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Advances in Perioperative Pulmonary Protection Strategies

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Keywords

• Perioperative • Pulmonary protection • Postoperative pulmonary complications
• Acute respiratory distress syndrome

Key points

- Postoperative pulmonary complications (PPCs) significantly affect patient-important outcomes and utilization of health care resources.
- Identification of risk factors that portend risk for PPCs is an essential first step in mitigating these adverse events.
- Prevention strategies specifically targeting those with modifiable risk factors for PPCs are likely to have the largest impact on patients' outcomes.
- Prevention of PPCs requires an awareness of risk factors and implementation of prevention strategies during all phases of the perioperative experience.
- Unless specifically contraindicated, lung-protective ventilation should be used for all mechanically ventilated patients.
- Although early smoking cessation is preferred, it is recommended for all patients who are to receive general anesthesia regardless of the duration of cessation.

INTRODUCTION

Postoperative pulmonary complications (PPCs) are a significant cause of morbidity and mortality in modern surgical practice. Although published definitions frequently vary, PPCs generally include respiratory infections, respiratory failure, pleural effusions, atelectasis, pneumothorax, bronchospasm, and aspiration pneumonitis [1,2]. A recent review of PPCs reported a composite frequency of 5.0%, with more specific risk rates for respiratory failure (2.6%),

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bronchospasm (1.8%), pleural effusion (1.7%), respiratory infection (1.6%), atelectasis (1.4%), aspiration pneumonia (0.4%), and pneumothorax (0.3%) during the in-hospital postoperative period [1]. Specific complications, such as respiratory infection and respiratory failure, likely have a more significant impact on patient-oriented outcomes, including length of stay in hospital and mortality [3].

A large study using the National Surgical Quality Improvement Project (NSQIP) database found that independent of preoperative risk, PPCs were associated with a significant increase in mortality from 2% to 22% [4]. The impact of PPCs on mortality is similar in other studies; one of which showed an overall incidence of PPC of 5% and a 30-day mortality of 19.5% in patients with a PPC versus only 0.5% in patients without a PPC [1]. Furthermore, PPCs have a dramatic impact on health care costs, with NSQIP data suggesting that each PPC may have an attributable cost of US$50,000 and may extend the length of stay in hospital by as much as 20 days [5].

In an early review of PPCs in 1920, the term ''ether pneumonia'' was used demonstrating the long-standing association between anesthesia, surgical procedures, and pulmonary complications [6]. Anesthesiologists and other perioperative care providers have the potential to affect many of the modifiable risk factors for PPCs and, therefore, enhance the safety of surgical patients.

In this review a broad range of general PPC prevention measures are discussed. Specific topics include smoking cessation, mechanical ventilation, anesthetic and analgesic techniques, pulmonary hygiene, aspiration, fluid and blood products, and some monitoring techniques. Additional discussion centers on specific high-risk patients including those with obstructive lung disease, obesity, obstructive sleep apnea, and patients undergoing high-risk surgical procedures such as intrathoracic operations. In an effort to keep this review concise, the impact of baseline neuromuscular weakness is not discussed, nor are thoracic anatomic abnormalities (such as scoliosis) that may portend risk for PPCs. Likewise, prevention strategies for venous thromboembolism are not addressed, nor is the management of perioperative pleural effusions and pneumothoraces.

RISK FACTORS AND CAUSES OF POSTOPERATIVE PULMONARY COMPLICATIONS

Risk factors for postoperative pulmonary complications

Whether reflecting true causation or simply association, the identification of potential risk factors for PPCs is an essential first step as we work toward mitigating these undesirable postoperative outcomes. Indeed, strategies aiming to prevent PPCs are presumed to be most effective when directed toward the population at highest risk. To this end, a large systematic review by Smetana and colleagues [7] previously outlined patient-related and procedure-related risk factors associated with PPCs (Table 1). Specifically, patient-related factors associated with the highest risk of PPCs included advanced age, American Society of Anesthesiologists (ASA) class II or greater, congestive heart failure (CHF), functional dependence (not able to perform activities of daily living without