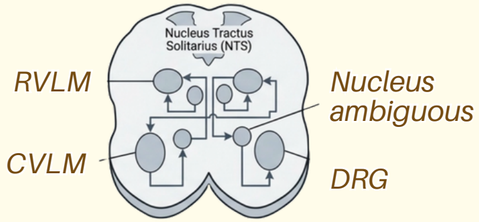
RAPID REGULATION OF ABP

The Neural Mechanisms & Cardiovascular Control Loops

By Dr.Jana Ahmed

1.THE COMMAND CENTER: MEDULLARY CONTROL



The Hub: Nucleus tract us solitarius (NTS) recieves all incoming sensory data.

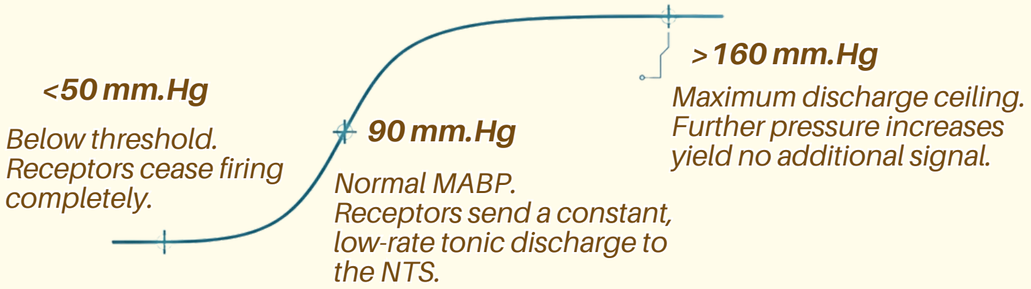
*VASOMOTOR AREA

*Located in Restral Ventrolateral Medulla (**RVLM**).Sends sympathatic signals to heart & vessels to increase ABP via **vasoconstriction & increased heart rate.***

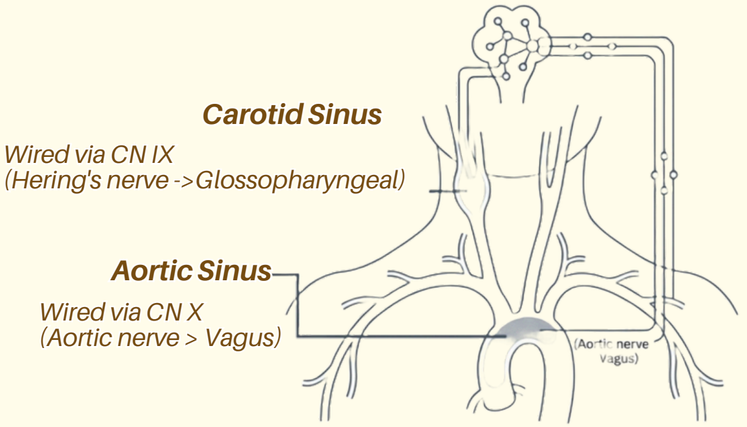
*CARDIAC INHIBITORY AREA

*Comprises Nucleus Ambiguous & Dorsal Motor Nucleus of Vagus. Mediates vagal discharge to heart to decrease **heart rate & CO, lowering ABP.***

*THE ACTIVATION CURVE



2.PRIMARY SENSORS: ARTERIAL BARORECEPTORS

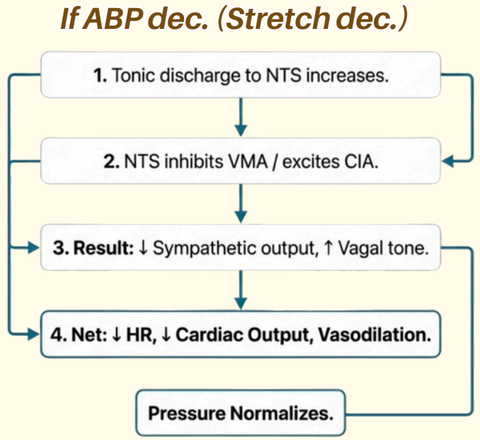


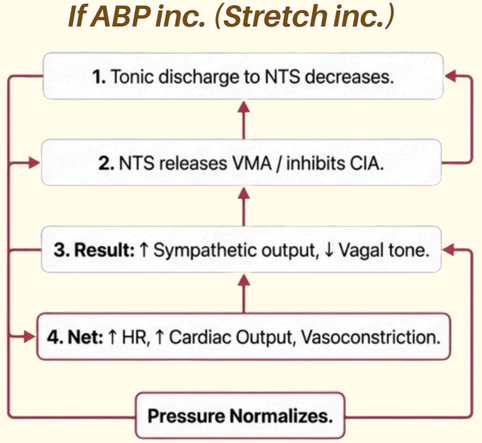
*THE HIGH PRESSURE SENSORS:

Located in the walls of the carotid sinus and aortic arch. They are mechanical stretch receptors that monitor arterial pressure by physically stretching as vessels expand.

***KEY TRAIT:** Highly sensitive to pulsatile (pulse) pressure. A drop in pulse pressure with no change in mean pressure still triggers a decreased firing rate.*

3.THE FEED-BACK LOOP





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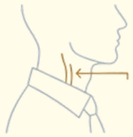
4.SYSTEMIC GLITCH: CAROTID SINUS SYNDROME

The Error



Hypersensitive carotid sinus baroreceptors misinterpret mild external pressure (e.g., a tight collar, shaving) as a massive spike in internal blood pressure.

The Mechanism

Mild Pressure

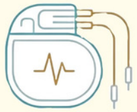
False High BP Signal

NTS overreacts → Extreme vagal response

Massive HR Drop (Severe bradycardia)

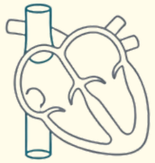
Cerebral ischemia & syncope (fainting)

The Override



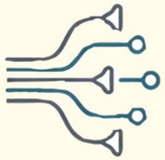
Often requires implantation of an artificial cardiac pacemaker to bypass the faulty neural brake.

5.SECONDARY SENSORS: ATRIAL VOLUME RECEPTORS



*LOW-PRESSURE RECEPTORS

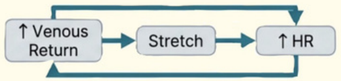
Located in the distensible walls of the atria and pulmonary vessels. triggered by blood volume/venous return.



*NEURAL PATHWAY

*Afferent signals travel via the **Vagus nerve** to the medullary cardiovascular centers to initiate the reflex arcs.*

*BAINBRIDGE REFLEX



Increased volume triggers an increase in HR to pump extra venous return forward, preventing accumulation and pulmonary edema.

*RENAL OVERRIDE

*Triggers systemic vasodilation (**especially renal**) and shifts hormones to immediately dump fluid.*

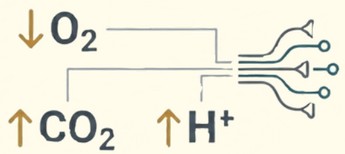
↓ADH

↓Renin

↑ANP

6.THE EMERGENCY OVERRIDES

*PERIPHERAL CHEMORECEPTORS



*Triggered by chemical crisis (**low P02, high PCO2, high H+**). Detects hypoxia and acidosis when flow is severely compromised. Direct stimulation of the **VMA** increases sympathetic output to restore perfusion.*

*CNS ISCHEMIC RESPONSE

*The ultimate failsafe. Triggered only when ABP crashes **below 50 mmHg** and baroreceptors fail. Local ischemia and trapped CO2 in the medulla trigger the most powerful sympathetic stimulation possible, causing **massive vasoconstriction to preserve brain perfusion.***

7.THE NEURAL REGULATION MATRIX (VIP SUMMARY)

Mechanism	Sensor Location	Primary Trigger	Threshold/ Key Trait	Net Effector Response
Baroreceptors	Carotid/Aortic	Mechanical Stretch	50-160 mmHg (Pulsatile)	Buffers HR/VC to stabilize.
Atrial Receptors	Atria/Pulm	Volume Distension	High Venous Return	↑ HR (Bainbridge), Renal fluid dump.
Chemoreceptors	Carotid/Aortic Bodies	Chemical (↓O2, ↑CO2, ↑H+)	Hypoxia/Acidosis	Stimulates VMA (↑ VC/ABP).
CNS Ischemic	Medulla	Extreme Local Ischemia	ABP < 50 mmHg	Maximum systemic VC.