

WebM&M

Morbidity and Mortality Rounds on the Web

Spotlight

Fatal PCA Opioid-Induced Respiratory Depression



Agency for Healthcare Research and Quality
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- This presentation is based on the May 2020 AHRQ WebM&M Spotlight Case
 - See the full article at <https://psnet.ahrq.gov/webmm>
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At the conclusion of this educational activity, participants should be able to:

- Describe risks associated with intravenous opioid administration through patient-controlled analgesia (PCA).
- Identify patient populations at high risk for postoperative opioid-induced respiratory depression.
- Discuss best practices for PCA prescribing and administration.
- Discuss best practices for monitoring sedation and respiratory status in postoperative patients receiving opioid PCA.

FATAL PCA OPIOID-INDUCED RESPIRATORY DEPRESSION

A case of postoperative opioid administration through patient-controlled analgesia (PCA) causing fatal respiratory depression highlights the challenges of PCA use particularly among patients with sleep apnea and other comorbidities

Case Details (1)

- 69-year old man
- Past medical history: cervical stenosis, coronary artery disease, chronic kidney disease and hypertension
- Worsening neck pain which prevented him from working, socializing and performing household tasks
- Used a motorized scooter due to severe osteoarthritis and knee pain
- Admitted for elective surgery for decompression and to extend a prior C3-C6 fusion down to T3

- Surgery concluded at approximately 13:00
- Patient recovered in the PACU
 - Placed on hydromorphone patient-controlled analgesia (PCA) for pain control
 - Usual home doses of gabapentin and acetaminophen continued
- Transferred from the PACU to the surgical floor at 20:00
 - Supplemental oxygen was placed due to SpO₂ of 88%

- The patient was awake and participating in care until 02:45 on post-operative day 1
- At 04:05, patient was found unresponsive and Code Blue was called
 - Patient initially responsive to resuscitation efforts and transferred to the ICU, where he arrested twice more
 - Tests the next day confirmed brain death and ventilatory support was withdrawn

FATAL PCA OPIOID-INDUCED RESPIRATORY DEPRESSION

The Commentary

By Sarina Fazio, PhD, RN and Rachelle Firestone,
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INTRODUCTION

Patient Controlled Analgesia (PCA) and Opioid-Induced Respiratory Depression

- Widely used for postoperative intravenous pain management and enabling patient control of medication administration frequency.
- PCA delivers a preprogrammed dose of opioid via infusion pump when the patient pushes a demand button
 - Lockout interval on the demand dose (~6-15mins) helps prevent overdose and dose-stacking, and can be adjusted depending on opioid used, tolerance and risk for respiratory depression
 - PCA avoids peaks/troughs seen with PRN opioid administration and allows more more individualized dosing

Opioid-Induced Respiratory Depression (1)

- Criteria defining opioid-induced respiratory depression:
 - Respiratory rate < 8-10 bpm
 - SpO₂ < 90%
 - Airway obstruction
 - Over-sedation
 - Naloxone administration
 - Respiratory arrest
 - Cardiopulmonary resuscitation
- Cumulative incidence in postoperative patients estimated between 0.1% and 23.7% (wide range due to variations in respiratory depression definitions); however, true incidence is unknown because respiratory depression can resolve without leading to a sentinel event

Opioid-Induced Respiratory Depression (2)

- PCA can result in critical respiratory depression events with significant consequences
- Review of anesthesia claims data (1990-2009) found 26% involved likely opioid-induced respiratory depression; of those, 77% resulted in severe brain damage or death
 - Most injuries occurred within 24h of surgery and were deemed preventable with better monitoring and clinician response
- Review of nationally reported opioid-related sentinel events found that 75% were attributable to medication error and improper monitoring

Opioid-Induced Respiratory Depression (3)

- Majority of PCA errors are associated with human factors
 - Prescribing (incomplete/contradictory orders, failure to adjust for organ dysfunction/comorbidities)
 - Dispensing (compounding errors, look alike/sound alike errors)
 - Administration (pump mis-programming)
 - Monitoring (lack of continuous pulse oximetry or capnography)
- The Joint Commission has made specific recommendations about policies and procedures to minimize risk of respiratory depression associated with opioid administration

BEST PRACTICES IN OPIOID PCA USE

Identification and Assessment of High-Risk Patients

Risk Factors for Opioid-Induced Respiratory Depression

Patient Characteristics	Comorbidities	Surgical & Perioperative Factors
<ul style="list-style-type: none">• Age > 55 years• Female gender• American Society of Anesthesiologists (ASA) physical status classification III-V• Opioid-dependent• Carrier of a risk-related genetic polymorphism• Smoker	<ul style="list-style-type: none">• Confirmed or suspected obstructive sleep apnea (OSA)• Renal disease• Pulmonary disease (including COPD)• Cardiac disease (including CAD, CHF, arrhythmias)• Diabetes mellitus• Obesity (BMI > 30 kg/m²)• Hypertension• Neurologic disease (including stroke, dementia)• Liver disease	<ul style="list-style-type: none">• First 24 hours after surgery• Orthopedic, general, and transplant surgery• Prolonged surgery (> 2 hours)• Patient-controlled analgesia (with basal rate)• Inadequate monitoring and handoff communication• PACU respiratory events (including desaturation, apnea, hypoventilation)• Hours between 12 am – 6 am

Table adapted from Gupta (2018) and modified with risk factors presented in Jazyna (2011) and Arozullah (2003)

Identifying and Assessing High-Risk Patients (2)

- Preoperative use of gabapentin (>300mg) and sustained oxycodone (>10mg) is associated with opioid-induced respiratory depression among patients undergoing orthopedic surgery
- Among patients with respiratory depression, an analysis of claims data found that:
 - 45% had confirmed or suspected obstructive sleep apnea (OSA)
 - 66% were morbidly obese
- Among patients who died due to opioid-induced respiratory depression, 50% had OSA

- Methods to identify patients at higher risk for opioid-induced respiratory depression:
 - STOP-BANG questionnaire to screen for OSA
 - Body Mass Index (BMI)
 - Serum bicarbonate level (screens for obesity hypoventilation syndrome, a risk factor for opioid-induced respiratory depression)

Identifying and Assessing High-Risk Patients (4)

- In this Case, the patient had multiple risk factors for an opioid-induced respiratory event:
 - Age >55 years
 - Elevated serum creatinine
 - Home use of gabapentin
- The risk of a postoperative respiratory event may have been reduced by preoperative evaluation for OSA and development of a risk-based postoperative pain management plan before surgery

BEST PRACTICES IN OPIOID PCA USE

PCA Prescribing and Administration

- Use of standardized pain order sets can improve opioid safety through:
 - Proper patient selection (opioid-naïve versus opioid-tolerant)
 - Emphasis on oral opioids
 - Multi-modal pain management strategies
- PCA order sets should leverage clinical decision support to guide:
 - Opioid selection (hydromorphone should be reserved for opioid-tolerant patients)
 - Doses
 - Lockout periods
 - Include embedded rescue naloxone orders

- Use of PCAs require additional safeguards to prevent harm

Prescribing	Dispensing	Administration
<ul style="list-style-type: none">• Standardized PCA order sets• Dose in mg or mcg (not mL)• Reserve hydromorphone for opioid-tolerant patients• When choosing demand dose and lockout interval, consider concomitant sedating medications on profile• Set maximum dose limits with alerts	<ul style="list-style-type: none">• Have a single concentration option for each opioid• Assess pump guardrails for hard and soft limits• Use pre-made or commercially available products when possible• “Tall man” lettering on pharmacy-applied labels	<ul style="list-style-type: none">• Dual signature verification with double-check by 2 RNs to verify proper PCA connection and settings for new administration, rate change, assumed care, or change of shift• Connection between IV and PCA should be as close to the patient’s venous access site as possible• Avoid administering concomitant opioids• Ensure availability of oxygen and naloxone• ETCO₂ use (capnography)• Teach patient and family about the proper use of PCA prior to initiation

Table adapted from ISMP (2003) and the San Diego Patient Safety Council Tool Kit (2009)

- When using PCAs, the following must be prescribed by a provider and programmed by staff – each of these steps presents an opportunity for human error
 - Drug concentration
 - Initial loading dose
 - Demand dose
 - Lockout interval
 - Background infusion rate
- Additional risks include activation of PCA by others (e.g., family) and equipment failure

- In this Case, the patient was prescribed hydromorphone PCA without a continuous basal rate
- Several institutional policy changes resulted:
 - Development of standardized pain order sets
 - Guidelines for inpatient opioid administration
 - Education on opioid selection for high-risk patients, with prompts to guide prescribers based on patient-specific risk factors (such as organ dysfunction and comorbidities)

BEST PRACTICES IN OPIOID PCA USE

Postoperative Monitoring of Patients Receiving PCA

Postoperative Monitoring (1)

Postoperative patients receiving IV opioid PCA should be monitored closely

Monitoring Component	Assessment Type
Vital Signs	Heart Rate Blood Pressure
Pain	Numeric Rating Scale Faces Pain Scale Iowa Pain Thermometer
Oxygenation	Pulse Oximetry (SpO ₂)
Ventilation	Respiratory Rate (RR) Capnography (ETCO ₂)
Sedation and Consciousness	Pasero Opioid Scale (POSS) Aldrete Score Glasgow Coma Scale Richmond Agitation-Sedation Scale (RASS)

Table adapted from Jungquist (2017)

- Timing of assessments should coincide with peak drug effects and should occur more frequently for high risk patients but recommendations differ:
 - The Anesthesia Patient Safety Foundation (APSF) recommends continuous monitoring of SpO₂ for all hospitalized adult patients receiving intravenous opioids for postoperative pain. For patients also receiving supplemental oxygen, APSF recommends continuous SpO₂ and ETCO₂.
 - A 2012 CMS Panel for PCA suggested that respiratory rate, sedation level, and SpO₂ monitoring should be performed every 2 to 2.5 hours.

- Evidence increasingly supports continuous monitoring of patients receiving IV opioids through PCA
 - Continuous SpO₂ monitoring on surgical ward associated with significant improvements in detecting oxygen desaturation compared with intermittent nursing spot-checks
 - Deaths most frequently occur overnight when nurse staffing and monitoring decrease to encourage sleep
 - In 42% of claims data analyzed by Lee et al, the time interval from last nursing assessment to detection of respiratory depression <2 hours

- Increasing the type and frequency of patient monitoring should be discussed by the interprofessional team (MD, RN, PharmD) under any of the following circumstances:
 - Evidence of desaturation, bradypnea, or hypoventilation (SpO₂ < 93% or RR < 12 bpm or ETCO₂ > 45 mmHg)
 - Use of supplemental O₂, especially in the first 24h after surgery or between 12:00am-6:00am
 - Increased sedation or change in level of consciousness (RASS = -2 or POSS =3)
 - Presence of risk factors for opioid-induced respiratory depression
 - Unrelieved pain or repeated attempts/demands within the lockout period despite patient education

- In this Case, the patient was monitored at prescribed intervals but need for supplemental O₂ was a potential indicator that continuous SpO₂ and end tidal CO₂ monitoring was warranted.
- Additionally, a standardized PCA handoff tool from the PACU to the surgical unit might have alerted the nursing staff to the patient's risk factors for opioid-induced respiratory distress.

TAKE-HOME POINTS

- Opioid administration through PCA can result in fatal respiratory depression.
- Patients with obstructive sleep apnea and other comorbidities are at increased risk for postoperative respiratory depression.
- The first 24 hours after surgery and the hours between 12am and 6am hold the highest risk for fatal respiratory depression events.
- Continuous capnography and/or pulse oximetry should be used in all patients receiving PCA opioids for early detection of opioid-induced respiratory depression.
- Continuous capnography should be used in all patients receiving supplemental O₂.
- Interdisciplinary collaboration and communication are necessary to develop, implement and evaluate policies and protocols to guide safe opioid prescribing, administration, and postoperative monitoring.

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THANK YOU!