

Aspiration Pneumonia

Topical Report



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The information contained in this topical report has been prepared by the Royal Australasian College of Surgeons Queensland Audit of Surgical Mortality Management Committee.

The Queensland Audit of Surgical Mortality was established as a quality improvement committee on 30 October 2007 under section 7(1) of the *Health Services (Quality Improvement) Act 1994* (WA) (gazetted 9 November 2007).

The Australian and New Zealand Audit of Surgical Mortality, including the Queensland Audit of Surgical Mortality, also has protection under the Commonwealth Qualified Privilege Scheme, under Part VC of the *Health Insurance Act 1973* (gazetted 2 May 2017).

Foreword

Aspiration (and resulting aspiration pneumonia) is one of the more common causes of death in surgical patients (1).

Aspiration has significant morbidity and mortality (1). It is important that patients who are at risk of aspiration are managed appropriately.

This report looks at surgical patients who developed aspiration pneumonia between 2015 and 2020. In particular, the report:

- outlines patient groups that are at the highest risk of aspiration
- provides recommendations for surgeons on how to avoid aspiration and manage aspiration pneumonia.

Data in this report have been collected from:

- Queensland Hospital Admitted Patient Data Collection, from the Queensland Department of Health (Queensland Health) (2)
- Queensland Audit of Surgical Mortality (QASM), which is a part of the Australian and New Zealand Audit of Surgical Mortality (3).

The case studies and insights from Queensland surgeons used in this report are taken from QASM first- or second-line assessments that were generated by expert surgeons in the field. Any advice given relates to these cases as they were presented.



Queensland surgeon Insight

The underlying cause of one patient's death was most likely related to aspiration. This risk had been highlighted during the patient's admission and had been actively managed throughout their stay. Unfortunately, complications that developed because of aspiration pneumonia proved too much for someone with limited medical reserves. Fasting related to their two surgeries was not a contributing factor.

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Shortened forms

ERAS	enhanced recovery after surgery
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ICU	intensive care unit
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PPC	postoperative pulmonary complication
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QASM	Queensland Audit of Surgical Mortality
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Queensland Health	Queensland Department of Health
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Chair's report

Aspiration pneumonia has become a more common diagnosis in recent years, especially in the aged. Both surgical and medical patients can have aspiration pneumonia.

Aspiration must always be considered a possibility. Steps must be taken to avoid 'return of the swallow' at all costs.

Aspiration can happen when the normal peristalsis of the bowel stops or slows significantly. Because of normal bowel wall secretion and the inability to push bowel contents towards the colon, fluid builds up within the bowel. Intestinal flora produce gas, which adds to the already complex situation. Distension, lack of peristalsis, and fluids not being absorbed by the bowel wall create an unsolvable situation. As the 'balloon' distends, sooner or later it must burst. The analogy is simple.

Oral intake becomes impossible because of nausea and abdominal pain. Attempts to control pain using medication may complicate any remaining peristalsis and stop any normal bowel function. Similarly, narcotics prescribed for the pain may compromise the patient's ability to vomit without some aspiration. With gastric contents in the bronchial tree, pneumonia will soon follow.

The older patient is particularly vulnerable to this, even if the bowel is not the origin of the significant pathology. A constipated patient who has been lying immobile in bed, and has perhaps taken medication that slows the normal bowel function even more, is always at risk.

Patients who cannot move are also at risk. For example, patients with hip fracture lie immobile on their backs; this position, along with the administration of oral medication that slows bowel function, is a serious but significant risk factor. Transfer to hospital, where extra pain relief is prescribed and given, may reduce normal bowel function even more.

Regular aspiration of a nasogastric tube will help to stop the 'return' of stomach or bowel contents. But this must not be seen as dealing with the underlying cause.

The treating practitioner needs to make a diagnosis that is precise and deals with the pathology, if possible. Treating the underlying cause must always be the priority.

Bowel decompression may be appropriate if obstruction is evident and individual comorbidities allow for surgical intervention.

Immobilisation or internal fixation of a fracture (if appropriate) as soon as possible after injury will allow the patient to be nursed or mobilised quickly. It will also reduce narcotic use that may affect the return of normal bowel function.

Decision-making in these scenarios is complex. Conversations within the multidisciplinary team are a must in moving to any intervention, be it a laparotomy pathway, a palliative care pathway, or an internal fixation of fracture pathway.

I trust this document will assist you in managing patients who may develop ileus and are, therefore, candidates for aspiration and all its consequences.

Dr John North FRACS

QASM Clinical Director

Aspiration

Aspiration, and the associated complications of aspiration pneumonia, aspiration pneumonitis and symptoms of choking, are distressing for patients and families.

Aspiration is the inflow of material from the mouth or upper gastrointestinal tract into the lungs (4). This material can be:

- gastric fluids
- saliva and associated oral bacteria
- food or ingested fluids.

Aspiration can be classified as macro-aspiration or micro-aspiration, and either overt or silent.

Aspiration, especially silent aspiration, can be difficult to detect clinically. Surgeons must identify at-risk patients, as well as procedures that have a higher risk for aspiration. A skilled multidisciplinary team may help lessen, and manage the risk of, aspiration.

Aspiration pneumonia

Aspiration pneumonia is a condition associated with significant morbidity and mortality (1). Patients who develop aspiration pneumonia:

- are four times more likely to require admission to an intensive care unit (ICU)
- will have a significantly longer length of stay in an ICU (estimated mean increase of seven days)
- have an in-hospital mortality that is seven times higher than those who never have aspiration pneumonia (1).



Queensland surgeon Insight

A patient with an otherwise asymptomatic and uncomplicated large inguinal scrotal hernia was given Endone (oxycodone) for pain relief. Constipation, which is a risk of Endone use, may have caused the borderline obstruction and secondary aspiration. The events that followed were complications of the aspiration pneumonia and coincidental obstructed inguinal hernia. It is most likely that the poor recovery from aspiration pneumonia contributed to the patient's death.



Patient case

Aspiration in a high-risk patient

An 80-year-old woman was admitted to the hospital with critical limb ischaemia of her right leg. She passed away from aspiration pneumonia on day 17 of her admission.

Her presentation was a necrotic ulcer over the medial aspect of her great toe. There was mild surrounding cellulitis and x-ray evidence of osteomyelitis. She did not have fever or systemic signs of sepsis.

She had considerable background history, including peripheral vascular disease and a previous left above-knee amputation. She was wheelchair-dependent but able to transfer independently, and still lived at home with her husband. She was frail and malnourished, with a weight of 40 kilograms. Other relevant history included hypertension, chronic obstructive pulmonary disease and monoclonal B-cell lymphoma; she was an ex-smoker.

She was admitted under a vascular surgeon, was started on intravenous antibiotics, and underwent an angiogram on the second day of her admission. This resulted in a successful angioplasty and stent of her popliteal artery. She then had a right great-toe amputation on the next available elective list. Postoperatively, the main problem was pain around the wound.

She had allied health input from a physiotherapist and a dietician.

The toe amputation wound failed to improve and became necrotic. The patient and the treating surgeon agreed to proceed to a right above-knee amputation on day 14.

On day 15, the patient had a medical emergency call for desaturation secondary to aspiration. She was observed to have eaten a meal, vomited, and desaturated to 85% on room air. There was a nursing note describing a family member feeding the patient while she was lying on her side. This prompted oxygen therapy, and a plan to start antibiotics if a fever developed. The patient was reviewed by a speech therapist and put on a modified diet.

Later that evening, she had a further medical emergency call for confusion and increased respiratory rate (30 breaths per minute). A chest x-ray confirmed consolidation consistent with aspiration, and bloods showed a raised white cell count of more than 30.0×10^9 per litre (a normal range is $4.0\text{--}11.0 \times 10^9$ per litre). The medical team started intravenous antibiotics and frusemide to treat the fluid overload.

The patient was reviewed the following day by the treating surgeon. They discussed ceiling of care with her family, as the patient was still confused. She remained confused and drowsy overnight and refused to eat. The treating surgeon had further discussions with her family, and it was agreed that she would be moved to palliative care.

In summary, this was an unfortunate complication in the care of a frail, elderly woman. She had a high risk of mortality from this admission because of her medical comorbidities.

Risk factors for aspiration and aspiration pneumonia

Patient risk factors

Patient risk factors that are both nonmodifiable (such as age and male gender) and potentially modifiable should be identified (5). Potentially modifiable risk factors include:

- altered mental status, including delirium or effects of medications such as
 - opioids and sedatives
 - other psychotropic medications such as benzodiazepines and antipsychotics, which depress the central nervous system
- dysphagia from conditions such as Parkinson's disease, dementia syndromes and previous strokes
- gastrointestinal disorders, including oesophageal motility disorders and gastric outlet obstruction
- comorbidities, including diabetes mellitus, lung disease and poor oral health.

For patients with numerous risk factors, surgeons may choose to involve a perioperative medicine physician.

Surgical risk factors

Emergency surgery (1) – especially hip fracture repair and abdominal surgery (6, 7) – is one of the highest risk factors for aspiration. Other surgical risk factors include:

- emergency admission (1)
- postoperative vomiting (7)
- ileus (7), which shares many risk factors with aspiration, such as
 - older age
 - male gender
 - open surgery (especially emergency surgery)
 - prolonged duration of surgery (7).

While intraoperative aspiration is a feared complication of anaesthesia, it is uncommon; it occurs in less than 0.5% of operations requiring anaesthesia (8). Strategies to reduce the risk of intraoperative aspiration are also well described (8, 9). Postoperative aspiration, especially after the patient has returned to the ward, is not as well described – this is despite it possibly being more common than intraoperative aspiration.



Queensland surgeon Insight

I believe the patient died from aspiration, either during his high-risk endoscopy or the following day when the nasogastric tube – which had not had a problem for seven days – became dislodged, causing coughing and vomiting.

Recommendations for surgeons

1. Always consider the possibility of aspiration in the following situations:
 - emergency admission
 - emergency surgery
 - hip fracture procedure
 - ileus
 - postoperative vomiting
 - older patients with comorbidities.
2. Take steps to avoid vomiting at all costs:
 - Ask about nausea and vomiting when getting a patient's history
 - Carefully assess the patient for possible vomiting or aspiration
 - If appropriate, label the patient as a 'risk' so medical, nursing and allied health staff know to be extra vigilant in their care
 - Insert a nasogastric tube after ensuring that the patient is in an appropriate position (reposition if necessary)
 - Aspirate the patient often and record volumes
 - Review the patient regularly to assess their progress
 - Investigate suspected aspiration quickly
 - Ensure that high-risk patients who do not have a nasogastric tube are sat up when eating.
3. Consider involving a multidisciplinary team when discussing the need to operate on high-risk patients.
4. Consider postoperative admission of high-risk patients to an intensive care unit or a high dependency unit; monitoring these patients for 24 hours may reduce the likelihood of aspiration pneumonia.



Queensland surgeon Insight

The spigot of the nasogastric tube with high output and continual oral intake, along with oral administration of Gastrografin, may have led to aspiration in a 90-year-old patient. This could have been prevented by having the nasogastric tube on free drainage, having regular aspirates, and stopping the Gastrografin.

Evidence of aspiration in surgical patients

Aspiration following surgical procedures in Queensland Health facilities, 2015–2020

Queensland Department of Health (Queensland Health) data from July 2015 to June 2020 showed that 1.4% (9,484/687,306) of all patients admitted to Queensland public hospitals for more than one day were identified as having a hospital-acquired complication of aspiration pneumonia.

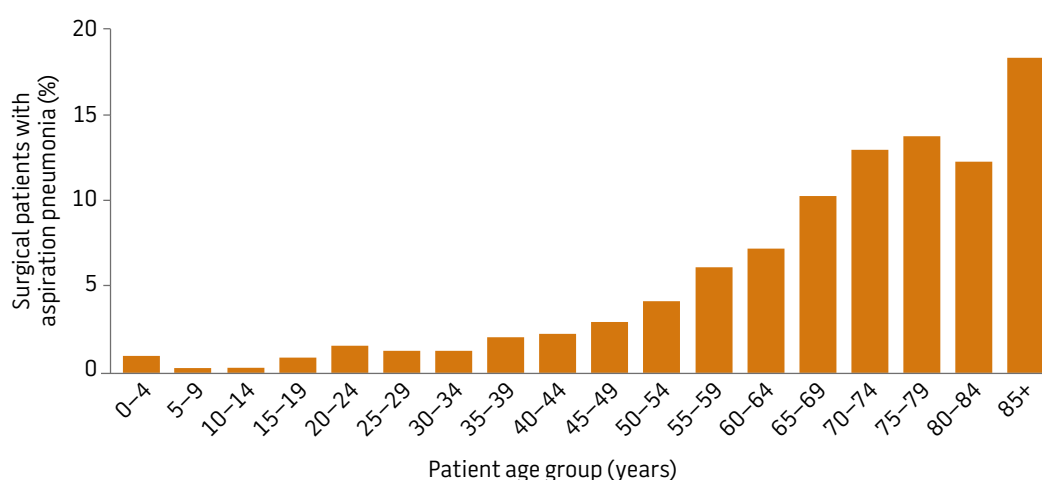
This report focuses on patients who developed aspiration pneumonia following a surgical procedure (45.0%; 4,269/9,484).

More than half of these patients had an emergency admission (58.9%; 2,516/4,269).

Contributing factor 1: Age

Data from Queensland Health show that the likelihood of a patient having an episode of aspiration pneumonia following a surgical procedure increased with age.

Patients aged over 70 years accounted for more than half of all surgical aspiration pneumonia cases (57.9%). Those aged 85 and older had the highest incidence of aspiration pneumonia (Figure 1).



Notes: Queensland Health data from July 2015 to June 2020; $n = 4,269$.

Figure 1. Age group distribution of patients who had a surgical procedure and aspiration pneumonia in Queensland Health facilities

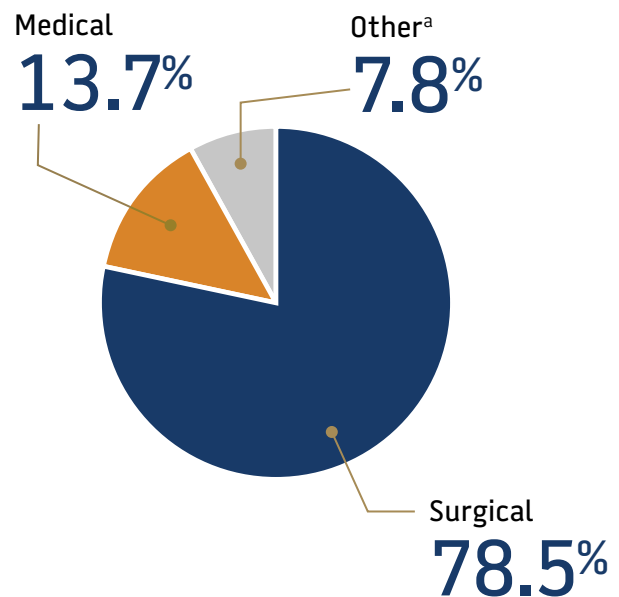


Queensland surgeon Insight

A high level of concern and care must be offered to patients with very complex comorbid issues. Despite rapid and appropriate care, aspiration pneumonia can be fatal in the very frail and unwell.

Contributing factor 2: Type of admission and surgical procedure

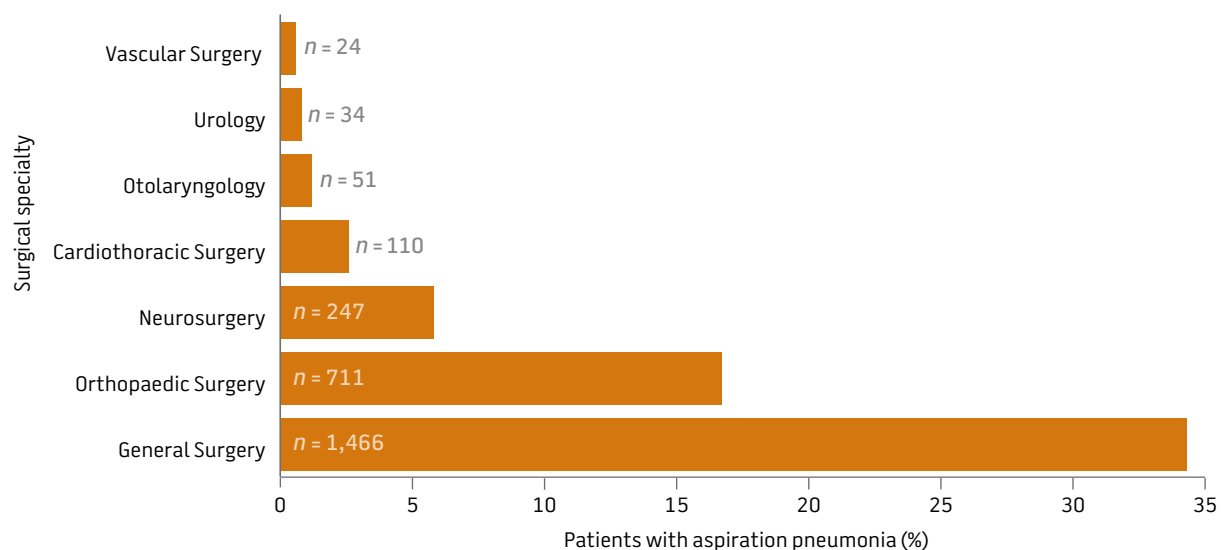
According to Queensland Health data, the type of admission is a factor when identifying patients at risk of aspiration pneumonia. Of the patients who had a surgical procedure and aspiration pneumonia, more were surgical admissions (78.5%; 3,352/4,269) than medical admissions (13.7%; 586/4,269) (Figure 2). One-third of patients (34.3%; 1,466/4,269) were admitted for General Surgery, and less than one-fifth (16.7%; 711/4,269) had been admitted for Orthopaedic Surgery (Figure 3).



a Includes nonsurgical or nonmedical patients admitted for a procedure (e.g. endoscopy).

Notes: Queensland Health data from July 2015 to June 2020; n = 4,269.

Figure 2. Patients who had a surgical procedure and aspiration pneumonia in Queensland Health facilities, by admission type

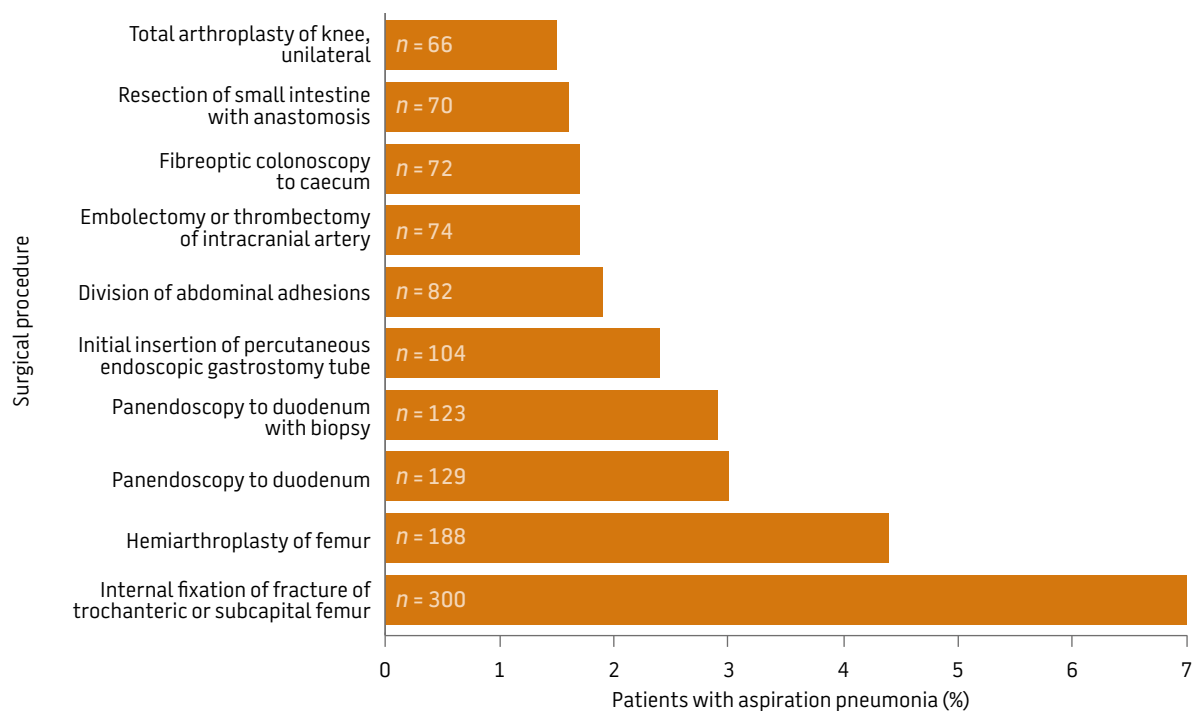


Notes: Queensland Health data from July 2015 to June 2020; n = 4,269.

Figure 3. Most common surgical specialties that resulted in aspiration pneumonia in Queensland Health facilities

Although patients admitted for General Surgery were more likely to develop aspiration pneumonia, Queensland Health data showed that aspiration pneumonia was more likely to occur following the Orthopaedic procedure of repair of fractured neck of femur (11.4%; 488/4,269).

The General Surgery procedure of panendoscopy to the duodenum (with and without biopsy) accounted for 5.9% (252/4,269) of all aspiration pneumonia cases (Figure 4).



Notes: Queensland Health data from July 2015 to June 2020; n = 4,269.

Figure 4. Surgical procedures that resulted in the most cases of aspiration pneumonia in Queensland Health facilities

Aspiration pneumonia deaths in Queensland surgical hospitals, 2015–2020

Queensland Audit of Surgical Mortality (QASM) data from July 2015 to June 2020 showed that aspiration pneumonia accounted for 4.9% (262/5,362) of surgical deaths in Queensland surgical hospitals (both public and private). Nearly all of these patients (92.4%; 242/262) were emergency admissions. This differs from the Queensland Health data:

- The mortality status of the Queensland Health patients was not available for this report

- Only 60.0% of Queensland Health patients had been emergency admissions.

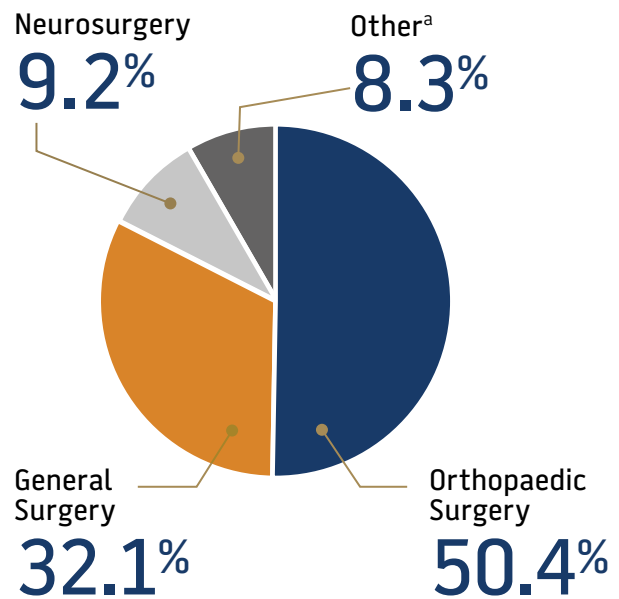
The average age of patients with aspiration pneumonia was 82 years (interquartile range of 73–89 years); this was similar to the Queensland Health data. There were more male patients (60.0%) than female patients (40.0%).

Contributing factor 3: Type of surgery

QASM data showed that many patients (78.6%; 206/262) who died from aspiration pneumonia had an emergency surgical procedure. The most common emergency surgical procedures were:

- repair of fractured neck of femur
- closed reduction and bone fixation
- emergency laparotomy
- bowel resection
- other general procedures.

Half of the aspiration pneumonia deaths (50.4%; 132/262) were Orthopaedic Surgery patients. One-third were General Surgery patients (32.1%; 84/262), and some were Neurosurgery patients (9.2%; 24/262) (Figure 5). This is comparable to the distribution of surgical procedures in the Queensland Health data.



^a Includes nonsurgical or nonmedical patients admitted for a procedure (e.g. endoscopy).

Notes: Queensland Audit of Surgical Mortality data from 2015 to 2020; $n = 262$.

Figure 5. Surgical deaths from aspiration pneumonia in Queensland hospitals, by surgical specialty

Contributing factor 4: No specialist care following surgery

One-third of patients who were admitted to an intensive care unit (ICU) had aspiration pneumonia (36.0%; 90/250). This suggests that patients who develop aspiration, or are at high risk of aspiration pneumonia, should be treated in an ICU or a high dependency unit postoperatively. ICU admission data were not available in the Queensland Health data.



Queensland surgeon Insight

Aspiration is a potentially fatal complication. It can happen in the well-fasted patient, especially in those who have had recent gastrointestinal surgery. It would not be unreasonable to manage patients who had major gastrointestinal procedures and then need review surgery as if they were not fasted, and use appropriate anaesthesia induction and intubation strategies.

Preventing aspiration and aspiration pneumonia

Prevention of aspiration and aspiration pneumonia applies to both medical and surgical patients. Multifaceted strategies are usually used, and include:

- changing consistency of food
- changing head position
- improving oral hygiene
- using pharmacological agents to improve the swallowing reflex (10).

Interventions that prevent delirium in surgical patients, such as Eat Walk Engage (11) and the Hospital Elder Life Program (12), may also prevent aspiration (13).

Preventive strategy 1: Use a multidisciplinary team to care for patients at risk of aspiration

Surgeons should consider involving a multidisciplinary team when deciding whether to operate on patients at risk of aspiration. A multidisciplinary team can also help with patient care:

- The pain team can advise on expert pain management that uses opioid-sparing analgesic regimens

- Geriatricians can help with preventing and managing postoperative delirium, and managing common risk factors for aspiration in older people
- Allied health professionals and nursing team members can make changes that reduce the risk of aspiration.

Preventive strategy 2: Reduce the incidence of ileus

Ileus can lead to aspiration. Ileus and aspiration also share many risk factors. Strategies that reduce the incidence of ileus may prevent aspiration from occurring.

Enhanced recovery after surgery (ERAS) principles of colorectal surgery can reduce the incidence of ileus:

- opioid-sparing pain management
- early postoperative oral intake
- minimising attachments such as nasogastric tubes (14).



Queensland surgeon Insight

Emergency laparotomy patients are a high-risk group; careful nursing and medical postoperative care is key. Medications like opiates can make ileus worse, but can also contribute to delirium and aspiration events by suppressing laryngeal reflexes.

Preventive strategy 3: Prevent postoperative pulmonary complications

Strategies that prevent postoperative pulmonary complications (PPCs) may also reduce the risk of postoperative aspiration pneumonia. These interventions should be started preoperatively, where feasible:

- preoperative respiratory physiotherapy (this has been shown to prevent PPCs in upper gastrointestinal surgery) (15)
- ERAS pathways (16)
- intraoperative lung protection ventilation (16)
- prophylactic mucolytics (16).

However, some of these recommendations are based on low-quality evidence.

It has also been shown that incentive spirometry does not prevent PPCs (16).

The role of specific surgical interventions in preventing PPCs, such as in open or laparoscopic surgery, is less clear (17).

Preventive strategy 4: Consider the risks and benefits of 'nil by mouth'

Aspiration of saliva (containing oral bacteria) can happen without the intake of food or fluids. Prolonged periods of 'nil by mouth' are rarely helpful in patients with multiple nonmodifiable risk factors.

'Risk feeding' is a term used when a person at risk of aspiration continues to eat and drink (18). It overlooks the social benefits of mealtimes and general enjoyment of food (18). Surgeons may need to advocate for patients, and lead the health care team in promoting eating and drinking as a quality-of-life measure – especially for patients with limited life expectancy.



Queensland surgeon **Insight**

The sequence of ileus, vomit and aspiration is not uncommon in very unwell patients. But not all aspirations are entirely preventable. There is a trade-off between the potential risks and the benefits gained with early return to enteral feeding.

Managing aspiration pneumonia

Even if all reasonable preventive strategies are used, aspiration can still happen. Strategies that prevent aspiration may also help with its management.

Not all aspiration leads to aspiration pneumonia (18). It is difficult to clinically differentiate aspiration pneumonitis from pneumonia (19).

Once aspiration pneumonia is suspected or confirmed, the antibiotic used depends on local infection control guidelines, and whether the infection was acquired in the hospital or in the community.

Respiratory support is sometimes needed. This can range from ward-based supplemental oxygen to intubation and ventilation in an ICU.

For a deteriorating patient, it is important that surgeons:

- consider an appropriate ceiling of intervention
- start conversations about advance care planning with the patient (or their alternative decision-maker) as soon as possible
- provide appropriate palliative care, to manage symptoms and enable a comfortable and dignified death.

Pneumonia was once described by William Osler as the 'old man's friend' (20). This is a statement that still holds true today.



Queensland surgeon Insight

The patient died because of aspiration of faeculent material back-flow from a paralytic ileus. The aspiration occurred alongside hospital-acquired pneumonia. There were great efforts made to diagnose and treat these conditions. These efforts were appropriate but, unfortunately, unsuccessful. The prognosis was always poor! There were possibly too many specialties involved and no responsible patient advocate.



Patient case

Mismanagement of aspiration

A 92-year-old man was admitted for repair of a fractured neck of femur.

There was a 48-hour delay before surgery, which was necessary for preoperative medical management. Acceptable reasons for delay to the surgery could be cough, fever, and the need to stop the patient's oral anticoagulant. The treating physician assumed that the patient's cough was due to influenza A virus; this diagnosis was based on a throat swab for virology. There was no record of sputum culture for an alternative diagnosis, or any record of antibiotic use. The anaesthetist requested the 48-hour delay to surgery because the patient was on oral Xarelto, which is not reversible, and a spinal anaesthetic was planned.

There was no documentation of postoperative intravenous antibiotic use. Although the patient was prescribed oral Ibilex (cefalexin) on admission, it was most likely not suitable postoperatively, especially with his swallowing difficulty.

The physician reviews were sparse and not detailed.

Ideally, the patient should have gone to a high dependency unit postoperatively, irrespective of his age. All signs pointed to compromised swallowing in an old patient with altered sensorium, cough, fever and hypoxia, yet Valium and haloperidol were used for his agitation.

Aspiration, worsening of pneumonia and hypoxia were inevitable.

The physician identified the aspiration pneumonia in his last review.

Physician management could have been better. The patient was compromised preoperatively, and such a patient could have benefited from close monitoring and regular reviews. For example, lack of fever in the elderly sometimes indicates severe sepsis, as these patients may not be able to produce a fever response.

In the assessor's opinion, the patient had bacterial pneumonia preoperatively, as well as the diagnosed influenza virus infection that was not treated well preoperatively.

Postoperatively, the patient should have been admitted to a high dependency unit for monitoring. There was also no evidence of intravenous antibiotic use postoperatively, which is usually used in patients with aspiration. There was a possibility of stroke that affected the patient's swallowing ability.

All these, with inappropriate use of sedative agents, will cause aspiration. The patient most likely died from aspiration pneumonia, which was not well treated.

References

1. Kozlow JH, Berenholtz SM, Garrett E, Dorman T, Pronovost PJ. Epidemiology and impact of aspiration pneumonia in patients undergoing surgery in Maryland, 1999–2000. *Crit Care Med*. 2003;31(7):1930-1937.
2. Statistical Collection and Integration Unit, Statistical Services Branch. Queensland Hospital Admitted Patient Data Collection (QHAPDC) manual 2019–2020. Brisbane: Queensland Health; 2019. From: www.health.qld.gov.au/_data/assets/pdf_file/0024/934413/Final_2019-20-QHAPDC-manual_v1.2.pdf. Accessed 6 May 2021.
3. Queensland Audit of Surgical Mortality. Queensland Audit of Surgical Mortality annual report 2007–2016. Brisbane: Royal Australasian College of Surgeons; 2017.
4. Son YG, Shin J, Ryu HG. Pneumonitis and pneumonia after aspiration. *J Dent Anesth Pain Med*. 2017;17(1):1-12.
5. Van der Maarel-Wierink CD, Vanobbergen JNO, Bronkhorst EM, Schols JMGA, de Baat C. Risk factors for aspiration pneumonia in frail older people: a systematic literature review. *J Am Med Dir Assoc*. 2011;12(5):344-354.
6. Byun SE, Shon HC, Kim JW, Kim HK, Sim Y. Risk factors and prognostic implications of aspiration pneumonia in older hip fracture patients: a multicenter retrospective analysis. *Geriatr Gerontol Int*. 2019;19(2):119-123.
7. Venara A, Neunlist M, Slim K, Barbieux J, Colas PA, Hamy A, et al. Postoperative ileus: pathophysiology, incidence, and prevention. *J Visc Surg*. 2016;153(6):439-446.
8. Nason KS. Acute intraoperative pulmonary aspiration. *Thorac Surg Clin*. 2015;25(3):301-307.
9. Kluger MT, Short TG. Aspiration during anaesthesia: a review of 133 cases from the Australian Anaesthetic Incident Monitoring Study (AIMS). *Anaesthesia*. 1999;54(1):19-26.
10. Loeb MB, Becker M, Eady A, Walker-Dilks C. Interventions to prevent aspiration pneumonia in older adults: a systematic review. *J Am Geriatr Soc*. 2003;51(7):1018-1022.
11. Mudge AM, McRae P, Donovan PJ, Reade MC. Multidisciplinary quality improvement programme for older patients admitted to a vascular surgery ward. *Intern Med J*. 2020;50(6):741-748.
12. Hsieh TT, Yang T, Gartaganis SL, Yue J, Inouye SK. Hospital Elder Life Program: systematic review and meta-analysis of effectiveness. *Am J Geriatr Psychiatry*. 2018;26(10):1015-1033.
13. Demeure MJ, Fain MJ. The elderly surgical patient and postoperative delirium. *J Am Coll Surg*. 2006;203(5):752-757.
14. Carmichael JC, Keller DS, Baldini G, Bordeianou L, Weiss E, Lee L, et al. Clinical practice guidelines for enhanced recovery after colon and rectal surgery from the American Society of Colon and Rectal Surgeons and Society of American Gastrointestinal and Endoscopic Surgeons. *Dis Colon Rectum*. 2017;60(8):761-784.

15. Boden I, Skinner EH, Browning L, Reeve J, Anderson L, Hill C, et al. Preoperative physiotherapy for the prevention of respiratory complications after upper abdominal surgery: pragmatic, double blinded, multicentre randomised controlled trial. *BMJ*. 2018;360:j5916.
16. Odor PM, Bampoe S, Gilhooly D, Creagh-Brown B, Moonesinghe SR. Perioperative interventions for prevention of postoperative pulmonary complications: systematic review and meta-analysis. *BMJ*. 2020;368:m540.
17. Lawrence VA, Cornell JE, Smetana GW. Strategies to reduce postoperative pulmonary complications after noncardiothoracic surgery: systematic review for the American College of Physicians. *Ann Intern Med*. 2006;144(8):596-608.
18. Murray A, Mulkerrin S, O’Keeffe ST. The perils of ‘risk feeding’. *Age Ageing*. 2019;48(4):478-481.
19. Mandell LA, Niederman MS. Aspiration pneumonia. *N Engl J Med*. 2019;380(7):651-663.
20. Rijkers GT, Pelton SI. The old man’s friend. *Pneumonia*. 2018;10:8.

