SLEEP IN THE INTENSIVE CARE UNIT PATIENT

Focus on Critical Care
May, 2017

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Objectives

• Document patients sleep
• Recognize the impact of sleep deprivation on co-morbid conditions
• Recommend sleep enhancing techniques
What is Sleep?

A temporary perceptual disengagement from and unresponsiveness to environmental surroundings

~8 hours/day, 56 hours/week, 240 hours/month and 2,920 hours/year

Carskadon and Dement, Principles and Practices of Sleep Medicine, 2011
Sleep Wake Cycle: Two Process Model

Homeostatic Sleep Drive

Circadian Alerting Signal (SCN)

Melatonin

Awake  Asleep

9 am  3 pm  9 pm  3 am  9 am

The stages of sleep

- Sleep is comprised of stages
  - Non rapid eye movement
    - Stages 1, 2 and 3 (slow wave sleep)
  - Rapid Eye Movement Sleep
    - Dream Sleep
Physiologic Differences - Sleep States

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>NREM</th>
<th>REM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of sleep cycle</td>
<td>75-80%</td>
<td>20-25%</td>
</tr>
<tr>
<td>Ability to arouse</td>
<td>Easy</td>
<td>Difficult</td>
</tr>
<tr>
<td>Airway resistance</td>
<td>Increases from wakefulness</td>
<td>Increases and varies from wakefulness</td>
</tr>
<tr>
<td>Respiration</td>
<td>Decreases</td>
<td>Increases; coughing suppressed; may show brief stoppages</td>
</tr>
<tr>
<td>Muscle tone</td>
<td>Muscular activity</td>
<td>No movement</td>
</tr>
<tr>
<td>Heart rate</td>
<td>Decreases</td>
<td>Increases</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>Decreases</td>
<td>Increases</td>
</tr>
<tr>
<td>Sympathetic nerve activity</td>
<td>Decreases</td>
<td>Increases</td>
</tr>
<tr>
<td>Blood flow to brain</td>
<td>Decreases</td>
<td>Increases (dependent on brain region)</td>
</tr>
<tr>
<td>Brain activity</td>
<td>Decreases</td>
<td>Increases in motor and sensory areas</td>
</tr>
<tr>
<td>Body temperature</td>
<td>Regulated at lower set point</td>
<td>No regulation</td>
</tr>
</tbody>
</table>

All in reference to state of wakefulness. NREM, non-rapid eye movement; REM, rapid eye movement.

Transition from Wake to sleep

Stage W (transition to stage 1: note drop out of alpha rhythm)
Features of stage 2 sleep (N2)
REM and SW Sleep

REM (Phasic)

Stage 4: > 50% delta waves (still Stage N3)
Normal Sleep Histogram-Age Related

http://thoracickey.com/sleep-disorders-laboratory-evaluation/
Good vs Bad Night of Sleep

Figure 1

Sleep Stages

Wake
REM
Stage 1
Stage 2
Stage 3
Stage 4

Hours of Sleep

(A)

Sleep Stages

Wake
REM
Stage 1
Stage 2
Stage 3
Stage 4

Hours of Sleep

(B)

The sleep architecture demonstrated in the top hypnogram (A) demonstrates a pattern of normal sleep stage progression across the night. The lower hypnogram (B) demonstrates a very disrupted pattern of sleep with frequent brief awakenings throughout the night.

Why is sleep important?

- Animal models, sleep loss leads to
  - Failure of body temperature regulation
  - Increased metabolism
  - Deterioration of hypothalamic neurons
  - Progressive breakdown of host defenses
  - Death

Redeker & McEnany, 2011
Functions

- Conserve energy and metabolism
- Maintain physiologic systems within proper homeostatic mechanisms
- Maintain host defenses
- Reverse/restore physiologic processes that degrade during wakefulness
- Memory Consolidation
- Learning

Redeker & McEnany, 2011
How much sleep do we really need?

• ~8 hours!
• U shaped curve of sleep duration

People reporting consistently sleeping five hours or less per night should be regarded as a higher-risk group for cardiovascular morbidity and mortality; higher odds of having diabetes and insulin resistance.

Sleep restriction may be an independent risk factor for developing symptomatic diabetes: Nurses Health Study (Ayas et al, Diabetes Care 2003)

People sleeping nine hours or more per night may represent a useful diagnostic tool for detecting subclinical or undiagnosed comorbidity; higher odds of having diabetes and insulin resistance.

Cappuccchio et al, 2011, Eur Heart Journal
Factors Contributing to Sleep Loss

- Voluntary curtailment (social)
- Environment (i.e. work, technology, etc)
- Role (new parent, school)
- Sleep Disorders
- Medical and psychiatric disorders

Redeker & McEnany, 2011
Effects of Sleep deprivation

- Irritability
- Cognitive impairment
- Memory lapses or loss
- Impaired moral judgement
- Severe yawning
- Hallucinations
- Symptoms similar to ADHD
- Impaired immune system
- Increased heart rate variability
- Risk of heart disease
- Decreased reaction time and accuracy
- Tremors
- Aches

Other:
- Growth suppression
- Risk of obesity
- Decreased temperature

- Risk of diabetes Type 2
Outcomes of Disturbed Sleep

- Increased stress hormones (catacholamines)
- Insulin and glucose dysregulation
- Ability to perform activities of daily living
  - Lack of mental processing of self care activities upon discharge
- Decrease in SWS
  - ↓ HGH
  - Alterations in processing and consolidating newly acquired information
Patients are admitted already sleep deprived

Think about this.............
Sleep and Co-Morbidity

Bi-directional impacts

Lack of sleep impacts a host of body functions

Illness impacts an individual’s ability to have adequate sleep.
Co-Morbidity and OSA

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug resistant hypertension</td>
<td>83%</td>
</tr>
<tr>
<td>Obesity</td>
<td>77%</td>
</tr>
<tr>
<td>Congestive Heart Failure</td>
<td>76%</td>
</tr>
<tr>
<td>Diabetes Type 2</td>
<td>72%</td>
</tr>
<tr>
<td>Stroke</td>
<td>63%</td>
</tr>
<tr>
<td>Pacemakers</td>
<td>59%</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>58%</td>
</tr>
<tr>
<td>Coronary heart disease</td>
<td>57%</td>
</tr>
<tr>
<td>Afib (Atrial Fibrillation)</td>
<td>49%</td>
</tr>
<tr>
<td>Depression</td>
<td>45%</td>
</tr>
</tbody>
</table>

Note: % represent comorbidity

Source: Seet & Chung, Anesthesiology Clin 2010
General Sleep Assessment (1)

• Challenges
  • Sleep problems typically occur gradually; patients may not be aware or concerned
  • May attribute daytime symptoms to other causes

• Assessment
  • BEARS (all ages)
    • B-bedtime problems
    • E-Excessive Sleepiness
    • A-Awakenings
    • R- Regularity of sleep
    • S-Sleep disordered breathing

Redeker & McEnany, 2011
Restless Legs-Bedtime Problems

• Sensorimotor disorder
  • Urge to move legs, worsened by rest or inactivity, symptoms relieved by movement, develop or worsen in the evening or nighttime

• Prevalence 2-3%

• Associated with
  • comorbidities
  • Immobility
  • Sleep deprivation
  • Circadian disruption
  • anemia

https://www.youtube.com/watch?v=k2eG0Hk9AAC
General Sleep Assessment (2)

- General health
- Specific Conditions
  - Co-morbid/bi-directionality (heart disease, asthma, diabetes, Parkinsons, pain, depression and anxiety)
  - Cardiovascular (BP, EKG, heart sounds)
  - Pulmonary system (scoliosis, muscle tone)
  - Neuromuscular (restless legs syndrome)
  - Glycemic control

Redeker & McEnany, 2011
General Sleep Assessment (3)

- Anthropometric data
  - Ht/Wt (BMI >30), neck circumference (17 m, 16 f) correlate with OSA in adults
  - Waist circumference and BMI>95th percentile in children
  - Inspection of the profile, oral and nasal cavities

- Mallampati

Retrognathia
Alterations in Sleep Health

• Quantity
• Quality
• Timing and Consistency

“sleep is viewed as a basic biologic process that affects all individuals and has significant impact on the function of all organ systems” (1)

Multiple environmental barriers to sleep in the ICU were identified when participants were directly asked about factors affecting sleep. Responses highlighted healthcare system-based barriers related to hospital/ICU policy and workflow. Implicit barriers to sleep were found when participants responded to open-ended questions. These included attitudinal barriers such as the uncertainty about the significance of sleep, the tension between providing protocol-driven ICU care and allowing uninterrupted patient sleep, and lack of consensus regarding interventions to promote sleep.

Conclusions

This qualitative study suggests that health care worker attitudes, methods of sleep promotion, hospital institutional policies and workflow may contribute to sleep disruption in the ICU. These barriers provide additional targets for intervention in studies designed to improve sleep in the ICU.
## Sleep in the ICU

<table>
<thead>
<tr>
<th>Sleep Parameter</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Sleep Time</td>
<td>Unchanged/decreased</td>
</tr>
<tr>
<td>Sleep Latency</td>
<td>Unchanged/increased</td>
</tr>
<tr>
<td>Sleep Efficiency</td>
<td>Decreased</td>
</tr>
<tr>
<td>NREM Stage 1</td>
<td>Increased</td>
</tr>
<tr>
<td>NREM Stage 2</td>
<td>Increased</td>
</tr>
<tr>
<td>NREM Stage 3</td>
<td>Decreased</td>
</tr>
<tr>
<td>REM</td>
<td>Decreased</td>
</tr>
</tbody>
</table>

Environmental and Pathophysiological Factors

Noise and Light

• Noise levels typically exceed that recommended by WHO
  • 30 dB Average; 40 dB maximum (Yoder, et al., 2012)
    • As high as 80dB
  • Day/Night Variance
  • Reduced sleep, poor sleep efficiency
  • HCAPS score
  • Medical devices and conversation

• Lighting is aperiodic
  • Morning light to improve entrainment
  • Open window coverings
  • Circadian influence

• Quality Improvement Programs

"He's resting comfortably."
ICU Delirium

1. American Association of Critical Care Nurses, 2014
2. Cavallazzi, et al., 2012 Annals of Intensive Care
3. Flink, et al. 2012 Anesthesiology
Adverse Outcomes of Delirium

- Self extubation
- Removal of catheters
- Increased
  - length of stay
  - Increased costs
  - Increased falls
  - Use of restraints

- Increased morbidity and mortality
  - Worse cognitive status at discharge and 12 months after DC
- Family/caregiver distress
Sleep Deprivation and Delirium

DIRECT EFFECT ON THE BRAIN:
- Medications
- Dementia
- Sepsis
- Head trauma
- Advanced age
- Alcoholism

STRESS RESPONSE:
- Critical illness
- Mechanical ventilation
- Pain
- Sepsis

ICU ENVIRONMENT:
- Noise
- Light/Circadian disruption
- Patient care activities
- Stress and sensory deprivation

Pharmacology Impacts

• Opioids
  • Decrease total sleep time, SWS, REM
  • Precipitate OSA
  • Worsen hypoxia
  • Ventilator asynchrony

• Benzodiazapines
  • Increase theta; reduce SWS (low doses)
  • Loss of SWS has been shown to increase delirium

• Dexmedetomidine (Precedex)
  • Decrease sleep latency; REM
  • Increases REM
  • Reduces ventilator days
  • Reduces delirium

• Propofol
  • Reduces REM sleep and contributes to poor sleep quality in mechanically ventilated patients (Kondili, 2011)

http://www.medscape.com/viewarticle/723907_2?pa=FKay6DydWAoldEOyiMJ7mNUPPP%2BJBMnDcVlg2VcXoz8cg2BFgaJxZUoCbMkbFK5aN0JnN08P2fm2zqEsifi7A%3D%3D

Wienhourse, Crit Care Clinics, 2008
Pharmacology Impacts

• Cardiovascular
  • B agonists: increase wake and REM
  • ACE inhibitors: No effect on sleep
  • Dopamine: decrease SWS, REM

• Respiratory
  • Xanthines: Decrease total sleep time, REM, sleep efficiency, SWS
A bit about Melatonin

- Secreted by the pineal gland
- Modulated by the SCN (circadian pacemaker)
- Outside of the blood brain barrier
- Released into the bloodstream
- Secreted at night (darkness), highest levels ~3-4 AM
- Secretion reduced on light exposure

- Critically ill patients have been found to have abnormal levels of melatonin
Melatonin Use in the ICU

- Few RCT
- Data are inconclusive for the prevention or lessening of dementia

- Use of Ramelteon
  - Melatonin agonist
  - Indicated for insomnia
  - Some success reported

http://www.medscape.com/viewarticle/820795?pa=4%2F5zOMn2NBfa97sNtFmW%2FReOlcteyvWIYQwO3c4QJtUyfsH6gLbrmoZz1O3yo%2Bpv43mU9jD%2B1DtnxY47OmyybA%3D%3D
Interventions

- Reduce Effects of Environmental Stimuli
  - Decrease noise
  - Cluster patient care interventions
  - Provide eye masks and ear plugs if appropriate
- Complementary and Alternative Medicine
  - Relaxation, music and biofeedback
    - White noise may improve sleep quality in cardiac post op patients
  - Massage
  - Meditation
- Progressive mobility/up in the chair during the day
- Families bring in familiar objects and pictures.
- Review Drug interactions, understand the consequences
Interventions

"We haven't recognized the importance of prescribing sleep“ Friese, R 2007

About Obstructive Sleep Apnea

Risk factors
- Nasal congestion
- Route of breathing

Pathogenic mechanisms
- Craniofacial structure
- Obesity
- Genetics or ethnic origin
- Sex
- Age
- Low lung volume
- Respiratory instability
- Poor upper airway muscle function
- Low arousal threshold
- Surface forces

Possible treatments
- Surfactant
- MAD
- UPPP
- CPAP
- O2/Drugs
- HGNs
- Sedatives

Figure 1: Risk factors, pathogenic mechanisms, and treatments for obstructive sleep apnoea

Risk factors for obstructive sleep apnoea have long been recognised, but novel pathogenic mechanisms have now been detected in patients with the disorder. Although CPAP is the current treatment of choice irrespective of underlying cause, treatments based on tackling individual pathogenic mechanisms might prove a successful alternative approach in the future. CPAP = continuous positive airway pressure. MAD = mandibular advancement device. UPPP = uvulopalatopharyngoplasty. HGNs = hypoglossal nerve stimulation. Figure adapted from Jordan and colleagues, by permission of Elsevier.
What does OSA look like?
Patterns of Unexpected Hospital Death

Table 2 The Three Clinical Pattern Types of Unexpected Hospital Death (PUHD)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE I</td>
<td>Hyperventilation Compensated Respiratory Distress (e.g. Sepsis, PE, CHF)</td>
</tr>
<tr>
<td></td>
<td>Stable SPO2 with progressively falling PaCO2 eventually yields to slow SPO2</td>
</tr>
<tr>
<td></td>
<td>decline (mitigated by respiratory alkalosis) and followed by precipitous</td>
</tr>
<tr>
<td></td>
<td>SPO2 decline when metabolic acidosis dominates</td>
</tr>
<tr>
<td>TYPE II</td>
<td>Progressive Unidirectional Hypoventilation (CO2 Narcosis)</td>
</tr>
<tr>
<td></td>
<td>Progressive rise in PaCO2 (and etCO2) and fall in SPO2 over 15 minutes to</td>
</tr>
<tr>
<td></td>
<td>many hours. (Often due to overdosing of narcotics or sedatives)</td>
</tr>
<tr>
<td>TYPE III</td>
<td>Sentinel Rapid Airflow/SPO2 Reductions Followed by Precipitous SPO2 Fall.</td>
</tr>
<tr>
<td></td>
<td>A state of &quot;arousal dependent survival&quot; that occurs only during sleep.</td>
</tr>
<tr>
<td></td>
<td>Arousal failure allows precipitous hypoxemia during apnea causing</td>
</tr>
<tr>
<td></td>
<td>terminal arousal arrest.</td>
</tr>
</tbody>
</table>

Lynn and Curry *Patient Safety in Surgery* 2011, 5:3
http://www.pssjournal.com/content/5/1/3
Figure 3: Type III Pattern of Unexpected Hospital Death (Sleep Apnea with Arousal Failure)

- ALARM
- FATIGUE

Note: Timelines and data points for Ve, Apnea, PaCO₂, and SpO₂ are indicated, with annotations suggesting a pattern of events leading to an alarm.
OSA in the Hospital

- Estimated 25% of candidates for elective surgery
- OSA undiagnosed in 80% at the time of surgery
- Estimates of OSA in hospitalized patients
  - >50%
- <20% with a diagnosis of OSA received therapy during hospitalization (Premier Inc, database; Memtsoudis et al, 2013, NEJM)
Screening for OSA

• Variety of questionnaires
  • Epworth, Berlin, STOP/STOP BANG, Sleep Apnea Clinical Score, perioperative sleep apnea prediction (P-SAP, 2010)
• Pulse Oximetry
• Home sleep testing for all elective surgical procedures
• Full polysomnography

2004 National Hospital Discharge Survey

• 6.8% reported SA in discharge data
• 5.8% received continued PAP therapy while hospitalized
## STOP-BANG

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Snoring, do you snore loudly (louder than talking or loud enough to be heard through closed doors?)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>Tired, do you often feel tired, fatigued, or sleepy during the daytime?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>Observed, has anyone observed you stop breathing during your sleep?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Blood Pressure, do you have or are you being treated for high blood pressure?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>BMI, BMI more than 35 kg/m²?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Age, age over 50 years old?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Neck Circumference, neck circumference greater than 40 cm (16 in)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Gender, gender male?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
OSA in the Hospitalized Patient

• Why OSA is an important assessment
  • Association with MI, arrhythmias, CHF, stroke, sudden cardiac death
    • Sudden death ~ 50% those with OSA compared to 21% without OSA
    • Die during the sleep hours (12-6 AM)
    • Sudden death related to the AHI, the more severe the higher the risk
  • Depressed arousal mechanisms due to sleep fragmentation and deprivation; acquired arousal failure in obese patients
    • Narcotics further delay arousal

Kaw & Mokhlesi (2012) Sleep and Breathing
Types of patients at high risk for OSA

- CHF
- Obese
  - Patients undergoing bariatric surgery
- Atrial Fibrillation
- Refractory Hypertension
- Type 2 diabetes
- Stroke
- Nocturnal cardiac arrhythmia
- Pulmonary Hypertension

AASM Task Force, 2009 JCSM
2 Relevant Joint Commission Directives

Characteristics of patients who are at higher risk for oversedation and respiratory depression:

- Sleep apnea or sleep disorder diagnosis\(^5,6,10\)
- Morbid obesity with high risk of sleep apnea\(^2,8\)
- Snoring\(^5,8\)

The Joint Commission
Sentinel Event Alert

2014 Hospital
National Patient Safety Goals

The purpose of the National Patient Safety Goals is to improve patient safety. The goals focus on problems in health care safety and how to solve them.

Use alarms safely

NPSG.06.01.01 Make improvements to ensure that alarms on medical equipment are heard and responded to on time.
Key Take Away

- OSA patients live in a state of “perpetual arousal dependent survival” (Lynn & Curry, 2011)
- Acquired arousal failure
- Sleep deprivation may have long lasting ramifications
Sleep Apnea in Hospitalized Patients

Regardless of admission diagnosis

↑ vulnerability to adverse outcomes when left untreated
• Cardiorespiratory failure and unanticipated death
• Falls, HCAP, prolonged intubation, longer ALOS

↑ utilization health care resources

↑ risk hospital litigation

Slide used with permission Dr. Lisa Kuhnen
Care Process Changes

**Do’s**

- Always assess your patients sleep health
- Document/communicate alterations in sleep
- If patients use CPAP at home, have them bring it and use it
- Create an opportunity for sleep; limit interaction

**Don’ts**

- Underestimate the consequences of poor sleep
- Dismiss alarms from oximeters
- Forget to monitor frequently
- Assume the patient is sleeping
Summary

- Sleep deprivation can be acute or chronic
  - Both have resulting physiological consequences
- Sleep in hospitalized patients is disturbed resulting in sleep deprivation.
- A large proportion of patients who enter the hospital have not been diagnosed with sleep apnea or have CPAP initiated or continued from home
- Increased awareness of sleep deprivation and sleep apnea can provide for improvement in interventions and early recognition of patients with a potential for adverse consequences
- Program implementation can have important financial considerations
Goals for Sleep in the ICU

- Get enough sleep
- Reset circadian rhythms
- Adjust abnormal sleep structure
- Reduce sleep interruption
- Reduce fatigue/stress

Huang, et al, 2014, Trials
“I fear to become a patient…”
“…that’s what scares me: to be made helpless before my time…. To be awoken when I wish to sleep”

Don Berwick, MD
What ‘Patient-Centered’ Should Mean: Confessions of an Extremist
Health Affairs, 2009
• Please feel free to contact me!

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