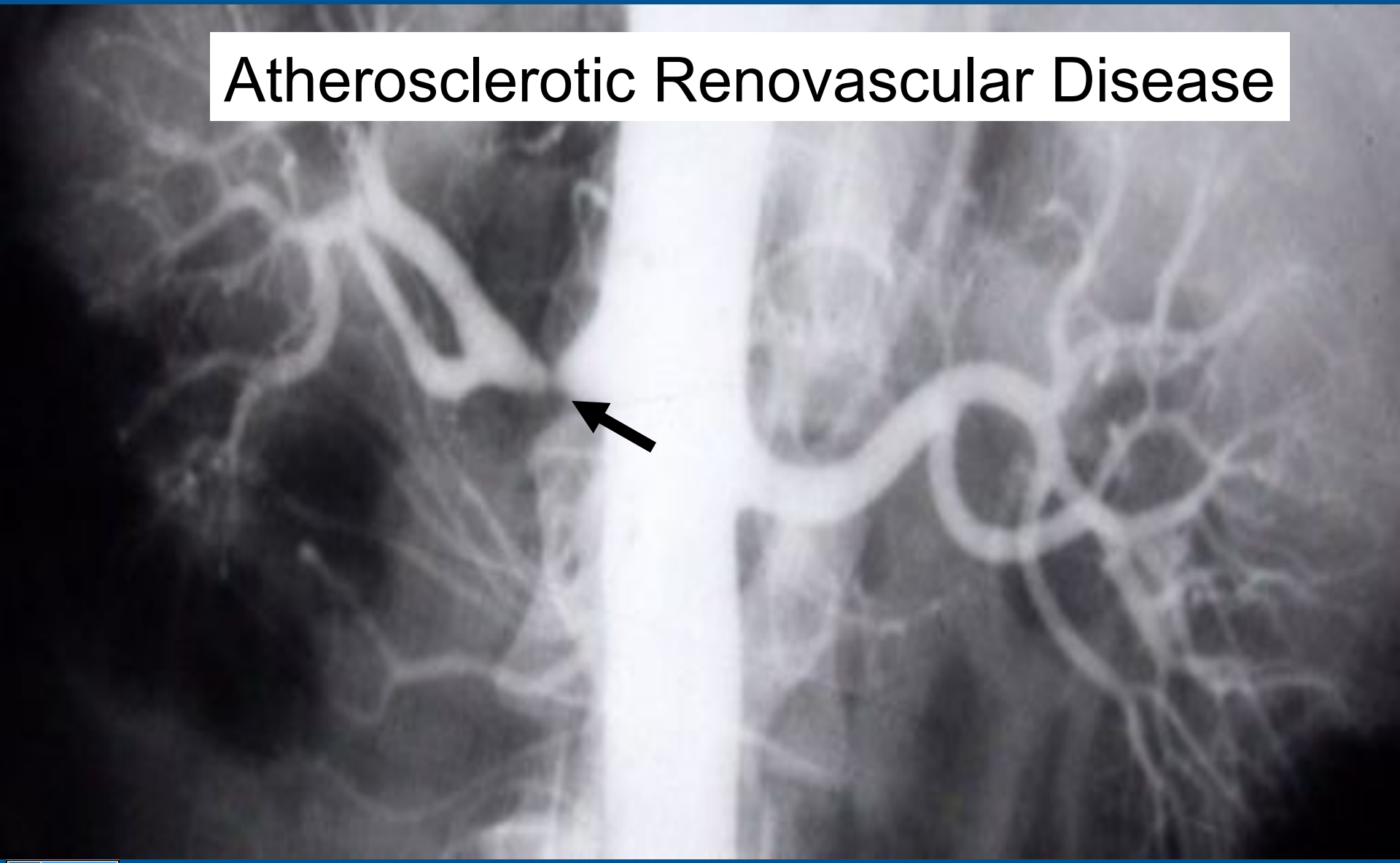
- "Essential" 90-95%
- Renal 3-5 %
  - Chronic renal failure
  - Renovascular disease
- 1^{o} aldosteronism < 1%
- Pheochromocytoma < 1%
- Hypertension of pregnancy

Identifiable Causes of Hypertension

- Renovascular disease
- Primary aldosteronism
- Pheochromocytoma
- Pseudopheochromocytoma

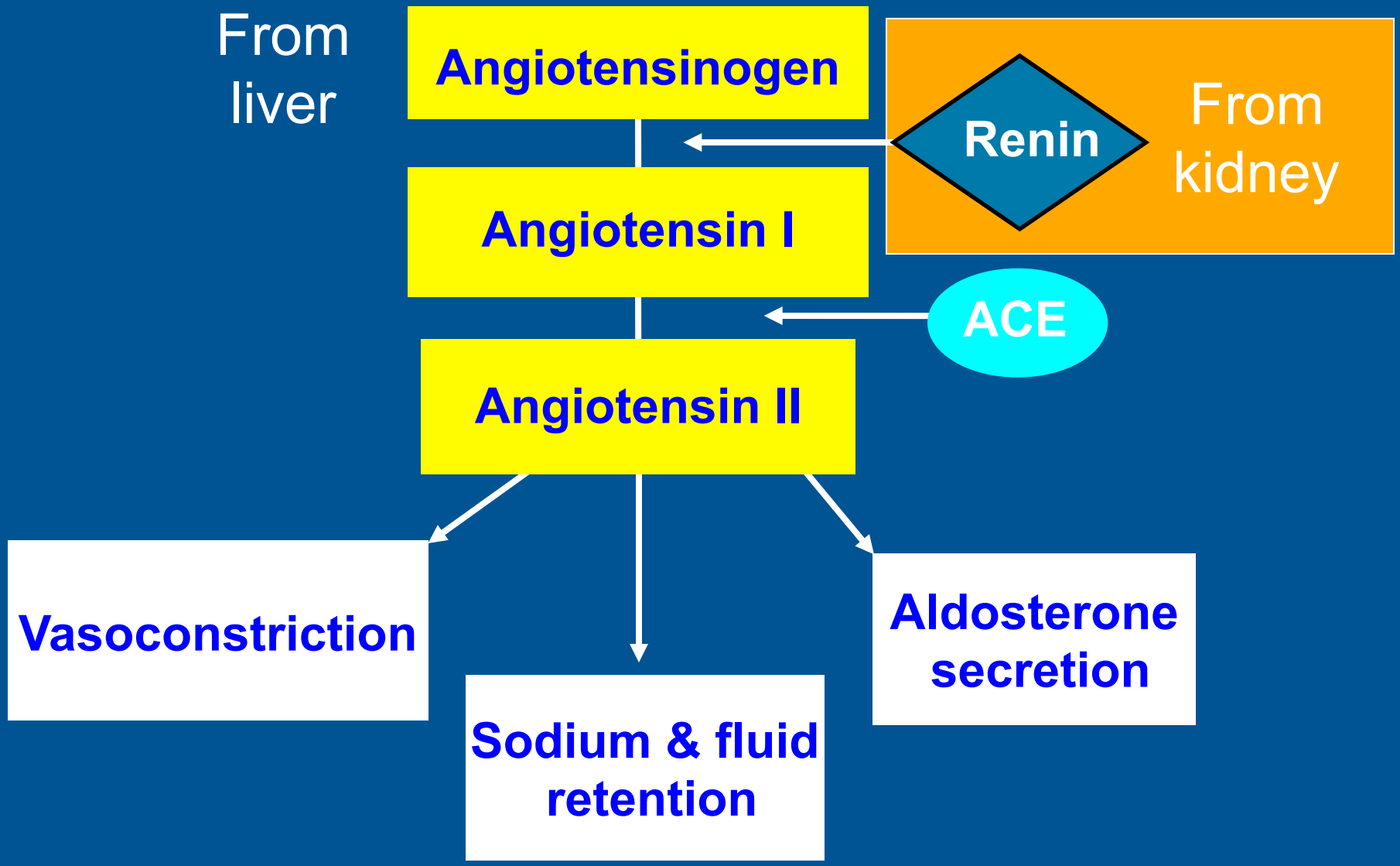
- Sleep apnea
- Drug-induced or related causes
- Chronic kidney disease
- Chronic steroid therapy and Cushing's syndrome
- Coarctation of the aorta
- Thyroid or parathyroid disease

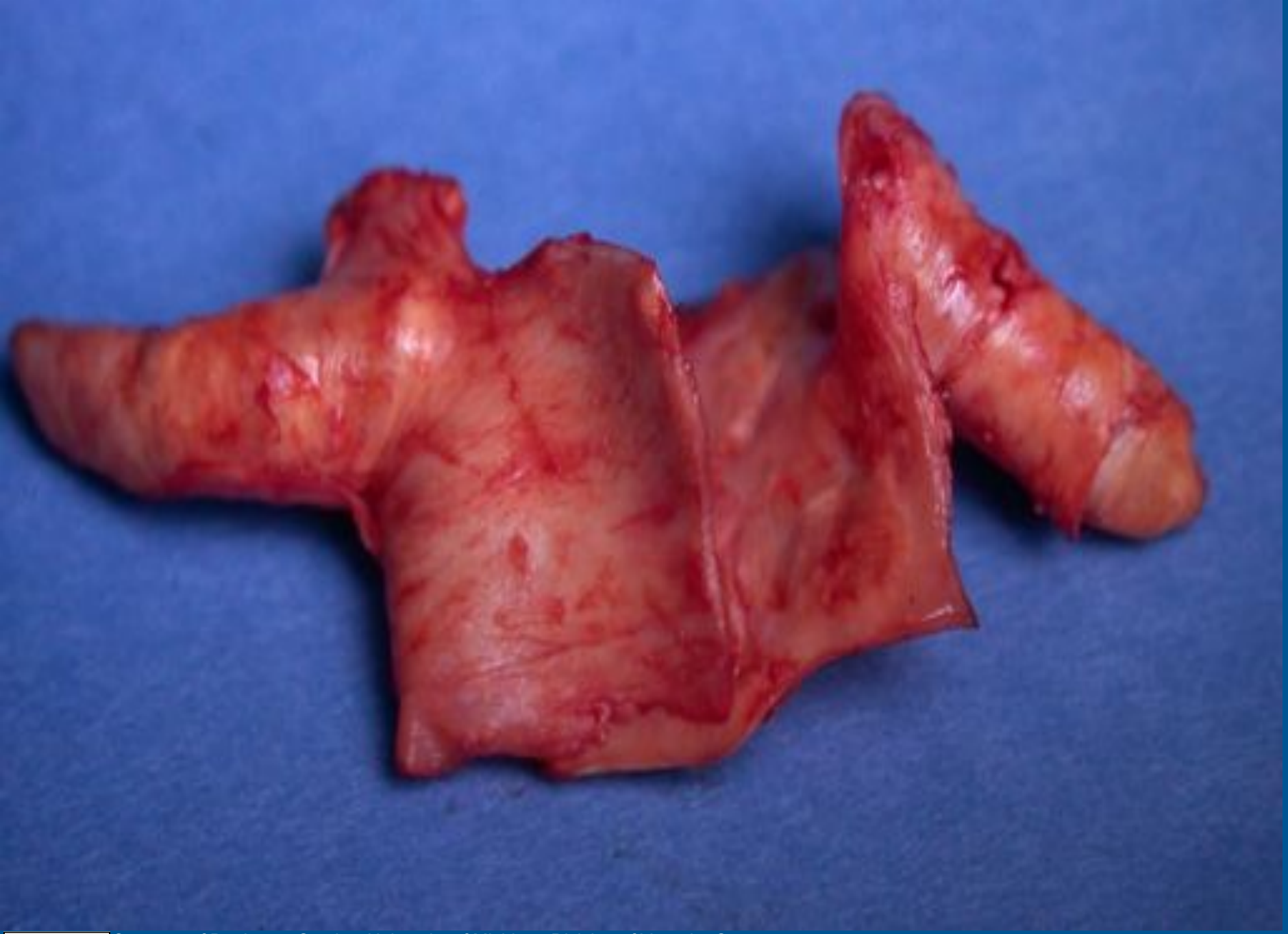
Atherosclerotic Renovascular Disease



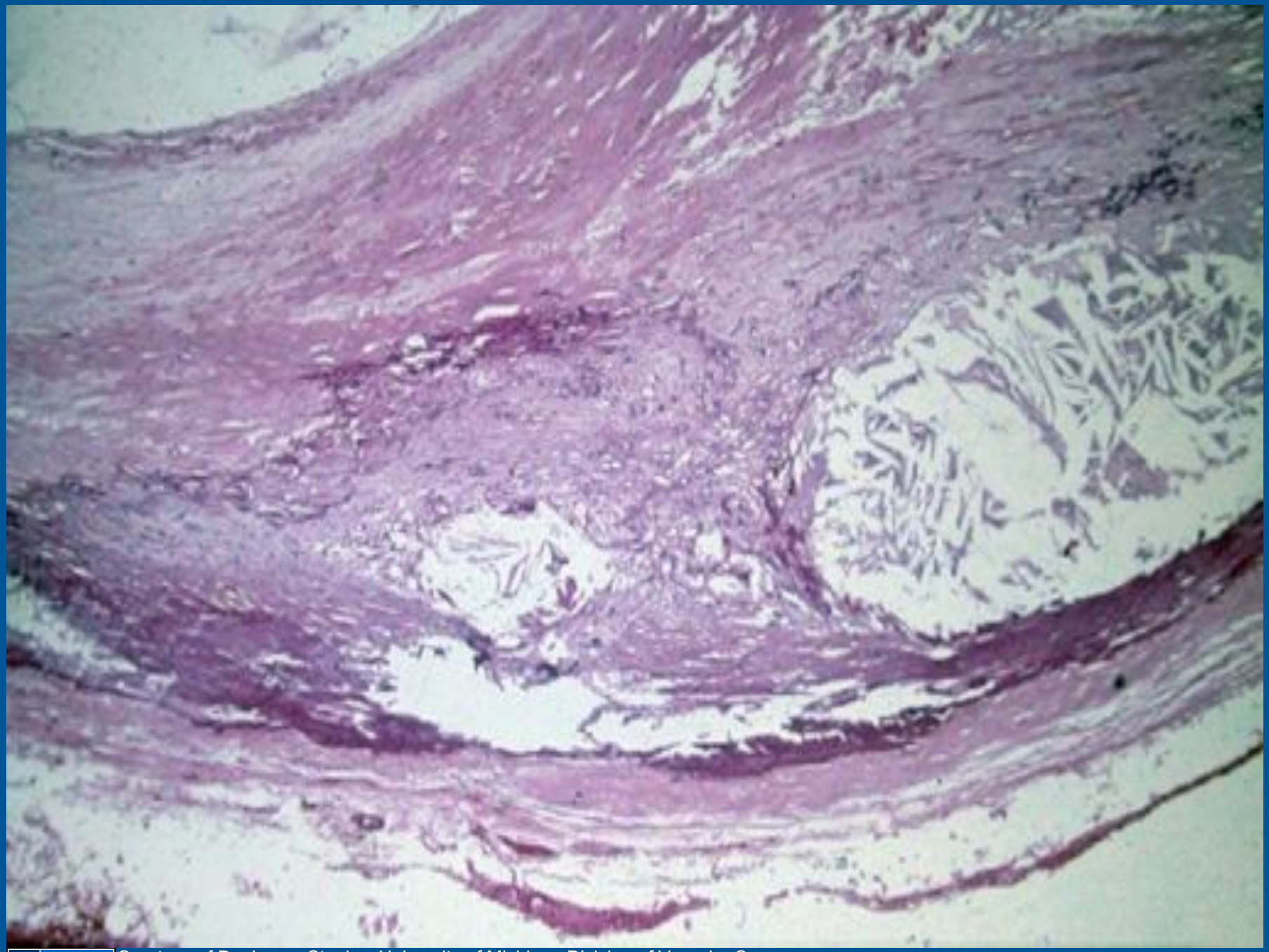
Courtesy of Dr. James Stanley, University of Michigan Division of Vascular Surgery

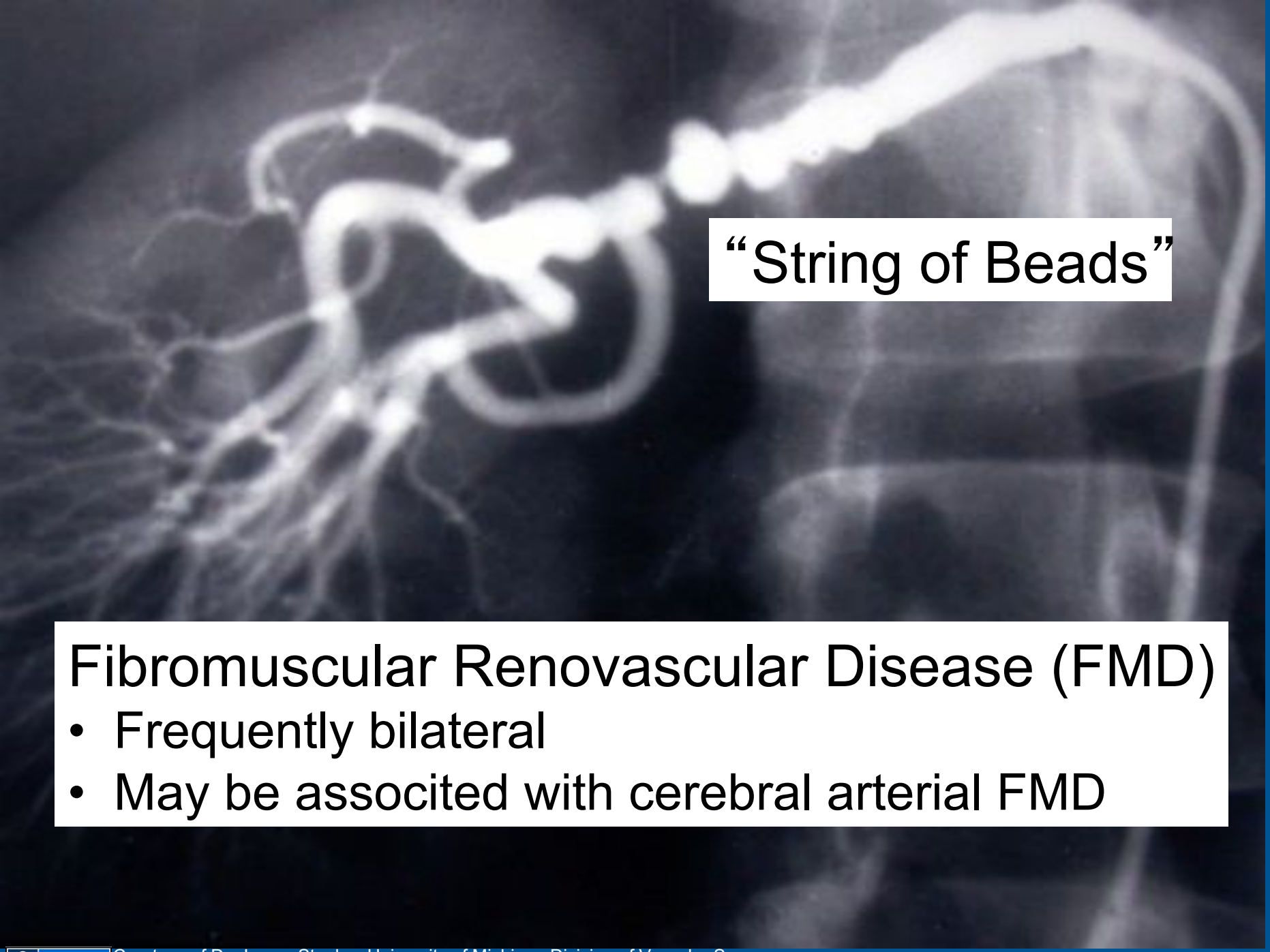
Renin-Angiotensin-Aldosterone System





 Courtesy of Dr. James Stanley, University of Michigan Division of Vascular Surgery

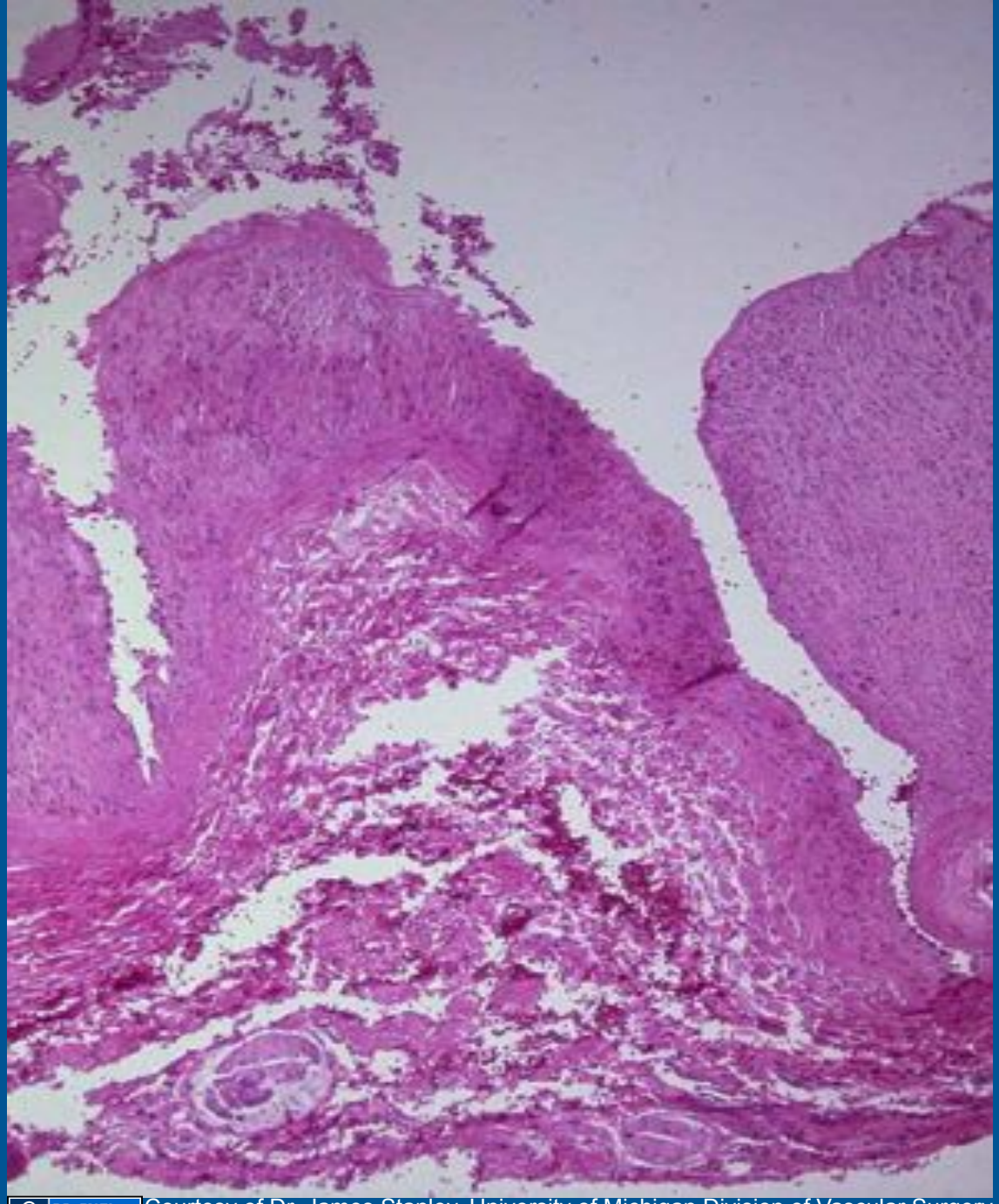




Fibromuscular Renovascular Disease (FMD)

- Frequently bilateral
- May be associted with cerebral arterial FMD

Courtesy of Dr. James Stanley, University of Michigan Division of Vascular Surgery

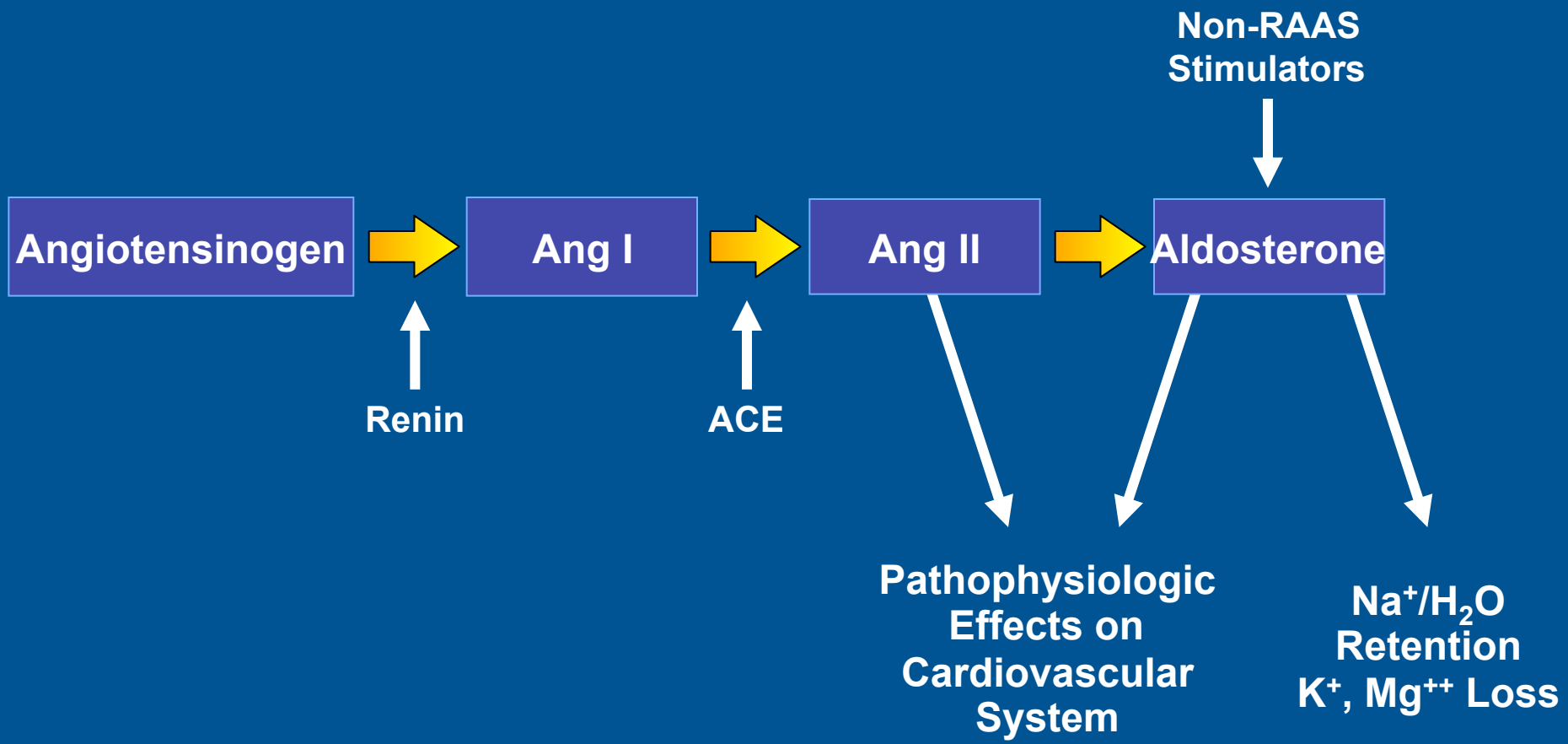


 Courtesy of Dr. James Stanley, University of Michigan Division of Vascular Surgery

Clinical Clues Suggesting Renovascular Hypertension

- Onset of hypertension under age 25 or over age 55
- An abdominal bruit, particularly in diastole
- Refractory, accelerated, or malignant hypertension or worsening of previously controlled hypertension
- Undiagnosed renal failure, with or without hypertension (particularly with normal urine sediment)
- Acute renal failure precipitated by hypertension treatment, particularly with ACE inhibitors
- A unilateral small kidney (by any prior investigational procedure)

Aldosterone: Important Component of Renin-Angiotensin-Aldosterone System



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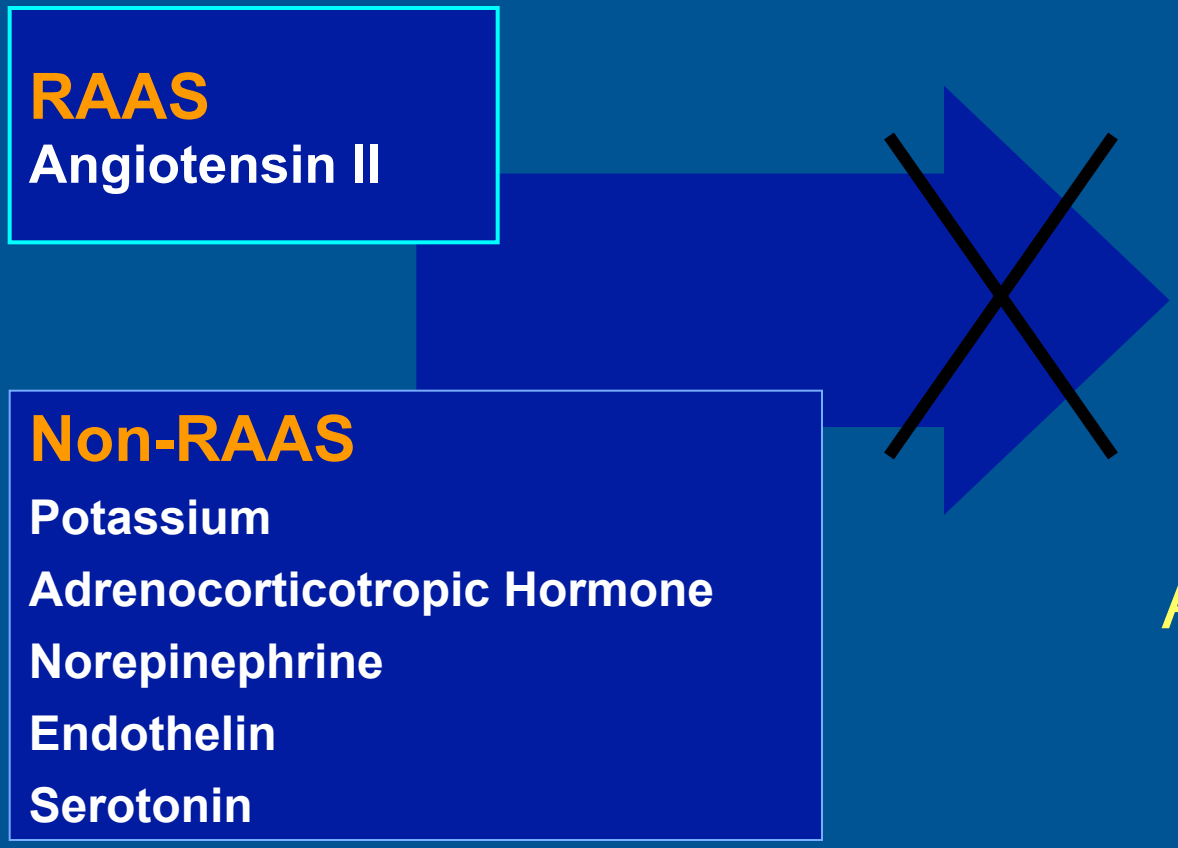
Stimulators of Aldosterone



1º Aldosteronism

Aldosterone secretion independent of normal regulators

RAAS = renin-angiotensin-aldosterone system

Pheochromocytoma

- Tumors of chromaffin cells (adrenal or extra-adrenal)
- “Rule of 10s”
  - 10% are extra-adrenal
  - 10% of extra-adrenal are extra-abdominal
- “5 Ps”
  - Pressure, palpitations, perspiration, pallor, pain

Secondary Hypertensions

Pheochromocytoma

- Pl. free metanephrine

  99% sensitive and 89% specific

JAMA 287: 1427-1434, 2002

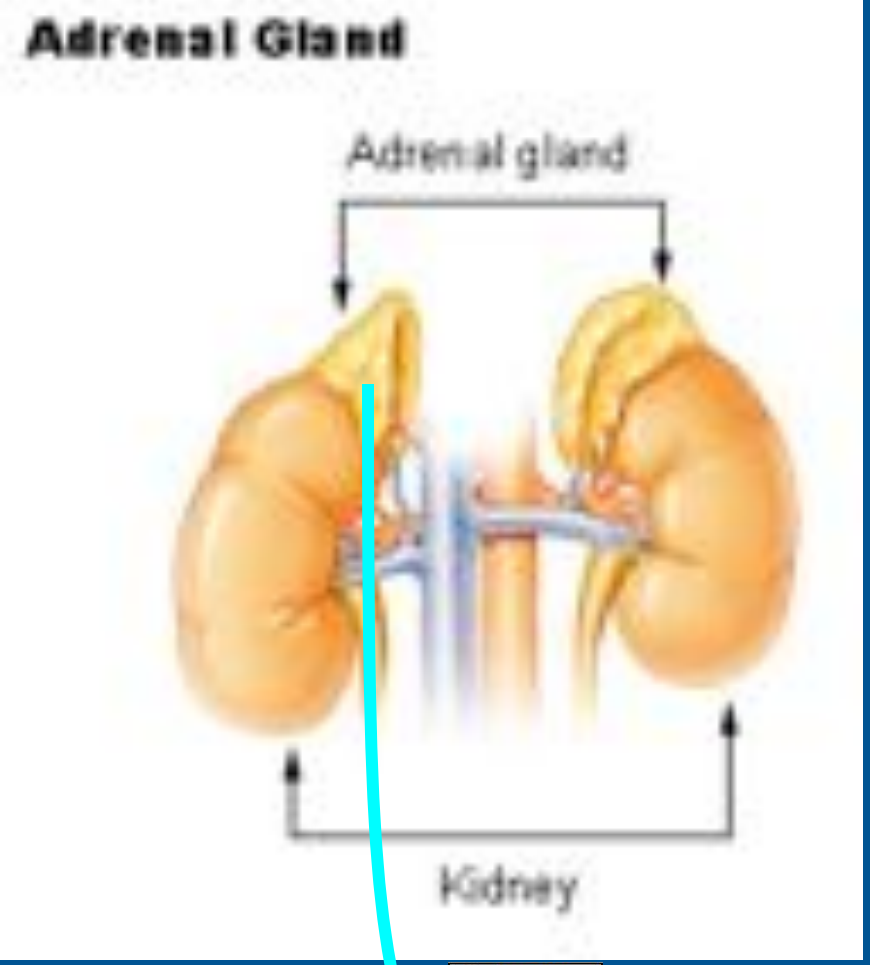
1º Aldosteronism

- Plasma aldosterone-renin ratio (ARR)

  PRA (ng/mL/hr)

  Plasma aldosterone (ng/dl)
- ARR > 30 suggests 1º Aldosteronism

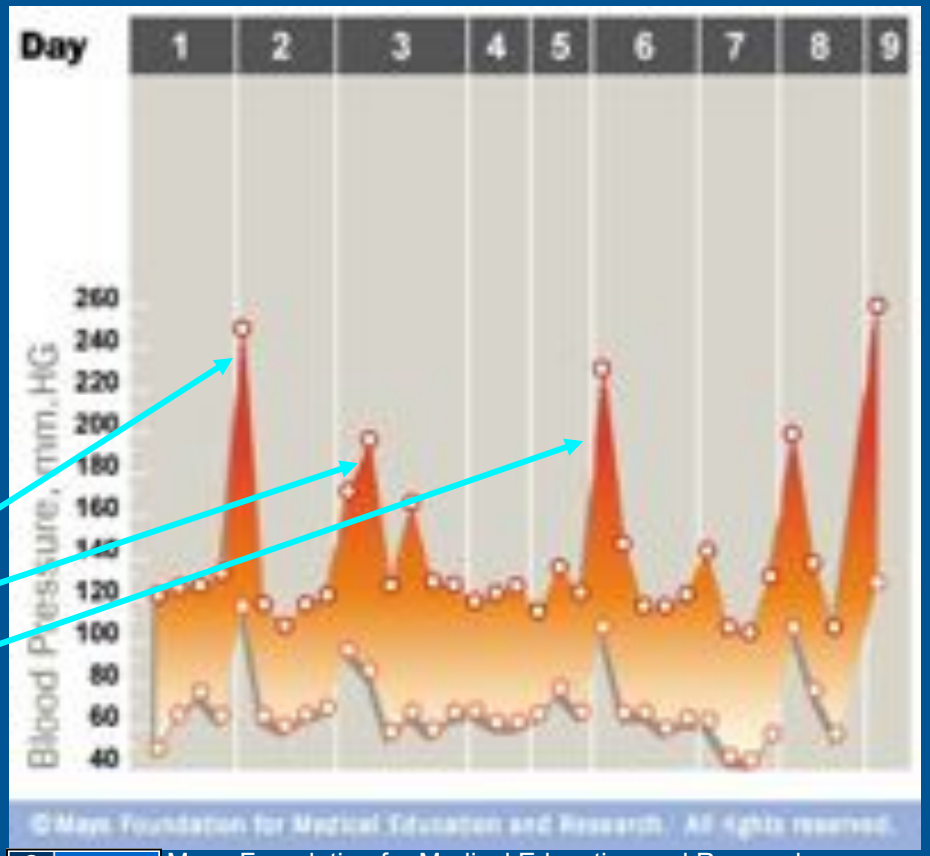
AJ Kid Dis 37:699-705, 2001



Pheochromocytoma = Tumor

Pseudopheochromcytoma = Physiological hyperactivity

Norepinephrine
Epinephrine



Primary Prevention

- Primary prevention offers an opportunity to interrupt the costly cycle of managing hypertension.
- Lifestyle modifications have been shown to lower blood pressure
- A population-wide approach may reduce morbidity and mortality; trials are lacking.
- Most patients with hypertension do not sufficiently change their lifestyle or adhere to drug therapy enough to achieve control.

Goal of Hypertension Prevention and Management

- To reduce morbidity and mortality by the least intrusive means possible. This may be accomplished by
  - Achieving and maintaining SBP < 140 mm Hg and DBP < 90 mm Hg.
  - Controlling other cardiovascular risk factors.

Additional Source Information

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Slide 11: Source Undetermined
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Slide 14: A. Weder
Slide 15: A. Weder
Slide 16: Prospective Studies Collaboration. *Lancet*. 2002;360:1903-1913.
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