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Facilitators Guide

I.A. In a patient of this age and presentation the broad category of sleep disorders include:

1) 1) Sleep disordered breathing conditions: OSA, CSA, hypoventilation
2) 2) Insomnia (patients with HF rarely sleep 7-8 hours but usually <4/night and have developed horrible sleep hygiene
3) 3) Parasomnias like REM behavioral disorder (if treated with beta blockers)
4) 4) RLS like symptoms from renal insufficiency/failure, iron deficiency

I.B. What are known risk factors for Central Sleep Apnea?

1) age - >65 years old
2) sex – men>women – higher apneic threshold in men
3) heart failure
4) stroke – especially in first 3 months after stroke
5) opioid use
6) renal failure

II. A. What is a central sleep apnea?
Cessation of airflow for at least 10 seconds, without respiratory effort during the event.

II. B. How does your assessment for central sleep apnea risk alter with the given information?

- oxycodone can increase risk of central sleep apnea
- new onset atrial fibrillation and increased left atrial size can increase the risk of CSA in SHF patient
- oropharyngeal exam does not support increased risk of OSA

II. C. What are the syndromic presentations of central sleep apnea? What type of central sleep apnea might you expect to see on a sleep study in this patient at this time?

1. Primary central sleep apnea
2. Secondary central sleep apnea
    a. Cheyne Stokes Respiration
    b. Secondary to a medical condition – CNS diseases, neuromuscular disease, severe abnormalities in pulmonary mechanics (such as kyphoscoliosis)
    c. Secondary to a drug or substance
    d. High altitude periodic breathing

IIIA. How can the residual pulmonary edema and hypoxemia affect the sleep disordered breathing?
Pulmonary edema can increase work of breathing and contribute to hypoventilation. Alternatively, the hypoxia and stretch receptor activation can result in hyperventilation. In the case of this patient, acute respiratory alkalosis is consistent with hyperventilation.
Acute cardiogenic pulmonary edema can result in increased left atrial size/stretch, and this finding is associated with Cheyne-Stokes respiration in heart failure. Pulmonary edema and hypoxemia can also worsen the intermittent hypoxia associated with sleep disordered breathing.

III. B. How does the respiratory alkalosis affect sleep (and wake) disordered breathing?

Respiratory alkalosis during wakefulness can trigger Cheyne Stokes respiration in this patient. The low PaCO2 can be below the apnea threshold at sleep onset, resulting in an apnea. If the CO2 sensitivity is high, the ventilator response to the CO2 derangements can result in the periodicity of breathing seen in Cheyne Stokes respiration.

At sleep onset, the lower PaCO2 may fall below the apnea threshold, resulting in a central apnea. The lower PaCO2 during wakefulness is often due to chemoreflex hypersensitivity, which would set a higher alveolar hyperventilation rate at baseline. Associated to chemoreflex hypersensitivity is hypercapneic ventilatory hyperresponsiveness – in which the change in ventilation in response to fluctuations in CO2 are exaggerated, thus perpetuating the periodic breathing noted in Cheyne Stokes Respiration.

IIII. A) Are the nurse descriptions and the portable monitoring example consistent?
Yes. The nurses describe a crescendo decrescendo pattern of oscillating respiration – alternating between hyperventilation and apneas – consistent with Cheyne Stokes respiration.

IIII. B) What potential causes of central sleep apnea does the patient have?
- systolic heart failure (especially with acute exacerbation, atrial fibrillation)
- enlarged left atrial size
- oxycodone use

IIII. C) How would you treat this patient at this time?
1) Initial treatment directed at conditions that ay be causing or exacerbating CSA – heart failure, opioid use, atrial fibrillation..
2) If symptoms persist or patient has severe consequences of CSA, then CSA-specific therapy is indicated

3) For hyperventilation-related CSA (primary CSA, CSR, medical condition, high altitude)
    a. CPAP
        i. Can be in-lab titration to eliminate central apneas
        ii. Also acceptable, as in CanPAP study, over 2-3 nights in hospital, start at CPAP 5 and titrate up to max CPAP 10.
    b. ASV
    c. BPAP with backup rate
    d. All patients with hypoxemia during sleep should receive supplemental oxygen

IIII. D) What are the management issues upon discharge from the MICU?

1 Optimization of heart failure management
2 Evaluation of sleep by an in-laboratory sleep study. Portable sleep studies would not be an option for this patient given the probable diagnosis of central sleep apnea.
3 Evaluation in sleep clinic for non-breathing related sleep disorders – insomnia, poor sleep hygiene, possible parasomnias, possible RLS.

Extra information:

Diagnostic criteria:

1) Primary central sleep apnea
    a. PSG reveals >= 5 central apneas and/or central hypopneas per hour, and central events are >50% of the total apneas and hypopneas
    b. No evidence of Cheyne Stokes respiration
    c. Symptoms of sleepiness, awakening SOB, snoring, witnessed apneas, or insomnia
    d. No evidence of daytime or nocturnal hypoventilation
    e. Not explained by another sleep disorder, medical or neurological disorder, medication or substance use.
2) Cheyne Stokes breathing
    a. PSG reveals >= 5 central apneas and/or central hypopneas per hour, and central events are >50% of the total apneas and hypopneas
    b. At least 3 consecutive central apnea/hypopneas separated by crescendo-decrescendo breathing with a cycle length of t least 40 seconds
    c. Associated with atrial fibrillation/flutter, congestion heart failure or a neurological disorder
    d. Symptoms of sleepiness, awakening SOB, snoring, witnessed apneas, or insomnia
    e. Not explained by another sleep disorder, medical or neurological disorder, medication or substance use.

3) CSA due to high altitude periodic breathing
    a. Recent ascent to a high altitude (typically 2500 meters, sometimes as low as 1500m)
    b. Symptoms of sleepiness, awakening SOB, snoring, witnessed apneas, or insomnia
    c. If PSG is performed, then NREM central AHI is >= 5/hour.
    d. Not explained by another sleep disorder, medical or neurological disorder, medication or substance use.
4) CSA due to medication or substance
    a. Taking an opioid or other respiratory depressant
    b. PSG reveals >= 5 central apneas and/or central hypopneas per hour, and central events are >50% of the total apneas and hypopneas
    c. No evidence of Cheyne Stokes respiration
    d. Symptoms of sleepiness, awakening SOB, snoring, witnessed apneas, or insomnia
    e. Not explained by another sleep disorder, medical or neurological disorder, medication or substance use.

Pathogenesis of CSA:

1) Apnea threshold.
    a. Hypoxia or any stimulating factor causes a hyperpnea.
    b. The ventilator overshoot results in hypocapnea, below the apnea threshold, and a central apnea results.
    c. PaCO2 rises during the central apnea. Mild hypercapnea (4-6 mm Hg above normal PaCO2) can restore episodic respiration, with or without an arousal.
    d. Hyperpnea, ventilator overshoot, hypocapnea, and another central apnea continues the cycle.
2) Loop gain
    a. In normal patients, a short-term potentiation mitigates the magnitude of ventilator response to a stimulus.
3) Upper airway can narrow or occlude during a central apnea. Greater respiratory effort is required to open the airway. Upper airway deformation with large negative airway pressure can induce central apnea in animal models. This is possibly why CSA is more common in the supine position.
4) Central apnea due to hypoventilation is caused by the disappearance of wakefulness stimulus to breathing during sleep.
5) Central apnea at sleep onset. With transition from wakefulness to sleep, PaCO2 is at or below the apneic threshold. Happens during NREM sleep. Central apneas during REM are uncommon, because of the ventilatory output from the active brain.

Consequences of CSA:

1) prolonged severe oxyhemoglobin desaturations precipitating myocardial ischemia or arrhythmia during sleep

5) symptoms of sleepiness, awakening SOB, snoring, witnessed apneas, or insomnia

Treatment of CSA:

4) Initial treatment directed at conditions that ay be causing or exacerbating CSA – heart failure, opioid use.
5) If symptoms persist, then CSA-specific therapy
6) If patient has severe consequences of CSA, then CSA-specific therapy is indicated
7) For hyperventilation-related CSA (primary CSA, CSR, medical condition, high altitude)
    a. CPAP
        i. Can be in-lab titration to eliminate central apneas
        ii. Also acceptable, as in CanPAP study, over 2-3 nights in hospital, start at CPAP 5 and titrate up to max CPAP 10.
    b. ASV
    c. BPAP with backup rate
    d. All patients with hypoxemia during sleep should receive supplemental oxygen
8) For hypoventilation-related CSA
    a. BPAP with a backup rate
9) If doesn't tolerate PAP therapy, supplemental oxygen
10) Possible role of acetazolamide or theophylline (respiratory stimulants) – not proven, needs close monitoring

Complex sleep apnea = Treatment-emergent central sleep apnea

Risk factors for CompSA

- male>female
- heart failure
- severe OSA
- mixture of obstructive and central apneas on initial PSG
- use of higher CPAP pressures (over-titration) or higher pressure support level
- high altitude
- oral breathing
- opioid narcotics
- supine position sleep (possible)
- more NREM sleep

Pathogenesis of CompSA:

- high loop gain, resulting in self-sustained periodic breathing. Arousals from sleep result in exaggerated ventilatory response, and when $PaCO_2$ decreases below the apnea threshold, a central apnea results.

- Improved ventilation (by opening upper airway with CPAP and boosting ventilation with BPAP) results in lowered PaCO2, and if below the apnea threshold, will result in a central apnea.
- Stretch receptor activation by positive airway pressure can inhibit central respiratory output and cause a central apnea

Definition of CompSA:

- presence of OSA, with predominantly obstructive or mixed apneas occurring at a frequency of >=5events/hour.
- With PAP therapy, all of the following:
    - AHI>= 5/hour
    - Central apneas and hypopneas > 50% of AHI
    - Central AHI is >= 5/hour
    - Symptoms of EDS or distrupted sleep

Treatment:

- some patients with CompSA resolve spontaneously after 3 months
- continue CPAP and reassess at 3 months (at most 50% of patients)
- ASV or BPAP with a backup rate
- ASV results in less AHI at 3 months compared to CPAP (**Morganthaler T et al. Sleep, Vol. 37, No. 5, 2014)**
- ASV slightly superior to BPAP with backup rate – lower residual AHI, and less likely for central apnea re-emergence after 6 weeks (Morganthaler T et al. Sleep 2007; 30:468.; Dellweg D et al. Sleep 2013; 36:1163.)