Regurgitation and aspiration

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Abstract

Regurgitation and aspiration remains one of the major complications of general anaesthesia. Aspiration is defined as oropharyngeal or gastric content entering the airway below the level of the vocal cords. This can cause morbidity and mortality by direct effects of the particulate, acid-related damage and bacterial pneumonia. It occurs largely in patients with risk factors although occasionally in patients that are low risk. Anaesthetic technique should be adjusted depending on the patient's risk of aspiration with rapid sequence induction considered in high-risk patients. Recognition and appropriate management of aspiration is essential.

Keywords Aspiration; pneumonitis; rapid sequence induction; regurgitation

Royal College of Anaesthetists CPD Matrix: 1A01, 2A03, 2A06

Learning objectives

After reading this article you should be able to:

- define pulmonary aspiration including the classifications and features of aspiration syndromes
- identify those patients at risk of aspiration and plan their anaesthetic accordingly
- be able to manage regurgitation and aspiration

Pulmonary aspiration is defined as the inhalation of oropharyngeal or gastric content into the airway below the vocal cords. It can be caused by passive regurgitation or active vomiting and is a serious complication of general anaesthesia. Regurgitation and aspiration was first recognized as a cause of anaesthesia-related deaths by James Simpson in 1848.[1] Subsequently, Mendelson reported on the morbidity of non-fatal aspiration during anaesthesia in 1946.[2]

Multiple studies have tried to determine the prevalence of aspiration during anaesthesia. Warner et al., in 1993,[3] examined over 400,000 cases and found aspiration occurring in 1 in 4000 elective cases and 1 in 900 emergency cases. A more recent study in 2009 by Bernardini et al. quotes an incidence of 1 in 6 500 after examining over 65 712 cases.[4]

Aspiration and regurgitation can have catastrophic consequences, including prolonged intensive care unit (ICU) admission, brain damage and death. This was highlighted in the 4th National Audit Project (NAP 4),[5] where 55 serious incidents during general anaesthesia were reported. Of these, 26 involved aspiration and of all the anaesthetic-related deaths reported to NAP 4, 50% were due to aspiration. What is striking is that despite developments in anaesthetic technique, drugs and airway devices over the last few decades, pulmonary aspiration remains the leading cause of mortality during induction and maintenance of anaesthesia.

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Normal physiology

The protective barriers to aspiration are the lower oesophageal sphincter (LOS), the upper oesophageal sphincter (UOS) and the laryngeal reflexes.

The LOS consists of the lower 3–4 cm of circular oesophageal smooth muscle. Its role is to prevent regurgitation of gastric contents back into the oesophagus, achieved by having a higher resting pressure (15–25 mmHg) than the gastric pressure (5–10 mmHg). In healthy subjects the sphincter is relaxed to a pressure of 9 mmHg during swallowing to allow food to enter the stomach. The LOS is aided by the muscular diaphragmatic fibres that surround the oesophageal hiatus and by the acute angle at which the oesophagus joins the stomach. Drugs that increase the LOS pressure include suxamethonium, antiemetics, cholinergics and antacids. Drugs that lower the LOS pressure include anticholinergics, opioids, inhalational anaesthetics and thiopentone. Cricoid pressure and supraglottic airway devices also reduce the LOS pressure. Atracurium and ranitidine have no effect on LOS pressure.

The UOS is important in preventing oesophageal air entrainment during inspiration and it also prevents oesophageal content reflux into the larynx during peristalsis. It lies between the pharynx and upper oesophagus and is composed of the hyoid bone, the posterior surface of the cricoid and thyroid cartilages and the cricopharyngeus, inferior pharyngeal constrictor and cervical oesophageal muscle.

Airway reflexes such as coughing and laryngospasm are protective against aspiration. These are impaired throughout the perioperative period.

Pathophysiology

Disruption of normal physiology can allow oropharyngeal or gastric contents to pass through the vocal cords. In 1946 Mendelson reported two problems arising from cases of aspiration during general anaesthesia for operative delivery. These were choking and suffocation on solid material and an 'asthma-like syndrome' after liquid aspiration.[2] There has been further investigation into the sequelae of aspiration which can be divided into three groups:

- particle related
- acid related
- bacterial.

Particle-related complications

In Mendelson's description, there were five cases of solid aspiration.[2] There was complete obstruction in three cases causing suffocation in two with incomplete obstruction causing collapse,

cyanosis, tachycardia, dyspnoea and consolidation. The other patient survived after coughing up a solid piece of aspirated meat.

Acid-related complications

The pH of the contents of the stomach, particularly its secretions, can be as low as 1 due mainly to hydrochloric acid released by the parietal cells. If aspirated this can lead to pneumonitis (Mendelson syndrome), particularly if the pH is below 2.5 and the volume is greater than 0.3 ml/kg. Two distinct phases are recognized.

The initial stage involves a chemical burn to the airways occurring within 5 seconds. By 6 hours there is a loss of ciliated cells and type II pneumocytes. Alveolar permeability increases and leads to increased lung water and interstitial oedema. This leads to a reduction in lung compliance and increases alveolar-arterial oxygen tension difference and VQ mismatching. Cellular regeneration following this takes 3–7 days.

The second phase is the subsequent inflammatory response caused by potent cytokine release (e.g. tumour necrosis factor-α and interleukin-8), up-regulation of cell adhesion molecules and migration of neutrophils releasing oxygen free radicals and proteases. This can lead to acute lung injury, acute respiratory distress syndrome and multi-organ failure.

Bacterial complications

Aspiration of non-sterile gastric content, colonized oropharyngeal secretions or bacterial superinfection on lungs damaged by acid aspiration can lead to pneumonia. The disease process is similar to community-acquired pneumonia, although cavitation and abscess formation are more common.

Risk factors for aspiration

There are multiple risk factors predisposing a patient to aspiration. These can be categorized into patient factors, surgical factors and anaesthetic factors.

Patient factors are those that delay gastric emptying, compromise the oesophageal sphincters and impair the laryngeal reflexes. Bowel obstruction, abdominal pain, recent trauma, concomitant acute illness causing acidosis and autonomic neuropathy, diabetes and renal failure can all delay gastric emptying. The oesophageal sphincters can be compromised by oesophageal pathology (e.g. hiatus hernia, oesophagitis and achalasia), pregnancy over 20 weeks and obesity. The laryngeal reflexes are reduced by opioids, alcohol, head injury, seizures and advanced age.

Surgical factors increasing risk of aspiration include emergency surgery, laparoscopic surgery as it increases the intra-abdominal pressure, upper abdominal surgery and positioning in the head-down or lithotomy position.

Anaesthetic risk factors for aspiration are inadequate depth of anaesthesia[6] and inappropriate airway device selection.

Prevention of aspiration

All patients should undergo a risk assessment to identify those at risk of aspiration, allowing appropriate precautions to be taken. In the NAP 4 census,[5] 23 patients had a primary aspiration. Of those, two patients had no assessment of aspiration risk and 11 patients were deemed low risk. Of the low risk patients, risk factors for aspiration were identified in 9 of the 11. Appropriate consideration of all risk factors and modification of anaesthetic technique, where appropriate, should be routine for all surgery.

In non-emergency cases, all patients should be starved to reduce the volume and acidity of the stomach contents. The rate at which chyme is emptied in healthy individuals depends on how full the stomach is, the chemical composition and the size of the particles. Liquids clear faster than particulate matter, which in turn clears faster than solids. Current guidelines suggest 2 hours for clear fluids, 4 hours for breast milk and 6 hours for solids (including formula milk and cow's milk).

Choosing the appropriate airway for general anaesthesia is crucial. In the NAP 4 census,[5] four patients that underwent a general anaesthetic with a first-generation laryngeal mask had strong risk factors for aspiration and went on to have pulmonary aspiration, demonstrating the need to identify these risk factors and act upon them. If the patient is low risk and the surgery is high risk (e.g. laparoscopic cholecystectomy) then a cuffed endotracheal (ET) tube may be an appropriate choice for airway. Second-generation laryngeal masks (ProSeal and i-gel) with improved seals and gastric ports may be appropriate in patients with a borderline risk of aspiration, although this is difficult to prove.

Medication can be given if indicated to reduce the risk of aspiration and also to reduce the damage caused in the event of aspiration occurring. Metoclopramide will increase gastric emptying (in the absence of obstruction), whilst ranitidine, omeprazole or lansoprazole will decrease the acidity of gastric contents.[7] A nasogastric (NG) tube can also be inserted preoperatively to reduce gastric content volume. This is important in unstarved patients and those with pathologies that may delay gastric emptying such as bowel obstruction.

In high-risk cases a rapid sequence induction (RSI) with cricoid pressure remains standard practice although does not completely prevent aspiration. The standard procedure for an RSI is as follows.

- The usual machine check should take place.
- Explain the procedure to the patient.
- Ensure all team members are happy with the plan and that there is a third member of staff available to call for help should the need arise.
- Pre-oxygenate the patient. The aim of pre-oxygenation is to wash the nitrogen out of the lungs and replace it with oxygen. This allows the maximum amount of time for

Methods for pre-oxygenation

- The patient should be positioned in a 15–30° head-up position
- Ensure adequate gas flow for the circuit you are using (e.g. co-axial Bain needs 250 ml/kg/minute to prevent rebreathing)
- The mask should be tight fitting to prevent air entrainment, which dilutes the inspired oxygen
- Monitor expired oxygen fraction and aim for >90% oxygen. It will never reach a 100% due to expired CO_2
- This can be achieved by pre-oxygenating as above for 3 minutes or getting the patient to take three vital capacity breaths

Box 1