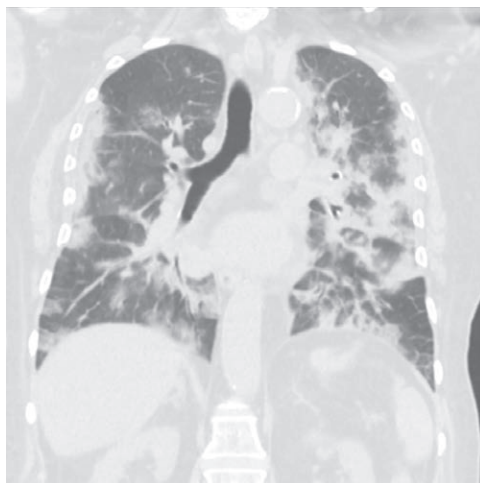# Pulmonary Aspiration of Gastric Contents: Can We Improve Patient Outcomes?

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While it is not possible to foretell the exact outcome of an individual patient, the goal of preoperative evaluation is to predict the probability with which a given undesirable outcome may occur, given similar circumstances and to tailor clinical management to mitigate this risk.[1,2] While early epidemiologic research estimated that pulmonary aspiration of gastric contents was a rare event,[3] more recent evidence suggests that it continues to be a significant source of morbidity and mortality despite other advances in anesthesia patient safety.[4–7] For example, the National Audit Project 4 study by the Royal College of Anesthetists in the United Kingdom reported that pulmonary aspiration was the single most common cause of death among airway management complications, more so than the inability to establish an airway.[6]

In this issue of ANESTHESIOLOGY, Warner *et al.* present a timely and valuable analysis of closed anesthesiology malpractice cases of pulmonary aspiration from the Closed Claims Project analysis between 2000 and 2014.[8] Despite the limitations of this type of data (the lack of denominators precludes estimation of prevalence or incidence) and the complex relationship between complications and litigation, the analysis of closed claims provides useful insight into uncommon but potentially serious complications of anesthesia. The 115 cases identified in this report likely represent a small proportion of all cases of pulmonary aspiration that occurred in this time period, but they allow us to reflect on the circumstances of events that went really wrong, leading to serious consequences for patients such as death and permanent injury.[8] Perhaps the most important question we can ask ourselves is: does

"…pulmonary aspiration of gastric contents continues to be a significant source of morbidity and mortality in modern anesthesiology."

this study give us any insight that can help us prevent future cases of aspiration improving either its incidence or severity?

It should not come as a surprise that 80% of all cases of aspiration in the current series involved general anesthesia, as this blunts or abolishes protective upper airway reflexes, and that 60% of all cases occurred during induction, a time when patients are rendered unable to protect their upper airway from aspiration of gastric contents before the airway is secured.[8] Similarly, given the nature of cases in medical litigation, it is also not entirely surprising that most of the outcomes were severe, with about two-thirds of all cases resulting in death or permanent injury.[8] Given that the treatment of pulmonary aspiration is nonspecific and is limited to supportive measures and management of sequelae, it is particularly important to correctly identify patients who are at risk and introduce interventions before induction of anesthesia to mitigate this risk.

At least one risk factor was identified in 93% of the claims, and most (61%) had either a documented gastrointestinal obstruction or another acute intraabdominal process.[8] However, it is interesting to note that 55% of all cases occurred in elective surgical procedures, where the risk of aspiration is typically considered to be low.[8] It is also interesting to note that commonly reported risk factors such as pregnancy, diabetes, and gastroesophageal reflux were remarkably not widely represented in this sample. While it may be easy to identify risk factors retrospectively after the complication has occurred (hindsight is 20/20), the data presented in this closed claims analysis suggests that in a significant proportion of cases, the risk may have been equivocal or difficult to ascertain based on available

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clinical information, leading to gaps in care and failure of prevention.[9] Clinical care issues or deficiencies were identified in 77% of cases.[8] For example, the fact that 55% of these procedures were elective suggests that the presence of a "full stomach" may not have been appreciated at the time, as most clinicians would likely defer elective procedures in the presence of a "full stomach." In addition, only 51% of patients with a documented gastrointestinal obstruction or other intraabdominal processes in this series had a nasogastric tube inserted before induction of anesthesia and 43% of all cases involving endotracheal intubation did not report performance of a rapid sequence induction.[8]

Claude Shannon (1916 to 2001), an American mathematician, electrical engineer, and cryptographer, became known as the Father of Information Technology after publishing the landmark paper "A Mathematical Theory of Communication" in 1948.[9] He proposed the concept of "information entropy" as the level of surprise or uncertainty in the outcome of a given variable. Information entropy is greatest for a given outcome (entropy = 1), when the probability of it occurring is 50%, as in a coin toss. Information entropy is lowest (entropy = 0) when there is complete certainty about the possible outcome (probability of 0% or 100%). In clinical practice, most cases have a very low entropy, approaching zero, when the outcome is easy to predict. These are cases with either a very high probability (a patient with a proximal bowel obstruction who requires a general anesthetic for an urgent laparotomy) or a very low probability (a completely healthy patient who has fasted before an elective surgical procedure) of pulmonary aspiration. However, the level of risk is a continuum with many patients falling somewhere in the middle, where the risk is equivocal based on clinical information alone, and the information entropy approaches one. We concur with the authors who suggest that bedside gastric ultrasound could help clarify the risk in cases with high information entropy, when the pretest probability of a full stomach is around 50%.[10] Gastric ultrasound can provide accurate and reliable qualitative (the type of content as *nil*, clear fluid, or solid) and quantitative (fluid volume) information about gastric contents.[10–13] A recent study of a simulated clinical scenario with a pretest probability of 50% suggests that a positive study increases the likelihood of a full stomach to more than 95% and a negative study decreases the chances of a full stomach to less than 0.1%, thus substantially limiting information entropy. This noninvasive bedside test could therefore help to narrow diagnostic uncertainty in cases where clinical information about gastric content is unknown or equivocal.[13]

In summary, the current analysis of closed anesthesia malpractice claims underscores the fact that pulmonary aspiration of gastric contents continues to be a significant source of anesthesia morbidity and mortality in modern anesthesiology practice, posing a threat to patient safety, with the majority of claims cases resulting in death or permanent injury. The data suggest that the risk may have been often underappreciated leading to suboptimal care in more than half of the cases. Future improvements in patient safety may arise from a more accurate preoperative identification of risk, including point-of-care ultrasound when the risk is equivocal. Confirmation of a full stomach should lead to rescheduling elective procedures. In the setting of urgent or emergency procedures, however, accurate risk stratification may lead to more consistent interventions that mitigate this risk such as the insertion of a nasogastric tube and suctioning of gastric contents, consideration of alternatives to general anesthesia where possible, and performance of a rapid sequence induction and timely extubation when general anesthesia is urgently required.

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Competing Interests

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