Royal Australasian College of Surgeons

Infections and surgical mortality 1 July 2011 – 30 June 2019

Report from the Queensland Audit of Surgical Mortality (QASM)

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Introduction

The Queensland Audit of Surgical Mortality (QASM) audits all surgical deaths in Queensland. All hospitals (public and private) in Queensland participate in QASM and all surgeons are obliged by the Royal Australasian College of Surgeons (RACS) to participate in the audit as part of the Continuing Professional Development program.

The theme of "infections" has been a focus of QASM educational activities in recent years. Hospital-acquired infections (HAIs) are infections that patients may acquire while receiving medical treatment in a health care facility. HAIs are a major threat to patient safety but are often preventable. Surgeons in Queensland hospitals use the surgical case form (SCF) to report if a surgical patient under their care died with a clinically significant infection.

All hospitals receive an annual report from QASM comparing rates of infection (as reported by surgeons) at their facility with those of similar hospitals statewide and nationally. For every death, each surgeon receives a peer-reviewed report, which may include comments on infections. QASM has published several *Lessons from the Audit* booklets based on QASM cases, presenting examples of how infections were treated and/or how treatment could have been improved.

In 2017, QASM published a report on infections in surgical patients who died in the five-year period 1 July 2011 – 30 June 2016. In 2018, QASM hosted a seminar on infections, which received strong attendance from surgeons, physicians, trainees and nurses.

This report covers the 9,530 surgical deaths reported to QASM during the period 1 July 2011 – 30 June 2019. The report includes data from several questions in the SCF, focusing in particular on questions 21a and 21b:

21a – Did this patient die with a clinically significant infection?

- ☐ Yes
- ☐ No

Was this infection acquired:

- ☐ before this admission
- ☐ during this admission

If acquired during this admission, was the infection acquired:

- ☐ preoperatively
- ☐ postoperatively
- ☐ surgical site infection
- ☐ other invasive site infection

21b – Was the infection:

- ☐ pneumonia
- ☐ intra-abdominal sepsis
- ☐ septicaemia
- ☐ other source

Was the infective organism identified?

- ☐ Yes
- ☐ No

If yes, what was the organism?

Was there a delay in treatment of the infection?

- ☐ Yes
- ☐ No

Notes on the data

Data are provided by surgeons caring for patients, not by an infection control program.

Not all audit questions were answered on all SCFs, so denominators differ for some analyses. Only complete answers are used. In this report, results are presented as the number of respondents who indicated “yes” for the point of interest (numerator, or x) from the overall number of respondents who answered the question in the SCF (denominator, or y) – that is, x/y.

This report is based on the 9,530 surgical patients who died; 86.8% of all the patients in this report were emergency admissions (7,242/8,340; missing data: 1,190).

Key points

This report presents QASM data on surgical patients who died with a clinically significant infection at the time of death.

The rate of infections in surgical patients who died has remained steady since 2011 at around 35%.

More than 3,000 surgical patients (37.6%) died with an infection present from 1 July 2011 to 30 June 2019 (3,139/8,340; missing data: 1,190).

Almost 60% of patients who died with an infection present acquired the infection while an inpatient (56.5%; 1,527/2,702).

Risk of infection was 30% higher for all-cause readmissions than for single admissions.

The proportion of reported cases dying with infection varied by surgical specialty, from 1.4% for Head and Neck to 43.5% for General Surgery.

Very young patients and elderly patients had the highest rates of infections among surgical patients who died.

Infections in surgical patients are an ongoing challenge for hospital staff. Incidence rates remain unacceptably high, despite strenuous efforts by safety and quality staff and clinical staff to control infections.

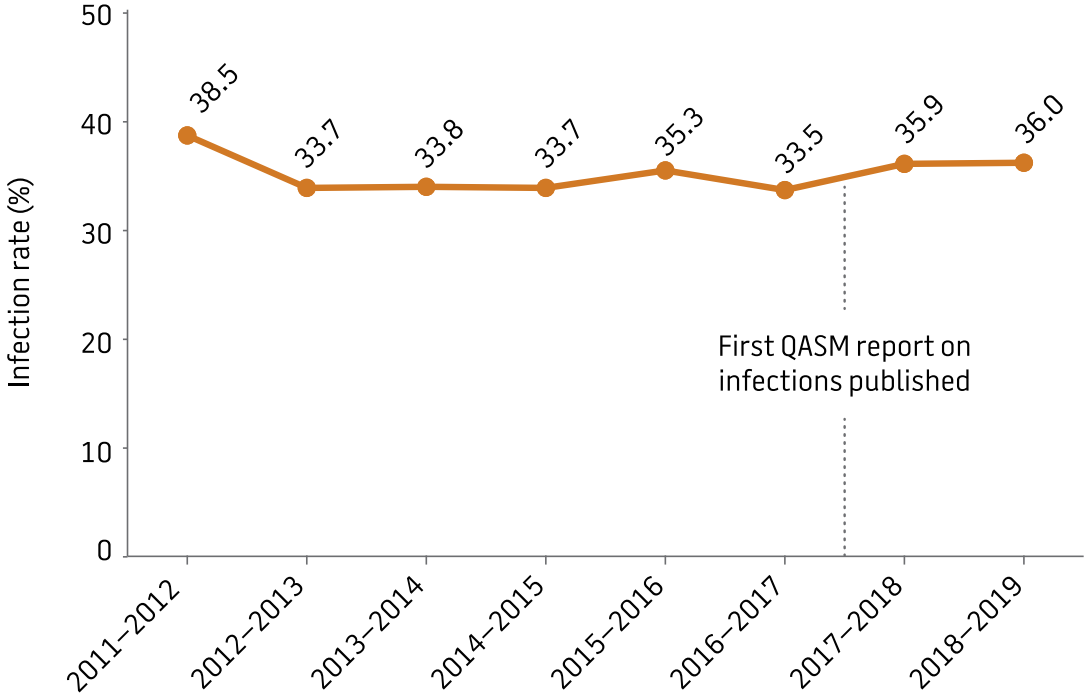
Infections

Infection rate

The rate of infection in surgical patients who died following surgery has changed little over time.

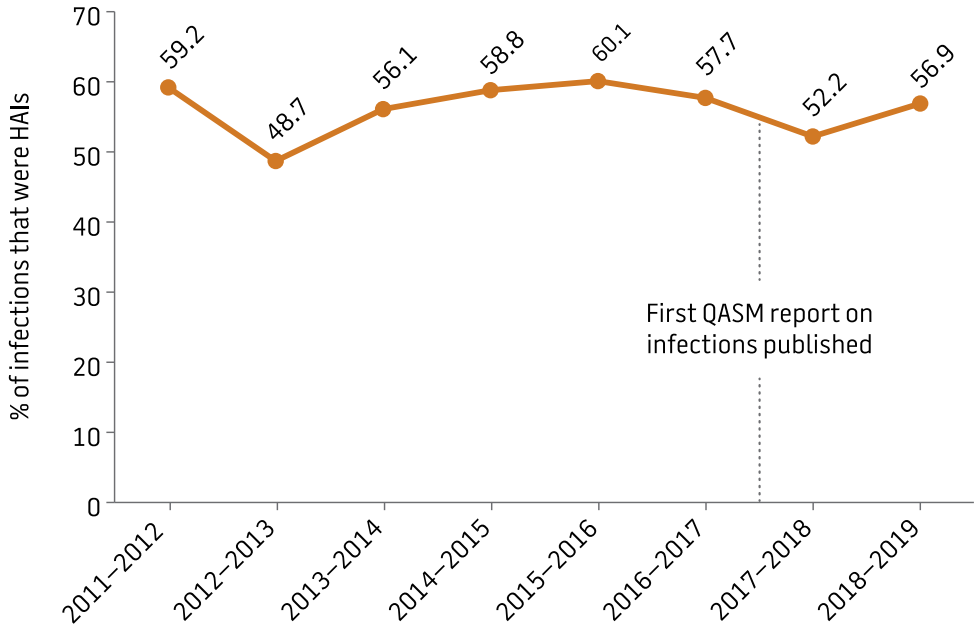
The proportion of preventable infections or those contributing to death is unknown. However, the high rate of infections in this context implies that careful attention to infection prevention and optimal treatment of infection in surgical patients is warranted.

Publication of the previous QASM report on infections in 2017 and the education session in 2018 showed no impact on overall rates of infection.

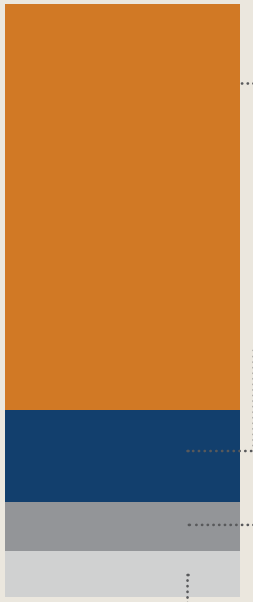


HAIs account for 50–60% of infections

Each year, 50–60% of surgical patients who died with an infection acquired their infection in hospital. Others acquired their infection in the community prior to hospital admission.



Most HAIs were acquired postoperatively:

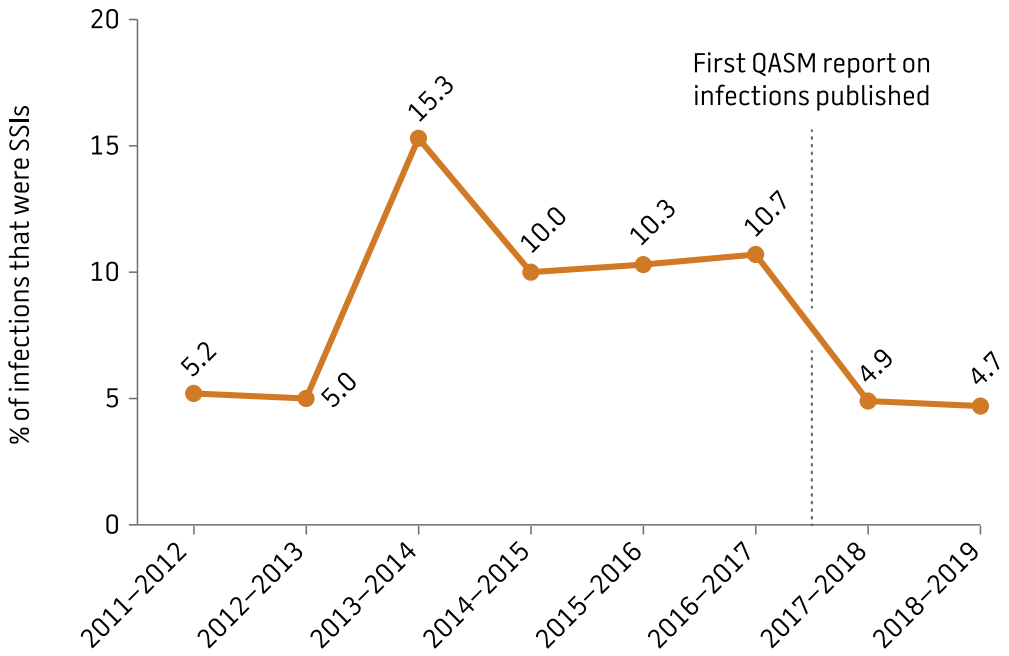


Acquired postoperatively
68.0% (669/984)

Acquired preoperatively
16.1% (158/984)

Other invasive sites
8.4% (82/984)

Surgical site infections
7.6% (75/984)



Surgical site infections

Surgical site infections (SSIs) are those occurring within 30 days of surgery (up to a year after surgery for implants) affecting either the incision or deep tissue at the operation site.

SSIs lead to longer hospital stays and higher costs to patients, hospitals and health systems. The United States Centers for Disease Control and Prevention (CDC) publishes authoritative guidelines for preventing SSIs. These guidelines highlight the importance of:

- good patient preparation
- aseptic practice
- attention to surgical technique
- antimicrobial prophylaxis (in appropriate circumstances).

Among surgical patients who died with infections, the percentage of SSIs has varied over time. However, SSIs are significantly outnumbered by other types of infection.

Types of infection

Pneumonia was the most frequent type of infection present when the patient died (40.1%; 1,082/2,696)

Septicaemia was the second most frequent (26.8%; 722/2,696)

All other infection types (33.1%; 892/2,696)

Infectious organisms

One in ten patients were infected with multiple pathogenic organisms (11.1%; 96/865).

Pseudomonas aeruginosa was the most prevalent organism in patients with pneumonia (6.6%; 22/333). This is not unexpected, as most cases of hospital-acquired pneumonia have no specific pathogen identified, and *Pseudomonas* is more common in patients with underlying lung problems who may be more vulnerable to postoperative pneumonia.

Staphylococcus aureus (including methicillin-resistant *Staphylococccus aureus* – MRSA) was the most prevalent organism in patients with community-acquired infections (10.1%; 80/790).

In general, gram-positive organisms were more common in community-acquired infections, possibly because *Staphylococcus aureus* infections often need surgery as part of treatment (e.g. for septic arthritis).

Gram-negative organisms were more common in HAIs. This may reflect the high volume of gastrointestinal surgery, as gram-negative organisms are more common in the gastrointestinal tract.

The higher prevalence of gram-negative organisms in HAIs is important for treatment protocols because antimicrobial resistance is rapidly emerging in gram-negative organisms. Antimicrobial resistance may be associated with the need for different antibiotics for treatment and increased mortality.

The following organisms were identified from surgical patients who died with infections present from 1 July 2011 to 30 June 2019.

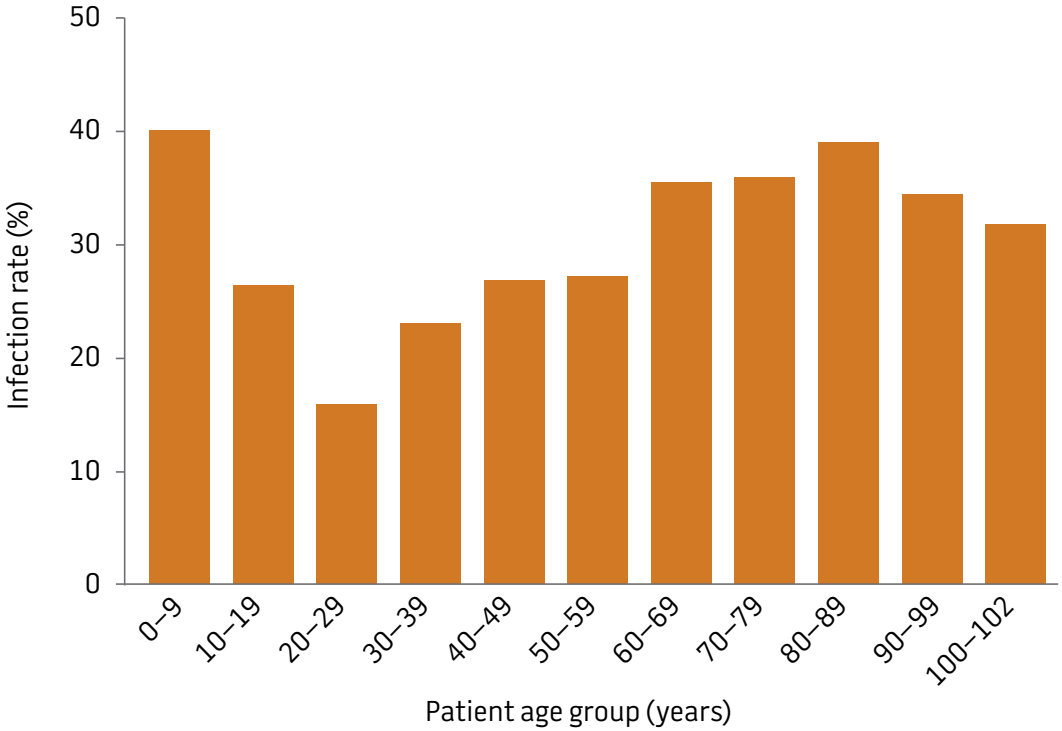
Organism	Number of surgical patients who died with this organism present
Other coliforms	144
Escherichia coli (including ESBL and CPE)	140
Pseudomonas	108
Staphylococcus aureus (including MRSA)	106
Candida species	82
Klebsiella species (including ESBL and CPE)	74
Streptococcus species	66
Enterococci (including VRE)	59
Coagulase-negative staphylococci	43
Anaerobes (including *Clostridium difficile*)	28

CPE = carbapenem-resistant enterococci; ESBL = extended-spectrum beta-lactamase; MRSA = methicillin-resistant *Staphylococcus aureus*; VRE = vancomycin-resistant enterococci

See the appendix for a complete list of organisms isolated from surgical sites.

Patients

Very young patients and elderly patients had the highest rates of infections among surgical patients who died from 1 July 2011 to 30 June 2019.



Readmissions had a 30% higher risk of infection

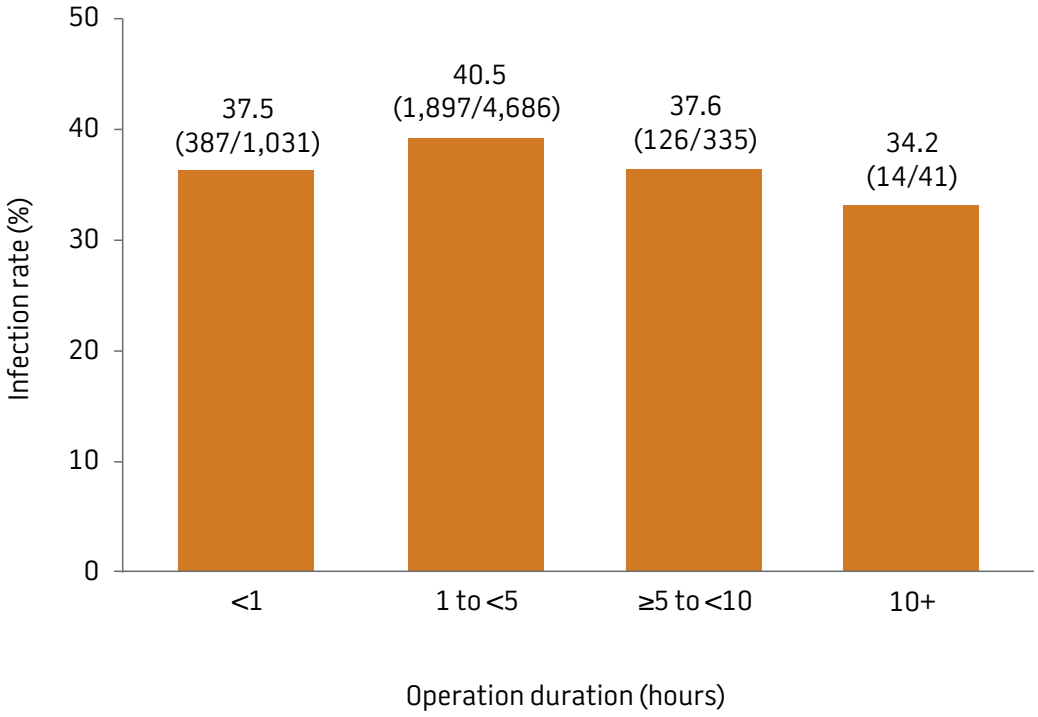
From 1 July 2011 to 30 June 2019, patients who were readmitted to hospital had a risk of acquiring a clinically significant infection that was approximately 1.3 times greater than for patients who had only one admission:

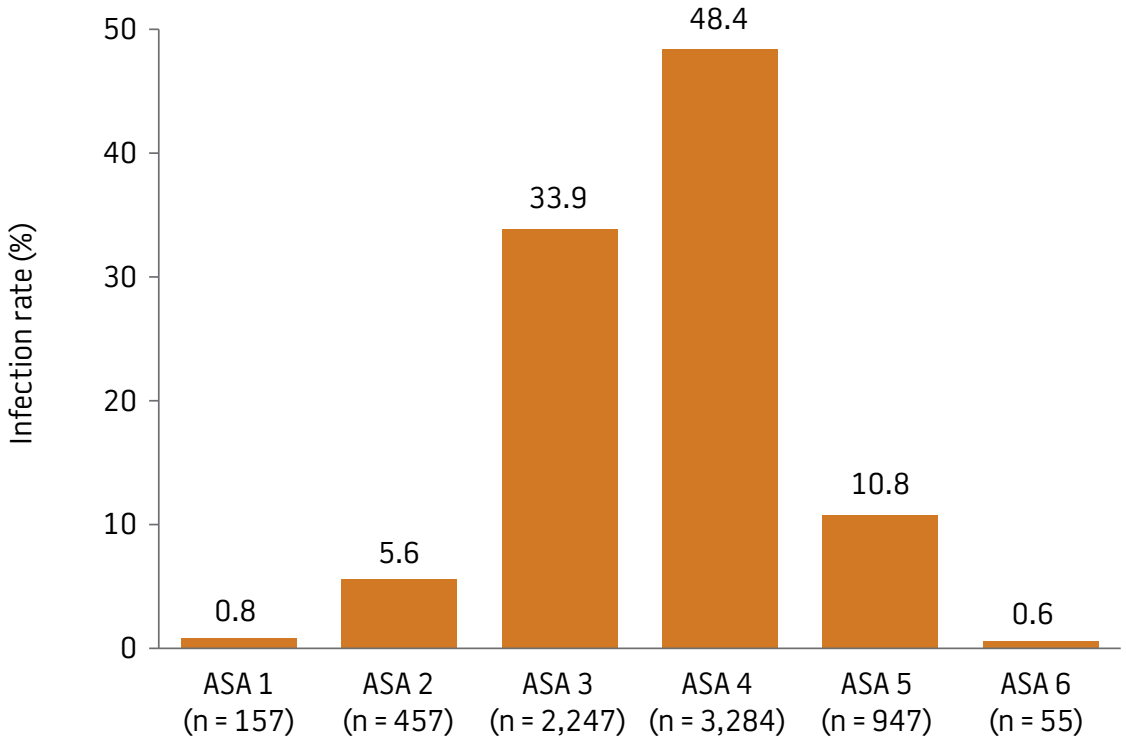
- single admission infection rate 34.4% (2,551/7,409)
- all-cause readmission infection rate 44.7% (92/206) (relative risk 1.3; 95% CI 1.1, 1.5).

Infection rate unaffected by duration of operation

Longer operations mean more time for potential contamination and infection. However, there was no relationship between operation duration and overall HAIs.

The number of patients with an SSI ranged from 6 patients to 26 patients per year from 1 July 2011 to 30 June 2019.





Note: Missing data for 592 patients.

91.4% of patients who died with infections were ASA class 3 or higher

From 1 July 2011 to 30 June 2019, most patients (91.4%; 6,533/7,147) who died with an infection were classified as ASA class 3 or higher. The proportion of patients in each ASA class has not changed significantly over time.

The American Society of Anesthesiologists (ASA) physical status classification system is used to assess patient fitness before surgery:

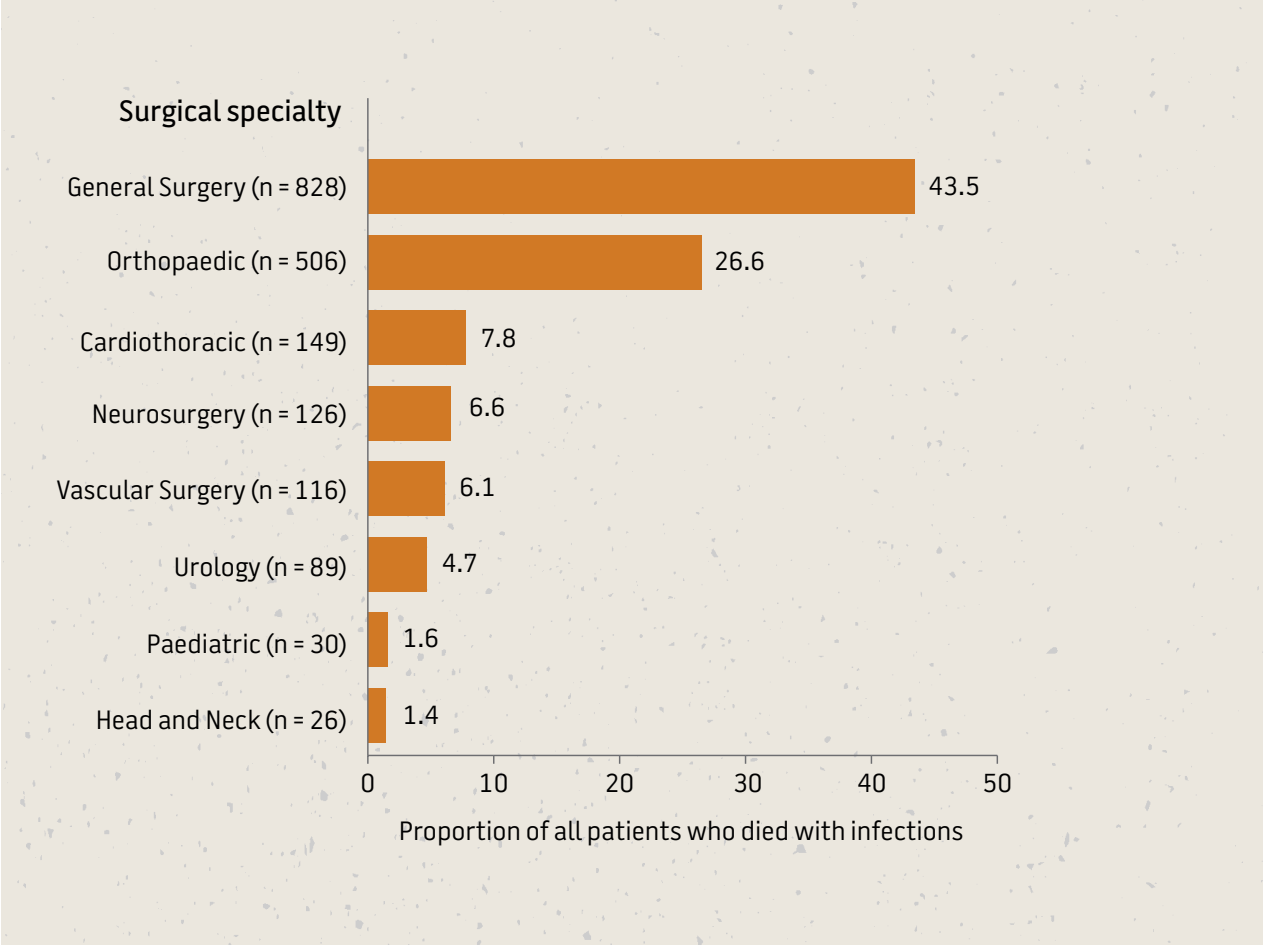
- ASA 1 – normal healthy patient
- ASA 2 – patient with mild systemic disease
- ASA 3 – patient with severe systemic disease that limits activity but is not incapacitating
- ASA 4 – patient with an incapacitating systemic disease that is a constant threat to life
- ASA 5 – moribund patient who is not expected to survive 24 hours, with or without an operation
- ASA 6 – brain-dead patient for organ donation.

Surgical specialties

The greatest proportion of surgical deaths with infections were patients under General Surgery (43.5% of people who died with infections), followed by the Orthopaedic specialty (26.6% of people who died with infections).

Infection rates varying by specialty may be due to:

- the number of operations performed in each specialty
- the relatively higher risk of surgical site infection following clean-contaminated (gastrointestinal) or contaminated surgery
- the emergency status of patients – 88.0% (2,387/2,712) of surgical patients who died with infections were emergency admissions, consistent with the proportion of patients who died without an infection and were emergency admissions (85.7%; 4,336/5,058)
- comorbidities in patients – 95.6% (2,604/2,724) of surgical patients who died with infections had at least one significant contributing factor that increased their risk of death
- postoperative complications – 43.6% (853/1,958) of patients with a postoperative complication also had an infection present at death.



Conclusions

In 2017, QASM published:

- a report on infections
- a case note review booklet with the theme of infections (*Lessons from the Audit*, volume 18)
- a peer-reviewed paper on infections in surgery.

In 2018, QASM hosted a seminar on infections attended by surgeons, physicians, trainees and nurses.

These activities did not lead to reduced infection rates in surgical patients who died – the rate remained at 36.0% in 2018–2019.

Why are one-third of surgical patients dying with infections present despite almost a decade of progress in this area?

It is impossible to draw definitive conclusions from the data in this report. Interventions may be working, but perhaps other factors are overcoming the effects. Contributing factors are likely to be many and complex, and may include:

- increasing age – the median age of surgical patients who died increased from 74 years to 77 years over the 8-year period from 1 July 2011 to 30 June 2019 (n = 9,530), although neither ASA scores nor the proportion of emergency admissions increased over the same period
- comorbidities in older patients
- immune suppression
- emerging antimicrobial resistance

More work is needed to determine why surgical patients in our hospitals are dying with infections.

The data suggest that interventions to prevent postoperative pneumonia would be beneficial, as this is the most prevalent infection present at the time of patient death. The following steps are recommended for the specific prevention of pneumonia:

- raising or elevating patient beds
- encouraging patients to use an incentive spirometer to improve respiratory testing
- conducting twice daily percussion physiotherapy for patients at high risk.

Interventions that prevent the emergence and spread of antimicrobial-resistant pathogens remain important for minimising morbidity and mortality in surgical patients. Large numbers of infections are caused by pathogens in which emerging antimicrobial resistance is a significant concern, including *E. coli, Klebsiella* species, *S. aureus* and *Enterococcus* species.

For prevention of SSIs, QASM strongly recommends the CDC guidelines for preventing SSIs, highlighting the importance of patient preparation, surgical technique, aseptic practice and antimicrobial prophylaxis.

More information

For more information about preventing and controlling HAIs, including surgical infections, see:

- Centers for Disease Control and Prevention guideline for the prevention of surgical site infection, 2017
- Australian guidelines for the prevention and control of infection in healthcare, 2019
- National Safety and Quality Health Service (NSQHS) Standards, Preventing and Controlling Healthcare-Associated Infection Standard and other resources from the Australian Commission on Safety and Quality in Health Care, 2017.

Appendix

Organisms isolated from surgical patients who died with infections present at surgical sites

Data reproduced from SCFs completed by surgeons reporting on surgical patients who died.

A total of 116 cases from 1 July 2011 to 30 June 2019 were identified as having an SSI. Of these, surgeons reported the identities of the infectious organism(s) in 70 cases.

Organisms identified from surgical sites

Organism	Frequency of cases
Candida	2
Enterobacter cloacae	3
Escherichia coli	1
Fungi (not specified)	1
Gram-negative bacillus	2
Klebsiella	1
Morganella morganii	3
MRSA	5
Propionibacterium	1
Pseudomonas	3
Serratia marcescens	2
Staphylococcus aureus	6
Staphylococcus epidermidis	3
Staphylococcus haemolyticus	1
Streptococcus angiosus	1
VRE	2

MRSA = methicillin-resistant *Staphylococcus aureus*; VRE = vancomycin-resistant enterococci

Cases with multiple organisms identified from surgical sites

Organisms	Frequency of cases
Enterococcus and *Candida*	1
Candida glabrata, Enterococcus, Staphylococcus epidermidis, multiple other organisms	1
Candida glabrata + albicans, Klebsiella oxytoca, Candida species, *E. coli, Candida glabrata*	1
Candida glabrata, VRE, HSV	1
Escherichia coli, Pseudomonas, Candida	1
Enterococcus, Enterobacter, Candida	1
Escherichia coli, Staphylococcus epidermidis, Staphylococcus hominis, Clostridium paraputrificium	1
Enterobacter faecalis, Staphylococcus epidermidis, Staphylococcus capitis	1
Gram-negative bacillus, *Escherichia coli*, gram-positive cocci, *Enterococcus* species	1
Gram-positive cocci, gram-positive bacilli, *Candida*, *Staphylococcus aureus*	1
Escherichia coli, Enterococcus faecalis	1
Mixed enteric	1
MRSA, mixed enteric flora	1
Multibacterial	2
Gram-negatives	1
Klebsiella and *Escherichia coli*	1
Morganella morganii, Klebsiella oxytoca, Haemophilus influenzae	1
Enteric organisms	1
Fungi	1
Staphylococcus aureus, Stenotrophomonas maltophilia, Pseudomonas aeruginosa	1
Staphylococcus haemolyticus, Corynebacterium jeikeium	1
Pseudomonas aeruginosa, Staphylococcus aureus	1
Staphylococcus aureus, Morganella morganii	1
Serratia marcescens, Staphylococcus aureus	1
Serratia, Klebsiella	1
Staphylococcus epidermidis, Escherichia coli and subspecies, *Enterobacter*	1
Staphylococcus, Pseudomonas	1
Staphylococcus, Enterococcus faecalis, Enterobacter cloacae	2
Streptococcus, Candida	1
VRE, MRSA	1
Candida, Staphylococcus epidermidis, Candida albicans, VRE	1

HSV = herpes simplex virus; MRSA = methicillin-resistant *Staphylococcus aureus*; VRE = vancomycin-resistant enterococci

Totals of all organisms for all infections (community acquired and hospital acquired)

Category	Organism	Frequency of cases	Notes
Gram-positive bacteria	*Staphylococcus aureus* (incl MRSA)	106	None
	Coagulase-negative staphylococci	43	All other *Staphylococcus* species (many not specified)
	Streptococcus sp.	66	Including *Granulicatella*, *Peptostreptococcus*
	Enterococci (incl VRE)	59	None
	Other gram-positive bacteria	13	*Bacillus* sp., *Propionibacterium, Corynebacterium, Listeria, Mycobacterium, Nocardia, Arcanobacterium, Dermabacter, Pediococcus*
Gram-negative bacteria	*E. coli* (incl ESBL and CPE)	140	None
	Klebsiella species (incl ESBL and CPE)	74	None
	Other coliforms	144	*Enterobacter, Morganella, Serratia, Citrobacter, Proteus, Providencia, Salmonella*
	Pseudomonas	108	None
	Other non-fermenting GNB	18	*Acinetobacter, Burkholderia* sp., *Stenotrophomonas, Vibrio, Achromobacter*
	Other GNB	6	*Aerococcus, Brucella, Haemophilus*
Anaerobes	Anaerobes (incl *Clostridium difficile*)	28	*Bacteroides, Clostridium, Finegoldia*
Miscellaneous bacteria	na	4	*Chlamydia psittaci, Legionella, Streptobacillus*
Fungi	*Candida* species	82	None
	Other yeasts	6	*Cryptococcus, Saccharomyces, Pneumocystis*
	Moulds	23	*Absidia* sp., *Aspergillus* sp., *Mucor, Paecilomyces, Fusarium, Lomentospora, Rhizopus, Scedosporium*
Protozoa	na	nc	Naegleria
Viruses	na	39	Adenovirus, BK virus, CMV, RSV, influenza, parainfluenza, EBV, HHV-6, HSV, human metapneumovirus

CMV = cytomegalovirus; CPE = carbapenem-resistant enterococci; EBV = Epstein–Barr virus; ESBL = extended-spectrum beta-lactamase; GNB = gram-negative bacteria; HHV-6 = human herpesvirus 6; HSV = herpes simplex virus; MRSA = methicillin-resistant Staphylococcus aureus; na = not applicable; nc = not counted; RSV = respiratory syncytial virus; VRE = vancomycin-resistant enterococci