Acute Intraoperative Pulmonary Aspiration

Katie S. Nason, MD, MPH

KEYWORDS

• Anesthesia • Intratracheal • Intraoperative complications • Prevention and control • Pneumonia • Aspiration • Respiratory aspiration of gastric contents

KEY POINTS

- Thoracic surgery patients are at increased risk (threefold) for intraoperative aspiration compared with other surgical specialties.
- Aspiration pneumonitis is the most common sequela of significant intraoperative aspiration, followed by aspiration pneumonia.
- The severity of pulmonary parenchymal injury is modified by the degree of acidity, the volume of the aspirate, and the presence or absence of particulate matter in the aspirated fluid.
- Predisposing conditions include gastrointestinal obstruction, need for emergency surgery, previous esophageal surgery, esophageal cancer, hiatal hernia, impaired coordination of swallowing or respiration, and obesity.
- Preoperative assessment, appropriate fasting, and use of rapid-sequence induction, antisecretory medications, and rapid recognition/response to gastric regurgitation are critical to prevention and management.

INTRODUCTION

Although anesthesia is generally safe, respiratory complications such as anesthesia-related aspiration can be fatal.[1,2] Occurring as often as 1 in every 2000 to 3000 operations requiring anesthesia,[3] almost half of all patients who aspirate during surgery develop a related lung injury, such as pneumonitis or aspiration pneumonia.[4] This issue is of particular relevance to thoracic surgeons; Sakai and colleagues[5] retrospectively compared characteristics of patients with and without anesthetic-related pulmonary aspiration and found that aspiration occurred 3 times more often in thoracic surgical procedures than in any other specialty. As such, understanding the potential impact of anesthesia-related aspiration on perioperative outcomes, factors that contribute to an increased risk of this complication, and strategies for preventing the occurrence of or minimizing the sequela from an anesthesia-related aspiration are imperatives for the thoracic surgeon.

PULMONARY ASPIRATION: DEFINITION, CONSEQUENCES, AND RISK FACTORS

Definition and Consequences

Defined as the entry of liquid or solid material into the trachea and lungs, anesthesia-related aspiration occurs when patients without sufficient laryngeal protective reflexes passively or actively regurgitate gastric contents. Pulmonary syndromes of differing severity result, ranging from mild symptoms, such as hypoxia, to complete

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Division of Thoracic and Foregut Surgery, Department of Cardiothoracic Surgery, University of Pittsburgh, 5200 Centre Avenue, Suite 715, Shadyside Medical Building, Pittsburgh, PA 15232, USA
E-mail address: nasonks@upmc.edu

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respiratory failure and acute respiratory distress syndrome (ARDS), and even cardiopulmonary collapse and death. The types of pulmonary syndromes include acid-associated pneumonitis, particle-associated aspiration (eg, airway obstruction), or bacterial infection, with subsequent development of lung abscess, exogenous lipoid pneumonia, chronic interstitial fibrosis, and *Mycobacterium fortuitum* pneumonia.[6] Which of these syndromes develops depends on the composition and volume of the aspirate.

The most common lung injury is aspiration pneumonitis. Initially described by Mendelson in 1946, aspiration pneumonitis is damage to the lung parenchyma resulting from inhalation of sterile, acid (or bile) gastric contents. The severity of pulmonary parenchymal injury is modified by the degree of acidity, the volume of the aspirate, and the presence or absence of particulate matter in the aspirated fluid. Low-volume aspirate with a very low pH can rapidly lead to fatal pneumonitis, whereas higher volumes of aspirate that are buffered (ie, higher pH) can be better tolerated. As little as 50 mL of regurgitated gastric contents can be considered a "severe" aspiration.[7] When the aspirate is not sterile or when particulate matter are present in the aspirate, mechanical airway obstruction and infectious complications can develop, with the most common pathogens being *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Enterobacter* species, anaerobes, *Klebsiella* species, and *Escherichia coli*.[8]

Risk Factors

There are a number of patient-related and procedure-related characteristics that place some patients at higher risk for an anesthesia-related aspiration event.

Risk factors: medications

In and of itself, anesthesia places patients at risk for aspiration. This risk results from the effects of medications on the lower esophageal sphincter, level of consciousness, and loss of protective reflexes.

There are a number of medications that are routinely used during anesthesia that are known to decrease lower esophageal sphincter tone.[9] These include the following:

- Propofol
- Volatile anesthetic agents
- β-agonists
- Opioids
- Atropine
- Thiopental
- Tricyclics
- Glycopyrrolate

In addition to effects on lower esophageal sphincter pressures, these medications by design induce a progressive loss of consciousness with subsequent decline and then loss of protective reflexes.[10] This risk is even greater when topical anesthesia to the larynx is used, because the cough reflex is compromised.[11]

Risk factors: predisposing conditions

It is important to note, however, that most patients undergoing anesthesia do not suffer from an aspiration event; predisposing conditions must also exist that, in combination with progressive loss of consciousness and diminished protective reflexes, create a favorable environment for aspiration. These predisposing conditions include[12] the following:

- Gastrointestinal obstruction
- Need for emergency surgery
- Previous esophageal surgery
- Esophageal cancer
- Hiatal hernia
- Lack of coordination of swallowing or respiration
- Obesity

Consistent with the upper gastrointestinal stasis and/or obstruction associated with most of these conditions, passive regurgitation with induction of general anesthesia is far more common than active vomiting.[13]

Risk factors: provider expertise

At least one study found that provider factors, such as improper decision-making, lack of experience, and lack of knowledge, were responsible for most intraoperative aspiration events.[14] Provider expertise also is implicated in failure of preventive measures, such as the use of cricoid pressure during rapid-sequence induction[15] (RSI) (see later in this article) and wide variation in the execution of these approaches to anesthesia induction in the high-risk patient. In the retrospective review of anesthesia-related aspirations by Sakai and colleagues,[5] 10 of the 14 cases were attributed to improper anesthesia technique. In their critical review of anesthetic management, they found that cricoid pressure was not applied at the time of induction in 4 cases, and provider inexperience contributed to aspiration in a high-risk patient in another patient. Kluger and Short[13] reported similar concerns regarding provider-specific factors in their review of 133 cases drawn from the New Zealand Anesthetic Incident Monitoring Study database. As with other studies, passive regurgitation was 3 times more common than active vomiting and most cases had at least one