Respiratory depression is a complication that often follows cancer-related surgery and can result in life-threatening consequences. Oncology nurses caring for postoperative patients must monitor for respiratory complications and implement measures to prevent respiratory depression. A review of postoperative respiratory depression risk factors, clinical findings, and monitoring will be presented in this article using a case study.

AT A GLANCE

- A significant percentage of patients undergoing general surgeries have obstructive sleep apnea, but most members of this population remain undiagnosed at the time of surgery.
- Atelectasis, which involves failure of the lungs to expand or collapse, may be caused by general anesthesia, which creates a pulmonary shunt.
- Nurses often do not recognize changes in respiratory rates and are falsely reassured by saturation levels measured by pulse oximetry, which tends to be the method least sensitive to detecting hypoventilation.

KEYWORDS
respiratory depression; postoperative; respiratory rate; obstructive sleep apnea

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Respiratory Depression

A case study of a postoperative patient with cancer

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More than 20 million Americans with a history of cancer will be alive on January 1, 2026, according to estimates, with many of these survivors likely having undergone surgical treatment for the disease (Khanna, 2017). Respiratory depression is a common but life-threatening surgery-related complication that is preventable with appropriate nursing assessment and the timely implementation of interventions (Khanna, 2017). This article offers a review of postoperative respiratory depression prevention and recognition, as well as a case study that illustrates its risk factors, pathophysiology, and implications.

Pathophysiology

The incidence of respiratory events in the postoperative period is estimated to be about 3% (Karcz & Papadakos, 2013). Perioperative respiratory depression has a 26% mortality rate within the first 30 days after surgery (Gupta et al., 2011), as well as a six times higher possibility of transfer to a skilled nursing facility (Pfeifer & Smetana, 2016). The most common postoperative pulmonary complications are atelectasis, pneumonia, respiratory depression, exacerbation of underlying lung disease, pleural effusion, and pneumothorax (Pfeifer & Smetana, 2016). General anesthesia causes atelectasis by creating a pulmonary shunt, which is evident immediately after induction. In an adult with healthy lungs, about 15% of the entire lung, as well as 20%–25% of the tissue at lung bases, becomes atelectatic (Karcz & Papadakos, 2013).

The immediate postoperative period is critical because respiratory depression involves several mechanisms that may lead to alveolar hypoventilation and resultant hypercapnia. Weakening of the respiratory muscles occurs because of neuromuscular disease or residual neuromuscular block because of the effects of opioids, sedative hypnotics, and inhaled anesthetics used during surgery. Severe hypothyroidism can cause metabolic alkalosis, leading to hypoventilation. Pulmonary edema, obstructive airway disease, and increased inspiratory workload in patients with severe obesity result in respiratory muscle fatigue and carbon dioxide retention (Karcz & Papadakos, 2013).

Obstructive sleep apnea (OSA) is highly prevalent in the general population but remains undiagnosed in many patients (Ramsay, 2017). About 20%–25% of patients undergoing general surgeries have OSA, but most are undiagnosed at the time of surgery (Pfeifer & Smetana, 2016). Patients with OSA demonstrate a higher sensitivity to opioids that inhibit the upper respiratory muscles, leading to airway collapse and depression of the brain’s respiratory center. Use of other sedating medications, particularly benzodiazepines, results in a synergistic effect with opioids to markedly impair the pharyngeal muscles in decreasing the respiratory drive (Karcz & Papadakos, 2013).

Risk Factors

Postoperative respiratory depression can be categorized by patient-, anesthesia-,
Perioperative respiratory depression has a 26% mortality rate within the first 30 days after surgery.

Surgery-related risk factors include a surgical incision close to the diaphragm (shallow breaths), prolonged surgery, emergency surgery, and open surgery (Karcz & Papadakos, 2013). Surgery that lasts more than three hours (Pfeifer & Smetana, 2016) prolongs patient exposure to anesthesia and poses higher risks for blood loss, damage to vital organs, thromboembolism, infection, and reoperation (Yang et al., 2015). Open surgery results in greater injury to tissues and higher pain, which requires higher doses of opioids that limit deep breathing and increase the risk for opioid-related respiratory depression. Better respiratory outcomes for patients exist with laparoscopic surgery, given the greater risks associated with open surgery (Karcz & Papadakos, 2013).

Prevention and Recognition

Preventive measures during and after surgery involve the nurse’s recognition of the following, as applicable to the diagnosis of respiratory depression: clinical history of the patient, the surgical procedure, anesthesia and/or related opioids given, physical assessment findings, laboratory studies, and imaging studies. Recommendations for postoperative care after general anesthesia include the use of lung-protective mechanical ventilation, cautious dosing of systemic opioids, and the employment of short-acting neuromuscular blocking agents (Karcz & Papadakos, 2013). The use of regional or spinal anesthesia instead of general anesthesia helps to reduce pulmonary complications, such as atelectasis. Nurses should also educate patients about performing breathing exercises, splinting the incision, turning in bed, and ambulating to prevent atelectasis.

Screening for pulmonary complication risks because of medical history becomes particularly relevant when considering the increasing number of undiagnosed cases of OSA (Pfeifer & Smetana, 2016); in addition, an increased risk for airway obstruction exists in the first 24 hours after surgery (Karcz & Papadakos, 2013). The American Society of Anesthesiologists Task Force on Perioperative Management of Patients With Obstructive Sleep Apnea (2014) recommends that all patients be screened preoperatively for OSA using the STOP-BANG questionnaire (see Figure 1). Patients with known OSA should wear their continuous positive airway pressure (CPAP) device immediately after surgery at the prescribed pressure levels used at home. It is recommended that patients at risk for OSA use a CPAP device with an empiric pressure setting of 8–10 cm of water that is later titrated to the individual patient (Karcz & Papadakos, 2013).

Monitoring respirations, presence of snoring, level of sedation, mental status,
oxygen saturation by pulse oximetry, end-tidal carbon dioxide levels, and periods of apnea may help the nurse to recognize respiratory depression. New-onset confusion, agitation, or delirium in the postoperative period may indicate acute hypoxemia rather than psychosis or sundowning (late-day confusion and restlessness in individuals with dementia) in older adults (Karcz & Papadakos, 2013). Patients with drowsiness and decreased alertness warrant a decrease in opioid dosing (Lee et al., 2015).

Respiratory rate has been found to be the single most important and reliable early warning sign of respiratory depression (Karcz & Papadakos, 2013). A deviation of four breaths per minute on either side of the normal range of respiration indicates serious clinical decline (Flenady et al., 2017). Although heart failure, sepsis, and pulmonary embolism result in increased respiratory rates, opioid overdose results in slow respiratory rates (Ramsay, 2017).

Pulse oximetry alone is an unreliable method of monitoring for respiratory depression, particularly when patients are receiving supplemental oxygen (Ramsay, 2017). Although supplemental oxygen may easily reverse hypoxia and hypoxemia, it cannot correct the cause of hypoventilation (Karcz & Papadakos, 2013). In patients receiving supplemental oxygen, desaturation by pulse oximetry is not detected until arterial carbon dioxide levels reach as high as 100 mmHg; ventilator support is then required to correct the respiratory depression (Ramsay, 2017).

**Case Study**

M.V., a 62-year-old Vietnamese man who is fluent in English, was diagnosed with renal cell carcinoma. About eight months ago, he underwent right radical nephrectomy. At that time, a mass was observed in the left kidney; it slowly increased in size over time and eventually required M.V.’s admission to the hospital for left partial nephrectomy. M.V. has no significant medical or surgical history involving lung disease or hypertension, and he does not smoke and is able to function independently.

M.V. was admitted to the postanesthesia care unit following left partial nephrectomy. About 10 hours postsurgery, the nurse responded to the pulse oximeter alarm for a sudden drop in oxygen saturation. M.V. was receiving oxygen at 2 liters per minute via nasal cannula. The nurse found M.V. unresponsive and his oxygen saturation level steadily dropping to 60%. In addition, M.V.’s breathing was slow and shallow, with a rate of four to six breaths per minute. His pulse was still palpable, his heart rate 107 beats per minute, and his blood pressure 137/103 mmHg. A code blue was initiated, and M.V. was resuscitated by the code team. Questions that should be considered include the following:

- What are the factors that placed M.V. at risk for respiratory depression?
- Is respiratory depression in the postoperative period preventable?
- What are the clinical signs in postoperative patients that are indicative of a developing respiratory depression?
- What are the monitoring parameters that are specific for respiratory status?

In this case study, M.V. was placed postoperatively on cardiac and pulse oximetry monitoring while being administered hydromorphone injection via patient-controlled analgesia for pain control at a dose of 0.2 mg every 10 minutes, with as-needed bolus doses of 0.25 mg every four hours for severe pain. M.V.’s surgery and the postoperative period were uneventful until about 10 hours after the surgery, when the nurse found M.V. unresponsive.

M.V.’s surgery involved the kidney, which is a highly vascular organ, but hemorrhage was excluded as the cause of respiratory depression based on clinical findings of normal blood pressure; appropriate amount, color, and consistency of wound drain; and soft, nondistended, nontender abdomen. Absence of tachycardia, hypotension, inadequate urine output, and oozing at the incision were helpful in excluding hemorrhage. Arterial blood gas analysis showed severe respiratory acidosis (see Table 1). M.V. was resuscitated with a bag valve mask and 0.02 mg naloxone via IV, which was given twice. After the second dose of naloxone and with oral airway stimulation, M.V. became alert and responsive, and he began breathing spontaneously at 12–14 breaths per minute. He was placed on a bilevel positive airway pressure machine and transferred to the intensive care unit for monitoring.

| TABLE 1. ARTERIAL BLOOD GAS ANALYSIS RESULTS IN CASE STUDY |
|-----------------|-----------------|-----------------|
| **TEST**        | **NORMAL VALUE**| **PATIENT’S VALUE** |
| Base exchange   | 2–3 mmol/L      | -9 mmol/L       |
| Bicarbonate     | 22–26 mmol/L    | 22 mmol/L       |
| FiO₂            | 21% room air    | 100%            |
| Oxygen saturation | 95%–98%        | 100%            |
| pCO₂            | 35–45 mmHg      | 72 mmHg         |
| pH              | 7.35–7.45       | 7.09            |
| PO₂             | 89–105 mmHg     | 237 mmHg        |

FiO₂—fraction of inspired oxygen; pCO₂—partial pressure of carbon dioxide; PO₂—partial pressure of oxygen
Nurses caring for patients after cancer-related surgery play a major role in the prevention and management of respiratory depression (Pfeifer & Smetana, 2016). Close monitoring for subtle changes in respiration, periods of apnea, desaturation, tachycardia, drowsiness, and altered mental status should alert nurses to signs of respiratory depression. The importance of accurately monitoring respiratory rate and avoiding reliance on pulse oximetry monitoring can improve prevention and early response to avoid respiratory depression.

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REFERENCES