COPD, OSA, AND OHS: WHAT DOES IT ALL MEAN

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COPD, OSA, and OHS

- Discuss the normal respiratory changes which occur with sleep
- Discuss the impact of COPD on sleep
- Review the clinical presentation of obstructive sleep apnea
- Discuss the clinical significance of the overlap syndrome (COPD and OSA)
- Discuss obesity hypoventilation syndrome (OHS)
- Sudden death in the hospital
Sleep Stages
- Non REM (NREM)
  ▫ Increase in parasympathetic activity
  ▫ Decrease in sympathetic activity
- Rapid Eye Movement (REM)
  ▫ Tonic phase
    ▪ Further Parasympathetic activity increase
  ▫ Phasic phase
    ▪ Sympathetic surge

Control of breathing
- Metabolic (automatic)
  ▫ paCO2, paO2
- Voluntary (behavioral)
  ▫ Activity of Reticular Activating System (RAS)
  ▫ Brainstem tonic activity
- Both metabolic and voluntary are active in wake
- Sleep onset: voluntary (RAS) activity ceases; control of breathing metabolic only
Normal Sleep
- Minute ventilation decreases
  - Function of reduction in Tidal Volume, less Respiratory Rate
  - PaCO2 increase 2-8 mmHg
  - PaO2 decreases 3-10 mmHg; O2 saturation < 2%
  - Ventilation decrease is greatest in REM sleep
    - Up to 40% reduction in ventilation esp phasic REM
- Both the hypoxic and hypercapnic ventilatory response decrease as sleep deepens.
- Upper airway resistance increases
  - Level of palate and hypopharynx
  - Increase 3-7 x wake
- Metabolism decreases: both VCO2 and VO2

Arousal responses are reduced in sleep
- PCO2 increase of 6-15 mmHg.
- SaO2 < 75% (normals).
- Hypercapnea more potent arousal stimulus

- Reduction in response to laryngeal stimulation
  - Risk of aspiration
COPD, OSA, and OHS

- Cardiovascular response to sleep
  - NREM sleep (parasympathetic)
    - Reduced Heart Rate (5-10%)
    - Reduced Blood Pressure
    - Reduced Cardiac Output
    - Reduced Systemic vascular Resistance
    - Overall reduction in myocardial work
  - REM sleep
    - Variable depending on tonic or phasic REM

- Pulmonary Artery Pressure (PAP)
  - Increase in both NREM and REM

- Coronary Blood Flow
  - NREM: Decrease
  - REM: Increase

- Cerebral Blood Flow
  - No change or slight decrease in sleep
COPD and Sleep

- Chronic Obstructive Airways Disease (COPD)
  - Incidence continues to increase
    - Cigarette smoking remains greatest risk factor
    - Cigarette smoking alone:
      - Sleep onset latency increased
      - Increase stage 1 sleep; decrease in slow wave sleep
      - Withdrawal of nicotine during sleep – sleep fragmentation
  
  - By 2020, third leading cause of death in the United States
COPD and Sleep

- **Sleep Parameters:**
  - Total sleep time (TST): decreased
  - Sleep onset latency (SOL): increased
  - Increased awakenings / Increased sleep state changes
  - Waking after sleep onset (WASO): increased
  - Slow wave sleep: decreased
  - REM sleep: decreased
  - Sleep efficiency (SE): decreased
  - Increased use of hypnotic medications

- **Physical factors**
  - Cough, shortness of breath, sputum production, pain
  - Nocturnal cough or wheezing: 39% will c/o sleep disturbance
  - Both cough and wheeze: 53% will c/o sleep disturbance
  - Excessive daytime sleepiness: 23%  Ezzie, M Sleep Medicine Clinic 2008.

- **Metabolic factors**
  - Hypoxemia, hypercarbia

- **Primary sleep disorders**
  - Obstructive sleep apnea, insomnia

- **Medications**
  - Bronchodilators / steroids: stimulants

- **Psychological factors**
  - Mood disorder: depression and anxiety
COPD and Sleep

- Mechanisms of oxygen desaturation
  - Hypoventilation
    - REM sleep (phasic REM worse)
  - Ventilation Perfusion Mismatch
    - REM sleep: Decrease in FRC (accessory muscles)
  - Oxyhemoglobin desaturation curve
    - Wake SaO2
  - Obstructive Sleep Apnea (Overlap Syndrome)
    - 10-15% OSA in COPD patients
    - “Blue Bloaters”

- Hypoventilation / V/Q mismatch
  - Increase in airway resistance (bronchoconstriction)
  - Ventilatory drive is decreased
  - Basal metabolic rate decreased
  - REM sleep: loss of accessory muscles of respiration
  - Result is a reduction in FRC

- Severe COPD could see
  - 20% decrease in oxygen saturation NREM sleep
  - 40% decrease in REM sleep
COPD and Sleep

- Nocturnal oxygen desaturation
  - Various reports 27% to 70% in patients with COPD
    - Defined SaO2 nadir or % time < 90%.
    - Problem: what is significant and requires treatment
      - NOTT Guidelines / GOLD Initiative / Medicare Guideline
    - Difficult to predict
      - PFT’s: not predictive
      - Awake PaO2: predictive “Blue Bloaters”
        - Resting SaO2 < 93%
      - Awake PaCO2: predictive
        - Resting PaCO2 > 50 mmHg
What is obstructive sleep apnea?

- Repetitive episodes of complete or near complete obstruction of the upper airway resulting in brief arousals from sleep.

- The arousals fragment sleep resulting in a shift from deeper to lighter stages of sleep.

- Drops in oxygen level are also associated with airway obstruction.
COPD, OSA, and OHS

- Pathogenesis
  - Anatomy
    - Upper airway, jaw position, neck circumference
  - Dilator muscle activity
  - Lung volume
    - Decrease in lung volume increase upper airway collapse
  - Ventilatory control stability
  - Sleep state stability
  - Fluid shift in neck

- Risk Factors
  - Male sex
  - Postmenopausal women
  - Age
  - Genetics (familial)
  - Ethnicity
  - Smoking / Alcohol use
  - Sinus disease (?)
  - Body habitus (Apple vs. Pear) Waist to hip ratio
Bed Partners may complain of
- Loud disruptive snoring
- Pauses in breathing at night
- Episodes of snorting, choking, gasping for breath
- Restlessness
- Kicking, flailing arms/legs at night
- Sleep talking

Individuals may complain of
- Nonrestorative or unrefreshing sleep
- Excessive daytime sleepiness
- Restless sleep
- Daytime fatigue or tiredness
- Insomnia
COPD, OSA, and OHS

- Sleep Apnea and Women
  - Fewer complaints of snoring / witnessed apnea
  - More likely to complain of daytime fatigue, tiredness, morning headache
  - Insomnia rather than daytime sleepiness
  - Mood disturbance
  - Symptomatic at lower levels of sleep apnea
  - Higher incidence of hypothyroidism

- Elderly
  - Despite higher prevalence, snoring less prominent.
  - Higher prevalence of central sleep apnea
  - May have different presentation, medical consequences
COPD and OSA

- The Overlap Syndrome (Flenley)
  - Given the relative frequency of the individual conditions would expect the two to occur in the same individual.
  - The prevalence of both conditions continues to increase.
  - No increased association between the two conditions.
    - SHHS: No increased association was found between COPD and OSA. The majority of the COPD was mild.
    - OSA: 22% participants with COPD (FEV1% < 70%).
    - OSA: 29% participants without COPD
COPD and OSA

- Overlap Syndrome
  - Prevalence of COPD in patients with OSA is 10-15%
  - Prevalence of COPD in patients with OSA is similar to its prevalence in the general population around 4%.

COPD and OSA (Overlap Syndrome)

- Clinical significance:
  - Greater degree of nocturnal oxygen desaturation
    - SaO2 nadir, number of desaturations, time spent < 90%
  - Abnormal daytime arterial blood gases
  - Chronic hypercarbia at lower BMI than OSA
  - Chronic hypercarbia at higher FEV1 than COPD.
  - Pulmonary hypertension
    - Overlap syndrome 86%; OSA alone 16%.
COPD and OSA

- Clinical significance
  - Complications such as pulmonary hypertension and right sided heart failure occur earlier.
  - Primarily “blue bloaters”
  - Quality of life measures are reduced

- McNicholas observed that patients admitted to the hospital with COPD were more likely to die at night than with other medical conditions.

- Lavie (2007). The presence of COPD conferred a 7 fold risk of death in OSA patients. (higher than CHF or DM)
- Patients with COPD and overlap syndrome followed for 9 years. All cause mortality
  - Untreated (no CPAP) overlap group: 42.2%
  - COPD only: 24.2%
  - Treated overlap group similar to COPD only
  - Even when adjusted for severity of COPD OSA remained risk factor for death

  Marin, JM et al. A. Am J Respir Crit Care Med 2010
COPD and OSA

- Clinical significance
  - Increased incidence of COPD exacerbations
  - Increase risk of respiratory failure
  - Hospitalization and death
  - Patients admitted with acute exacerbation of COPD in which evaluation does not demonstrate an obvious reason: consider sleep disordered breathing

- Treatment
  - Maximize medical therapy
  - Nocturnal oxygen
    - GOLD guidelines /Medicare guidelines
  - Positive pressure therapy
    - CPAP or Bilevel pressure
    - Marin study which showed reduction in mortality
    - APAP not recommended in “significant” lung disease (Practice parameters AASM) 2008.
COPD and OSA

- COPD: When to evaluate for OSA (sleep study)
  - Obesity: BMI > 30
  - History of snoring, nocturnal pauses
  - Excessive daytime sleepiness
  - Physical exam
    - Neck circumference: M > 17 inches; W >16 inches
    - Crowded upper airway: Mallampati III-IV
  - Use of a screening questionnaire for obstructive sleep apnea
    - STOP / STOP-BANG
    - Berlin Questionnaire
    - Sleep Apnea Clinical Score (SACS)
Obesity Hypoventilation Syndrome

- Daytime hypercapnea and hypoxemia
  - \( \text{PaCO}_2 > 45 \text{ MM HG} \) and \( \text{PaO}_2 < 70 \text{ mm Hg} \)
  - \( \text{BMI} > 30 \text{ kg/m}^2 \)
- Sleep disordered breathing
  - 90% obstructive sleep apnea
  - 10% hypoventilation
- Diagnosis of exclusion
  - R/O pulmonary/neuromuscular / chest wall abnormality
COPD, OSA, and OHS

- Sleep Related Hypoventilation/Hypoxemic Syndromes  [Casey, K et al. Chest 2007; 131: 1936-1948]
  - Pulmonary parenchymal or vascular etiology
    - Pulmonary fibrosis
    - Primary pulmonary hypertension
  - Lower airway obstruction
    - Chronic bronchitis/asthma
    - Emphysema
  - Neuromuscular or chest wall abnormality
    - Obesity
    - Kyphoscoliosis/ALS
  - Idiopathic alveolar hypoventilation

- Obesity Hypoventilation Syndrome
  - Prevalence
    - General population: 0.3%.
      - 1:300-600 adults
    - Obstructive sleep apnea: 10-20%
    - Hospitalized patients with BMI > 35: 31%.
  - Prevalence increases with increasing BMI
    - BMI 30-34: 8%
    - BMI 35-39: 18%
    - BMI > 40: 25%  [Mokhesi; Chest 2007;132:1322-1336]
Obesity Trends* Among U.S. Adults
(*BMI ≥30, or about 30 lbs. overweight for 5’4’’ person)

Critical points of the NHANES data
- Prevalence of clinically severe obesity is increasing much faster than that of moderate obesity.
- BMI > 40 kg/m² has increased fivefold
  • 1:200 adults to 1:33 adults
- BMI > 50kg/m² has increased tenfold
  • 1:2,000 adults to 1:200 adults

More not less of these individuals will be presenting with acute respiratory failure.
COPD, OSA, and OHS

- Obesity Hypoventilation Syndrome
  - Pathophysiology
    - Respiratory mechanics associated with obesity
      - Reduced total respiratory system compliance
      - Increased lung resistance
      - Respiratory muscle weakness
    - Abnormal central responses to hypercapnea and hypoxemia
      - Sleep disordered breathing
      - Leptin resistance (neurohormonal)
  - Chronic hypercapnea is seen in less than one third of individuals with morbid obesity.

- Obesity Hypoventilation Syndrome
  - Clinical presentation
    - Classic symptoms of obstructive sleep apnea
    - Shortness of breath and periperal edema
    - Cognitive impairment, morning headache

  - Hospital presentation
    - Acute on chronic respiratory failure
COPD, OSA and OHS

- Obesity Hypoventilation Syndrome
  - Arterial Blood Gas:
    - Hypercarbia
    - Hypoxemia
  - Laboratory findings:
    - Elevated serum bicarbonate
    - Reduced resting oxygen saturation
    - Elevated hemoglobin

Measures of Severity of OSA associated with chronic hypercarbia
- AHI
- Mean overnight SpO2
- Minimum SpO2 during sleep
- %TST < 90% during sleep
COPD, OSA, and OHS

Obesity Hypoventilation Syndrome: an Emerging and Unrecognized Risk Factor Among Surgical Patients. Kaw et al. AJRCCM 183,2011; A3147
1784 patients both PSG and non cardiac surgery
471 eligible; 269 (57%) OSA

36/269 (13%) had ABG data. 9/36 (3%) criteria for OHS
14/269 (5%) post operative respiratory failure
44% OHS/OSA
3% OSA

CoMorbidities: should they be considered in the assessment of level of monitoring?

- Higher Risk:
  - Atrial fibrillation*
  - Congestive heart failure*
  - Severe COPD
  - Coronary artery disease*
  - Obesity Hypoventilation Syndrome
  - Pulmonary Hypertension Kaw, R. Respiratory Medicine 2011, 105, 619-624
  - Uncontrolled Hypertension*

- Lower Risk:
  - Mild COPD
  - Hypertension
  - Diabetes Mellitus
  - Cerebrovascular disease*
  - Obesity BMI > 35 kg/m2*
Obesity Hypoventilation Syndrome

  - BMI > 35; ABG: PaCO2 > 43; pH < 7.42.
  - General medical floor: 4332 consecutive admissions. 277 pts (6%) BMI criteria. 150 pts enrolled. 47/150 (31%) ABG
  - Obesity-Hypoventilation vs Obesity alone
    - Increased ICU with mechanical ventilation
    - Increased long term care post discharge.
    - Therapy for hypoventilation at D/C: 6/47 (13%)
    - Mortality at 18 months: 23% (OH) vs 9% (O) Hazard ratio 4.0
    - The difference in survival was evident as early as 3 months post discharge

Should screening for obstructive sleep apnea include screening for OHS?

- Should screening for obstructive sleep apnea include screening for OHS?
- Screening all patients with OSA/+screen and BMI > 35 with awake ABG not practical
- Initial screen:
  - HCO3 > 27 sens 92% spec 50% for hypercapnea
  - Resting wake SpO2 < 93%. (uncommon in simple OSA)
    - Piper, A. Sleep Medicine Review 2011; 15; 79-89.
- If both positive: resting wake ABG.
COPD, OSA, and OHS

- Obesity Hypoventilation Syndrome
  - Treatment (outpatient)
    - Positive Pressure Therapy
      - CPAP successful 80% of cases
      - Bilevel Pressure
      - High CPAP levels required
      - CPAP does not completely correct hypoxemia
      - Acute on chronic respiratory failure
      - OHS with pure hypoventilation; no OSA
      - Oxygen
      - Correct hypoxemia unresponsive to PAP therapy
Obesity Hypoventilation Syndrome

Treatment

- Positive Pressure Therapy
  - Volume-Assured Pressure Support Ventilation (VAPS)
  - Successful in small trial in mild OHS
    - Sture, J.H. Chest 2006; 130(3); 613-621.
  - APAP
    - Not recommended Practice parameters AASM
    - Caution: Protocols using APAP in hospital

- Surgical
  - Tracheostomy
  - Bariatric surgery
  - Little data on long term effectiveness

Treatment (hospital)

- Non invasive positive pressure therapy
  - Bilevel pressure to improve daytime hypercapnea and hypoxemia
  - Requires a 8-10 cm difference in IPAP to EPAP
  - IPAP pressure of 16-20 cm
  - EPAP pressures of 6-10 cm

Mokhlesi, B. et al Proc Am Thorac Soc. 2008. vol 5. 218-
**COPD, OSA, and OHS**

- **Obesity Hypoventilation Syndrome**
  - Treatment improves:
    - Dyspnea, morning headache, daytime sleepiness, edema
    - Arterial blood gases
    - Pulmonary hypertension and erythrocytosis
  - Improvement directly related to adherence: monitor ABG as well as compliance data
  - Retrospective study 126 patients adherent to PAP
    - 18 month mortality: 3%
    - 2 year mortality: 8%
    - 5 year mortality: 30%

  Budweiser, S. et. Al Jr Int Med; 2007; 261; 375-383

- **Obesity Hypoventilation Syndrome**
  - Response to treatment
    - Nocturnal hypoxemia
      - Positive pressure therapy with/without oxygen
    - Daytime Hyercapnea
      - 75% normalize paCO2
      - 25% will have persistent hypercapnea even on treatment
  - Primary reason for treatment failure is poor adherence to therapy
COPD, OSA, and OHS

- Acute cardiopulmonary failure
  - Associated with OSA
    - Postoperative respiratory failure
  - Associated with OSA and COPD (Overlap Syndrome)
    - Acute exacerbation of COPD
  - Associated with Obesity Hypoventilation Syndrome (OHS)
    - Acute respiratory failure
- Acute Congestive Heart Failure
- Sudden Death

COPD, OSA, and OHS

- Malpractice cases involving Obstructive Sleep Apnea in Hospitalized Patients
  - Intubation complications (20%)
  - Extubation difficulties (10%)
  - Post operative catastrophes (70%)
    - Drug induced respiratory arrest resulting in death/brain damage
    - Patients with OSA with inadequate monitoring

COPD, OSA, and OHS

- Postoperative catastrophes ("Dead in bed")
  - Severe OSA
  - Morbid obesity
  - Isolated ward room
  - No monitoring
  - Receiving narcotics
  - Off O2/PAP

Jonathan I. Berns, M.D.
Conclusions:
- Obstructive sleep apnea can coexist with other respiratory disorders.
- These overlap syndromes result in more severe disease than would be expected.
- Heightened awareness in the hospital provides an opportunity to identify previously undiagnosed patients.
- Appropriate treatment with positive pressure therapy can improve quality of life, reduce exacerbations with hospitalization and improve short term mortality.