Safely Monitoring Post-Operative Patients on a Medical/Surgical Unit Utilizing Continuous Cardiorespiratory Remote Monitoring

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Disclosures

- None

Objectives

- Identify factors that place patients receiving opioid analgesia at higher risk for opioid-induced respiratory depression.
- Describe the application and benefits of using integrated PCA pause protocol and continuous respiratory monitoring on a medical/surgical unit.
- Outline the considerations for nurse monitoring to reduce the patient's risk of opioid-induced sedation and respiratory depression.
- Outline the considerations for use of technological monitoring to reduce the patient's risk of oversedation and respiratory depression.
Munson Medical Center

- Eight affiliated hospitals
- Largest employer in Northern Michigan
  - 4,000 employees
  - 400 physicians
- High quality care with repeated national recognition such as
  - 2008 American Hospital Association-McKesson Quest for Quality Prize®
  - Top 100 Hospitals® list 11 times
  - Magnet hospital for nursing excellence
  - Bariatric Surgery Center of Excellence

Sleeping Bear Dunes Voted 'Most Beautiful Place in America By Good Morning America

Background

- In October 2006, the Anesthesia Patient Safety Foundation (APSF), hosted a workshop to look at opioid administration for post operative patients
- They summed up that there is a significant under appreciated risk of injury post operatively of drug induced respiratory failure
- Rates of respiratory depression are higher among patients receiving continuous opioid infusions

To maintain the status quo while awaiting newer technology is NOT acceptable.
Intermittent “spot checks” of oxygenation & ventilation are not adequate to reliably recognize clinically significant evolving drug-induced respiratory depression in the postoperative period.
Continuous monitoring should complement, not replace traditional nursing assessments and persistence.
All patients should have oxygenation monitored by continuous pulse oximetry.
Capnography or other monitoring modalities, which require measurement of ventilation and airflow, is indicated when supplemental oxygen is needed to maintain acceptable saturations.

Recommended that a progressed electronic continuous monitoring plan be adopted, which includes a careful preoperative screening mechanism for conditions that may be associated with increased risk of postoperative respiratory insufficiency.
Continuous monitoring from a central location (telemetry or comparable) is desirable
Nurse & Physician education is CRITICAL
- Important to have an understanding of physiology and pharmacology of drug induced respiratory depression
- Potential impact of patient arousal on respiratory depression
- Implication of supplemental oxygen administration of detection of progressive hypoventilation when SPO2 is the only continuous electronic monitor available
Threshold-based alarm limits being too sensitive (excess false alarms) or insufficiently sensitive.

Identify safety risk related to respiratory depression and opioid administration
Improve patient safety related to pain management while standardizing clinical practice and dosing
Invest in technology that supports clinical decision making (integrated infusion & monitoring platform with trend data for clinician decision making)
Decrease risk for respiratory depression by continuously monitoring EtCO2 or SpO2 and the ability to stop opioid infusions
How Munson believes in Safety

- Munson culture of safety extends from the bedside to the boardroom
- Belief that a culture of safety is characterized by communication founded on mutual trust
- Encourage errors to be identified at the bedside and evaluate the causes and take appropriate actions to improve performance

Effects of Opioid and Benzodiazepine Medications on Breathing

- Opioids act directly on the brainstem respiratory centers involved in the regulation of respiratory rhythmicity
- Opioids decrease the sensitivity of the normal brainstem response to CO₂ (normally, increased CO₂ results in an increased respiratory rate)
- Benzodiazepines suppress arousal and also cause hypotonia (including hypotonia of the muscles of the upper airway)
- Concomitant use of opioids with other sedatives including benzodiazepines and nonbenzodiazepine hypnotics can result in potentially fatal respiratory depression

Identified at Risk Using Opioids

- Sleep apnea patients
- Healthy post op patients receiving opioids through PCA’s & PCEA’s are at unpredictable risk
- The opioid naïve
- The elderly
- Patients that are receiving other concomitant CNS depressants
Who Is Monitored?

- Postoperative patients with a PCA or PCEA
- Sleep apnea confirmed by a sleep study not treated with a CPAP or BiPAP
- OSA screening score greater than or equal to 5
- Risk of deoxygenation observed by nurse or respiratory therapist as evidenced by loud snoring
- All patients identified at risk are monitored with EtCO₂ unless on CPAP or BiPAP or nasal/oral surgery

Obstructive Sleep Apnea Assessment Tool

Why Does OSA Increase Postoperative Risk?

OSA

- Obstructed airway
- CNS arousal
- Hyperventilation
- Normal breathing

Effects of Opioid and Benzodiazepine Sedation

- Reduction in airway muscle tone
- Suppression of the arousal response
- Reduction in respiratory rate and rhythmicity
- Blunting of response to CO₂

Why Capnography?

- Additional safety tool for monitoring high risk patients
- Better indicator of respiratory changes vs. oxygen saturation
- Early alarms notify clinician and can stimulate patient
- Safe pain control that can help improve outcomes
- Can provide information on the ventilatory status of the patient, which, combined with other assessments, can guide treatment

What is EtCO2? What does it measure?

- Capnography is a "snapshot in time" & is directly related to the ventilation status of the patient
- EtCO2 monitoring refers to a noninvasive measurement of exhaled carbon dioxide, which is most useful when applied directly to patient care. A sample of expired gas is collected via small-bore tubing to the bedside monitor from the patient’s airway
- Changes in the EtCO2 levels reflect changes in metabolism, circulation, equipment function, or as we are most interested in, ventilation

SpO2 vs. EtCO2

- Pulse oximetry (SpO2) measures heart rate and the percent of hemoglobin saturated with oxygen
- SpO2 may be misleading when the patient is receiving O2
- Pulse oximetry does not detect the following markers of respiratory depression:
  - Respiratory rate
  - Pauses in respiration cycle
  - Increased exhaled CO2
  - Inadequate respirations

St John, R. End-Tidal Carbon Dioxide Monitoring. Critical Care Nurse, 2003; 23, 83-88.
Capnography Basics

- Normal waveform with descriptor's:
  - A - B: Baseline period of no CO2, End of inspiration
  - B - C: Exhalation begins, Begin rapid rise in CO2
  - C - D: Sustained exhalation, Alveolar plateau
  - D - E: Inhalation, Rapid decrease in CO2

- Normal ranges
  - Normal: 35 – 45 mmHg
  - Hypoventilation: > 45 mmHg
  - Hyperventilation: < 35 mmHg

- Picture of nasal cannula
  - Increased surface area prevents dilution from non-breathing
  - Small pin holes deliver pillow of O2 around both nose and mouth.

Capnography Basics

- Hypoventilation (Abnormal Waveform)
  - Clinical findings:
    - Slow breathing, High EtCO2
  - Possible Causes:
    - Over medication or increased sedation
    - Snoring or possible obstruction

- Hypoventilation with shallow Breathing (Abnormal Waveform)
  - Clinical findings:
    - Slow breathing, Low EtCO2 followed by deep breath
  - Possible Causes:
    - Over medication or increased sedation
    - Low tidal volume

How we Implemented our Technology Alarm Limits

- End tidal (EtCO2) alarm parameters:
  - CO2: 55 mmHg
  - CO2: 10 mmHg
  - RR: 35 breaths / min
  - RR: 6 breaths / min
  - No breath 30 seconds
  - FiCO2 high: 8 mmHg

- Pulse Oximetry (SPO2 %) alarm parameters:
  - % high: off
  - % low: 88
  - Pulse high: 110
  - Pulse low: 50

- PCA Pause Limits:
  - Pause on SPO2: 87%
  - Pause on RR: 5 breaths/min
Barriers to your implementation

- Knowledge gaps of staff
  - Unit-based in-services for nursing and RT
  - RT provided education, support & collaboration
  - Equipment skills education and validation
  - Unit, Alaris & Oridion educators provided multiple training sessions
  - DVD of respiratory physiology, CPAP/BIPAP
  - Separate in-services for non-nursing support
  - Experience is the best educator
  - Bedside interventions based on a patient's physiologic changes proved most challenging

- Hospital changes
  - Various protocols initiated and changed

Barriers to your implementation

- System wide changes
  - Hospital wide practice change
  - Multidisciplinary team approach, averted significant PCA programming errors that would have likely caused serious negative outcomes

- Leadership
  - Supportive

How We Made It Happen

- Regional standards of care throughout the health system
- Order sets were standardized to minimize prescription-related errors
- Standardized concentrations, policies, procedures and protocols
Policy, Practice, Education

- Staff were educated to prevent programming errors, PCA and EtCO2 technology and pause protocol use.
- Patients and families were educated to prevent PCA by proxy.

How We Made It Happen

- Staff were educated to prevent programming errors, PCA and EtCO2 technology and pause protocol use.
- Patients and families were educated to prevent PCA by proxy.

Support for your implementation

- Model of patient safety
  - There is a commitment to providing the safest and highest quality health care possible at all times. Every hospital staff member has a role in making health care safe.
- Interdisciplinary efforts
  - Magnet
    - Exemplary Professional Practice
    - Culture of Safety
    - Quality Care Monitoring and Improvement
    - New Knowledge, Innovations and Improvements
    - Nurse driven research project.
Technology Supporting Clinical Decision Making: Trend Data

- Integrated PCA and EtCO₂/SpO₂ monitoring
- Provides real-time trend of PCA dosing and monitoring history data (1, 5, 30, 60 & 120 minute intervals)
- Provides enhanced clinical decision making throughout the duration of pain therapy

Technology Supporting Clinical Decision Making: PCA Pause

PCA Pause Protocol
- Decreases the risk of respiratory depression by
  - Stopping the continuous infusion of opioids
  - Inactivates dose request handset further decreasing risk of respiratory depression related to PCA by proxy events

How Clinical Decision Making is Supported
- Nurses use clinical assessment data along with technology data to make appropriate and patient specific adjustments to opioid dosing
- Our best practice drives PCA pause protocol
- Our ability to review opioid dosing and response trend data during nursing rounds, end of shift reports, & PRN
Technology Application

- Collaborative process - nursing, RT, anesthesia, pharmacy, and pain management team
- Listen and respond to the clinicians at the bedside

Technology Application: Systems Manager and Gateway Monitoring

- Wirelessly updates
- Server & Gateway sockets:
  - SpO2/CO2 data received
  - Critical thresholds transmitted from bedside IV Pumps
  - PCA module Paused as necessary, low RR or low SpO2

Central Monitoring Software
- Interface for alarm management, monitoring data, and reporting

Server & Gateway sockets:
- SpO2/CO2 data received
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Comprehensive Reporting Tools
PCA Pause case study
- 75 y/o, Asian Female, Postop Laminectomy, Hx of multiple p.o. opioids preop.

Post Op & PCA by Proxy
- Hydromorphone PCA, patient was wife of MD who was concerned over patient's pain management. Husband administered PCA by Proxy over several events.

Central Monitoring
- Patient experiences ↓ RR, PCA Pausing events are captured, naloxone IV administered, ↓ PCA settings, patient family education on husband's PCA by proxy behavior.

Outcome
- Early awareness, interventions and assessments avoided adverse drug event monitoring.
Case Studies - Discussion

PCA Pause case study
- 73 y/o female, Decompressive Lumbar Laminectomy L 4-5 with 2 BAK at level L 4-5 and L 5-S1. MSO4 PCA settings; PCA dose 2 mg, Lockout 30 mins, Continuous 1.5 mg/hr.

Post Op Day #1
- 8 a.m., 12 mg over 8hrs, drowsy, pain rating 9 on pain scale 0 – 10, able to stand and ambulate with PT during ADL’s.
- 4 p.m., 18 mg over last 12hrs
- 5 p.m. Experiencing episodes of intermittent RR, central monitoring alarms, LOC, sedate easily awaken, easily awaken by monitoring alarms
- Progressed to EtCO2 low 60’s, RR 3 – 4, PCA Pause events, assessed LOC was drowsy and difficult to awake

Outcome
- Treated with Narcan, PCA discontinued, Narcan was titrated and a total of 0.4 was given over 1.5 hours.

Case Studies – Discussion

PCA Pause case study
- 57 y/o female post op gastric bypass, denies history of obstructive sleep apnea, Hypopnea score <5.

Post Op Day #1
- PCA settings, no continuous infusion, PCA dose 0.2 mg with Lockout 10/min.
- Continuous EtCO2 monitoring, Central alarm triggers for RR 4/min and periods of no breath (apnea) >30 sec.

Early Intervention
- Nursing assessment and observation.
- Low RR, PCA Pause events. No breath events
- RT consultant and application of Auto PAP

Outcome
- Avoided adverse drug event, avoided transfer to ICU, referred for sleep study. Better airway management and PCA pain management control.

Case Studies – Discussion

PCA Pause case study
- 54 y/o post op male, gastric sleeve bypass. Hx of OSA, anxiety

OR/PACU Course/B3
- 50 mcg of Fentanyl (OR), 2 mg IV Dilaudid, 0.5 mg Ativan and PCA (PCA settings, no continuous infusion, PCA dose 0.2 mg with Lockout 6/min). Pt rates pain 3/10.
- EtCO2 monitoring applied. RR 7-8. pt. drowsy but responds easily to questions

Early Intervention
- PCA settings reduced by 50%, discontinued use of demand button, Encourage coughing & deep breathing, early ambulation and stimulation

Outcome
- Pt avoided Narcan, MRT interventions through staff awareness and clinical decisions from the bedside nurses.
Case Studies – Discussions

- PCA Pause case study
  - 45 y/o female, Gastric Roux-en-y, Dilaudid PCA settings: PCA dose 1 mg, Lockout 6 mins, Continuous 0 mg/hr. Hx of OSA & Asthma (non compliant with CPAP)

- Post op Day 0
  - 1300 admission to surgical floor from PACU, drowsy but responds appropriately. Rates pain 2/10. ECO2 monitor applied
  - 1430 intermittent RR alarms of 7-9, as well “no breath” alarms detection on central monitor/pagers. 10 second periods of apnea noted. LOC drowsy, awakens to alarms/nursing. PCA Pause Protocol initiated

- Interventions
  - Nursing assessment, PCA settings decreased. Incentive Spirometry initiated. RT consult? Need for Auto pap

Research Project

Post-Surgical Patient-Centric Central Surveillance: Predictors of Cardiorespiratory Morbidity

C Nichols PhD, A Holmes MS, G Helmboldt ADN, T Baumann PharmD, L Roth BSN, L Biehl MSN, B Mikowski BS

What Was The Research Project?

- To provide continuous EICO2 and SpO2 monitoring of postoperative patients with:
  - Diagnosed obstructive sleep apnea
  - Undiagnosed obstructive sleep apnea
  - Aggressive pain management with medication

- Evaluate patient safety and cost effectiveness of monitoring respiratory status

- Munson Medical Center is the first in the country to monitor and document continuous EICO2 and SpO2 on this population of patients
Research Subjects

- Baseline Ss were consecutive post-op admissions to ICU stepdown or post-operative surgical unit
- Baseline vs. monitored Ss did not differ significantly with regard to:
  - Use of opioid and opioid-like drugs
  - Route of pain management
  - Use of other sedating drug categories
- Monitored Ss were consecutive admissions to post-operative surgical unit
  - ICU stepdown admissions were excluded during the continuous monitoring phase of the study because post-operative patients previously admitted to ICU stepdown were admitted to post-operative surgical unit after implementation of continuous monitoring.

Research Interventions:
Significant Differences Between Baseline and Monitored Ss

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Baseline Ss (%)</th>
<th>Monitored Ss (%)</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>Increased frequency of nursing assessment</td>
<td>11.7</td>
<td>26.4</td>
<td>&lt;.005</td>
</tr>
<tr>
<td>Stimulation</td>
<td>2.6</td>
<td>14.4</td>
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<tr>
<td>Increase in O2 flow</td>
<td>30.5</td>
<td>16.4</td>
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Kolmogorov-Smirnov Test (Statistica V. 9, 2008)

Benefits to adding Capnometry

- Increased monitoring of vital signs beyond usual protocol
- Increased frequency of nursing assessment beyond usual protocol
- Increased stimulation
- Increased patient use of incentive spirometry
- Increased adjustments to PCA/PCEA settings in response to RR status
- Decrease in reversal agents used
- Decrease in nasal oxygen flow adjustment
- Decrease in calls to Physician
- Decrease in transfer to critical care unit
- Decrease in MRT’s
- Decrease in CODE’s
Research Economic Impact

- Prior to implementation of continuous monitoring, postoperative patients with suspected or known sleep-disordered breathing were admitted to ICU or ICU stepdown unit.
- Patient cost on post-operative unit (B3) is 56% less than in ICU unit (P2).
- The implementation of the monitoring system has reduced the ICU and stepdown ICU census by approximately 2 patients per day.
- At MMC this is annual savings of 1.28 million per year.


Conclusion: Clinician Support and Patient Outcomes

- Use of continuous monitoring allows clinicians to obtain a more accurate evaluation of the patient’s respiratory status.
- Leads to cost-effective post-op care on med/surg unit without any increase in adverse events as compared to ICU post-op care.

Conclusion: Clinician Support and Patient Outcomes

- Use of continuous monitoring allows clinicians to use nursing assessment data and technology data leading to more appropriate nursing interventions.
- Smart pump CQI data is beneficial to measure improvements in practice and compliance.
- Continuous monitoring with PCA pause leads to safer patient care during opioid PCA delivery.
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Thank You!

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