Respiratory Components of the Medulla Oblongata

• The Respiratory Centers
  – Dorsal Respiratory Group
  – Ventral Respiratory Group
Fig. 9-1. Schematic illustration of the respiratory components of the lower brainstem (pons and medulla oblongata). PNC = pneumotaxic center; APC = apneustic center; DRG = dorsal respiratory group; VRG = ventral respiratory group; CC = central chemoreceptors.
Neural impulses from the respiratory center travel to the diaphragm by way of the right and left phrenic nerves. The cervical, thoracic, and lumbar motor nerves stimulate the external intercostal muscles (accessory muscles of inspiration).
Influence of Pontine Respiratory Centers on Respiratory Components of Medulla Oblongata

- Apneustic center
- Pneumotaxic center
- Physiologic basis of the respiratory rhythm
Conditions that Depress Respiratory Components of Medulla Oblongata

- Reduced blood flow through medulla
- Acute poliomyelitis
- Ingestion of drugs that depress the central nervous system
• Central Chemoreceptors
• Peripheral Chemoreceptors
Blood-Blood Barrier (BBB) and CO₂, HCO₃⁻, and H⁺

Fig. 9-3. The relationship of the blood-brain barrier (BBB) to CO₂, HCO₃⁻, and H⁺. CO₂ readily crosses the BBB. H⁺ and HCO₃⁻ do not readily cross the BBB. H⁺ and HCO₃⁻ require the active transport system to cross the BBB. CSF = cerebrospinal fluid.
Carotid and Aortic Bodies

Fig. 9-4. Location of the carotid and aortic bodies (the peripheral chemoreceptors).
PaO₂ and Alveolar Ventilation

Fig. 9-5. Schematic illustration showing how a low PaO₂ stimulates the respiratory components of the medulla to increase alveolar ventilation.
Fig. 9-6. The effect of low PaO₂ levels on ventilation.
Effect of PaO$_2$ on Ventilation

Fig. 9-7. The effect of PaO$_2$ on ventilation at three different PaCO$_2$ values. Note that as the PaCO$_2$ value increases, the sensitivity of the peripheral chemoreceptors increases.
OTHER FACTORS THAT STIMULATE THE PERIPHERAL CHEMORECEPTORS
Accumulation of Lactic Acids

Fig. 9-8. The accumulation of lactic acids leads to an increased alveolar ventilation primarily through the stimulation of the peripheral chemoreceptors.

↑ Production of Non-CO₂ Acids (Lactic Acids)

↑ Arterial (H⁺)

Stimulation of Peripheral Chemoreceptors

Stimulation of Medullary Inspiration Neurons

↑ Increased Alveolar Ventilation
Other Responses Activated by Peripheral Chemoreceptors

- Peripheral vasoconstriction
- Increased pulmonary vascular resistance
- Systemic arterial hypertension
- Tachycardia
- Increased in left ventricular performance
Reflexes that Influence Ventilation

- Hearing-Breuer reflex
- Deflation reflex
- Irritant reflex
- Juxapulmonary capillary receptors
- Peripheral proprioceptor reflexes
Reflexes that Influence Ventilation

• Hypothalamic controls
• Cortical controls
• Reflexes from the aortic and carotid sinus baroreceptors
Fig. 9-9. The respiratory center coordinates signals from the higher brain region, great vessels, airways, lungs, and chest wall. (+) = increased ventilatory rate; (-) = decreased ventilatory rate.
Clinical Application 1 Discussion

• How did this case illustrate ...
  – How the peripheral and central chemoreceptors control the ventilatory pattern when an individual who normally resides at sea level ascends to a high altitude?
Clinical Application 2 Discussion

• How did this case illustrate …
  – How clinical factors other than an increased $\text{PCO}_2$ or decreased $\text{PO}_2$ can stimulate ventilation?