

# HTN

Friday, October 31, 2014  
2:04 PM

## Learning Objectives:

- relevant vs. irrelevant patient info
- BP, S, D, PP, MAP
- how CO & PVR determine BP
- physiological mechanisms that regulate BP
  - neuronal
  - humoral
  - BP volume
  - tissue auto-regulation
- importance of HTN
- renin-angiotensin-aldosterone system
- primary vs. secondary HTN
- identify pertinent:
  - evidence of target organ damage
  - CVD risk factors
  - secondary causes of HTN
  - lifestyle modification

## Epidemiology

- old

$$BP = CO \times PVR$$

$$CO = SV \times HR$$

PVR - artery resistance; represents arteriole diameter & blood viscosity

Systolic (120)	Diastolic (80)
$SV > PVR$ more influenced by <u>CO</u> SV stored in arteries (elastic)	$PVR > SV$ more influenced by <u>PVR</u> recoil of artery elastic fibers → blood to capillaries

\* ↑ age, ↓ arterial elasticity, ↑ PVR, ↑ BP  
 Stiff = ↑ PVR  
 Open = ↓ PVR

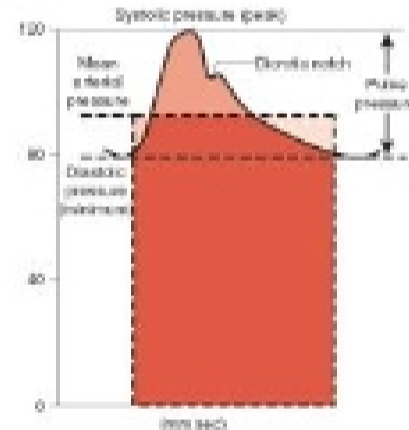
**PULSE PRESSURE (PP)** - measures distensibility of arteries

$$PP = S - D$$

**MAP** - avg. artery pressure; indicative of tissue perfusion

$$MAP = 1/3 (S) + 2/3 (D)$$

\* spend a longer time in diastolic



BP > 140/90 mmHg	Antihypertensive Reductions
- heart attack	- 35-40%
- stroke	- 20-25%
- CHF	- >30%

## Importance of S > D

\* starting @ 115/75, 2x CVD risk with each (S+20)/(D+10)

\* normotensive @ 50 yrs: +5 yrs life  
 \* normotensive @ 55 yrs: 90% lifetime risk for HTN

## HTN Stage 1

+CVD Risk Factors: (5-12) (over 10 yrs) will prevent 1/11 deaths

+CVD/Organ Damage: only 3 would need reduction of (5-12)

## HTN → CVD

↑ S	- left ventricle hypertrophy (too much muscle) - ↑ myocardial O <sub>2</sub> demands - left-side heart failure - stroke
↑ PP	- ↑ artery stretch, ↓ elasticity - aneurysms → atherosclerosis, thrombosis
↑ D	- ↓ coronary perfusion (heart arteries fill during D)

## Diagnosis

- (asymptomatic)
- ↑ S/D/both
- need 2 measurements (3 min diff) on 2+ days

## BP Goals

\* controversial (contradictions)

- JNC
- KDIGO
- ADA
- AHA/ACC\* (2015 guidelines)

- stricter ≠ better

- should be patient-centered

**Evaluation (subjective + objective)**

- 1) lifestyle, CVD risk
- 2) causes of HTN
- 3) organ damage

**BP Regulation (inter-related)**

- 1) neurons
- 2) humoral
- 3) ECF volume
- 4) tissue auto-regulation

**(1) Neurons**

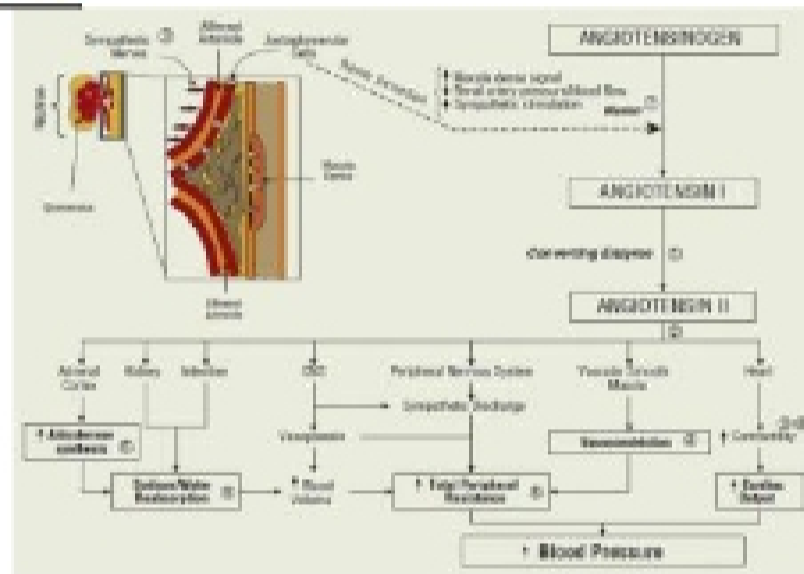
ANS: mediated via **intrinsic & extrinsic reflexes**

<b>SYMPATHETIC*</b>	spinal cord --> heart & tissues	fight/flight	↑HR, contractions, PVR
<b>PARASYMPATHETIC</b>	spinal cord --> heart & GI (VAGUS NERVE)	rest/digest	↓HR

Pre	CNS	α2	Inhibits NE release
		β	Causes NE release
Post	Heart	β1	↑HR, CO, BP
	Arterioles/Venules	β2	vasodilation
		α	vasoconstriction

Intrinsic	<b>BARORECEPTORS</b> - pressure/stretch (juxtaglomerular cells) <b>CHEMORECEPTORS</b> - O <sub>2</sub> , CO <sub>2</sub> , H <sup>+</sup> (macula densa)	(less sensitive in elderly & DM) (lung disease, hypoxia, ↑BP)
Extrinsic	pain, cold, emotion	(outside ANS, diffuse, inconsistent)

**(2) Humoral**



<b>KIDNEY</b>	RAAS - <b>most control of BP</b> ; kidney: Na <sup>+</sup> /K <sup>+</sup> /fluid, vasculature & symp <b>RENIN</b> - enzyme released by <b>Juxta</b> on kidney <b>afferent</b> arterioles; (Angiotensinogen --> Angio1) <b>Renin Release:</b> <b>Intrarenal factors</b> : renal perfusion, catecholamines, angiotensin 2 <b>Extrarenal factors</b> : Na <sup>+</sup> , Cl <sup>-</sup> , K <sup>+</sup>																	
	<table border="1"> <tr> <td>Juxta</td> <td>(baro)</td> <td>↓pressure</td> </tr> <tr> <td>Juxta/Macula Dense</td> <td>(chemo)</td> <td>↓Na<sup>+</sup>, Cl<sup>-</sup></td> </tr> <tr> <td>Juxta</td> <td></td> <td>catecholamines</td> </tr> </table> <p><b>ANGIOTENSIN 2</b> - directly &amp; indirectly ↑ BP (pressure &amp; volume)</p> <table border="1"> <tr> <td>Direct</td> <td><b>vasoconstriction</b></td> <td>↑ pressure</td> </tr> <tr> <td rowspan="2">Indirect stimulation</td> <td><b>CATECHOLAMINES</b> (adrenal medulla/CNS) - <b>vasoconstriction</b></td> <td>↑ pressure</td> </tr> <tr> <td><b>ALDOSTERONE</b> - ↑ Na<sup>+</sup>/H<sub>2</sub>O reabsorption</td> <td>↑ volume</td> </tr> </table>	Juxta	(baro)	↓pressure	Juxta/Macula Dense	(chemo)	↓Na <sup>+</sup> , Cl <sup>-</sup>	Juxta		catecholamines	Direct	<b>vasoconstriction</b>	↑ pressure	Indirect stimulation	<b>CATECHOLAMINES</b> (adrenal medulla/CNS) - <b>vasoconstriction</b>	↑ pressure	<b>ALDOSTERONE</b> - ↑ Na <sup>+</sup> /H <sub>2</sub> O reabsorption	↑ volume
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<b>HEART/ BRAIN</b>	Local RAAS (Angio2 <b>NOT</b> converted by ACE) <table border="1"> <tr> <td>Heart</td> <td>↑ contractility</td> </tr> <tr> <td>Brain</td> <td>↑ sympathetic</td> </tr> </table> <p><b>*ACE inhibitors have no effect on heart &amp; brain RAAS</b></p>	Heart	↑ contractility	Brain	↑ sympathetic													
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**(3) ECF Volume**

ECF VOLUME - directly & indirectly ↑ BP

Direct	↑ Na <sup>+</sup> intake, reabsorption	↑ CO
Indirect	↑ blood to organs, vasoconstriction tissue auto-regulation	↑ PVR

**(4) Tissue Auto-Regulation**

TISSUE AUTO-REGULATION - vascular epithelial cells releases substances that effect vasoconstriction/vasodilation

Vasoconstriction	Angio2, Endothelin 1
Vasodilation	Bredykinin, Prostacyclin, NO

**Types of HTN**

PRIMARY - 90%: no known cause

SECONDARY - 10%: due to disease/disorder

	Primary	Secondary	Other
<b>Pathogenesis</b>	<ul style="list-style-type: none"> <li>- Circadian Rhythm</li> <li>- ↑ CO: <ul style="list-style-type: none"> <li>- Na<sup>+</sup>/H<sub>2</sub>O</li> <li>- RAAS</li> <li>- symp</li> </ul> </li> <li>- ↑ PVR: <ul style="list-style-type: none"> <li>- ↑ vasoconstriction <ul style="list-style-type: none"> <li>- RAAS</li> <li>- symp</li> <li>- genes</li> <li>- tissue auto-regulation</li> </ul> </li> <li>- ↑ hypertrophy (muscle mass) <ul style="list-style-type: none"> <li>- RAAS</li> <li>- symp</li> <li>- genes</li> <li>- tissue auto-regulation</li> <li>- insulin (GH-like)</li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- Sympathomimetic (↑ NE/dopamine/serotonin) Drugs</li> <li>- Nephrotoxic Drugs</li> <li>- (↑ Na<sup>+</sup>/H<sub>2</sub>O/PVR) Drugs</li> <li>- Discontinuing Meds (β-blockers, α-agonists)</li> <li>- Withdrawal (nicotine, narcotics)</li> <li>- Renal <ul style="list-style-type: none"> <li>- Renovascular Disease (↓ blood flow, ↑ RAAS)</li> <li>- Renal Parenchymal Disease <ul style="list-style-type: none"> <li>- chronic glomerular nephritis</li> <li>- polycystic kidney disease</li> <li>- nephrosclerosis</li> <li>- diabetic nephropathy</li> <li>- chronic pyelonephritis</li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- office (home &lt;135/85)</li> <li>- HTN crisis (&gt;180/120) <ul style="list-style-type: none"> <li>- urgency (no TOD)</li> <li>- emergency (with TOD)</li> </ul> </li> </ul>
<b>Risk Factors</b>	<ul style="list-style-type: none"> <li>- Na<sup>+</sup></li> <li>- alcohol</li> <li>- smoking</li> <li>- obesity, lack of exercise</li> <li>- stress</li> <li>- old (Men &gt;55 / Women &gt;65)</li> <li>- black</li> <li>- DM, insulin resistance</li> <li>- dyslipidemia</li> <li>- microalbuminuria/CKD/GFR &lt;60</li> <li>- family history of early CVD</li> </ul>	<ul style="list-style-type: none"> <li>- Na<sup>+</sup></li> <li>- alcohol (&gt;3/day)</li> <li>- drugs</li> <li>- sleep apnea (snoring, daytime sleepiness, poor sleep)</li> <li>- CKD</li> <li>- endocrine disorders: <ul style="list-style-type: none"> <li>- Hyperthyroidism (↑ Ca<sup>2+</sup>)</li> <li>- Pheochromocytoma (HTN paroxysm + headache, palpitations, pale, perspiration)</li> <li>- ↑ Aldosterone (↑ K<sup>+</sup>)</li> <li>- Cushing's (obesity, glucose intolerance, purple striae)</li> </ul> </li> </ul>	

CIRCADIAN RHYTHM - 24hr BP cycle;  
highest in AM, lowest throughout day

Treatment Goals: ↓ morbidity (TOD) & mortality

TOD

Brain	stroke, ischemia, dementia
Eyes	retinopathy
Heart	left ventricle hypertrophy, MI, CHF
Kidney	CKD
Peripheral Veins/Arteries	Peripheral Arterial Disease

Modification	↓ S (mmHg)
weight loss	5-20
DASH diet	8-14
↓ Na	2-8
exercise	4-9
alcohol	2-4

HTN-Causing Drugs

↑ NE/dopamine/serotonin	<ul style="list-style-type: none"> <li>- herbals (licorice, ma huang, ephedrine)</li> <li>- decongestant</li> <li>- illicit (cocaine, meth)</li> <li>- ADHD</li> <li>- appetite suppressants (sibutramine, phentermine)</li> <li>- antidepressants:               <ul style="list-style-type: none"> <li>- MAOIs</li> <li>- TCAs (doxepin, amitriptyline, imipramine, nortriptyline)</li> <li>- bupropion</li> <li>- venlafaxine</li> </ul> </li> </ul>
nephrotoxic	NSAIDS (ibuprofen, naproxen)
↑ Na <sup>+</sup> /H <sub>2</sub> O/PVR	<ul style="list-style-type: none"> <li>- estrogens</li> <li>- cyclosporine</li> <li>- corticosteroids (prednisone)</li> <li>- sumatriptan</li> </ul>