Central Sleep Apnea

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Central Sleep Apnea

- Non-hypercapneic CSA
  - Cheyne Stokes Breathing
- Other CSA
  - Opioid-induced Sleep Apnea
Ventilatory Control

• Wakeful breathing is controlled by 2 systems:
  – Automatic
    • $\mathrm{pCO}_2$
    • $\mathrm{pO}_2$
    • pH
  – Behavioral
Ventilatory Control

• During sleep:
  – Automatic control only
  – Increased apneic threshold
    • PaCO$_2$ level below which breathing stops
  – Loss of wakefulness drive
    • PaCO$_2$ level rises with sleep
  – Decreased chemosensitivity

{ Promotes CSA }
Unstable Ventilatory Control

- Automatic ventilatory control is a negative feedback control system designed to regulate \( \text{PaCO}_2 \)
- Increased gain of the control system (high loop gain) leads to instability in ventilation and \( \text{PaCO}_2 \) levels
Loop Gain

- The measure of the propensity of a negative feedback control system to oscillate

Disturbance → **Ventilatory Control System** → Response
(e.g. hypopnea)  (e.g. hyperpnea)

Loop Gain = Response/ Disturbance

Dempsey JA, J Physiol 2004
White DP, AJRCCM 2005
Unstable Temperature Control
Unstable Ventilatory Control
Causes of High Loop Gain in CHF

• High controller gain (↑ chemosensitivity)
• Transit time is long (↓ cardiac output)
Ventilatory Instability

• Central apneas occur when there is a fluctuation of PaCO$_2$ below the apneic threshold
• This is more likely when PaCO$_2$ level is close to the apneic threshold
CSB / Clinical Presentation

- Associated with:
  - CHF
    - Atrial fibrillation
  - Stroke
    - Diminishes with time after stroke
  - Compared to typical OSA patient:
    - More likely male and complain of awakenings
    - Less likely to be obese, snore and have sleepiness
CSA / Pathophysiology
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• Episodic hypoxia
• Arousals
• Periodic breathing

↓

• Oscillations in BP and HR
• ↑ Sympathetic nervous system activity
CSA / Pathophysiology

• Outcomes in CSR
  – Worsening heart function
  – Ventricular arrhythmias
  – Mortality
CSB / Treatment Options

- Improve heart function
- CPAP
- Adaptive Servo Ventilation (ASV)
- Oxygen
• 258 patients with CHF and Cheyne Stokes Breathing (CSB) randomized to CPAP or no CPAP
• Primary outcome transplant free survival

Sleep Disordered Breathing

![Graph showing episodes of apnea and hypopnea over time for control and CPAP groups. The graph indicates a significant decrease in episodes over 24 months, with CPAP group showing a more significant reduction compared to the control group.](image)
Cardiac Function

![Graph showing Cardiac Function over time with CPAP group and Control group comparison. The graph indicates a significant difference in LVEF (%).](C.png)
CPAP for CSB

- CPAP did not improve transplant free mortality
- CPAP did improve LVEF and sympathetic nervous system activity
- CSB not fully controlled with CPAP
  - Need a better treatment
What is ASV?

- Adaptive Servo Ventilation
- Variable bi-level device
  - Base pressure 8/5
  - Adjusts inspiratory pressure to supplement ventilation when decreases to <90% of average ventilation
  - Initiates breath if no effort
ASV

• ASV appears be superior to CPAP in reducing CSA in CHF patients and improves heart function and symptoms

• A multi-center RCT with mortality as the primary endpoint in progress
Cheyne Stokes Breathing

- A potential cause of sleep related symptoms in patients with heart failure
  - Atrial Fibrillation
- Increases mortality
- More easily treated than past
  - ASV
Opioid related Sleep Apnea

- Effects on rhythm generators in medulla
  - Opiate sensitive neurons active during inspiration
Sleep Disordered Breathing and Opioid Use
Prevalence

• 30% of patients on chronic methadone maintenance therapy
• 70% of sleep clinic patients on chronic opioid medication
• Related to dose


Outcomes

- Disrupted sleep
- Sleepiness
- Mortality?