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

COPD, OSA, and OHS

- 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

COPD, OSA, and OHS

- 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

COPD, OSA, and OHS

- 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

COPD, OSA, and OHS

- 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 stimulaton
    - 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

COPD, OSA, and OHS

- Cardiovascular response to sleep
  - 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

COPD and Sleep

- 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

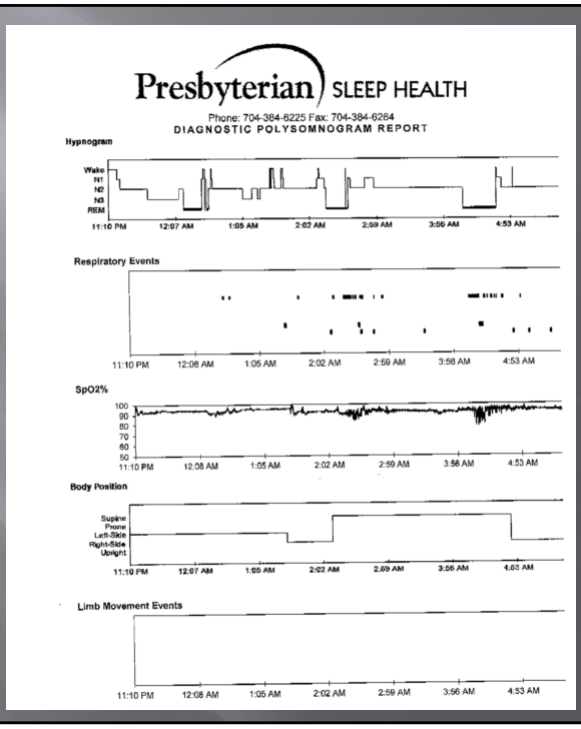
COPD and Sleep

- 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"

COPD and Sleep

- 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

COPD, OSA, and OHS

- 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

COPD, OSA, and OHS

- Risk Factors
  - Male sex
  - Postmenopausal women
  - Age
  - Genetics (familial)
  - Ethnicity
  - Smoking / Alcohol use
  - Sinus disease (?)
  - Body habitus (Apple vs. Pear) Waist to hip ratio

COPD, OSA, and OHS

- 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

COPD, OSA, and OHS

- 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

COPD, OSA, and OHS

- 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%.
      - Hawrylkiewicz, 2004.

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

COPD and OSA

- McNicholas observed that patient 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. A. Am J Respir Crit Care Med 2010

COPD and OSA

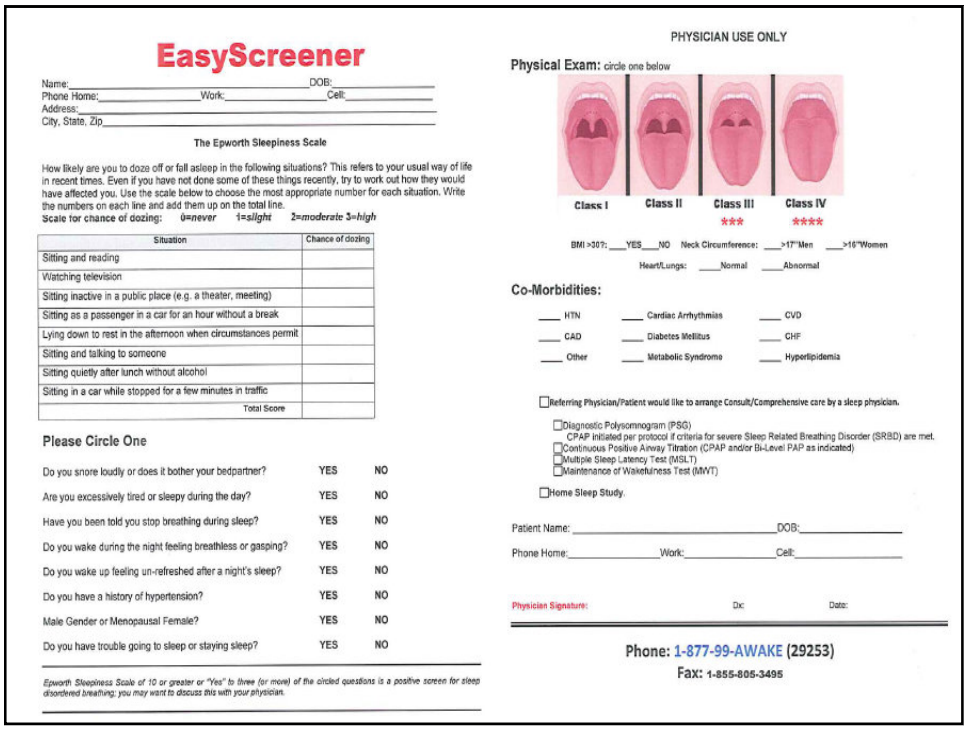
- Clinical significance
  - Increased incidence of COPD exacerbations
  - Increase risk of respiratory failure
  - Hospitalization and death
  - Patients admitted with acute exacerbation of COPD in which evaluation does not demonstrate an obvious reason: consider sleep disordered breathing

COPD and OSA

- 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)



EasyScreener

Name:_____DOB:_____
Phone Home:_____Work:_____Cell:_____
Address:_____
City, State, Zip_____

The Epworth Sleepiness Scale

How likely are you to doze off or fall asleep in the following situations? This refers to your usual way of life in recent times. Even if you have not done some of these things recently, try to work out how they would have affected you. Use the scale below to choose the most appropriate number for each situation. Write the numbers on each line and add them up on the total line.

Scale for chance of dozing: *0=never 1=slight 2=moderate 3=high*

Situation	Chance of dozing
Sitting and reading	
Watching television	
Sitting inactive in a public place (e.g. a theater, meeting)	
Sitting as a passenger in a car for an hour without a break	
Lying down to rest in the afternoon when circumstances permit	
Sitting and talking to someone	
Sitting quietly after lunch without alcohol	
Sitting in a car while stopped for a few minutes in traffic	
Total Score	

Please Circle One

Do you snore loudly or does it bother your bedpartner?	YES	NO
Are you excessively tired or sleepy during the day?	YES	NO
Have you been told you stop breathing during sleep?	YES	NO
Do you wake during the night feeling breathless or gasping?	YES	NO
Do you wake up feeling un-refreshed after a night's sleep?	YES	NO
Do you have a history of hypertension?	YES	NO
Male Gender or Menopausal Female?	YES	NO
Do you have trouble going to sleep or staying sleep?	YES	NO

Epworth Sleepiness Scale of 10 or greater or "Yes" to three (or more) of the circled questions is a positive screen for sleep disordered breathing; you may want to discuss this with your physician.

PHYSICIAN USE ONLY

Physical Exam: circle one below

Class I Class II Class III *** Class IV ****

BMI >30?: ___YES___NO Neck Circumference: ___>17"Men ___>16"Women

Heart/Lungs: ____Normal ____Abnormal

Co-Morbidities:

___ HTN	___ Cardiac Arrhythmias	___ CVD
___ CAD	___ Diabetes Mellitus	___ CHF
___ Other	___ Metabolic Syndrome	___ Hyperlipidemia

☐ Referring Physician/Patient would like to arrange Consult/Comprehensive care by a sleep physician.

- ☐ Diagnostic Polysomnogram (PSG)
  CPAP initiated per protocol if criteria for severe Sleep Related Breathing Disorder (SRBD) are met.
- ☐ Continuous Positive Airway Titration (CPAP and/or Bi-Level PAP as indicated)
- ☐ Multiple Sleep Latency Test (MSLT)
- ☐ Maintenance of Wakefulness Test (MWT)

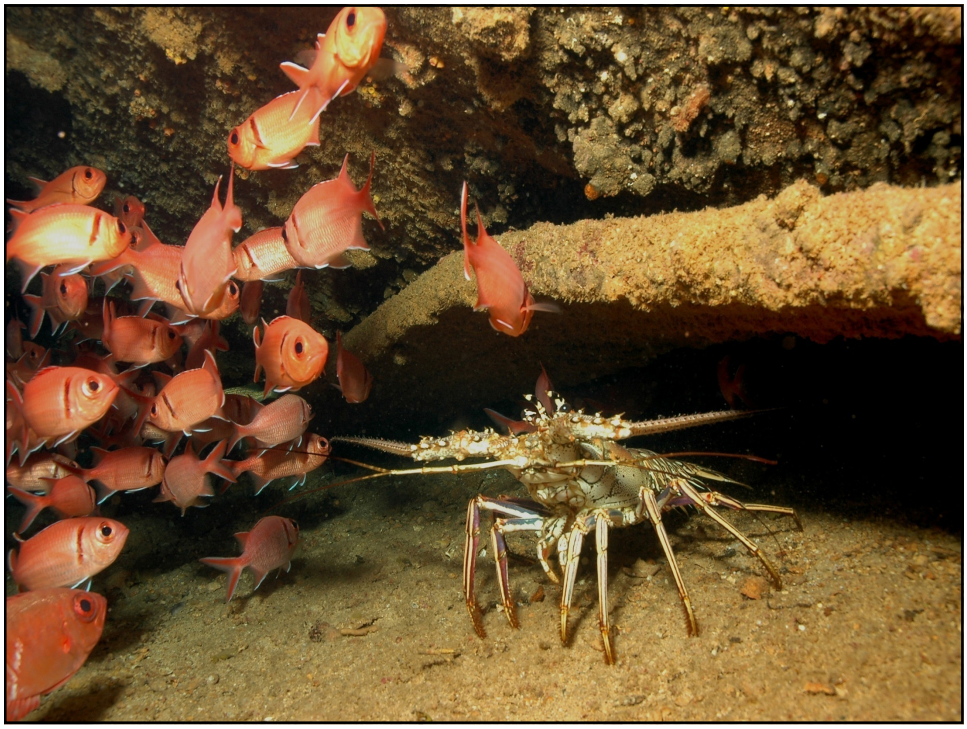
☐ Home Sleep Study.

Patient Name: _____DOB:_____

Phone Home:_____Work:_____Cell:_____

Physician Signature: Dx: Date:

Phone: 1-877-99-AWAKE (29253)
Fax: 1-855-805-3495



COPD, OSA, and OHS

- Obesity Hypoventilation Syndrome
  - Daytime hypercapnea and hypoxemia
    - PaCO2 > 45 MM HG and PaO2 < 70 mm Hg
  - BMI > 30 kg/m2
  - Sleep disordered breathing
    - 90% obstructive sleep apnea
    - 10% hypoventilation
  - Diagnosis of exclusion
    - R/O pulmonary/neuromuscular / chest wall abnormality

COPD, OSA, and OHS

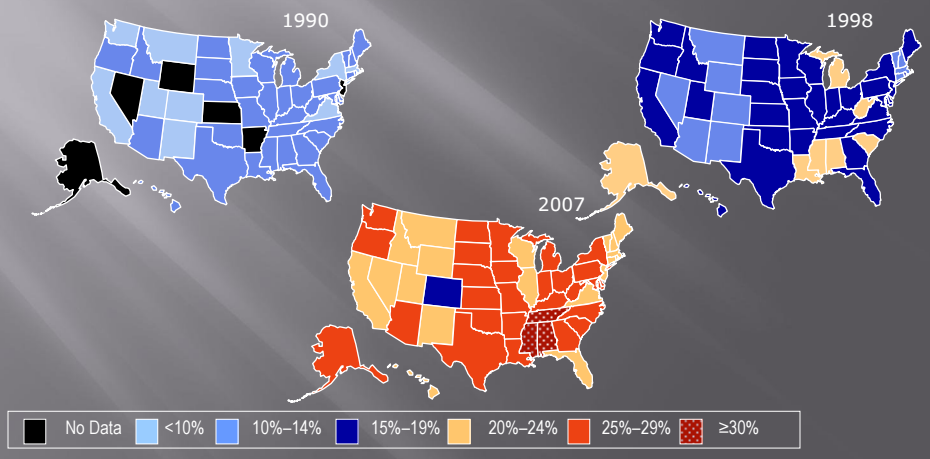
- Sleep Related Hypoventilation/Hypoxemic Syndromes Casey, K et al. Chest 2007; 131: 1936-1948
  - Pulmonary parenchymal or vascular etiology
    - Pulmonary fibrosis
    - Primary pulmonary hypertension
  - Lower airway obstruction
    - Chronic bronchitis/asthma
    - Emphysema
  - Neuromuscular or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

COPD, OSA, and OHS

- Obesity Hypoventilation Syndrome
  - Prevalence
    - General population: 0.3%.
      - 1:300-600 adults
    - Obstructive sleep apnea: 10-20%
    - Hospitalized patients with BMI > 35: 31%.
      - Nowbar Am Jr Med 2004.
  - 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
BRFSS, 1990, 1998, 2007

(*BMI ≥30, or about 30 lbs. overweight for 5'4" person)



COPD, OSA, and OHS

- Critical points of the NHANES data
  - Prevalence of clinically severe obesity is increasing much faster than that of moderate obesity.
    Strum, R. Increase in morbid obesity in the USA. Public Health 2007, 121(7), 492-496. Data from 2000-2005.
  - 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 resistence (neurohormonal)
  - Chronic hypercapnea is seen in less than one third of individuals with morbid obesity.

COPD, OSA, and OHS

- 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

COPD, OSA, and OHS

- Obesity Hypoventilation Syndrome
  - Measures of Severity of OSA associated with chronic hypercarbia
    - AHI
    - Mean overnight SpO2
    - Minimum SpO2 during sleep
    - %TST < 90% during sleep
      - Kaw, et al. Chest, 2009.

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

COPD, OSA, and OHS

- 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*

COPD, OSA, and OHS

- Obesity Hypoventilation Syndrome
  - Obesity-Associated Hypoventilation in Hospitalized Patients: Prevalence, Effects, and Outcome. Nowbar, S. et. al. Am Jr of Med 116; Jan 1 2004. pgs 1-7.
    - 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%() Hazard ratio 4.0
      - The difference in survival was evident as early as 3 months post discharge

COPD, OSA, and OHS

- Obesity Hypoventilation Syndrome
  - 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
      - Mokhlesi, B. et al. Sleep and Breathing 2007; 11; 117-24.
    - 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

COPD, OSA, and OHS

- Obesity Hypoventilation Syndrome
  - Treatment
    - Positive Pressure Therapy
      - Volume-Assured Pressure Support Ventilation (VAPS)
        - Successful in small trial in mild OHS
          - Store, JH. Chest 2006; 130(3); 815-821.
      - APAP
        - Not recommended Practice parameters AASM
        - Caution: Protocols using APAP in hospital
    - Surgical
      - Tracheostomy
      - Bariatric surgery
        - Little data on long term effectiveness

COPD, OSA, and OHS

- Obesity Hypoventilation Syndrome
  - Treatment
    - Hypoventilation only (10%)
      - Non invasive positive pressure therapy
      - Low EPAP with high IPAP
  - 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. 218-225.

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

COPD, OSA, and OHS

- 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
    - Post operative 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

Carr, G. et al. Acute Cardiopulomonary Failure From Sleep-Disordered Breathing. Chest 2012;141(3):798-808

COPD, OSA, and OHS

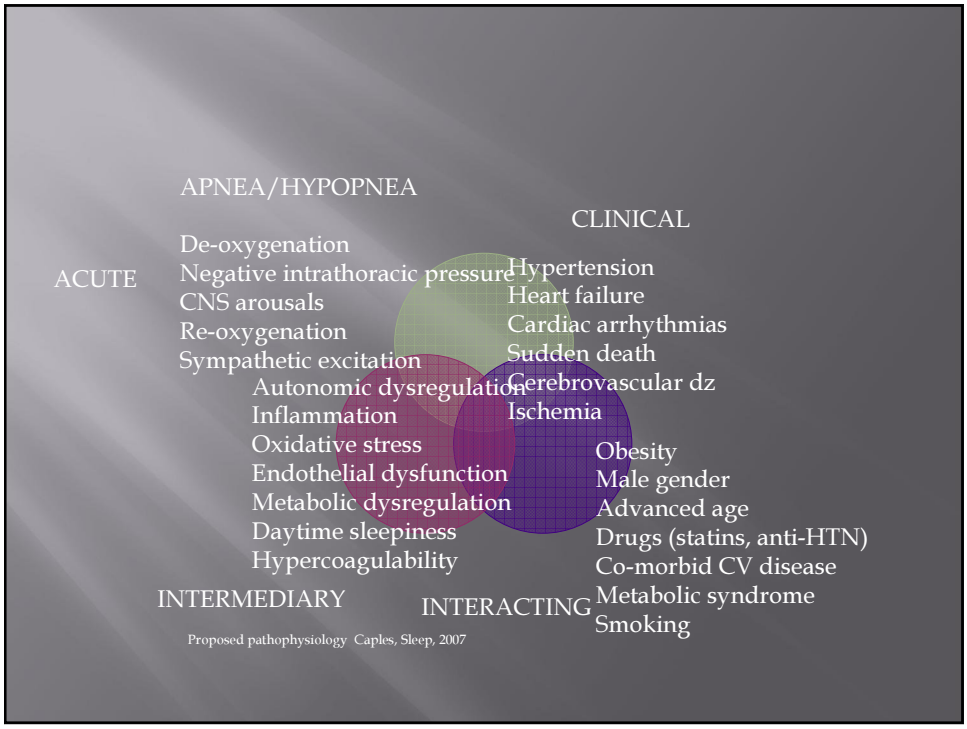
- Malpractice cases involving Obstructive Sleep Apnea in Hospitalized Patients
  - Intubation complications (20%)
  - Extubation difficulties (10%)
  - Post operative catastrophes (70%)
    - Drug induced respiratory arrest resulting in death/brain damage
    - Patients with OSA with inadequate monitoring

COPD, OSA, and OHS

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

COPD, OSA, and OHS

- 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.


APNEA/HYPOPNEA
ACUTE
De-oxygenation
Negative intrathoracic pressure
CNS arousals
Re-oxygenation
Sympathetic excitation
Autonomic dysregulation
Inflammation
Oxidative stress
Endothelial dysfunction
Metabolic dysregulation
Daytime sleepiness
Hypercoagulability
INTERMEDIARY
CLINICAL
Hypertension
Heart failure
Cardiac arrhythmias
Sudden death
Cerebrovascular dz
Ischemia
INTERACTING
Obesity
Male gender
Advanced age
Drugs (statins, anti-HTN)
Co-morbid CV disease
Metabolic syndrome
Smoking
Proposed pathophysiology Caples, Sleep, 2007