

Patient Safety Tip of the Week

December 6, 2016

Postoperative Pulmonary Complications

Postoperative pulmonary complications are associated with increased morbidity and mortality, prolonged hospital stays, and increased costs. A few recent studies have demonstrated that these are common, sometimes may go undetected, and even the milder ones have clinically significant implications.

One recent study ([Fernandez-Bustamante 2016](#)) notes that postoperative pulmonary complications are heterogeneous in their pathophysiology, severity, and reporting accuracy. The researchers performed a multicenter prospective observational study in 7 US academic institutions of patients with ASA physical status of 3 who had noncardiothoracic surgery requiring 2 hours or more of general anesthesia with mechanical ventilation. This included 1202 patients who underwent predominantly abdominal, orthopedic, and neurological procedures. At least 1 postoperative pulmonary complication occurred in 33.4% of patients. This included the need for prolonged oxygen therapy by nasal cannula (19.6%) and atelectasis (17.1%). Patients with 1 or more postoperative pulmonary complications, even mild, had significantly increased early postoperative mortality, intensive care unit (ICU) admission, and ICU/hospital length of stay. The authors conclude that mild frequent postoperative pulmonary complications (eg, atelectasis and prolonged oxygen therapy need) deserve increased attention and intervention for improving perioperative outcomes.

Another study ([Sun 2015](#)) assessed oxygen saturation continuously, in a manner that was blinded to clinicians, in patients who had undergone noncardiac surgery. Those authors noted that on a typical post-op ward vital signs are recorded at 4-6 hour intervals, including oxygen saturations that are measured on a “spot” basis with pulse oximeters. Moreover, they also note that nurses often respond to poor saturation values by encouraging patients to breathe deeply until a near-normal saturation value is obtained and then record that value in the medical record. Their study found that that prolonged hypoxemic episodes were common. 37% of patients had at least one episode of oxygen saturation <90% lasting an hour or more and that nurses missed 90% of hypoxemic episodes detected by the blinded continuous monitoring in which oxygen saturation was <90% for at least one hour.

We’ve also noted in our numerous columns on obstructive sleep apnea (OSA) that patients who have hypoventilation when sleeping often have normal ventilation and

normal oxygen saturation when aroused, such as when nursing records vital signs. So they often have normal oxygen saturations recorded in the medical record.

The Sun study does note that continuous monitoring of oxygenation was difficult. They used a system that was somewhat bulky and mounted on an IV pole and this significantly limited patient ambulation, causing many patients to discontinue the monitors. This may have led to an overestimation of hypoxemic events, as healthier patients may have disconnected them and ambulated early. Newer wrist-mounted systems that communicate wirelessly with hospital monitoring systems may alleviate this.

In an accompanying editorial, Robert Stoelting from the Anesthesia Patient Safety Foundation ([Stoelting 2015](#)) notes that the APSF recommends that all post-op patients receiving opioids be monitored with continuous pulse oximetry with data transmitted wirelessly to a qualified health care professional. APSF also recommends monitoring of ventilation if supplemental oxygen is needed to maintain an acceptable SpO₂.

The message is clear: the risk of hypoxemia post-operatively is not confined to those patients we already knew were at high risk (such as patients with known or suspected OSA). In fact, there is even one study ([Khanna 2016](#)) which showed that the STOP-Bang questionnaire (which predicts the presence of OSA and also predicts postoperative complications) does not predict hypoxemia in adults recovering from noncardiac surgery. So there really is a need for continuous monitoring in most postoperative patients.

A recent investigative report “Dead in Bed” by On Your Side News 5 (Cleveland, Ohio) brought to public attention the problem of fatal complications in postoperative patients considered at low-risk ([Regan 2016](#)). It described several cases of fatalities related to opioid-induced respiratory depression in patients following surgery. It highlighted two root causes: (1) aggressive pain management by hospitals to achieve better patient satisfaction scores and (2) the substantial costs of implementing continuous monitoring systems. Yet it noted that implementation of such monitoring capabilities at Dartmouth-Hitchcock Medical Center (DHMC) was cost effective ([AAMI 2013](#)).

The Dartmouth-Hitchcock implementation resulted in significantly fewer rescues (from 3.5 to 1.2 rescues per 1,000 patients) and transfers to intensive care units (from 5.6 per to 2.9 per 1,000 patients). They estimated a cost savings of roughly \$1.5 million just from reduction in ICU transfers ([Taenzer 2012](#)). DHMC subsequently implemented the continuous surveillance monitoring system on all its units, with variable cost saving based upon the underlying frequency of adverse events on each type of unit and the actual reductions in ICU transfers. Generally, results were more positive on surgical compared to medical units. And this was all accomplished with high levels of both patient acceptance and acceptance by clinical staff. Read the two documents ([AAMI 2013](#), [Taenzer 2012](#)) to see the challenges and solutions the DHMC staff found in implementing this system. They also describe how they set parameters to be sensitive to clinically important deterioration yet avoiding alarm fatigue.

Since so many pulmonary complications occur in post-op patients who are receiving opioid therapy, we are always looking for ways to reduce the impact of opioid therapy. Many have had the impression that such complications are fewer when short-acting opioids are used compared to long-acting ones. So a comparative study was done ([Belcher 2016](#)). Belcher and colleagues looked at patients on PCA pumps treated with fentanyl (short-acting opioid) vs. morphine or hydromorphone (longer-acting opioids) and found that the long-acting patient-controlled opioids were **not** associated with increased hypoxemia during the first 2 postoperative days during which the study was done.

The best way to avoid opioid-induced respiratory depression is obviously to avoid opioids or to use lower doses. Multimodal analgesia is one of the best ways to accomplish this (see our February 19, 2013 Patient Safety Tip of the Week “[Practical Postoperative Pain Management](#)”). That includes use of multiple non-opioid analgesics with different modes of action (eg. acetaminophen and an NSAID) plus local or regional nerve blocks. And, of course, avoiding use of concomitant drugs that depress respiration (eg. benzodiazepines) is equally important.

Ironically, one of the risk factors for some pulmonary complications is pain itself. It may impair the ability to cough, thus predisposing patients to atelectasis or pneumonia. Or pain may limit mobilization and early ambulation. In fact, the editorial ([Haines 2016](#)) accompanying the Fernandez-Bustamante study pointed out that the rate of postoperative pulmonary complications was actually higher in the group who underwent a combined anesthetic approach, including regional anesthesia. The reason for that is not readily apparent. But the lesson is that we need to find a happy medium between adequate management of pain and avoiding the respiratory depressant effects of our pain management approaches.

Large percentages of post-op patients also receive supplemental oxygen. While some ([Hopf 2016](#)) suggest even wider use of supplemental oxygen in this population, we always caution that supplemental oxygen may delay recognition of opioid-induced respiratory depression if one is not using capnographic monitoring.

In our October 11, 2016 Patient Safety Tip of the Week “[New Guideline on Preop Screening and Assessment for OSA](#)” we noted that the Canadian Agency for Drugs and Technologies in Health (CADTH) in 2016 did an analysis of end-tidal CO₂ monitoring in the hospital setting ([CADTH 2016](#)). Though admitting that high level evidence of efficacy is limited, they performed an exploratory analysis which concluded that for patients in serious or critical condition and for patients with obstructive sleep apnea or receiving high doses of opioids in post-operative care, use of end-tidal CO₂ monitoring is likely less costly and more effective than standard monitoring.

Given the significance of postop pulmonary complications it seems clear that implementation of continuous monitoring systems is critical and that we cannot just limit such to those patients who we suspect are at highest risk. The limited literature available

on cost effectiveness of such systems would certainly suggest that these are investments well spent.

Other Patient Safety Tips of the Week pertaining to opioid-induced respiratory depression and PCA safety:

- January 4, 2011 [“Safer Use of PCA”](#)
- July 13, 2010 [“Postoperative Opioid-Induced Respiratory Depression”](#)
- May 12, 2009 [“Errors With PCA Pumps”](#)
- September 21, 2010 [“Dilaudid Dangers”](#)
- November 2010 [“More on Preoperative Screening for Obstructive Sleep Apnea”](#)
- February 22, 2011 [“Rethinking Alarms”](#)
- May 17, 2011 [“Opioid-Induced Respiratory Depression – Again!”](#)
- September 6, 2011 [“More Tips on PCA Safety”](#)
- December 6, 2011 [“Why You Need to Beware of Oxygen Therapy”](#)
- February 21, 2012 [“Improving PCA Safety with Capnography”](#)
- September 2012 [“Joint Commission Sentinel Event Alert on Opioids”](#)
- September 2012 [“FDA Warning on Codeine Use in Children Following Tonsillectomy”](#)
- July 3, 2012 [“Recycling an Old Column: Dilaudid Dangers”](#)
- February 12, 2013 [“CDPH: Lessons Learned from PCA Incident”](#)
- February 19, 2013 [“Practical Postoperative Pain Management”](#)
- May 6, 2014 [“Monitoring for Opioid-induced Sedation and Respiratory Depression”](#)
- March 3, 2015 [“Factors Related to Postoperative Respiratory Depression”](#)
- June 2, 2015 [“Reminders of Dilaudid Dangers”](#)
- August 11, 2015 [“New Oxygen Guidelines: Thoracic Society of Australia and NZ”](#)
- August 18, 2015 [“Missing Obstructive Sleep Apnea”](#)
- December 2015 [“Opioid Alert Fatigue”](#)
- March 2016 [“Guideline for Management of Postoperative Pain”](#)
- June 14, 2016 [“Nursing Monitoring of Patients on Opioids”](#)

- Tools: [PCA Pump Audit Tool](#) and the [PCA Pump Criteria](#)

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