Royal Australasian College of Surgeons

South Australian Audit of Surgical Mortality

Annual Report
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CONTACT

South Australian Audit of Surgical Mortality
Royal Australasian College of Surgeons
24 King William Street
Kent Town SA 5067

Clinical Director: Associate Professor Anthony Pohl

Project Lead: Dr Nathan Procter

Phone: +61 8 8239 1144 | Email: saasm@surgeons.org | Website: www.surgeons.org/saasm

The information contained in this annual report has been prepared by the Royal Australasian College of Surgeons, South Australian Audit of Surgical Mortality Steering Committee.

The South Australian Audit of Surgical Mortality is a confidential project with legislative protection at a state level by the Health Care Act 2008 under Part 7 (Quality improvement and research) (gazetted April 2017).

The Australian and New Zealand Audit of Surgical Mortality, including the South Australian Audit of Surgical Mortality, has protection under the Commonwealth Qualified Privilege Scheme under Part VC of the Health Insurance Act 1973 (gazetted 25 July 2016).

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CHAIRMAN'S REPORT

The Annual Report is presented in a new format this year in order to provide more specific and useful information to hospital CEOs and heads of departments, as well as provide more extensive information requested by SA Health. I trust that this format will better meet the needs of all stakeholders.

As Clinical Director of the South Australian Audit of Surgical Mortality (SAASM) I am pleased to report that despite the Covid-19 turmoil:

- participation of private and public hospital remains at 100%
- 96.1% of practising Royal Australian College of Surgeons (RACS) Fellows are committed to the process
- a high proportion (96.3%) of surgical case forms (SCFs) continued to be completed in 2019
- the number of clinical management issues (CMIs) continued the steady decrease since 2015
- the number of deaths reported in 2019 continued to decrease slightly, despite an increasing and ageing population
- collaboration with anaesthesia colleagues continued in cases where there was an anaesthetic component
- engagement of gynaecology colleagues continued in gynaecological cases
- thousands of staff remain dedicated to their important role in improving surgical outcomes.

Completion of SCFs has remained stable, from 96.6% in 2018 to 96.3% in 2019. The Audit is now a mandatory component of continuing professional development (CPD) for RACS Fellows, but there remains a very small number of surgeons who complete their SCFs poorly (with inadequate information), return the forms late, or fail to return them at all. A change to end of financial year reporting that will align RACS CPD reporting with Australian Health Practitioner Regulation Agency registration timelines is expected to further improve the timely completion of SCFs.

In 2019 there was an average of 48 days between notification of surgeons and submission of SCFs, which does not facilitate areas of consideration, concern or adverse events to be optimally addressed. I encourage all surgeons to complete their SCFs by early self-reporting whenever possible. Comprehensive, accurate data are more easily obtained when events are fresh in mind and while hospital unit records are readily available. I encourage departmental heads and administrative staff to facilitate this process and ensure completion of SCFs at the time of mortality and morbidity meetings.

The annual report this year highlights the difference between surgeons and assessors in assessment of CMIs, confirming the potential educational value to surgeons of critically constructive reviews. Indeed, the educational value of the Audit to first-line assessors (FLAs) and second-line assessors (SLAs) themselves has previously been shown. With the added value of further professional development and education, I encourage surgeons to consider volunteering their services as FLAs.

Finally, I thank my many colleagues for their first- and second-line assessments. These assessments form the foundation of the educational and functional benefits of the Audit.

Tony Pohl, FRACS

RECOMMENDATIONS

It is recommended that surgeons, hospitals and health departments consider the recommended actions below and establish or review their systems or processes to improve outcomes and experiences for their patients.

Patient care

- Surgeons should be expected to undertake comprehensive clinical assessments preoperatively, including clear documentation of risks and patient preferences (particularly in relation to end-of-life treatment).
- Surgeons are encouraged to continue to carefully consider whether patients would benefit from admission to a critical care unit. There has been a decrease in assessors' concerns about failure to use critical care units (in cases where it was indicated), nevertheless it remains a potential risk.
- Adherence to protocols and guidelines such as the Australian Guidelines for the Prevention and Control of Infection in Healthcare, is essential to ensure best practice. Infections were observed in 35–40% of this cohort.
- Use of deep vein thrombosis (DVT) prophylaxis remains at about 75%, but the proportion of assessors who approved of the DVT prophylaxis strategy that was employed declined from 92% in 2015 to 80% in 2019. Adherence to recognised guidelines is essential to ensure best practice.
- Preoperative transfer between hospitals occurred in 24.9 % of audited cases. Although transfer delays were low, they were still reported in 7.8 % of cases. Surgeons should be expected to supervise staff and to review the ordering and interpretation of test results.
- A quarter of patients (25.6% of cases) did not undergo surgery during the final admission, which may reflect efforts by SAASM to highlight the disadvantages of futile surgery and improve education around approaches to palliative care. Surgeons are encouraged to consider palliative care when surgery will likely be futile.

Improved leadership and communication

- There should be continued focus on standardisation of communication processes to minimise errors. ANZASM has recently highlighted the importance of consultant-to-consultant communication during hospital transfers. Consultation with senior surgeons is essential when dealing with important decisions and unexpected complications.
- Surgeons are encouraged to discuss valuable assessor feedback, audit findings and recommendations with surgical colleagues at relevant meetings. Reflection and learning, especially following adverse outcomes, has been shown to improve surgical practice.

Improving the audit

- SAASM will continue to work with hospitals to increase the return rate of SCFs to ensure timely reporting of surgical mortality, and work with RACS CPD to optimise the monitoring of non-compliance.
- To improve the timeliness and accuracy of SCFs, SAASM will continue to encourage self-reporting of deaths by the treating surgeon, either directly or through mortality and morbidity meetings of surgical departments.
- To close the feedback loop, SAASM will continue to engage with hospitals to improve and monitor the effectiveness of reporting to hospitals.
- In 2019, a high proportion (25%) of audited cases involved transfers. SAASM will continue to contribute to educational activities to inform and promote discussion about transfer issues.

INTRODUCTION

Audits of surgical mortality enable the systematic provision of peer-reviewed feedback, with the overall goal of improving surgical outcomes by continuing education of active surgeons. Inspired by the Scottish Audit of Surgical Mortality (1), a pilot project was initiated in 2001 by the University of Western Australia (2) to evaluate a similarly styled audit program. Governance was transferred to the Royal Australasian College of Surgeons (RACS) in 2005 (3). Subsequently, under the governance of the Australia and New Zealand Audit of Surgical Mortality (ANZASM), similar audits have been initiated in all Australian states and territories (except New South Wales, which maintains its own program with RACS assistance). The fundamental principle of the audits is that they should be educational in nature. This has contributed to the generally positive interaction with the audits by the surgical community.

The South Australian Audit of Surgical Mortality (SAASM) is responsible for auditing all in-hospital surgical deaths that occur in public or private hospitals in South Australia. Engagement of surgeons and hospitals with SAASM continues to be positive: notifications of patient deaths are submitted in a timely manner by hospitals, and dialogue with the surgical community remains open and constructive.

The beneficial relationships that SAASM has with the health community have facilitated the effective collection of the data contained within this report. Here, we report the clinical and demographic characteristics of patient deaths reported to SAASM and any clinical management issues identified during the course of patient care. These data will be used to guide interventions that can contribute to the ongoing professional development of surgeons, thereby improving overall surgical outcomes.

METHODS

Data collection

SAASM receives notification of in-hospital surgical deaths from public and private hospitals, the Department for Health and Wellbeing (DHW), and from surgeons themselves. Inclusion criteria for deaths notifiable to SAASM are either of the following:

1. Any patient admitted to hospital by a surgeon, regardless of whether a procedure took place
2. Any hospital admission where a procedure took place that was performed by a surgeon

Following notification of a patient death, SAASM requests that the consultant surgeon responsible for the patient submits a surgical case form (SCF) reporting clinical, diagnostic and procedural data of the patient's final hospital admission. As part of the submission, opportunity is provided for the consultant surgeon to identify any clinical management issues (CMI) that occurred during the course of patient care. It is also possible, at this point, for a consultant surgeon to declare a case to have been a terminal admission (i.e. the patient was palliated almost immediately upon admission, with no surgical intervention taking place), resulting in its exclusion from the full audit process.

When SAASM receives an SCF, the contents are reviewed for clarity, de-identified and assigned for first-line assessment (FLA). Assessors provide initial feedback on the overall management of a case and the level of care provided. They also indicate whether there is a need for further evaluation via second-line assessment (SLA), which includes medical note review. SLA can be requested because of insufficient information from which to reasonably evaluate a case, or because of specific questions arising following FLA. All assessors invited to evaluate submissions are independent of the institution from which the case arose and are required to sign a declaration acknowledging the confidentiality of the process. SLA allows for the provision of in-depth feedback to the consultant surgeon responsible for the case.

CMIs identified by surgeons or assessors as part of the audit process may be classified into three categories:

Area of consideration: where the clinician believes areas of care could have been improved but recognises that this is debatable.

Area of concern: where the clinician believes that areas of care should have been better.

Adverse event: an unintended injury caused by patient management rather than by the disease process, which is sufficiently serious to lead to prolonged hospitalisation or to temporary or permanent disability of the patient, or which contributes to or causes death.

The collection of SCF and FLA data is facilitated through an online platform known as the Fellows Interface, to which surgeons have access. Data from SLAs are entered into the system by RACS staff using a bespoke program (Bi-national Audits of Surgical Mortality). All data are stored securely and encrypted in the ANZASM database using Microsoft SQL Server 2016. Data subsets are scrutinised for consistency on a monthly basis.

Collaborations

RACS has existing collaborations in place with the Australian and New Zealand College of Anaesthetists (ANZCA) and the Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG) for participation in SAASM. Any case in which there may be an anaesthetic component to the death, is referred to the South Australian Anaesthetic Mortality Committee (SAAMC). For any case involving gynaecological surgery, the treating surgeon is invited to participate in the audit and to voluntarily submit the case to SAASM. Similarly, Fellows from the Royal Australian and New Zealand College of Ophthalmologists (RANZCO) and the Royal Australasian College of Dental Surgeons (RACDS) are invited to participate in the audit on a voluntary basis if they are affiliated with a patient death. Participation in SAASM has been mandated by the Australian Orthopaedic Association (AOA) as part of their CPD program.

Data analysis

Data were extracted from the ANZASM database using Microsoft Access. Records included in the present analysis were limited to patient deaths occurring between 1 January 2015 and 31 December 2019, inclusive. All cases that had completed the audit process by 17 September 2020 were included in the analysis. All data pertain to patient admissions to South Australian hospitals.

Categorical variables are expressed as proportions. Continuous variables are expressed as means (+/- standard deviation) for normal data and medians (with 25th and 75th percentile) for non-normal data. Normalities of distributions were evaluated via the Shapiro-Wilk test. Differences across categories were evaluated by the $\chi 2$ test and differences between groups were evaluated by the independent t-test or the Mann-Whitney U test, as appropriate. Potential relationships between continuous variables were assessed by the Pearson or Spearman correlations, as appropriate.

Potential determinants for the presence of CMIs (as identified by treating surgeons or assessors) were identified by univariate analysis. For determinants where $p<0.1$, further analysis via backward stepwise logistic regression was undertaken. Non-normal data were subject to Z-score normalisation to facilitate this.

All analyses were performed using R version 4.0.2 (4), RStudio Version 1.3.1073 (5) and GraphPad Prism 9.0.0.

RESULTS

Notifications of death

From 1 January 2015 through 31 December 2019, SAASM was notified of 2,943 in-hospital surgical deaths from 308 consultant surgeons. Of these deaths, 517 were considered terminal cases and excluded from the full audit process. From the remainder, 26 are still awaiting SCF submission, 15 are still undergoing the audit process, and 15 were lost to follow up. A total of 2,370 cases have completed the audit process and feedback has been delivered to the responsible surgeon. A summary of this data is provided in Figure 1.

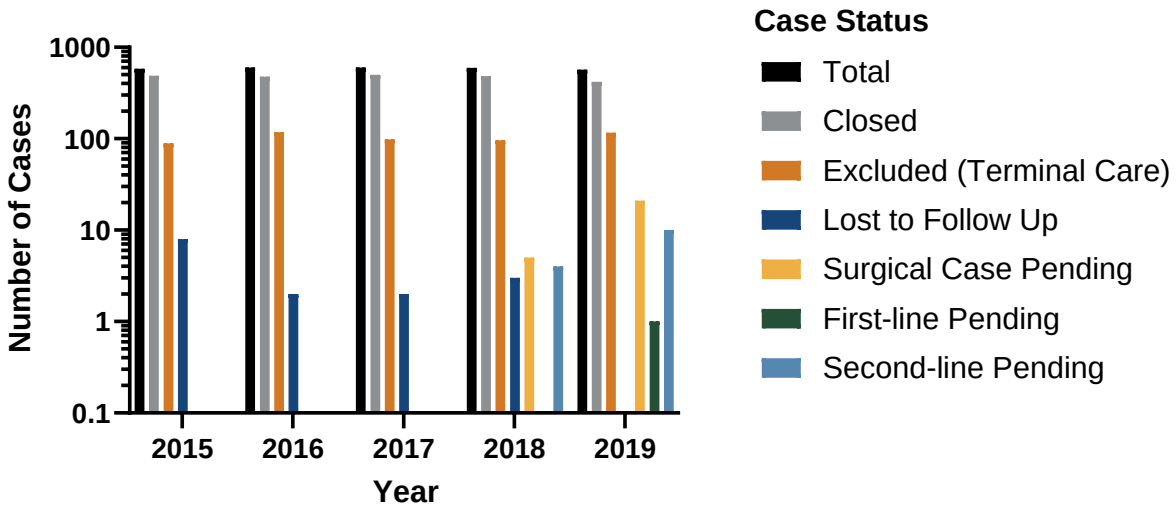

Figure 1: Status of SAASM cases, 2015–2019. Please note the logarithmic scale of the y axis.

Figure 2 shows the annual number of notifications for each surgical specialty, and Table 1 summarises the current overall status of SAASM cases, also according to specialty.

While notifications from most specialties have remained stable over time, Vascular Surgery continued the downward trend of recent years while notifications from Plastic Surgery and Urology increased in 2018/2019. General Surgery, Neurosurgery and Orthopaedics together account for approximately 75% of SAASM notifications over the past five years.

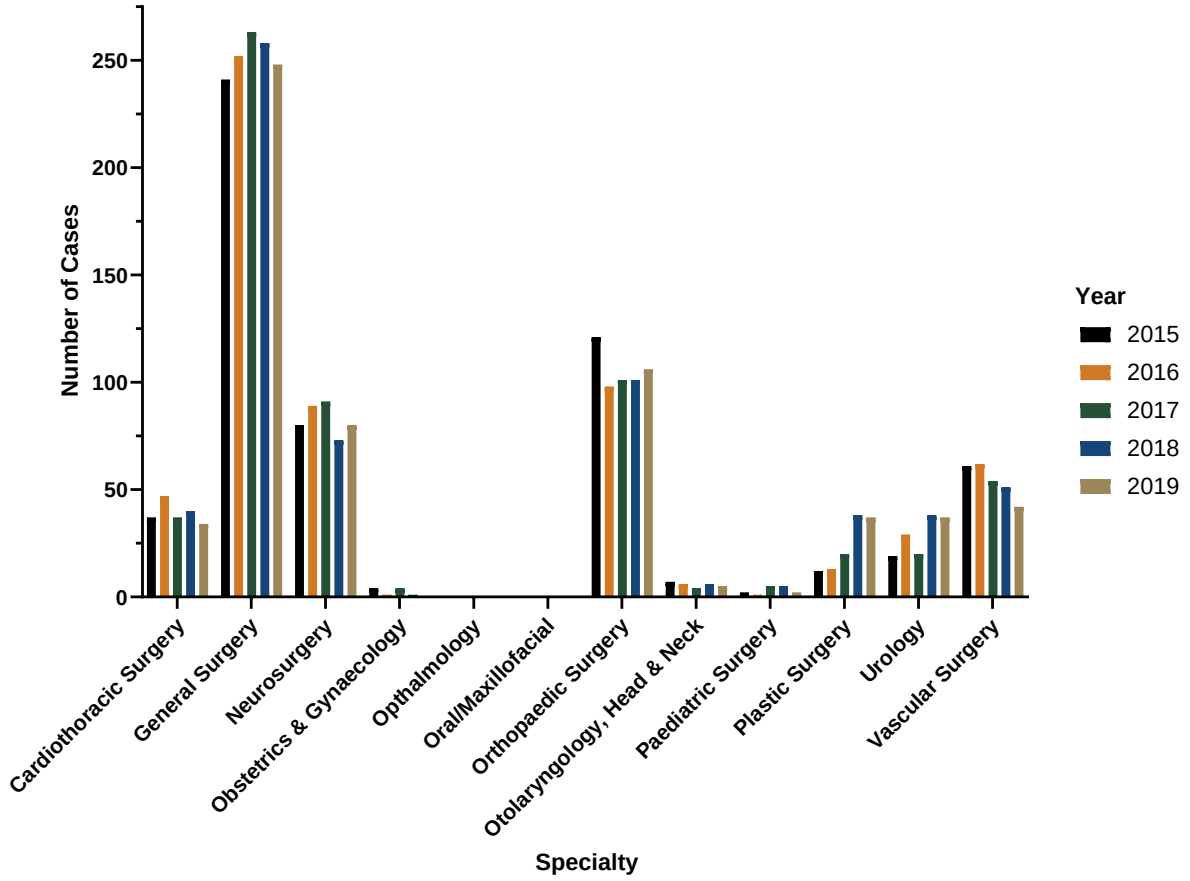

Figure 2: Cases reported to SAASM by specialty, 2015–2019

Table 1: SAASM case status by specialty, 2015–2019

Specialty	Closed	Excluded (terminal care)	SCF pending	FLA pending	SLA pending	Lost to follow-up	Total cases
Cardiothoracic Surgery	163	14	13	0	5	0	195
General Surgery	936	319	5	0	2	0	1,262
Neurosurgery	337	74	2	0	0	0	413
Obstetrics & Gynaecology	5	3	0	0	0	2	10
Ophthalmology	0	0	0	0	0	0	0
Oral/Maxillofacial	0	0	0	0	0	0	0
Orthopaedic Surgery	481	26	4	0	3	13	527
Otolaryngology, Head & Neck	18	8	2	0	0	0	28
Paediatric Surgery	14	0	0	0	1	0	15
Plastic Surgery	75	3	0	1	1	0	80
Urology	130	12	0	0	1	0	143
Vascular Surgery	211	58	0	0	1	0	270

Note: SCF = surgical case form; FLA = first-line assessment; SLA = second-line assessment; Closed = case has completed audit process; Lost to follow-up = SCF unlikely to be submitted, for varying reasons.

Hospital reports remain the primary means of initial notification to SAASM of in-hospital surgical deaths, though reports from DHW also constitute a significant proportion of initial notifications (Table 2). The period from patient death to notification to SAASM has increased markedly from 2015 to 2019. Ideally, submission of the SCF to SAASM and subsequent assessment should occur concurrently with hospital-based mortality and morbidity meetings. Efforts are ongoing to reduce the delay between patient death and SAASM notification, with self-reporting by surgeons being a particular focus.

Table 2: Source of SAASM notifications, 2015–2019

Case source	2015	2016	2017	2018	2019	Total
Hospital (n)	481	512	485	359	389	2,226
DHW (n)	99	84	107	232	174	696
Surgeon (n)	4	2	7	3	5	21
Death to notification (days)	18 (10, 40)	15 (9, 29)	24 (14, 45)	38 (20, 63)	30 (19, 43)	25 (13, 44)
Notification to submission (days)	47 (13, 116)	60 (17, 128)	50 (17, 148)	43 (12, 116)	48 (13, 99)	49 (14, 121)

Note: data expressed as total number of cases or median number of days (25^{th}, 75^{th} percentile). DHW = Department for Health and Wellbeing.

Patient demographics

Clinical characteristics of the SAASM cohort are summarised in Table 3. Patients were a median age of 79 years (67, 86) and had spent a median of 7 days (3, 17) in hospital; 54.0% were male. Public hospitals accounted for most admissions (83.6%), which were primarily emergency admissions (86.5%) of public patients (60.8%).

Table 3: Patient demographics for SAASM cases, 2015–2019

	2015	2016	2017	2018	2019	Total
Age (years)	79 (69, 87)	78 (66, 85)	77 (65, 85)	76 (64, 85)	79 (67, 86)	79 (67, 86)
Sex (% male)	50.3	57.1	56.5	59.9	53.3	54.0
Length of stay (days)	9 (4, 20)	9 (4, 19)	9 (3, 19)	9 (3, 21)	8 (3, 19)	7 (3, 17)
Hospital status (%)						
private	16.2	20.1	13.4	13.0	14.0	13.6
public	81.9	78.7	84.6	85.2	84.8	83.6
co-location	1.9	1.2	2.0	1.8	1.2	2.8
Patient status (%)						
private	19.9	24.7	18.8	19.3	19.8	16.6
public	66.3	68.0	80.4	79.8	78.3	60.8
veteran	1.2	1.3	0.2	0.5	0.5	0.6
unknown	12.6	6.0	0.6	0.4	1.4	22.0
Admission status (%)						
elective	13.8	13.4	9.0	14.8	13.6	12.9
emergency	84.8	86.2	90.6	84.4	86.4	86.5
unknown	1.4	0.4	0.4	0.8	0.0	0.6
Metropolitan (%)	96.1	96.3	95.8	97.3	96.8	96.5
ACHA	7.4	9.2	4.9	3.9	5.8	6.2
Calvary Healthcare	4.4	5.7	5.5	5.7	4.4	5.2
CALHN	52.9	49.7	56.3	53.4	51.9	52.8
NALHN	8.2	9.4	6.5	10.4	8.8	8.7
SALHN	19.8	18.9	19.5	20.9	22.2	20.3
WCHN	1.2	0.7	1.3	1.2	1.2	1.1
independent	2.2	2.7	1.8	1.8	2.5	2.2
Rural and Remote (%)	3.9	3.7	4.2	2.7	3.2	3.5
EFNLHN	0.0	0.1	0.0	0.3	0.0	0.1
FUNLHN	0.8	1.1	0.8	0.0	0.4	0.6
LCLHN	3.1	2.2	3.4	2.4	2.8	2.8
RMCLHN	0.0	0.3	0.0	0.0	0.0	0.0
ASA score[a]	4 (3, 4)	4 (3, 4)	4 (3, 4)	4 (3, 4)	4 (3, 4)	4 (3, 4)
Risk of death[b]	moderate	moderate	moderate	moderate	moderate	moderate

Abbreviations: ACHA = Adelaide Community Healthcare Alliance; ASA = American Society of Anesthesiologists; CALHN = Central Adelaide Local Health Network; EFNLHN = Eyre and Far North Local Health Network; FUNLHN = Flinders and Upper North Local Health Network; LCLHN = Limestone Coast Local Health Network; NALHN = Northern Adelaide Local Health Network; RMCLHN = Riverland Mallee Coorong Local Health Network; SALHN = Southern Adelaide Local Health Network; WCHN = Women's and Children's Health Network.

Note: [a] = ASA physical status classification system (6); [b] = overall mortality risk as determined by treating surgeon. Data expressed as median (25^{th}, 75^{th} percentile).

Overall, 25.8% of admissions from this cohort resulted from patient transfers between hospitals (Table 4). Of these transfers, 43.8% were initiated by remote and rural hospitals, 46.4% were initiated by metropolitan hospitals, and 9.8% were initiated by interstate hospitals. Transfers were overwhelmingly to metropolitan hospitals (98.1% of remote and rural hospital transfers, 99.6% of metropolitan hospital transfers and 98.3% of interstate hospital transfers). Similarly, the majority of patients were transferred to public hospitals (91.0% of remote and rural patients, 83.1% of metropolitan patients and 91.7% of interstate patients).

Table 4: Patient transfer details (percentages) for in-hospital surgical mortality, 2015–2019

	2015	2016	2017	2018	2019	Total
Transferred Patients	25.1	27.8	26.7	24.9	24.5	25.8
transfer appropriate	89.3	88.7	85.0	92.6	96.1	90.0
care appropriate	91.8	90.2	88.7	91.7	95.1	91.3
information sufficient	90.2	88.0	88.7	90.1	94.2	90.0
public accepting hospital	87.7	84.2	88.0	90.1	87.4	87.4
transfer delays	5.7	7.5	11.3	8.3	5.8	7.8

Patient surgical diagnosis

A delay in determining the surgical diagnosis was reported in 5.8% of cases (Table 5). Of those cases where a delay in surgical diagnosis was reported, these delays were predominantly associated with the patient's general practitioner (12.3% of cases), with the institutional medical unit (36.2% of cases) or with the institutional surgical unit (27.5% of cases). Multidisciplinary approaches and effective communication between all parties are encouraged.

Table 5: Delayed surgical diagnoses (percentages) for in-hospital patient mortality, 2015–2019

	2015	2016	2017	2018	2019	Total
Delay in main surgical diagnosis						
yes	5.1	6.3	7.0	5.3	5.2	5.8
no	94.7	93.7	93.0	94.4	94.0	94.0
not applicable	0.2	0.0	0.0	0.3	0.8	0.2
Delay associated with						
general practitioner	24.0	6.7	14.3	7.7	9.1	12.3
institutional medical unit	20.0	46.7	34.3	30.8	50.0	36.2
institutional surgical unit	32.0	20.0	25.7	34.6	27.3	27.5
other	24.0	26.6	25.7	26.9	13.6	24.0
Delay attributed to						
inexperienced staff	20.0	10.0	5.7	23.1	13.6	13.8
incorrect test	20.0	20.0	14.3	19.2	13.6	17.4
misinterpreted results	20.0	20.0	14.3	23.1	13.6	18.1
results not seen	0.0	3.3	0.0	0.0	9.1	2.2
unavoidable	20.0	30.0	25.7	26.9	31.8	26.8
other	20.0	26.7	40.0	7.7	18.3	43.5

Note: more than one option may be selected when attributing the causes of delays to reach a surgical diagnosis.

Patient surgical intervention

A majority of patients (74.4%) underwent at least one surgical procedure during their final admission (Table 6). For patients where surgery did not occur, it was an active decision not to operate in 51.2% of cases. This may reflect efforts by SAASM to highlight the disadvantages of futile surgery, and improved education around approaches to palliative care.

For 6.0% of patients who underwent surgery, the treating surgeon indicated a possible anaesthetic component to the death. These cases were reviewed by the Clinical Director and referred to SAAMC.

Critical care unit (CCU) facilities were used for 64.9% of patients (0.1% unknown), and in 91.9% of cases this was considered appropriate (Table 7). Fluid management was considered an issue by treating surgeons in 8.7% of cases. In 12.5% of cases there was an unplanned return to theatre, and in 21.4% of cases there was an unplanned admission to CCU (data not shown).

Table 6: Rationale for decision not to operate in patients with in-hospital surgical mortality, 2015–2019

	2015	2016	2017	2018	2019	Total
Surgical procedure during admission (%)	74.1	72.8	72.5	77.4	75.5	74.4
Decision not to operate (%)						
not a surgical problem	25.4	30.8	34.3	33.6	28.2	30.5
patient refused operation	16.7	20.8	15.3	16.4	21.4	18.0
limits of treatment reached	1.6	0.0	0.0	0.0	0.0	0.3
rapid death	14.3	18.5	21.1	20.9	23.3	19.5
decision made by consultant	46.0	43.8	50.4	48.2	55.3	48.5

Note: more than one option may be selected when a decision not to operate has been indicated.

Table 7: Resuscitative measures for patients experiencing in-hospital mortality, 2015–2019

	2015	2016	2017	2018	2019	Total
CCU used (%)						
yes	64.3	66.5	65.7	65.0	62.4	64.9
no	35.7	33.3	34.3	34.8	37.4	35.0
unknown	0.0	0.2	0.0	0.2	0.2	0.1
HDU should have been used[1] (%)						
yes	2.9	5.0	1.8	3.0	2.5	3.0
no	83.9	87.4	97.7	94.7	96.2	91.9
unknown	13.2	7.6	0.5	2.3	1.3	5.1
ICU should have been used[1] (%)						
yes	0.6	3.1	0.6	1.2	1.3	1.3
no	86.8	89.9	98.8	96.4	97.5	93.9
unknown	12.6	7.0	0.6	2.4	1.2	4.8
Fluid balance considered an issue by surgeon (%)						
yes	8.8	10.0	9.4	6.8	8.3	8.7
no	87.1	87.2	87.8	90.1	86.7	87.8
unknown	4.1	2.7	2.8	3.1	5.0	3.5
Fluid balance considered an issue by assessor (%)						
yes	6.8	7.7	6.4	5.3	6.2	6.5
no	92.4	92.3	92.8	94.2	92.9	92.9
unknown	0.8	0.0	0.8	0.3	0.9	0.6

Abbreviations: HDU = high dependency unit; ICU = intensive care unit. Note: [1] = for patients where CCU was not used.

Patient infection

During the 2015–2019 period, 37.6% of patients were reported to have a clinically significant infection, with 54.5% acquiring the infection during their last admission (Table 8). Of these, 67.1% developed infections following surgical intervention, with pneumonia (68.9%) being the most common ailment. The antibiotic regime was considered either appropriate (94.3%) or not applicable (3.4%) in the majority of cases.

There appears to have been a spike in ‘other invasive site’ infections during 2019, although the reasons for this are unclear.

Table 8: Clinically significant infections in patients with in-hospital surgical mortality, 2015–2019

	2015	2016	2017	2018	2019	Total
Infection (%)	40.2	35.5	40.2	38.4	34.6	37.6
Acquired during admission (%)	57.1	59.3	52.3	56.4	53.0	54.5
preoperative	17.6	20.2	13.7	12.7	12.0	15.4
postoperative	63.0	66.7	75.5	64.7	65.3	67.1
surgical site infection	5.6	4.0	4.9	10.8	8.0	6.6
other invasive site infection	7.4	7.0	3.9	6.9	14.7	7.6
unknown	6.4	2.1	2.0	4.9	0.0	3.3
Infection type (%)						
pneumonia	78.5	68.7	71.6	55.9	70.7	68.9
septicaemia	4.7	12.1	6.9	12.7	6.7	8.6
intra-abdominal sepsis	13.1	13.1	16.7	19.6	16.0	15.6
other	3.7	6.1	4.8	11.8	6.6	6.9
Antibiotic regime appropriate[1] (%)						
yes	92.8	91.1	99.0	94.1	93.7	94.3
no	1.5	0.6	0.0	0.5	0.7	0.7
not applicable	2.1	5.3	0.5	4.3	5.6	3.4
unknown	3.6	3.0	0.5	1.1	0.0	1.6

Note: [1] = as considered by treating surgeon.

Patient anticoagulant use

Deep vein thrombosis (DVT) prophylaxis was used in 74.9% of patients within the SAASM cohort (Table 9). Of those not receiving DVT prophylaxis, its use was considered inappropriate in 59.9% of cases, it was an active decision to withhold in 34.5% of cases and it was not considered in 3.1% of cases. In 2.5% of cases where DVT prophylaxis was withheld, this decision was unaccounted for. Following evaluation, 84.8% of assessors agreed with the DVT prophylaxis strategy, while 0.8% remained undecided. The decrease in the proportion of assessors that considered the DVT prophylaxis strategy appropriate, and the accompanying increase in the number of assessors disagreeing with the DVT prophylaxis strategy, is concerning.

Table 9: DVT prophylaxis use in patients with in-hospital surgical mortality, 2015–2019

	2015	2016	2017	2018	2019	Total
DVT prophylaxis used (%)	76.0	76.6	75.2	73.0	73.8	74.9
DVT prophylaxis not used (%)	22.2	22.2	22.6	24.7	25.2	23.3
active decision to withhold	26.9	29.2	46.0	31.7	38.2	34.5
not appropriate	65.7	64.2	51.3	63.4	55.5	59.9
not considered	3.7	0.9	1.8	2.4	6.3	3.1
unknown	3.7	5.7	0.9	2.5	0.0	2.5
DVT prophylaxis use unknown (%)	1.8	1.2	2.2	2.3	1.0	1.7
DVT prophylaxis use appropriate (%)						
yes	91.6	90.2	81.0	80.9	80.0	84.8
no	7.4	9.4	18.2	18.5	19.0	14.4
unknown	1.0	0.4	0.8	0.6	1.0	0.8

Patient management evaluation

As part of the audit process, treating surgeons and assessors evaluate the overall pathway of care for cases submitted to SAASM. Areas under evaluation include preoperative management, perioperative details and postoperative care. Consultant input and decision-making processes are also evaluated. These data are summarised in Figure 3.

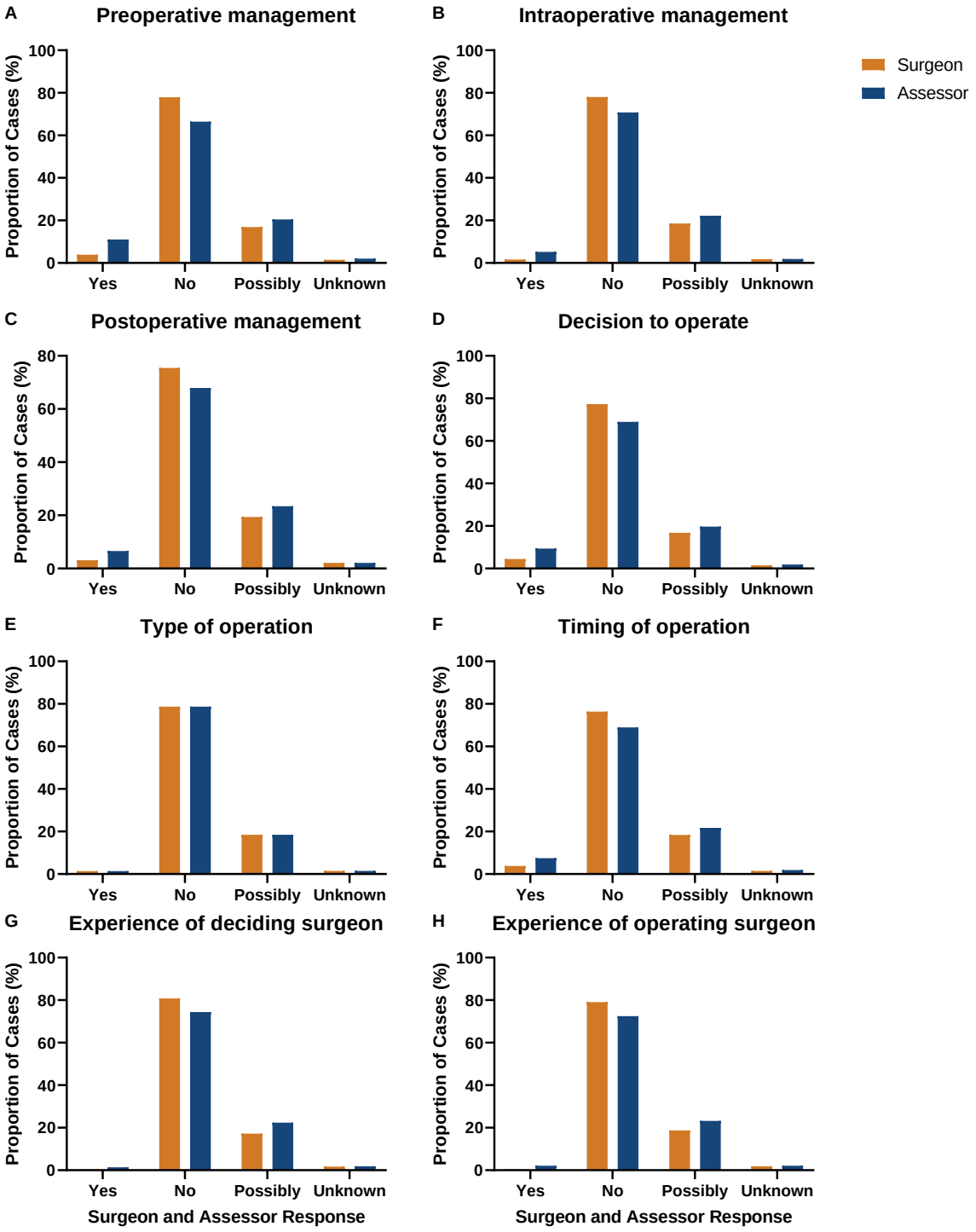

Figure 3: Surgeon and assessor evaluation of patient care management and possibility of improvement. A, Preoperative management; B, Intraoperative management; C, Postoperative care; D, Decision to operate; E, Type of operation; F, Timing of operation; G, Experience of surgeon deciding to operate; H, Experience of surgeon operating.

Determinants of clinical management issues

An important aspect to the audit process is to allow treating surgeons the opportunity to self-reflect on the overall management of a case and identify any CMIs that may have occurred. When considering potential systems-level responses to address these issues, it may be useful to identify those case characteristics that are associated with an increased likelihood of developing CMIs.

Evaluation of the cases submitted to SAASM during 2015–2019 found 463 CMIs identified by treating surgeons and 724 CMIs identified by assessors (summarised in Table 10). Assessors were more likely to consider the various CMIs to be preventable (66.9% considering the issues 'definitely' or 'probably' preventable) compared with treating surgeons (45.4% considering the issues 'definitely' or 'probably' preventable) (Figure 4).

Table 10: Clinical management issues identified by surgeons and assessors for cases reported to SAASM, 2015–2019

Clinical Management Issue	2015		2016		2017		2018		2019		Total	
	surgeon	assessor	surgeon	assessor	surgeon	assessor	surgeon	assessor	surgeon	assessor	surgeon	assessor
Operative management issue (n)	34	53	23	54	25	60	19	35	20	33	121	235
Delay issue (n)	27	37	26	38	26	37	28	34	17	30	124	176
Preoperative care issue (n)	4	8	4	7	3	13	3	6	1	10	15	44
Treatment protocol issue (n)	16	12	19	16	4	11	18	22	10	9	67	70
Postoperative care issue (n)	4	3	3	8	5	8	1	6	2	10	15	35
Complication of surgery (n)	1	5	4	3	4	5	7	4	5	4	21	21
Poor communication/documentation (n)	2	6	5	13	9	11	9	10	5	6	30	46
Adverse event (n)	5	10	10	7	3	7	5	11	2	2	25	37
Anaesthetic and critical care issue (n)	6	8	3	5	6	8	8	2	3	4	26	27
Septicaemia and wound issue (n)	0	1	1	1	0	3	1	0	1	0	3	5
Bleeding and thrombosis issue (n)	4	7	4	7	0	5	4	4	5	5	17	28
Total (n)	103	150	102	159	85	168	102	133	71	113	463	724
Preventability (%)												
definitely	16.5	26.0	10.8	33.3	18.8	25.6	17.6	16.5	7.0	19.5	14.5	24.8
probably	31.1	45.3	38.2	51.6	24.7	35.7	23.5	38.3	38.0	38.9	30.9	42.2
probably not	39.8	22.7	41.2	10.7	45.9	30.4	42.2	28.6	45.1	35.4	42.5	24.9
definitely not	3.9	0.0	5.9	0.6	5.9	2.4	9.8	7.5	4.2	1.8	6.0	2.4
not specified	8.7	6.0	3.9	3.8	4.7	5.9	6.9	9.1	5.7	4.4	6.1	5.7
Seriousness of issue (%)												
consideration	64.1	54.0	70.6	56.6	69.4	63.1	59.8	51.9	67.6	62.8	66.1	57.7
concern	25.2	28.7	18.6	33.3	24.7	30.4	22.5	33.8	21.1	27.4	22.5	30.8
adverse event	4.9	6.7	9.8	4.4	3.5	4.2	4.9	8.3	2.8	1.8	5.4	5.1
not specified	5.8	10.6	1.0	5.7	2.4	2.3	12.8	6.0	8.5	8.0	6.0	6.4

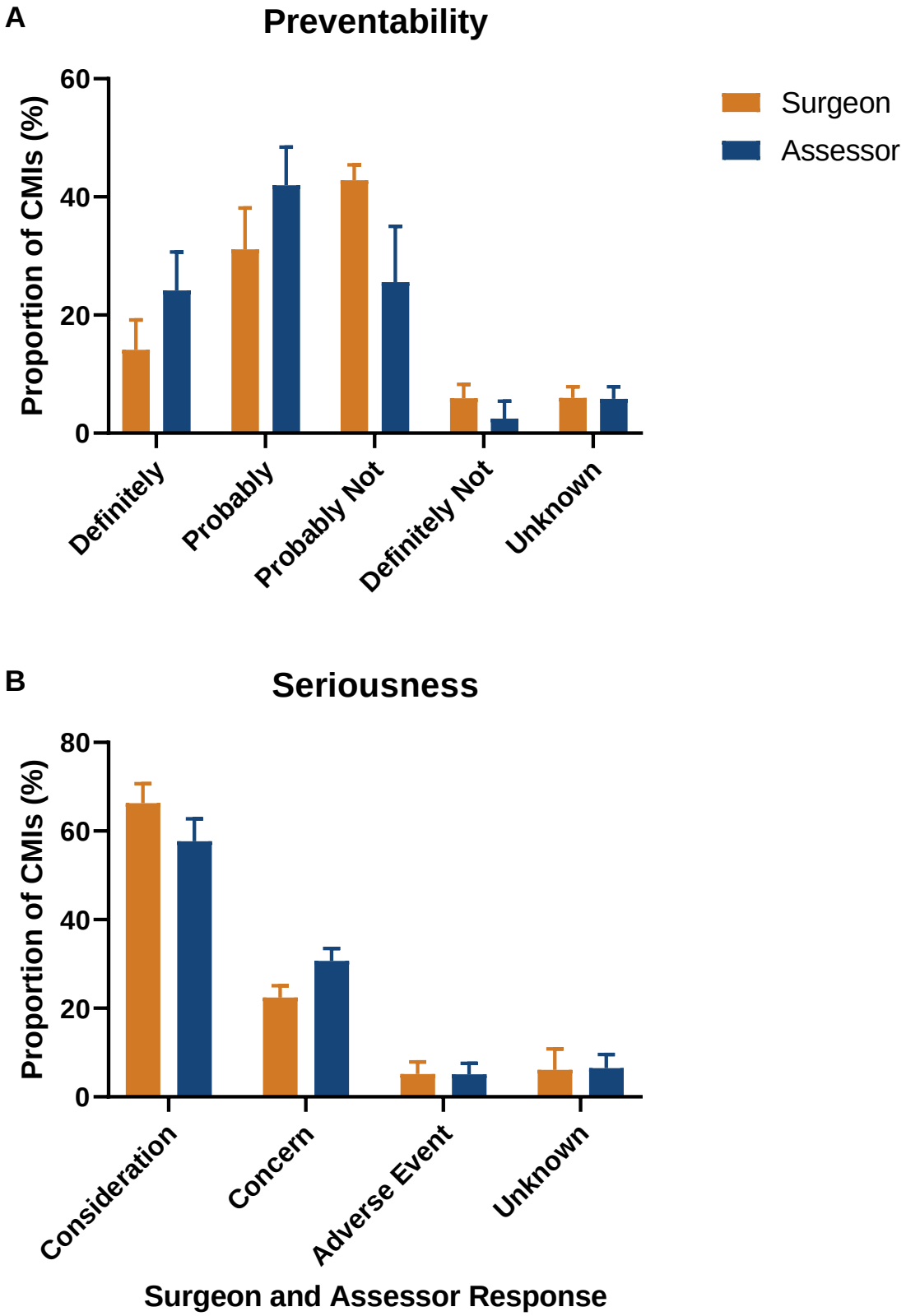

Figure 4: Surgeon and assessor perspectives on preventability (A) and seriousness (B) of clinical management issues for SAASM cases, 2015–2019. Note: CMI = clinical management issues.

Surgeon-identified clinical management issues

Univariate analysis indicated that surgeon-identified CMIs were more likely to be identified by particular surgeons ($\chi^2(287) = 546.99$, $p < 0.001$) and specialties ($\chi^2(9) = 49.5$, $p < 0.001$) (Table 11) from particular health networks ($\chi^2(10) = 18.5$, $p < 0.05$) (Table 12). CMIs were more likely to be declared in patients admitted electively ($\chi^2(2) = 17.1$, $p < 0.001$) (Table 13), patients who were transferred ($\chi^2(2) = 15.8$, $p < 0.001$) (Table 14), patients admitted to CCU during their final admission ($\chi^2(2) = 39.4$, $p < 0.001$) (Table 15), patients who were younger ($p < 0.001$), and patients with a higher risk of death estimated by the treating surgeon ($p < 0.01$).

When further evaluating these factors via multivariate analysis, elective admission status ($p < 0.001$), patient transfer between institutions ($p < 0.001$), patient admission to CCU ($p < 0.001$) and surgeon-estimated risk of death ($p < 0.05$) remained significantly associated with the presence of surgeon-identified CMIs. This was not unexpected.

Table 11: Proportion of cases with clinical management issues identified by the treating surgeon according to specialty, 2015–2019

Specialty	Cases with CMIs (n)	Notifications of death (n)	Rate of CMIs (%)
Cardiothoracic Surgery	44	163	27.0
General Surgery	162	936	17.3
Neurosurgery	32	337	9.5
Obstetrics & Gynaecology	1	5	20.0
Orthopaedic Surgery	53	481	11.0
Otolaryngology, Head & Neck	2	18	11.1
Paediatric Surgery	5	14	35.7
Plastic Surgery	14	75	18.7
Urology Surgery	15	130	11.5
Vascular Surgery	48	211	22.7

Table 12: Proportion of cases with clinical management issues identified by the treating surgeon according to local health network, 2015–2019

Local health network	Cases with CMIs (n)	Notifications of death (n)	Rate of CMIs (%)
private network	51	363	14.0
CALHN	181	1,238	14.6
CHSA	9	53	17.0
NALHN	34	195	17.4
SALHN	93	490	19.0
WCHN	8	31	25.8

Abbreviations: CALHN = Central Adelaide Local Health Network; CHSA = Country Health South Australia (Eyre and Far North Local Health Network, Flinders and Upper North Local Health Network, Limestone Coast Local Health Network, Riverland Mallee Coorong Local Health Network); NALHN = Northern Adelaide Local Health Network; SALHN = Southern Adelaide Local Health Network; WCHN = Women's and Children's Health Network.

Table 13: Proportion of cases with clinical management issues identified by the treating surgeon according to admission status, 2015–2019

Admission status	Cases with CMIs (n)	Notifications of death (n)	Rate of CMIs (%)
elective	73	305	23.9
emergency	301	2,050	14.7
unknown	2	15	13.3

Table 14: Proportion of cases with clinical management issues identified by the treating surgeon according to patient transfer status, 2015–2019

Patient transferred	Cases with CMIs (n)	Notifications of death (n)	Rate of CMIs (%)
yes	243	612	39.7
no	128	1,719	7.4

Table 15: Proportion of cases with clinical management issues identified by the treating surgeon according to whether the patient was admitted to a critical care unit, 2015–2019

CCU used	Cases with CMIs (n)	Notifications of death (n)	Rate of CMIs (%)
yes	297	1,537	19.3
no	79	830	9.5

Assessor-identified clinical management issues

Anonymous peer-review of case management is a fundamental component of the audit process. This allows treating surgeons to be challenged in a critical and constructive manner. Crucially, assessors are independent of the institution from which the case arose.

Following completion of the audit process, particular surgeons ($\chi^2(287) = 358.3$, $p < 0.05$) and specialties ($\chi^2(9) = 49.0$, $p < 0.001$) (Table 16) were more likely to register CMIs. Patient transfer status ($\chi^2(2) = 7.0$, $p < 0.05$) (Table 17), admission to CCU ($\chi^2(2) = 45.819$, $p < 0.001$) (Table 18), younger age ($p < 0.05$) (data not shown), ASA score ($p < 0.05$) (Table 19) and assessor-estimated risk of death ($p < 0.001$) (Table 20) were also associated with identification of CMIs. The local health network ($\chi^2(10) = 17.538$, $p = 0.06$) (Table 21) and the surgeon-estimated risk of death ($p = 0.06$) (Table 22) were both borderline variables for the presence of CMIs.

Upon multivariate analysis, patient transfer between institutions ($p < 0.05$), admission to CCU ($p < 0.001$), and both surgeon- and assessor-estimated risk of death remained significantly associated with the presence of CMIs.

Table 16: Proportion of cases with clinical management issues identified by the assessor according to specialty, 2015–2019

Specialty	Cases with CMIs (n)	Notifications of death (n)	Rate of CMIs (%)
Cardiothoracic Surgery	59	163	36.2
General Surgery	215	936	23.0
Neurosurgery	55	337	16.3
Obstetrics & Gynaecology	3	5	60.0
Orthopaedic Surgery	77	481	16.0
Otolaryngology, Head & Neck	0	18	0.0
Paediatric Surgery	1	14	7.1
Plastic Surgery	17	75	22.7
Urology Surgery	25	130	19.2
Vascular Surgery	52	211	24.6

Table 17: Proportion of cases with clinical management issues identified by the assessor according to patient transfer status, 2015–2019

Patient transferred	Cases with CMIs (n)	Notifications of death (n)	Rate of CMIs (%)
yes	153	612	25.0
no	344	1,719	20.0

Table 18: Proportion of cases with clinical management issues identified by the assessor according to whether patient was admitted to CCU, 2015–2019

CCU used	Cases with CMIs (n)	Notifications of death (n)	Rate of CMIs (%)
yes	391	1537	25.4
no	113	830	13.6

Table 19: Proportion of cases with clinical management issues identified by the assessor according to ASA status, 2015–2019

Clinical management issues (%)	ASA score						
	0	1	2	3	4	5	6
yes	8.7	1.1	4.1	28.6	43.7	12.8	1.0
no	5.4	1.2	8.1	34.1	41.7	8.3	1.2

Note: ASA = American Society of Anaesthesiologists physical status classification system

Table 20: Proportion of cases with clinical management issues identified by the assessor according to assessor-estimated risk of death, 2015–2019

Clinical management issues (%)	Assessor-estimated risk of death						
	n/a	minimal	small	moderate	considerable	expected	futile
yes	0.4	0.8	4.8	24.8	55.8	13.4	0.0
No	1.0	1.8	13.3	31.3	43.5	9.1	0.0

Table 21: Proportion of cases with clinical management issues identified by the assessor according to local health network, 2015–2019

Local health network	Cases with CMIs (n)	Notifications of death (n)	Rate of CMIs (%)
private network	88	363	24.2
CALHN	255	1,238	20.6
CHSA	15	53	28.3
NALHN	42	195	21.5
SALHN	101	490	20.6
WCHN	3	31	9.7

Abbreviations: CALHN = Central Adelaide Local Health Network; CHSA = Country Health South Australia (Eyre and Far North Local Health Network, Flinders and Upper North Local Health Network, Limestone Coast Local Health Network, Riverland Mallee Coorong Local Health Network); NALHN = Northern Adelaide Local Health Network; SALHN = Southern Adelaide Local Health Network; WCHN = Women's and Children's Health Network.

Table 22: Proportion of cases with clinical management issues identified by the assessor according to surgeon-estimated risk of death, 2015–2019

Clinical management issues (%)	Surgeon-estimated risk of death						
	n/a	minimal	small	moderate	considerable	expected	futile
yes	28.8	1.8	6.1	19.4	37.7	6.2	0.0
no	15.0	1.8	12.9	27.8	38.5	4.0	0.0

DISCUSSION

Death notifications to SAASM have remained relatively stable over the past five years, with the main source of notification being from the hospitals themselves. The patient population experiencing in-hospital surgical mortality is generally what one might expect: patients tend to be older, evenly distributed across sex, with most cases being public emergency admissions. Against the background of an aging population and increasing strain on hospital services, the fact that the rate of in-hospital mortality has seemingly remained stable (i.e. potentially decreasing as a proportion of total population and procedures performed) is very positive. Surgeon engagement with the audit also remains positive, with very few SCFs from 2015–2019 outstanding.

The audit maintains a focus on those factors in the overall pathway of care that may influence the final outcome for patients. In this cohort, transfers of patients between institutions occurred in approximately 25% of cases and was broadly seen as appropriate in the circumstances. Similarly, admission to CCUs (or not) was seen as reasonable, and delays in determining a surgical diagnosis were minimal. Difficulties in maintaining patient fluid balance were observed in less than 10% of cases.

Infections were observed in 35–40% of this cohort, with approximately half of those acquired during final admission. Of the patients that developed an infection during admission, most acquired it postoperatively, with pneumonia and sepsis being the most commonly diagnosed ailments. The patients in this cohort represent an at-risk population for development of pneumonia following admission to hospital. Mitigating infection risk remains a long-term goal, despite current strategies lacking a strong evidence base for effectiveness (7-9). Sepsis, if it develops, can be considered a medical emergency and is reliant upon early diagnosis and institution of resuscitative measures (10, 11). These remain challenging areas to address.

Use of DVT prophylaxis in this cohort to avoid venous thromboembolism (VTE) occurring after surgery, has been stable over the past five years at about 75%. VTE after surgery can be considered a ‘provoked’ event, with the rate of recurrence typically low (12). Appropriate use of DVT prophylaxis is complicated by the array of different anticoagulant options available, the particular pathophysiological process to mitigate, and the extent to which these processes are apparent in a patient. In a worrying trend, the proportion of SAASM assessors who approved the DVT prophylaxis strategy employed declined from 92% in 2015 to 80% in 2019. This is an area that requires clarification.

When evaluating the overall management of cases submitted to SAASM, it is notable that the assessments provided by the surgeons themselves and their assessors are broadly in agreement. In particular, differences observed between surgeon-identified CMIs and assessor-identified CMIs have diminished over the past five years. That said, surgeons are still less likely to consider CMIs preventable compared to their assessors and surgeons will also consider these CMIs to be less serious than what assessors determine. The data highlights the potential for improvement via the educational benefits of SAASM and ongoing assessment of surgical outcomes.

It was noteworthy to observe that, of all specialties analysed, only paediatric surgeons were more likely to identify CMIs for their cases than was determined by their assessors. Patient transfer between institutions, admission to a CCU facility, and a high surgeon- or assessor-estimated risk of death were all associated with increased likelihood of CMIs occurring. However, this likely reflects the complexity of these cases rather than any indicator of concern, since the instances in which patient transfer and/or admission to CCU took place were largely considered appropriate.

Management of patients is becoming an increasingly complex, multidisciplinary process. Effective communication between all parties remains critically important in support of robust decision-making processes when considering the welfare of patients. The ongoing activity of SAASM will continue to contribute to improved surgical outcomes through critical and constructive evaluation of surgical cases that have unfortunately ended in mortality.

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ABBREVIATIONS

ACHA	Adelaide Community Healthcare Alliance
ANZASM	Australian and New Zealand Audit of Surgical Mortality
ANZCA	Australian and New Zealand College of Anaesthetists
ASA	American Society of Anesthesiologists
CALHN	Central Adelaide Local Health Network
CCU	Critical Care Unit
CMI	Clinical Management Issue
CPD	Continuing Professional Development
DHW	Department for Health and Welfare
DVT	Deep Vein Thrombosis
EFNLHN	Eyre and Far North Local Health Network
FLA	First-line Assessment
FUNLHN	Flinders and Upper North Local Health Network
HDU	High Dependency Unit
ICU	Intensive Care Unit
LCLHN	Limestone Coast Local Health Network
NALHN	Northern Adelaide Local Health Network
RACDS	Royal Australasian College of Dental Surgeons
RACS	Royal Australasian College of Surgeons
RANZCO	Royal Australian and New Zealand College of Ophthalmologists
RANZCO	Royal Australian and New Zealand College of Obstetricians and Gynaecologists
RMCLHN	Riverland Mallee Coorong Local Health Network
SAASM	South Australian Audit of Surgical Mortality
SAAMC	South Australian Anaesthetic Mortality Committee
SALHN	Southern Adelaide Local Health Network
SCF	Surgical Case Form
SLA	Second-line Assessment
VTE	Venous Thromboembolism
WCHN	Women's and Children's Health Network