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2020 REPORT

The Western Australian Audit of Surgical Mortality (WAASM)

Western Australian Audit of Surgical Mortality

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The information contained in this annual report has been prepared by the Royal Australasian College of Surgeons, Western Australian Audit of Surgical Mortality Management Committee, which, as part of the Australian and New Zealand Audit of Surgical Mortality is a declared quality assurance activity under the *Health Insurance Act 1973 (Cwlth)*, Part VC (gazetted 2 May 2017).

ACKNOWLEDGEMENTS

WAASM would like to acknowledge the support and assistance of individuals and institutions that have helped in the development and continuation of this project, including:

- participating surgeons
- first-line assessors
- second-line assessors
- hospital medical records departments
- WA Department of Health for funding the project
- Patient Safety Surveillance Unit, Clinical Excellence Division, WA Department of Health for continual commitment to, and support of, WAASM
- RACS for infrastructure and oversight of this project
- ANZASM Steering Committee

- **WAASM Management Committee:**

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Mr Tom Bowles	Consultant General Surgeon, rural surgical representative
Dr Jennifer Bruce	Consultant Anaesthetist, anaesthetic representative
Mr Ian Gollow	Consultant Paediatric Surgeon, paediatric surgical representative
Mr Gregory Janes	Consultant Orthopaedic Surgeon, orthopaedic representative
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- **WAASM staff:**

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- **RACS, particularly RAAS staff:**

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Contents

LIST OF FIGURES

LIST OF TABLES

Clinical Director's Report

This report covers the calendar year 2019 when the coronavirus was essentially unknown, certainly in Australia, and had not developed into the current international coronavirus (COVID-19) pandemic. Since then, the impact of the COVID-19 pandemic on medical care in Australia has been profound, not least the curtailment of elective surgery.

The Australian and New Zealand Audit of Surgical Mortality (ANZASM) has maintained a close watch on the impact of COVID-19 and this will doubtless be an important part of future reports. At the time of writing (July 2020), ANZASM has not identified an increase in deaths, although one international report noted an increased mortality in patients who had a previous or current COVID-19 infection. The very low COVID-19 infection rate in Australia may make it difficult for ANZASM to authoritatively address COVID-19 related surgical mortality.

Overall, there may even be fewer surgically related deaths. For example, there have been fewer car accidents and other traumas. Attendance at emergency departments has fallen. Many emergencies are time critical and with minimal elective surgery, timely theatre access is more likely to be achieved, which may improve outcomes. Conversely, there is a strong suggestion that COVID-19 infection may have adverse long-term health implications, and if this is correct, elective surgery in previously infected patients may carry increased risk. It may be several years before the full surgical impact of COVID-19 is understood.

This report shows a continued small decrease in the number of deaths under a surgeon to 20.6 per 100,000 Western Australian (WA) population. Since WAASM initially reported this progressive fall, the overall number of deaths has reached a plateau, and this appears to be the 'natural' floor. ANZASM now has long-term data from other states and a similar national assessment is in progress.

However, there is no place for complacency. Two issues stand out in this report. The first is that the proportion of patients who did not receive deep vein thrombosis (DVT) prophylaxis is increasing every year, and last year a quarter did not receive prophylaxis. This seems higher than might be anticipated, as most patients who die after surgery are elderly and underwent at least one major, high-risk operation. Intuitively, one would expect that most would require DVT prophylaxis. Further, previous random checks by WAASM, supported by peer reviewed publications [1,2,3,4], show that DVT prophylaxis is very frequently imperfectly delivered. Taken together, it seems probable that many WA patients undergoing major surgery receive suboptimal DVT prophylaxis. There appears to be a compelling case for WA surgeons to study this in greater detail, perhaps through a short, sprint surgical trainee collaborative project.

The second issue is consultant presence in theatre. Almost all of these patients will have been high risk, with many having additional operations for complications. An earlier WAASM Annual Report showed that consultant presence was less than ideal and that as the number of operations increase direct consultant input fell. This report suggests a consultant was either the surgeon or assistant in about 80% of cases. This would seem lower than might be anticipated. WAASM is reviewing this data in greater detail.

A potential criticism of the ANZASM process is that the assessments have a degree of subjectivity – as do all clinical reports. An important way to reduce any subjectivity is to assist the First Line Assessor by ensuring complete data capture. The value of any audit will be jeopardised by incomplete data. Some forms returned to WAASM are completed very poorly and these are returned to the surgeon. Now that ANZASM is fully electronic, it would be possible to make submission of the surgeon form conditional on a high level of field completion. ANZASM has been exploring the ability to do that.

The first-line assessment is the gatekeeper that determines if a detailed second-line assessment is required. The proportion of second-line assessments has consistently been about 15%. These are expensive for WAASM and time consuming for the Second Line Assessor. WAASM has recently completed a 'double' first-line assessment validation study. This showed there was minor variation

between the First Line Assessors when determining if any clinical management issues were a cause for ‘consideration’ or cause for ‘concern’. There was minimal variation between the First Line Assessors when there was either no clinical management issue or there was an adverse event. This consistency is very reassuring. When considered alongside studies in other states that have assessed the reproducibility of the second-line assessment, this suggests that the ANZASM process is robust and reproducible.

The August 2020 College state meeting in Broome was cancelled as a result of the COVID-19 pandemic. WAASM in conjunction with South Australia Audit of Surgical Mortality and Northern Territory Audit of Surgical Mortality had planned two symposia that had a common theme of preoperative care. On the assumption that this conference takes place in 2021, it will hopefully be possible to hold these symposia then.

Nationally, the role of ANZASM’s Qualified Privilege remains under active discussion. The demand for openness and transparency is an international trend in all facets of life, and quality and safety in health is no exception. Finding the balance between the many conflicting demands is not straightforward.

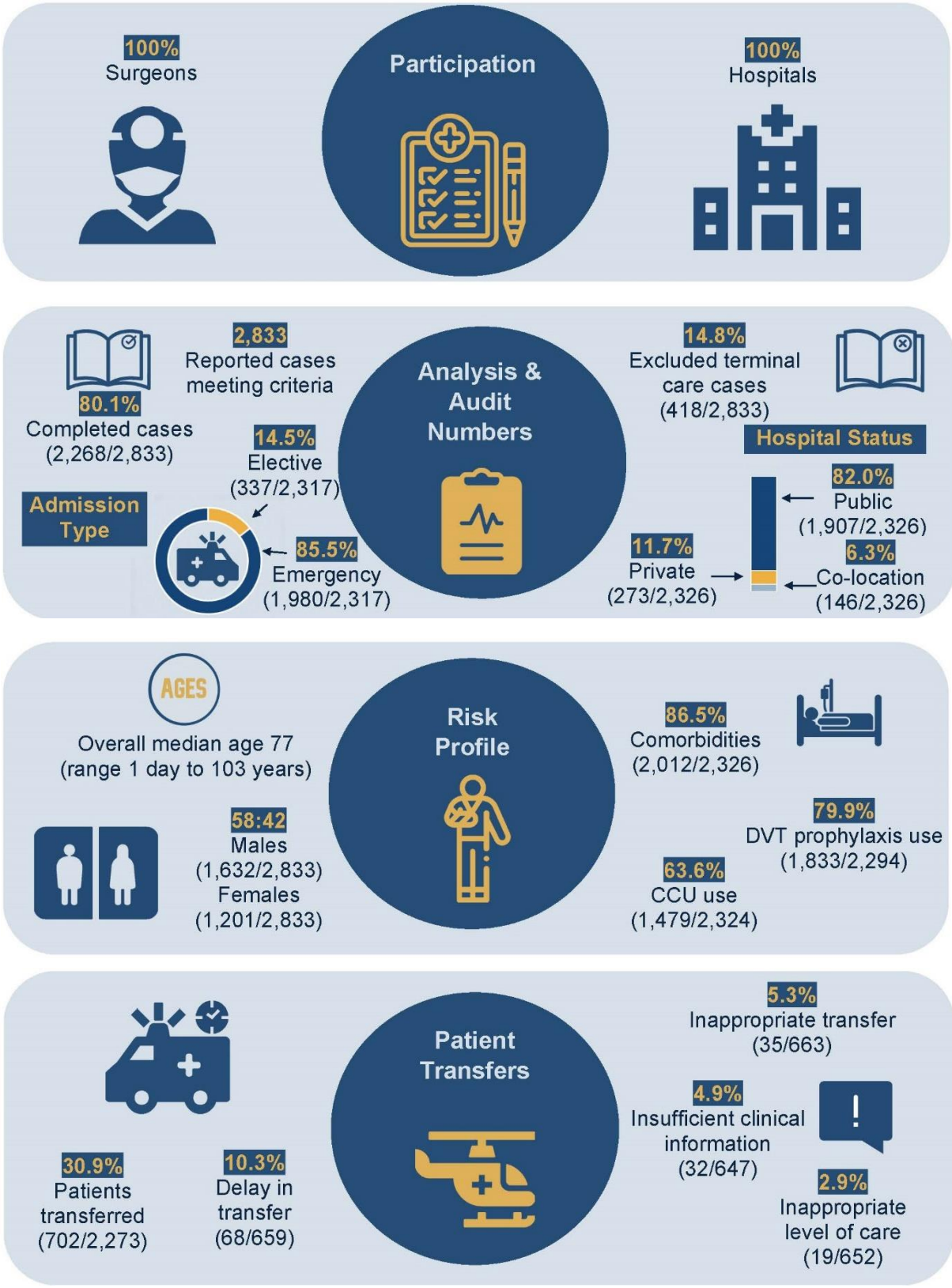
RJ Aitken
Clinical Director
Western Australian Audit of Surgical Mortality

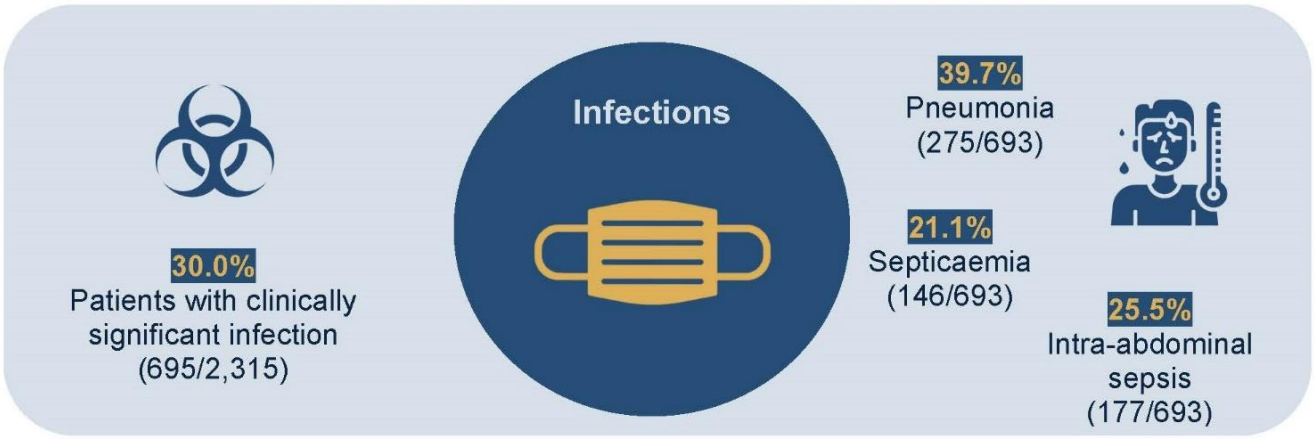
Abbreviations

ANZASM	Australian and New Zealand Audit of Surgical Mortality
ASA	American Society of Anesthesiologists
CCU	Critical care unit
CNR	Case note review
DVT	Deep vein thrombosis
FLA	First-line assessment
HDU	High dependency unit
ICU	Intensive care unit
RAAS	Research, Audit and Academic Surgery
RACS	Royal Australasian College of Surgeons
SCF	Surgical case form
SLA	Second-line assessment
SPSS	Statistical Package for Social Sciences
WA	Western Australia/n
WAASM	Western Australian Audit of Surgical Mortality

Executive Summary

This summary covers cases reported to WAASM from **1 January 2015** to **31 December 2019**.





Note that differences in denominators are due to incomplete information provided in surgical case and assessment forms, resulting in missing data.

Recommendations

ANZASM

- Facilitate a national analysis of change in rate of deaths under a surgeon since the full integration of all the regional audits into ANZASM.
- Review the impact of COVID-19 on deaths under a surgeon.

Clinical management

- Monitor and report any trends observed in the proportion of surgical patients who die with trauma being implicated, for the reporting periods over the next two years.
- Monitor and report on any trends in the proportion of surgical patients where there was an issue with communication at any stage of their care, for the reporting periods over the next two years.

Research

- Undertake a review of DVT prophylaxis use/non-use in surgical patients in WA.
- Undertake an analysis of consultant surgeon involvement in theatre.

See Appendix A for review of 2019 recommendations.

1 Introduction

1.1 Background

The quality and safety of healthcare is a high priority in Australia. Clinical audits are an essential component of evidence-based clinical practice and are particularly relevant to those areas of healthcare that have significant costs and variations in outcomes, such as surgical specialties.

The Western Australian Audit of Surgical Mortality (WAASM) is an independent, peer-reviewed audit of the process of care associated with surgically related deaths in WA. Established in 2001, WAASM is funded by the WA Department of Health and has protection under federal legislation. Participation in WAASM became a mandatory requirement in 2010 and since 2013 this has been monitored by the Royal Australasian College of Surgeons (RACS) Continuing Professional Development program.

As a patient safety and quality improvement intiative, WAASM detects and highlights emerging trends and system/process errors in surgical care to facilitate changes in practice, thereby improving patient safety and outcomes. This is achieved through an educational peer-review process, of which provision of information and feedback to surgeons is an integral component.

1.2 Objectives

The objectives of WAASM are:

1. To audit all surgically related deaths within the following criteria:
   - The patient was under the care of a surgeon, whether or not an operation was performed.
   - The patient was under the care of a physician and subsequently underwent a surgical procedure.

   Cases outside of these criteria are excluded from the audit. Patients admitted under the care of a surgeon specifically for terminal care are excluded from the full audit process as the cases do not undergo peer review.
2. To analyse clinical management issues identified by the assessors as follows:
   - **Area of consideration,** where the clinician believes an area of care could have been improved or been different, but recognises that there may be an area of debate
   - **Area of concern,** where the clinician believes that an area of care should have been better
   - **Adverse event,** an unintended injury caused by medical management rather than by the disease process, which is sufficiently serious to lead to prolonged hospitalisation or to temporary or permanent impairment or disability of the patient at the time of discharge, or which contributes to or causes death.

2 Methods

2.1 Structure and Governance

WAASM is governed by ANZASM, which is managed by the Research, Audit and Academic Surgery (RAAS) division of RACS and funded and supported by state and territory governments (see Appendix B).

WAASM is protected by federal legislation. ANZASM receives legislative protection under the Commonwealth Qualified Privilege Scheme, under part VC of the *Health Insurance Act 1973* (gazetted 2 May 2017).

2.2 Audit Process

Public hospital deaths are reported to WAASM via the WA Department of Health's web-based Patient Administration System. WAASM is notified of deaths in private hospitals through medical records departments. A surgeon involved in the care of the patient may also self-report a death using the Fellows Interface, a web-based application developed by RACS specifically for audits of surgical mortality.

All deaths where a surgeon was involved in the care of the patient are included in the audit, whether or not the patient underwent a surgical procedure. Details and cause of death are recorded in the surgical case form (SCF) by the treating surgeon. This is based on the patient's diagnosis during the last admission, taking into account test results, operations and post mortem reports when available.

The peer-review process, which follows submission of the SCF, is a retrospective assessment of the clinical management of the patient who died whilst under the care of the treating surgeon. Assessors must decide whether management of the patient was appropriate.

WAASM's full audit process is outlined in Appendix C.

2.3 Feedback

The core purpose of WAASM is to improve patient outcomes. This is accomplished by the provision of detailed feedback to inform, educate, facilitate change and improve practice, and is achieved at different levels (individual, hospital or grouped) and provided in several ways:

- **Feedback on individual cases**

  Treating surgeons are provided with assessors' feedback on individual cases. The identities of assessors remain anonymous at all times. WAASM encourages treating surgeons to complete a peer-review feedback evaluation form providing comments in response to the feedback received.

- **Hospital report**

  Individual hospital reports are sent annually to all hospitals participating in WAASM. These reports contain de-identified aggregated data that can be used for monitoring trends within the individual hospital and for comparisons with other participating peer-grouped hospitals across the country.

- **Case Note Review booklets**

  A selection of summaries of case notes reviewed by assessors is collated and disseminated to all surgeons. All information in the case note reviews is de-identified so events cannot be linked to an individual patient, surgeon or hospital.

  In addition, each month a national Case of the Month is emailed to surgeons.

- **Annual Report**

  An annual report is published in October and made available on the WAASM website. It is also widely circulated to all WA surgeons and hospitals, the WA Department of Health, and RACS.

2.4 Data Analysis

WAASM audits all surgically related deaths occurring in WA hospitals. This 2020 report covers deaths reported to WAASM from **1 January 2015** to **31 December 2019** (censored on 31 March 2020).

The full audit process can take three months or longer from initial notification of death, so some 2019 cases were still under review as of the census date and outcomes were unavailable for this report. Case numbers in previous reports may differ from those in this report because some cases were completed after the relevant census dates.

Patients admitted for terminal care are excluded from the full audit process. Cases are included in the full audit process if the patient was admitted with the intention to treat but after assessment it was decided to manage the patient conservatively or to palliate.

Data is entered and stored in the Bi-national Audit System database and analysed using the Statistical Package for Social Sciences (SPSS version 26) and Microsoft Office Excel (2010). Since not all data were completed for some cases (resulting from incomplete surgical case and assessment forms), the total number of cases used in each analysis may vary.

3 Audit Participation

In the period 2015 to 2019:

- 2,833 deaths met WAASM criteria
- 9.6% relative decrease in deaths per 100,000 WA population
- 80.1% (2,268/2,833) of cases completed the audit process
- 27 hospitals associated with the 2,833 cases meeting WAASM criteria
- 97.1% of SCFs returned.

3.1 Surgical Deaths Reported to WAASM

Between 1 January 2015 and 31 December 2019, 2,927 deaths were reported to WAASM. Of these, 94 deaths were excluded for not meeting WAASM inclusion criteria. This resulted in 2,833 deaths meeting the inclusion criteria (Table 1).

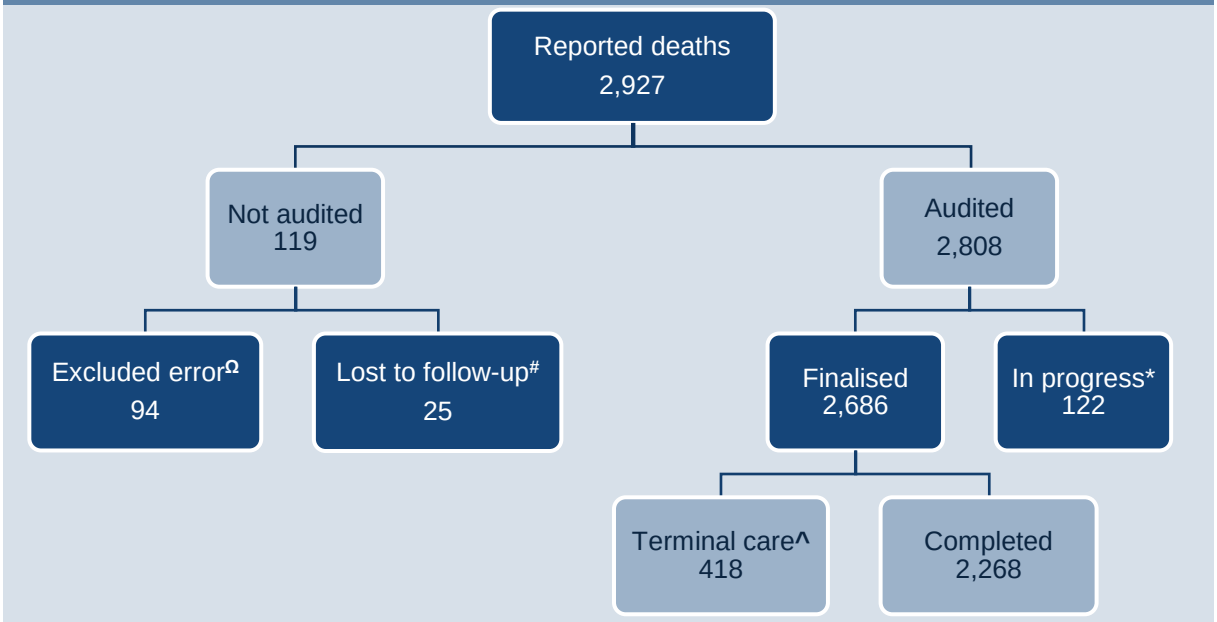
Table 1: Deaths reported to WAASM by year

Year	Number of deaths reported	Deaths not meeting criteria	Deaths meeting criteria
2015	596	15	581
2016	604	13	591
2017	595	27	568
2018	581	29	552
2019	551	10	541
Total	**2,927**	**94**	**2,833**

WAASM: Western Australian Audit of Surgical Mortality.
Refer to Appendix D.3 for further information on data.

Figure 1 shows the number of reported deaths that were audited and not audited in the period 2015 to 2019.

Figure 1: Deaths audited by WAASM



Ω Excluded error: reported deaths that do not meet WAASM inclusion criteria.
Lost to follow-up: cases remaining incomplete for a period of two years.
* In progress: cases that have not completed the full audit process.
^ Terminal care: patients admitted specifically for terminal care are excluded from the full audit process.
Refer to Appendix D.2 for further information for data.

Some cases have more than one cause of death noted. The most frequently reported causes of death were:

- multiple organ failure (9.9%; 357/3,590)
- septicaemia (6.7%; 239/3,590)
- respiratory failure (4.3%; 155/3,590)
- cardiac arrest (4.0%; 143/3,590)
- other aspiration pneumonia as a complication of care (3.5%; 124/3,590)

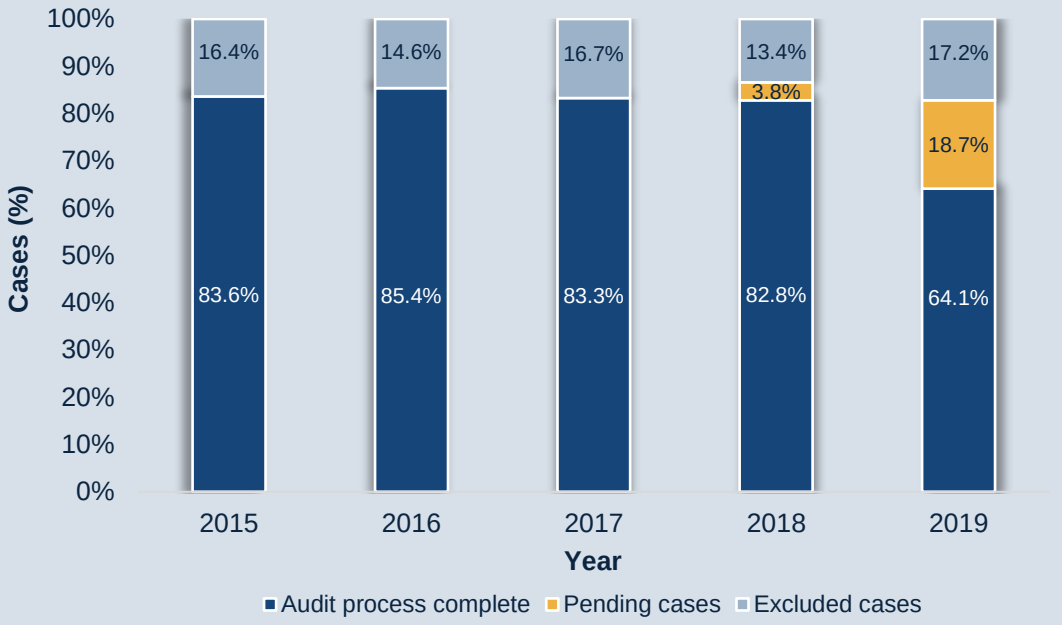
As of 31 March 2020, 80.1% (2,268/2,833) of cases had completed the audit process, 4.3% (122/2,833) of cases are pending, with a large proportion of these relating to 2019 cases (3.6%; 101/2,833).

Patients admitted specifically for terminal care (14.8%; 418/2,833) are excluded from the full audit process. Between 2015 and 2019, the proportion of reported terminal care cases have fluctuated (14.8%, 13.7%, 15.0%, 13.2% and 17.2% respectively).

Cases that have not been received by WAASM within two years are defined as 'lost to follow-up'. For the years 2015, 2016, 2017 and 2018, these accounted for 1.5% (9/581), 0.8% (5/591), 1.8% (10/568), and 0.2% (1/552) of cases, respectively. Over this four-year period, the proportion of cases 'lost to follow-up' was 1.1% (25/2,292).

Overall, a total of 15.6% (443/2,833) of cases were excluded from the audit due to being terminal care admissions or those 'lost to follow-up' (Figure 2).

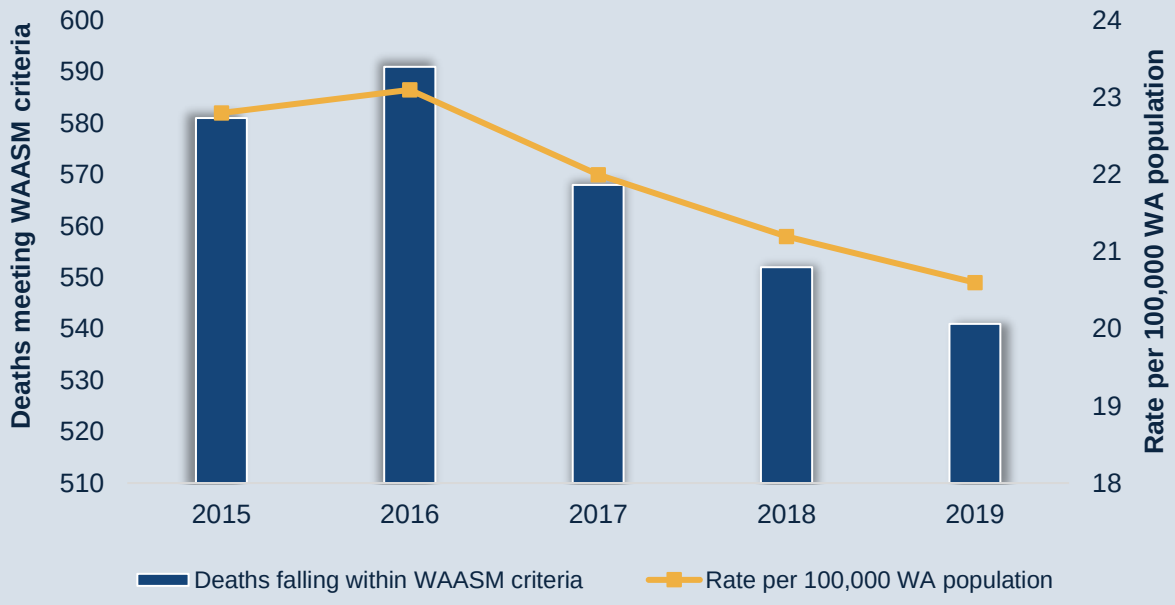
Figure 2: Case status by year



Note: some 2019 cases still undergoing review so case data unavailable for this report.
Refer to Appendix D.2 for further information on data.

Figure 3 shows that WAASM recorded an overall relative decrease of 9.6% (from 22.8% in 2015 to 20.6% in 2019) in the rate of deaths under a treating surgeon per 100,000 WA population [5].

Figure 3: WAASM deaths and mortality rate per 100,000 WA population by year



Note: some 2019 cases still undergoing review so case data unavailable for this report.
WAASM: Western Australia Audit of Surgical Mortality.
WA: Western Australia.
Refer to Appendix D.2 for further information on data.

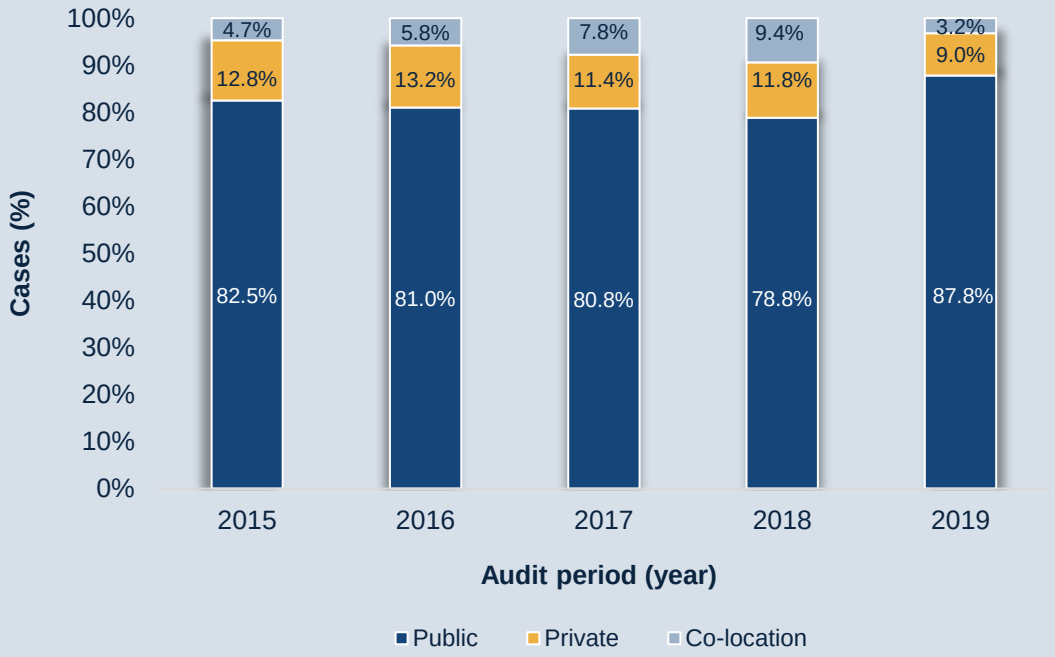
3.2 Hospital Participation

All hospitals in WA where surgery is performed participate in the audit. Between 2015 and 2019, the 2,833 deaths meeting WAASM criteria occurred in 27 (of 52) WA hospitals.

Between 2015 and 2019, public hospitals accounted for 82.0% (1,907/2,326) of deaths, with private and co-location hospitals accounting for 11.7% (273/2,326) and 6.3% (146/2,326) of deaths, respectively (Figure 4). (Co-location hospitals are those that provide both private and publicly-funded surgical services; data for co-location hospitals includes public and private patients).

The proportion of deaths occurring in co-location hospitals doubled in the period 2015-2018, from 4.7% (23/486) to 9.4% (44/466) in 2018. Data for 2019 currently suggests a decrease in the proportion of deaths in co-location hospitals, however this data is incomplete.

Figure 4: Death by hospital status by year



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3.3 Surgeon Participation

The return rate for SCFs, including terminal care cases, was 97.1% (2,750/2,833).

Table 2 shows WAASM deaths for each surgical specialty in the period 2015 to 2019. General Surgery reported the most deaths at 42.5% (1,203/2,833), followed by Neurosurgery at 17.2% (486/2,833).

Table 2: WAASM deaths by specialty

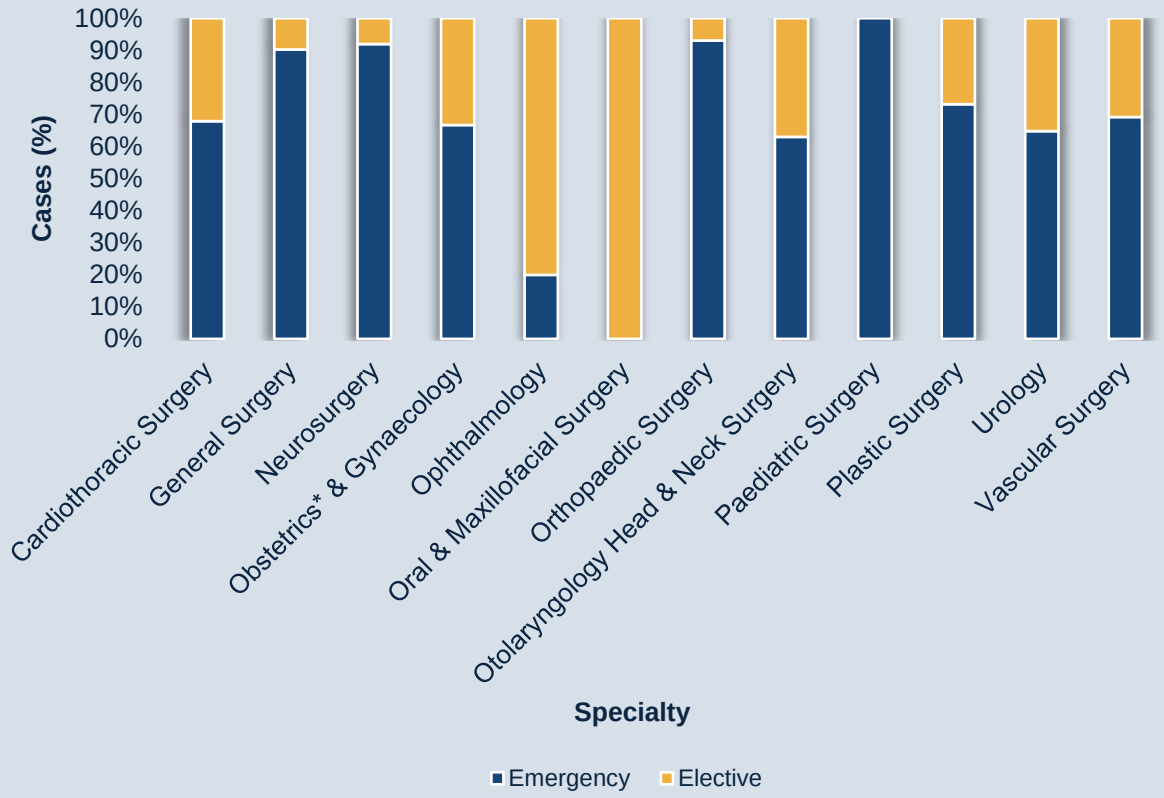
Surgical specialty	Number of deaths	Percentage (%)
General Surgery	1,203	42.5
Neurosurgery	486	17.2
Orthopaedic Surgery	461	16.3
Vascular Surgery	240	8.5
Cardiothoracic Surgery	206	7.3
Urology	105	3.7
Plastic Surgery	61	2.2
Otolaryngology Head & Neck Surgery	39	1.4
Paediatric Surgery	14	0.5
Obstetrics* & Gynaecology	11	0.4
Ophthalmology	6	0.2
Oral & Maxillofacial Surgery	1	0.04

WAASM: Western Australian Audit of Surgical Mortality.
*Obstetric cases are not included in the audit process; only gynaecological cases are audited.
Refer to Appendix D.3 for further information on data.

Emergency admissions accounted for 85.5% (1,980/2,317) of hospital admissions and elective admissions accounted for 14.5% (337/2,317) in the period 2015 to 2019.

Most specialties had more emergency admissions compared to elective admissions, with the exceptions being Ophthalmology and Oral and Maxillofacial Surgery (Figure 5).

Figure 5: Deaths by surgical specialty and hospital admission



*Obstetric cases are not included in the audit process; only gynaecological cases are audited.
Refer to Appendix D.2 for further information on data.

4 Results

In the period 2015 to 2019:

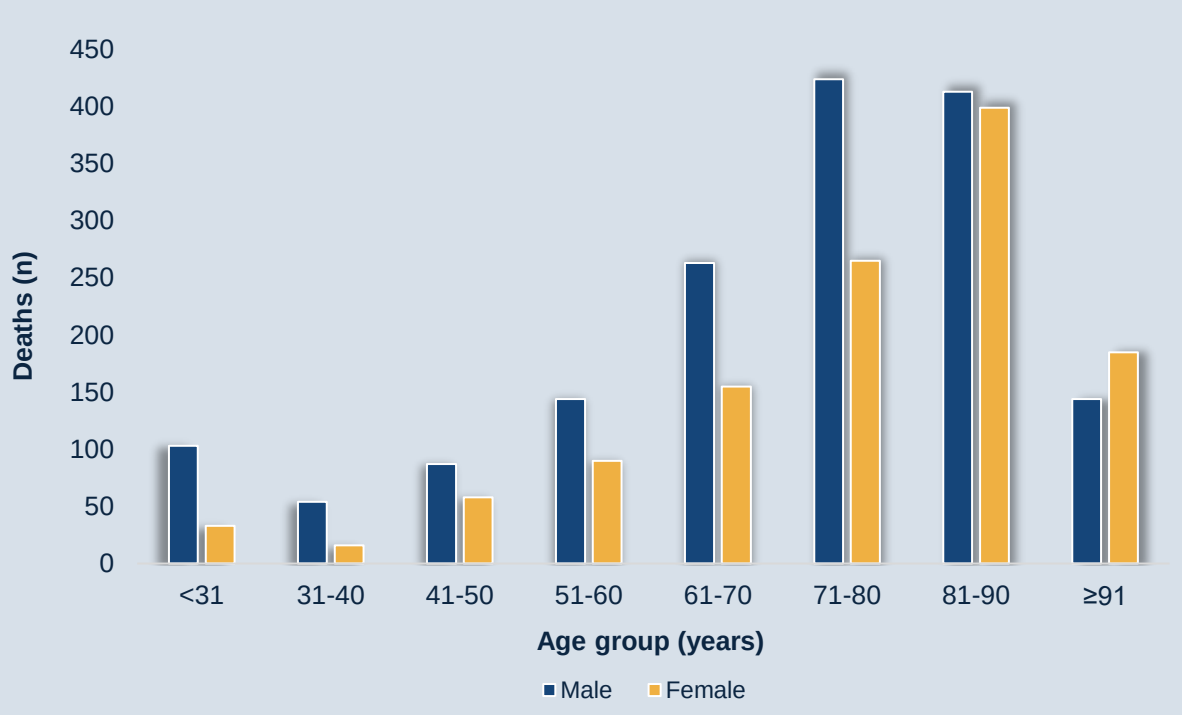
- 57.6% of patients were males
- 68.7% of patients had one or more operations
- 5.3% of cases were associated with a preoperative diagnostic delay
- 30.9% of patients had a preoperative transfer
- 86.5% of cases had one or more comorbidities present
- 30.0% of cases had a clinically significant infection.

4.1 Age and Gender Distribution

Median age at death for all patients was 77 years (interquartile range 64-86 years). Males accounted for 57.6% of all deaths (1,632/2,833) and females accounted for 42.4% (1,201/2,833) of deaths. The median age at death for males was 75 years (interquartile range 62-84 years) and for females was 80 years (interquartile range 68-88 years).

Figure 6 shows the distribution of deaths by age group and gender.

Figure 6: Deaths by age group and gender



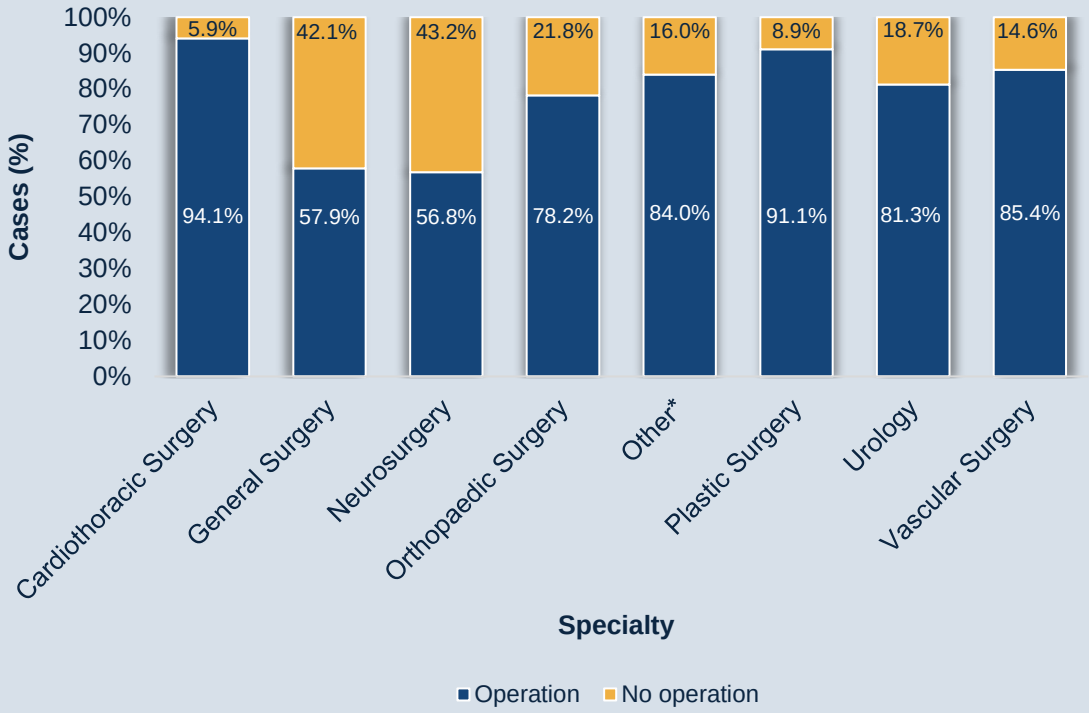
Refer to Appendix D.2 for further information on data.

For patients aged 90 years or younger, males represented a greater proportion of deaths than females. This reversed for patients aged 91 years and older, with females representing the greater proportion of deaths. Whilst the number of deaths began rising after the age of 50 years, 53.0% (1,501/2,833) of deaths occurred in patients aged 71–90 years. The decrease in deaths after the age of 90 years was likely attributable to the smaller population in this age group.

4.2 Operative and Non-operative Cases

In the period 2015 to 2019, most patients (68.7%; 1,601/2,330) underwent one operation or more. Figure 7 shows that Cardiothoracic Surgery reported the highest operation rate (94.1%; 177/188) while Neurosurgery had the lowest operation rate (56.8%; 241/424).

Figure 7: Operative and non-operative cases by specialty

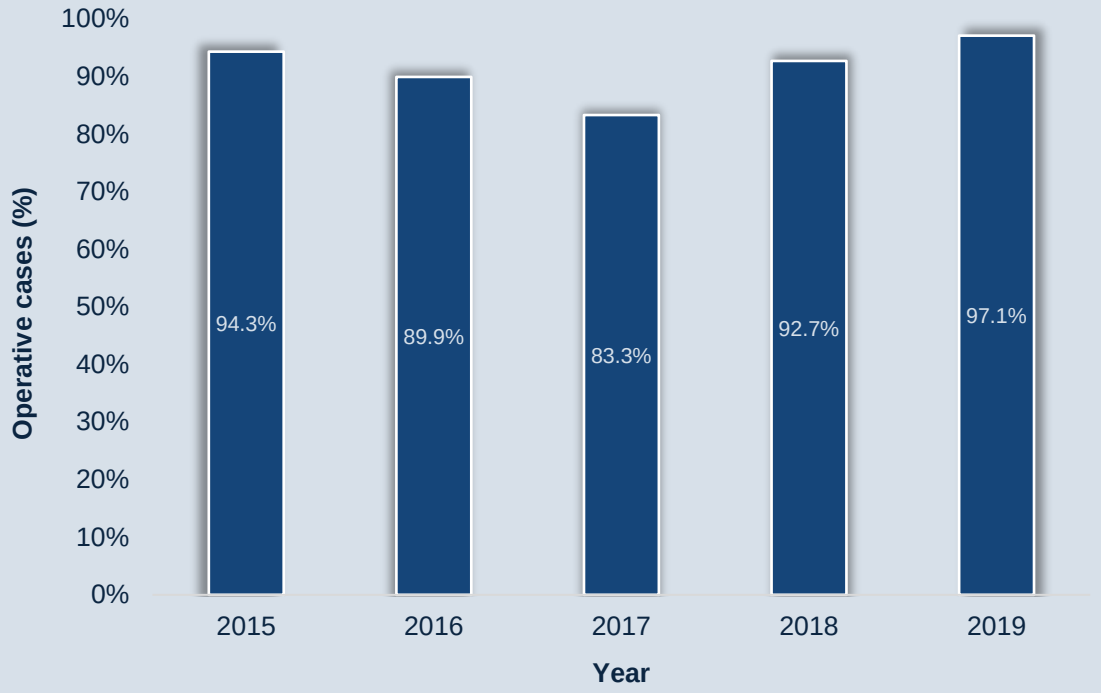


*Other includes Otolaryngology, Head and Neck Surgery, Ophthalmology, Paediatric Surgery, Obstetrics[#] &Gynaecology, Oral/Maxillofacial Surgery. [#]Obstetric cases are not included in the audit process; only gynaecological cases are audited
Refer to Appendix D.2 for further information on data.

The proportion of emergency and elective admissions involving an operation remained relatively steady in the period 2015 to 2019, with 80.0% (1,272/1,590) of patients admitted as an emergency. This is consistent with data in the previous two WAASM reports, which showed relatively steady proportions in relation to operative and non-operative hospital admissions since 2013 [6,7].

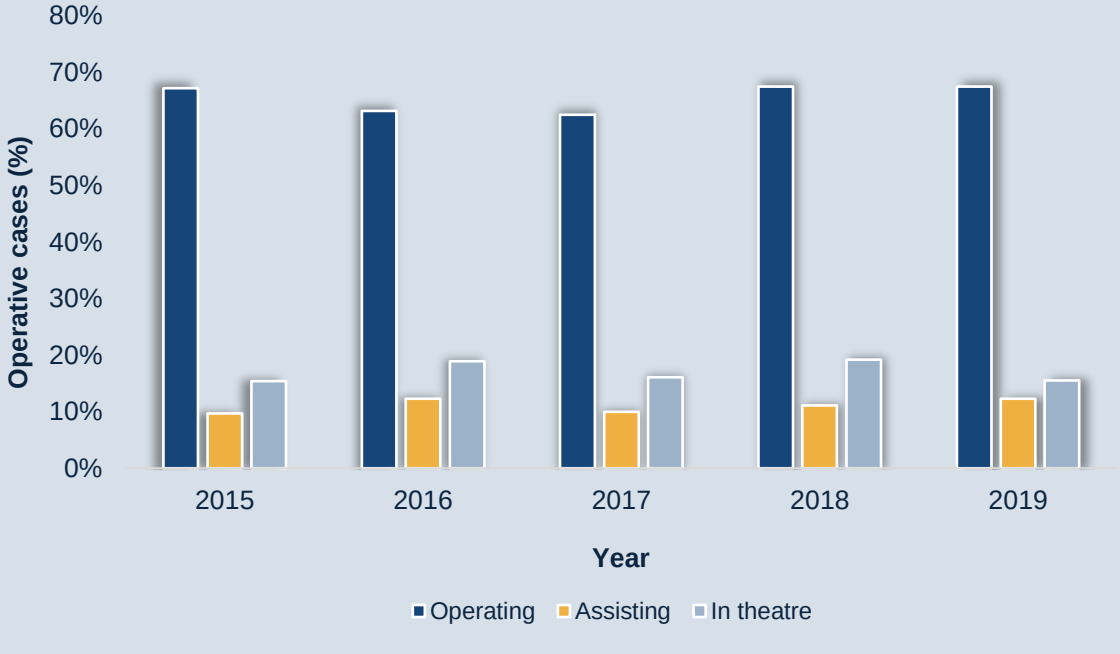
In total, 2,159 operations were performed on 1,601 patients between 2015 and 2019. The SCF asks consultant surgeons to indicate their involvement in operations, and this data shows that a consultant surgeon made the decision to proceed to surgery in 91.1% (1,967/2,159) of reported operations (Figure 8) and performed the surgery in 65.4% (1,413/2,159) of operations (Figure 9). An operation was abandoned upon finding a terminal situation in 5.1% (104/2,040) of operations.

Figure 8: Consultant surgeon making the decision to operate by year



Note: Some 2019 cases still undergoing review so case data unavailable for this report.
Refer to Appendix D.2 for further information on data.

Figure 9: Consultant surgeon involvement in operations by year



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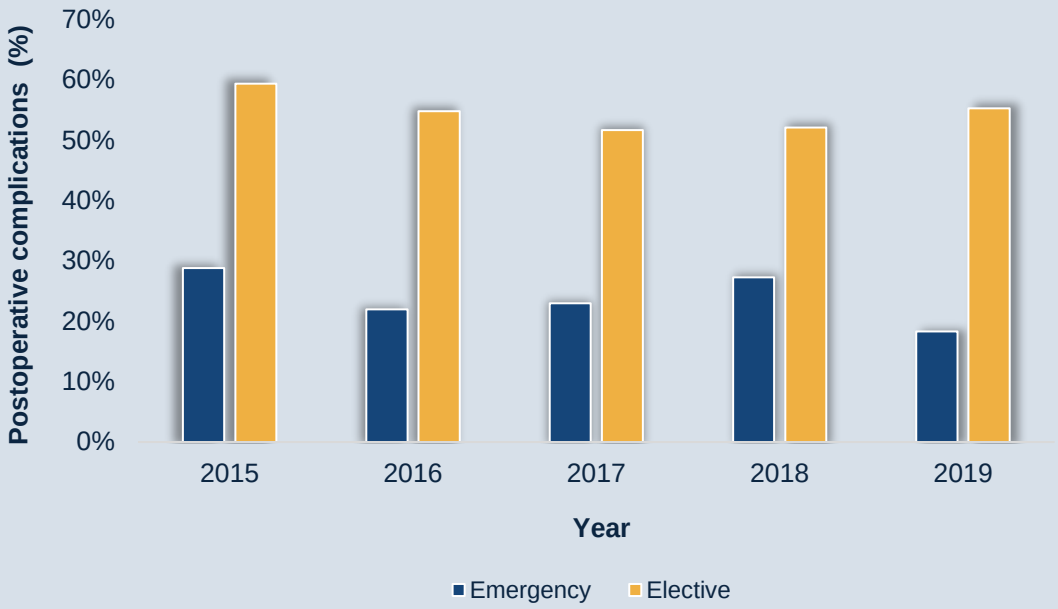
Consultant surgeons are asked to report on unplanned returns to theatre, which may indicate a complication from the initial operation. It was found that in the period 2015 and 2019, 14.4% (230/1,598) of operative cases had an unplanned return to the operating theatre.

Postoperative complications also occur, and these have been shown to be a major contributor to surgical mortality [8]. Between 2015 and 2019, consultant surgeons reported a postoperative complication in 30.2% (481/1,592) of operative patients (patients may have more than one postoperative complication). There was a total of 572 postoperative complications amongst 481 operative patients. The most frequently reported postoperative complications were tissue ischaemia (11.9%; 68/572), postoperative bleeding (11.7%; 67/572) and sepsis (7.7%; 44/572).

Figure 10 shows the distribution of postoperative complications by hospital admission and year.

Figure 10: Postoperative complications by hospital admission and year



Note: Some 2019 cases still undergoing review so case data unavailable for this report.
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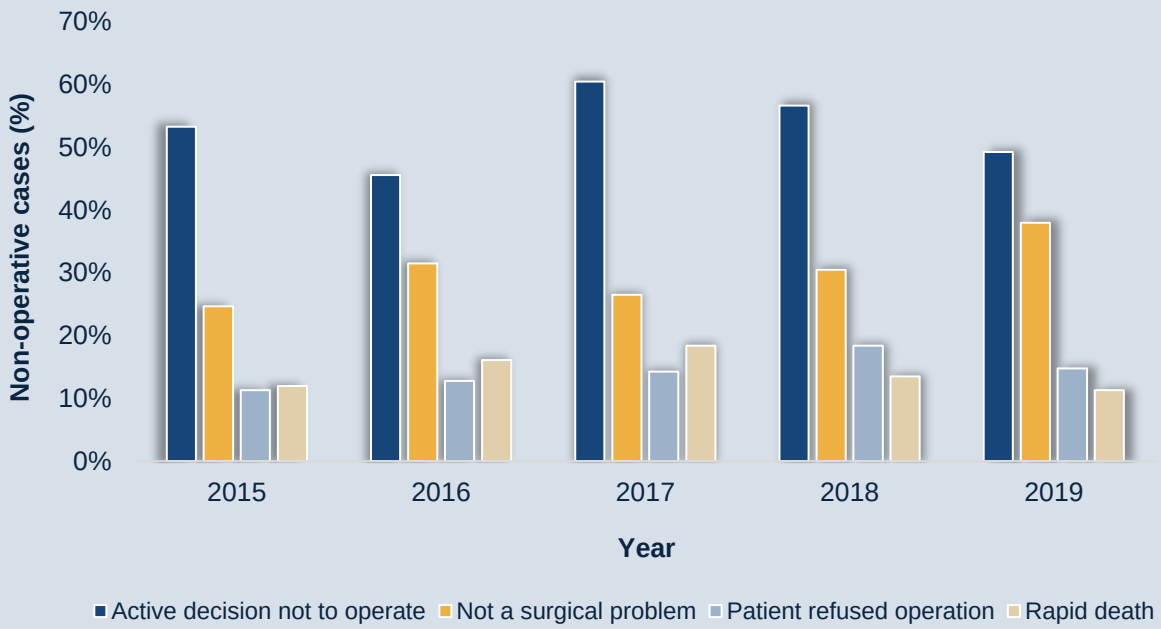
A higher proportion of elective patients (54.7%; 174/318) had a postoperative complication compared to emergency patients (24.1%; 306/1,272) between 2015 and 2019.

Overall, 31.3% (729/2,330) of patients did not undergo an operation for various reasons illustrated in Figure 11. Some cases reported more than one reason for not operating. Most non-operative cases were emergency admissions (97.5%; 707/725).

Figure 11: Reasons for not operating by year



Note: Some 2019 cases still undergoing review so case data unavailable for this report.
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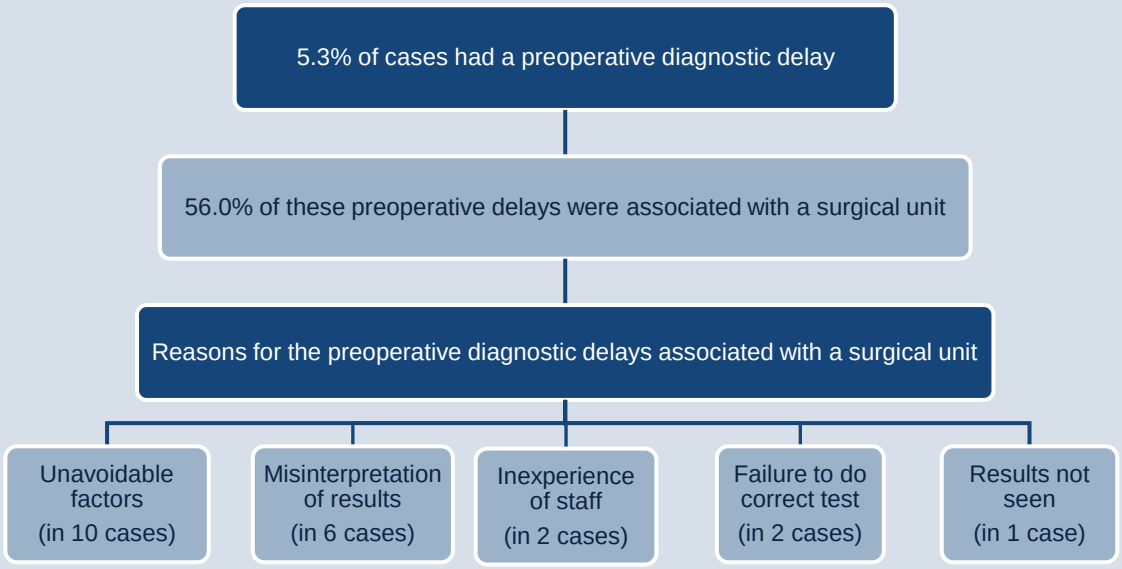
4.3 Preoperative Diagnostic Delays

The SCF asks treating surgeons if there was a preoperative diagnostic delay in confirming the main surgical diagnosis (Figure 12).

In the period 2015 to 2019, a preoperative delay in diagnosis was recorded by the treating surgeon in 5.3% (123/2,321) of cases. Of these delays, 56.0% (28/50, missing data=73) were associated with the surgical unit, however, this data lacks completeness. The most common reason stated for preoperative diagnostic delays associated with a surgical unit was ‘unavoidable factors’, reported in 10 cases.

Figure 12: Preoperative diagnostic delays



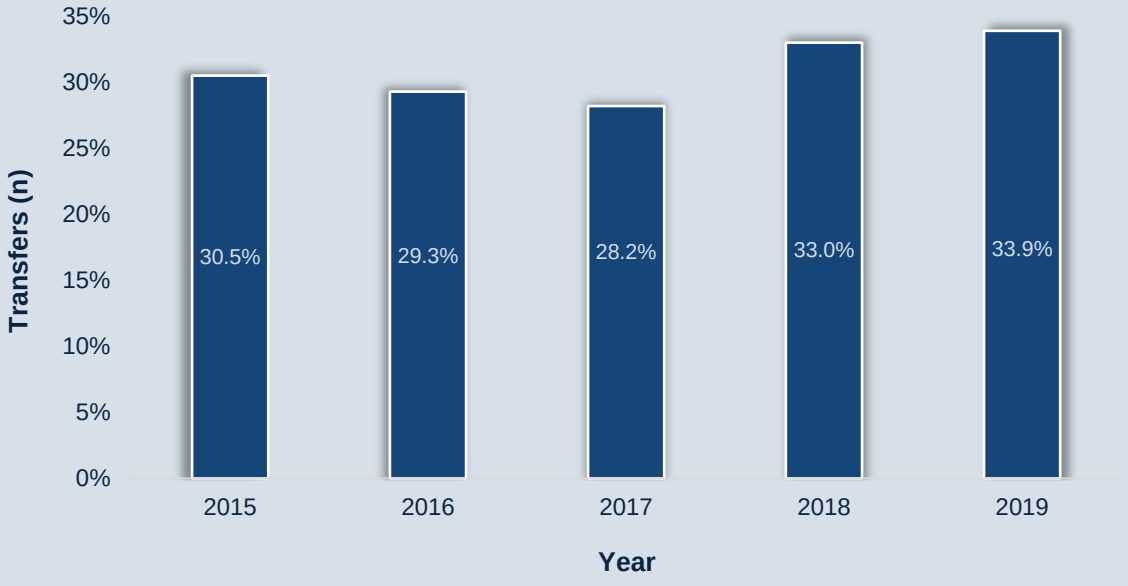
Refer to Appendix D.2 for further information on data.

4.4 Hospital Transfers

Preoperative hospital transfers occurred in 30.9% (702/2,273) of patients between 2015 and 2019.

Emergency admissions accounted for 97.4% (681/699) of this group. From 2015 to 2019 there was an increase of 3.4% in hospital transfers (30.5%, 142/466 in 2015; 33.9%, 135/398 in 2019).

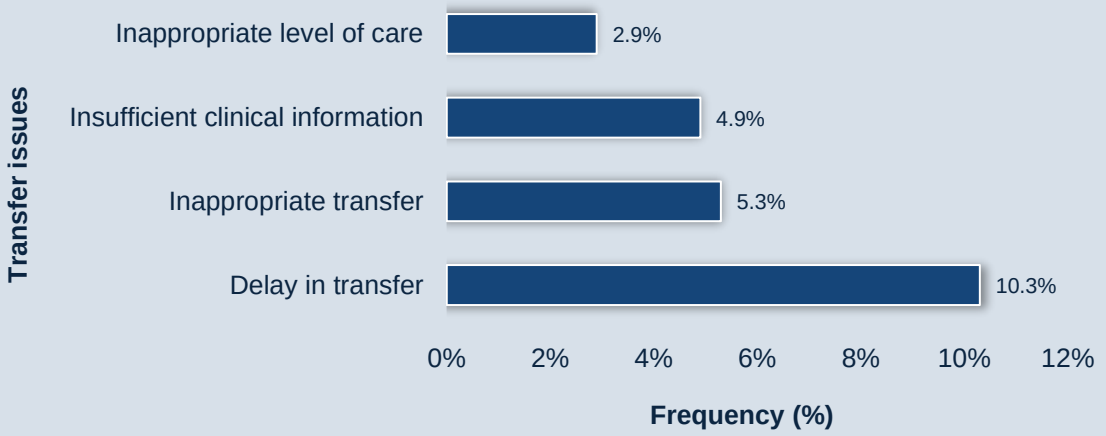
Figure 13: Hospital transfers by year



Note: Some 2019 cases still undergoing review so case data unavailable for this report.
Refer to Appendix D.2 for further information on data.

The majority of preoperative transfer cases occurred without incident, however, when transfer issues arose a variety of issues were reported (Figure 14). The most frequently reported transfer issue was 'delay in transfer' (10.3%; 68/659).

Figure 14: Hospital transfer issues

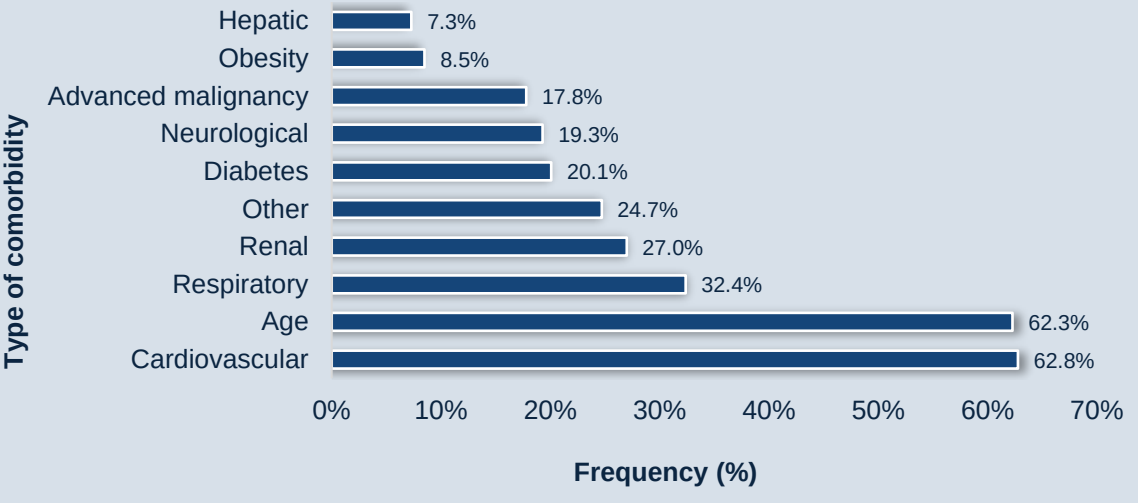


Refer to Appendix D.2 for further information on data.

4.5 Comorbidities

Treating surgeons are asked to identify any associated significant factors (comorbidities) that may increase a patient's risk of death. Most patients (86.5%; 2,012/2,326) had at least one comorbidity, with more than one comorbidity noted in some cases. Figure 15 shows that the most frequently occurring comorbidities were cardiovascular disease (62.8%; 1,264/2,012), age (62.3%; 1,254/2,012) and respiratory disease (32.4%; 652/2,012).

Figure 15: Cases with specific comorbidities



Note: 'Other' includes comorbidities other than those listed on the surgical case form and may include the presence of other chronic illnesses, haematological or drug-related conditions, vasculopathy, hypertension, dementia, malnutrition, alcoholism and cachexia.
Refer to Appendix D.2 for further information on data.

Patients were assigned grades according to the American Society of Anesthesiologists (ASA) grading system, an internationally recognised measure of a patient's physical status [9] (for ASA grade definitions see Appendix D.1). When combined with factors such as a patient's age, frailty, degree of deconditioning, comorbidities, medications, and type and duration of surgery, the ASA grade can assist in predicting a patient's perioperative risk, with a higher ASA grade indicating increased risk of perioperative complications [9,10,11].

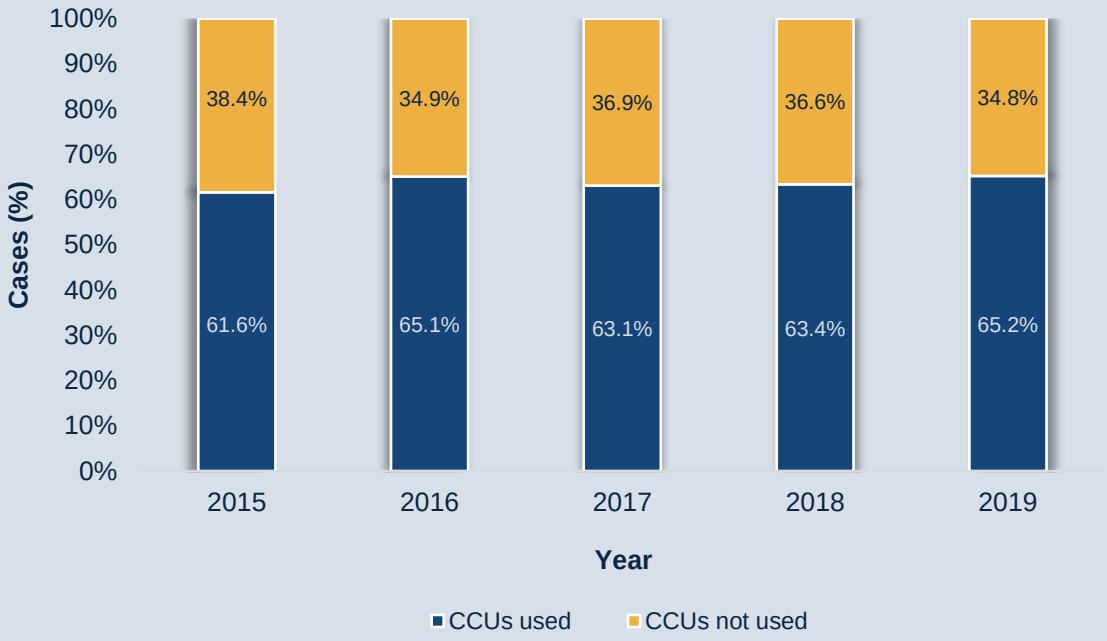
Patients were assigned ASA grade 4 (patient with severe systemic disease that is a constant threat to life) in 44.5% (897/2,014) of cases. ASA grade 3 (patient with moderate systemic disease) was the second most frequently assigned (29.6%; 597/2,014).

4.6 Critical Care Units

Treating surgeons report the use of critical care units (CCUs), which includes intensive care units (ICUs) or high dependency units (HDUs). Figure 16 shows that CCUs were utilised in 63.6% of cases (1,479/2,324) between 2015 and 2019.

Emergency and elective admissions accounted for 83.9% (1,235/1,472) and 16.1% (237/1,472) of CCU use, respectively.

Figure 16: Critical care units use by year

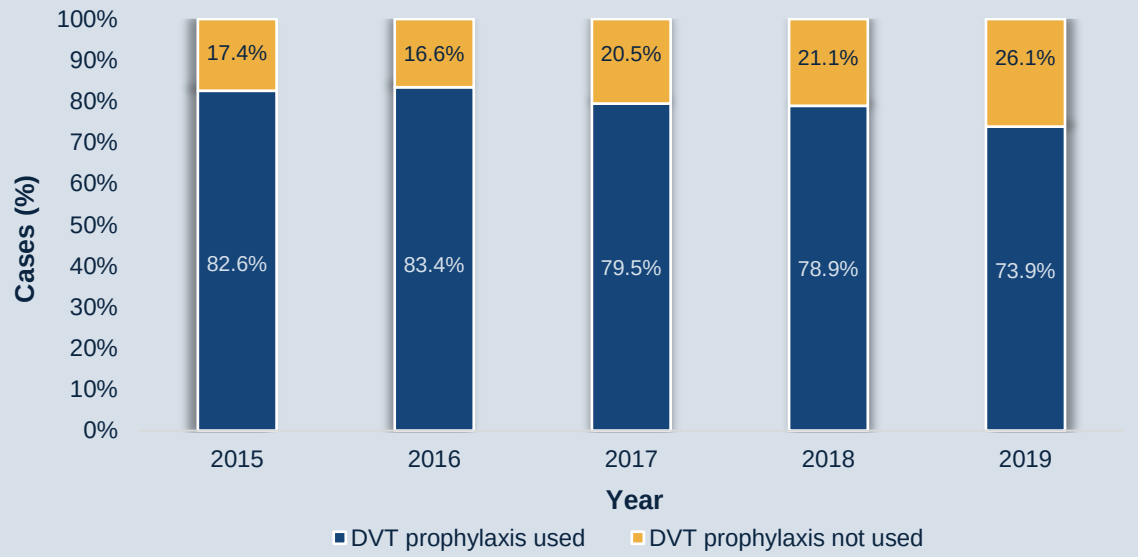


Note: Some 2019 cases still undergoing review so case data unavailable for this report.
Refer to Appendix D.2 for further information on data.

4.7 DVT Prophylaxis

Use of DVT prophylaxis was reported by treating surgeons in 79.9% (1,833/2,294) of cases. Figure 17 shows the use and non-use of DVT prophylaxis by year.

Figure 17: DVT prophylaxis use by year

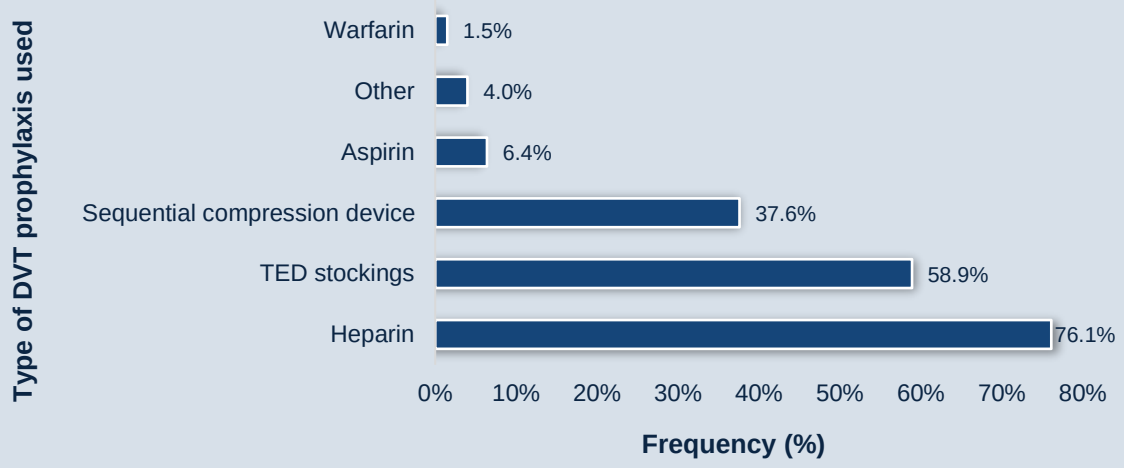


DVT: Deep vein thrombosis.
Note: Some 2019 cases still undergoing review so case data unavailable for this report.
Refer to Appendix D.2 for further information on data.

The SCF also requests information on the type of DVT prophylaxis used. In many cases more than one type of DVT prophylaxis was used. Figure 18 shows that heparin (76.1%; 1,394/1,833) and TED stockings (58.9%; 1,080/1,833) were the most frequently used DVT prophylaxis.

DVT prophylaxis was not used in 20.1% (461/2,294) of cases because it was not appropriate (65.5%; 290/443), or there was an active decision to withhold it (31.8%; 141/443), or it was not considered (2.7%; 12/443).

Figure 18: Type of DVT prophylaxis used



DVT: Deep vein thrombosis, TED: Thromboembolic deterrent.
Note: 'Other' includes enoxaparin sodium, clopidogrel bisulfate, danaparoid sodium, and enoxaparin sodium combined with early mobilisation.
Refer to Appendix D.2 for further information on data.

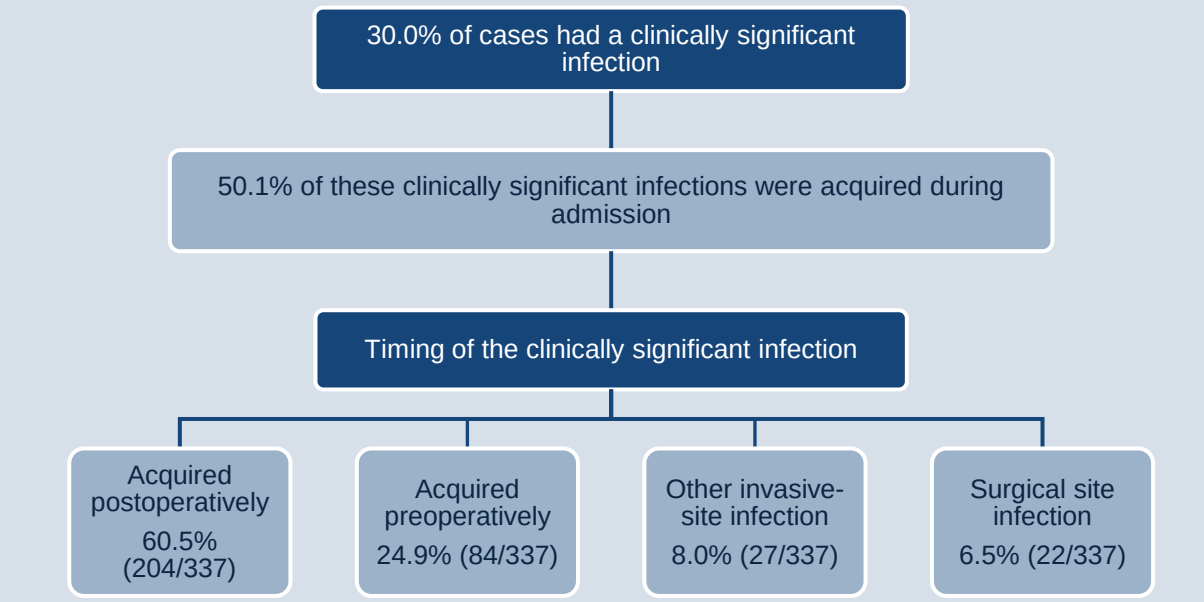
4.8 Infections

The significance of infections contributing to the cause of death in surgical patients cannot be underestimated. Nearly one-third of patients died with a clinically significant infection (30.0%; 695/2,315) between 2015 and 2019. Figure 19 shows the stage at which these clinically significant infections were acquired.

Treating surgeons reported that the clinically significant infection was acquired prior to admission in 49.9% (343/687) of cases. For the 50.1% (344/687) of cases where the clinically significant infection was acquired during the admission, more than half were acquired postoperatively (60.5%; 204/337).

The proportion of clinically significant infections acquired during hospital admission has remained relatively steady since 2013, as illustrated in the 2018 and 2019 WAASM reports [6,7].

Figure 19: Clinically significant infections



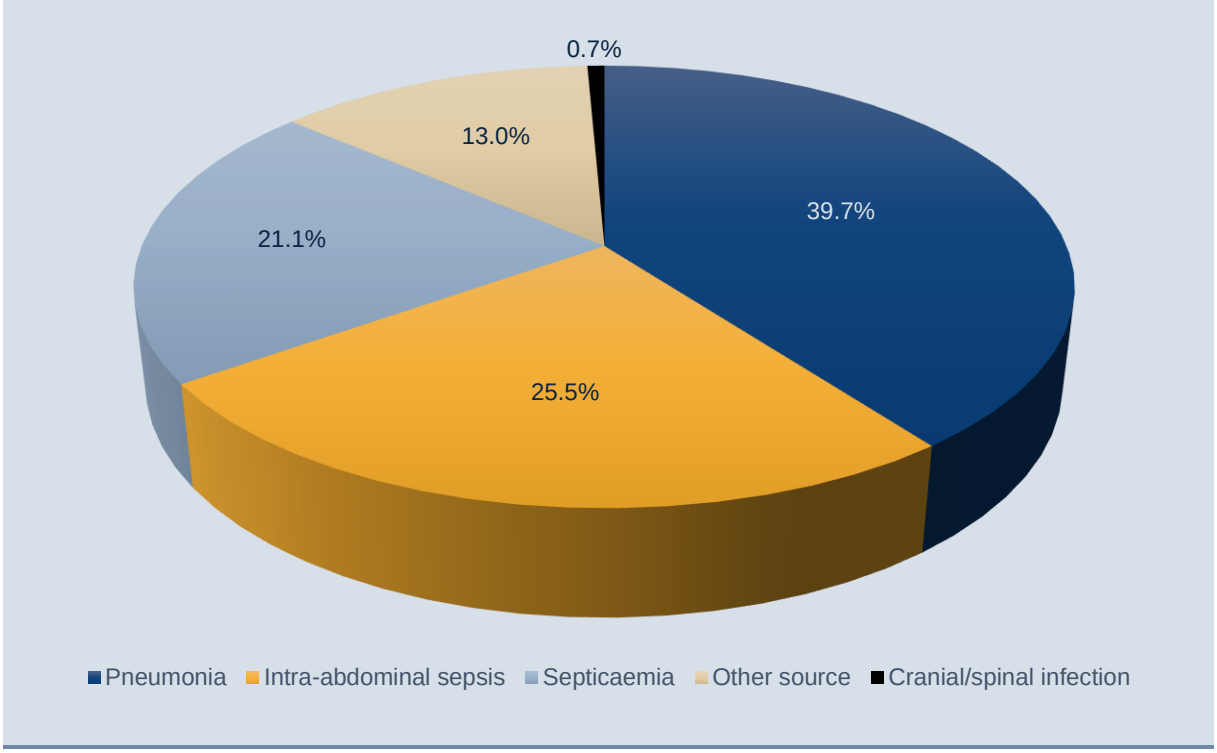
Refer to Appendix D.2 for further information on data.

Figure 20 shows the types of infections reported by treating surgeons, both prior to and during the admission, in the period 2015 to 2019.

Pneumonia was the most common type of clinically significant infection reported, accounting for 39.7% (275/693) of cases. Intra-abdominal sepsis accounted for 25.5% (177/693) of cases, followed by septicaemia (21.1%; 146/693). 'Other sources' and 'cranial/spinal infection' accounted for 13.0% (90/693) and 0.7% (5/693) of cases, respectively.

Where information was provided, treating surgeons reported that the antibiotic regime was appropriate in 96.8% (663/685) of cases of clinically significant infections. In 3.1% (21/685) of cases the appropriateness of the antibiotic regime was unknown, and in 0.1% (1/685) it was considered inappropriate.

Figure 20: Type of clinically significant infection reported



Refer to Appendix D.2 for further information on data.

5 Outcomes of Peer Review Assessment

In the period 2015 to 2019:

- 15.3% of cases were referred for an SLA by First Line Assessors
- 16.8% (382/2,268) of cases had clinical management issues reported by assessors
- 591 clinical management issues were identified in 382 cases by assessors
- 11.7% (69/591) of clinical management issues were classified as adverse events
- 63.2% (43/68) of adverse events were deemed to have caused the death of a patient
- 34.9% (15/43) of adverse events that caused the death of a patient were considered definitely preventable.

5.1 Second-line Assessment

All cases (apart from terminal care) are sent for peer-review assessment. Whilst many cases will be closed after initial first-line assessment (FLA), particularly when adequate information has been provided in the SCF, some will be identified as requiring a more detailed review and will be recommended for second-line assessment (SLA).

The rate of FLA returns between 2015 and 2019 was 98.9% (2,307/ 2,332). Of the 2,307 FLAs returned, 15.3% (352/2,307) were referred for SLA (Table 3).

Table 3: Peer-review assessments by year

Year	FLAs returned	Cases referred for SLA	
		Number	Percentage (%)
2015	486	71	14.6
2016	505	74	14.7
2017	473	82	17.3
2018	465	74	15.9
2019	378	51	13.5
Total	**2,307**	**352**	**15.3**

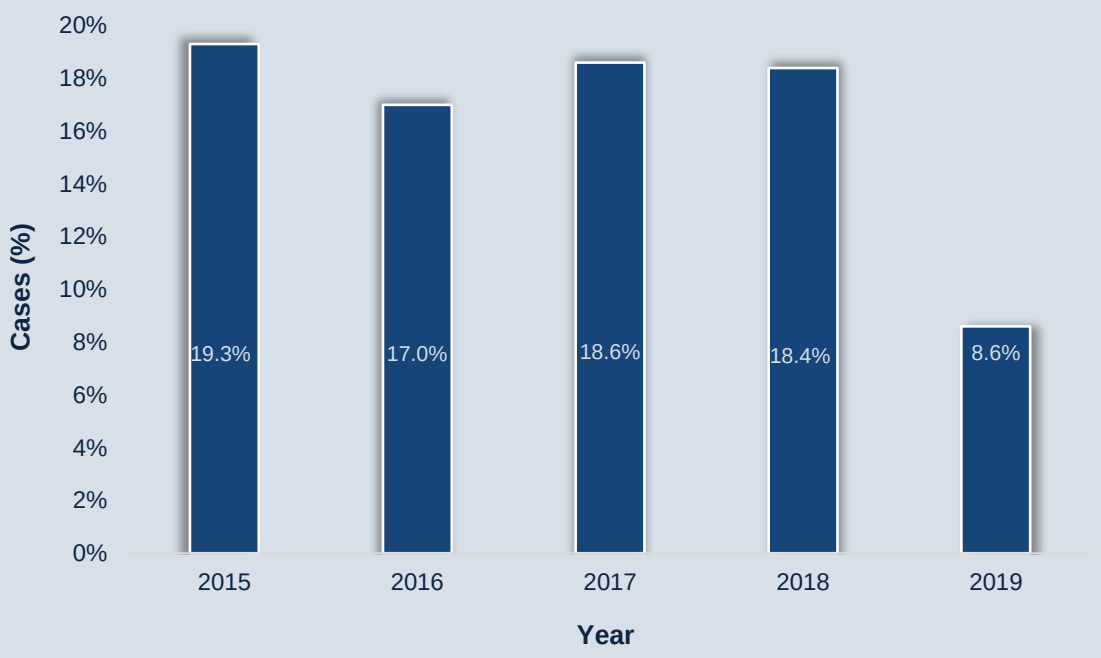
Note: Some 2019 cases still undergoing review so case data unavailable for this report.
FLA: First-line Assessment, SLA: Second-line Assessment.
Refer to Appendix D.3 for further information on data.

5.2 Clinical Management Issues

The assessment process determines whether a clinical management issue occurred, which is further classified into an ‘area of consideration’, an ‘area of concern’ or an ‘adverse event’ (Appendix C: WAASM Audit Process).

The proportion of cases in which clinical management issues were identified is shown in Figure 21. Where cases underwent both FLA and SLA, the analysis in this section uses data from the SLA. Data from the FLA is used for cases not referred for SLA.

Figure 21: Cases with clinical management issues by year



Note: Some 2019 cases still undergoing review so case data unavailable for this report.
Refer to Appendix D.2 for further information on data.

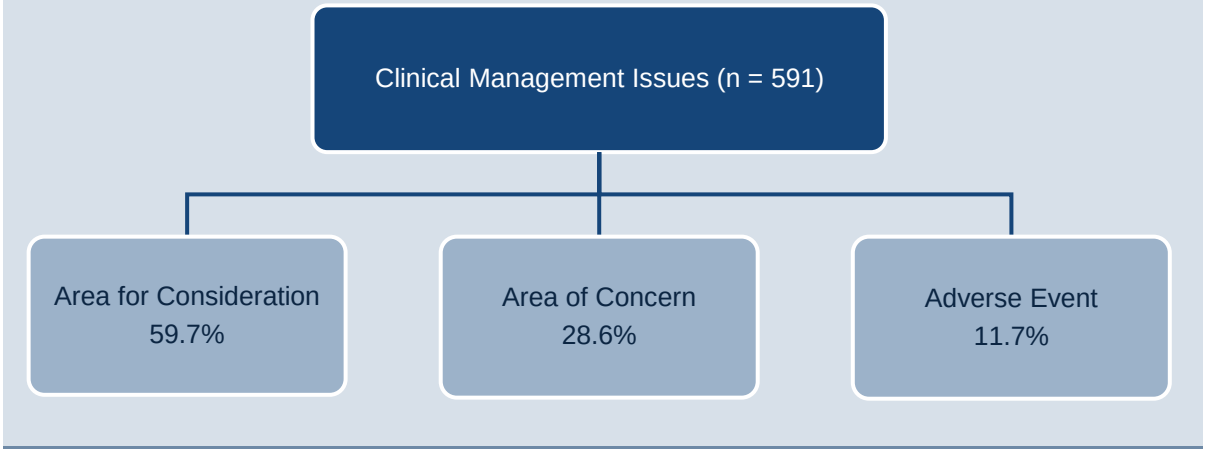
In the period 2015 to 2019, 16.8% (382/2,268) of cases had one or more clinical management issues. There were no clinical management issues identified in 83.2% (1,886/2,268) of cases, with the death resulting from the disease process.

Although 2019 data currently suggests a decrease compared to previous years in the proportion of clinical management issues identified by assessors, a number of 2019 cases are still undergoing the review process thus data is incomplete.

Assessors may identify more than one clinical management issue for each patient. Figures 22 to 24 show data based on the number of clinical management issues, not the number of patients.

There were 591 clinical management issues in 382 cases (Figure 22). More than half (59.7%; 353/591) of the clinical management issues were areas for consideration. Areas of concern and adverse events comprised 28.6% (169/591) and 11.7% (69/591) of clinical management issues, respectively.

Figure 22: Categories of clinical management issues

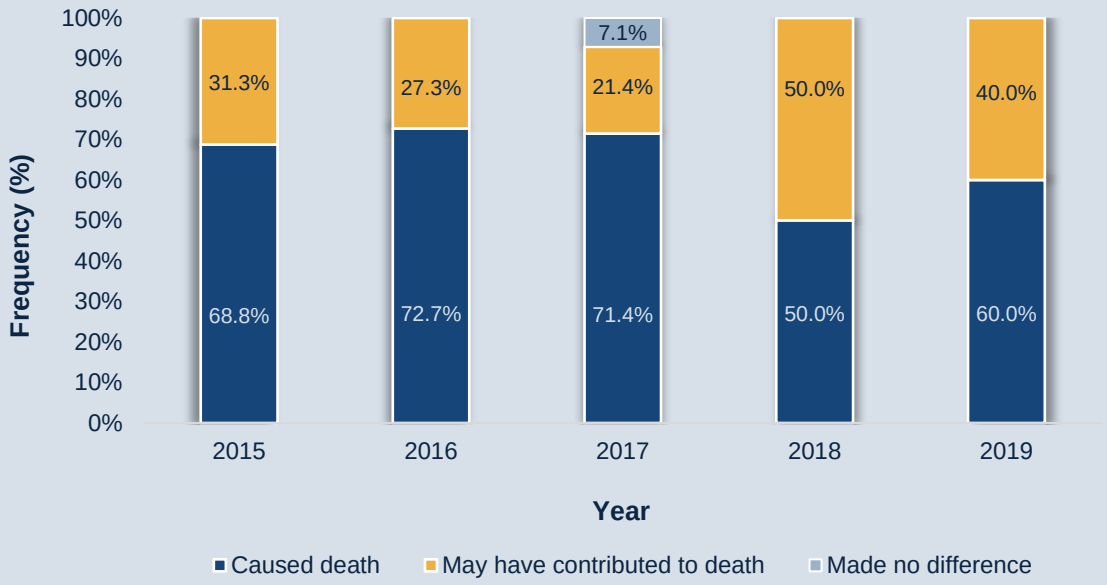


Refer to Appendix D.2 for further information on data.

When an adverse event is identified, assessors are asked to indicate the degree of impact this may have had on the clinical outcome. Figure 23 shows the breakdown by year of the impact of adverse events on clinical outcomes, as perceived by assessors.

In the period 2015 to 2019, assessors perceived that 35.3% (24/68) of the reported adverse events may have contributed to the death and 63.2% (43/68) of the reported adverse events caused the death of the patient. For 1.5% (1/68) of reported adverse events, assessors perceived that it made no difference to the outcome of the patient.

Figure 23: Assessors' perceived impact of adverse events on clinical outcome by year



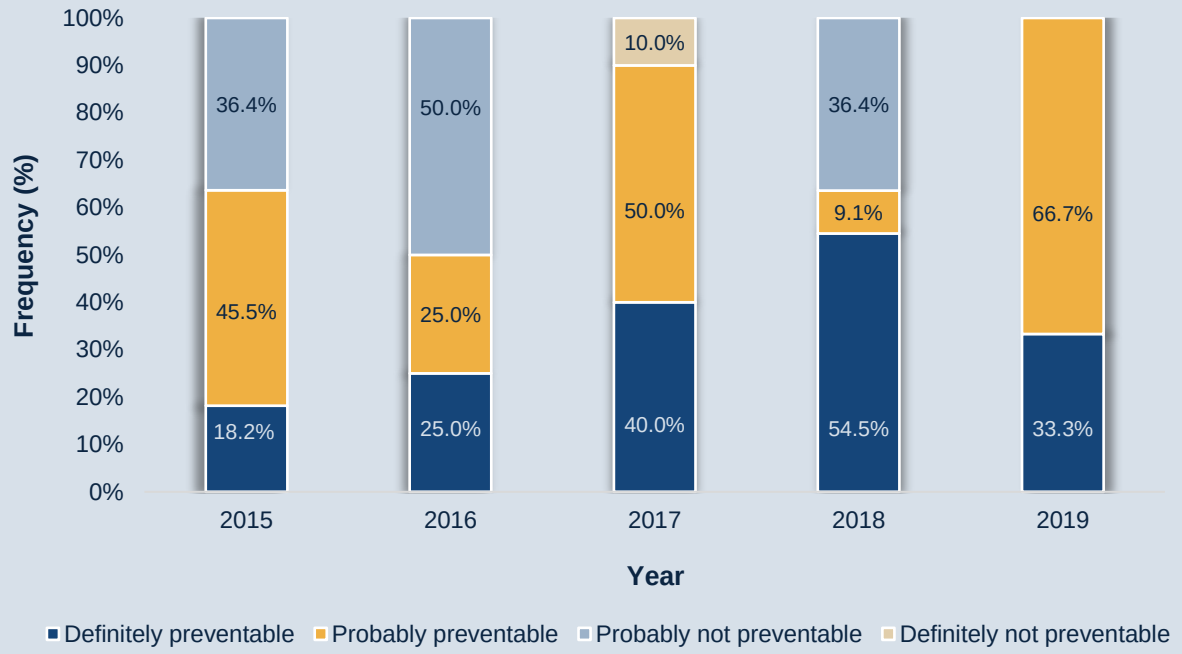
Note: Some 2019 cases still undergoing review so case data unavailable for this report.
Refer to Appendix D.2 for further information on data.

Assessors also report on the preventability of any adverse event that caused the death of a patient (Figure 24).

Assessors indicated that 2.3% (1/43) of adverse events that caused the death of a patient were 'not preventable' and that 27.9% (12/43) were probably not preventable. Assessors considered that 34.9% (15/43) of adverse events that resulted in the death of a patient were 'probably preventable', and that 34.9% (15/43) were 'definitely preventable'.

In 2019, assessors indicated that there were three adverse events that caused the death of a patient. Assessors considered that two of these adverse events were 'probably preventable' and the other, 'definitely preventable'.

Figure 24: Assessors' perceived preventability of adverse events that caused death by year



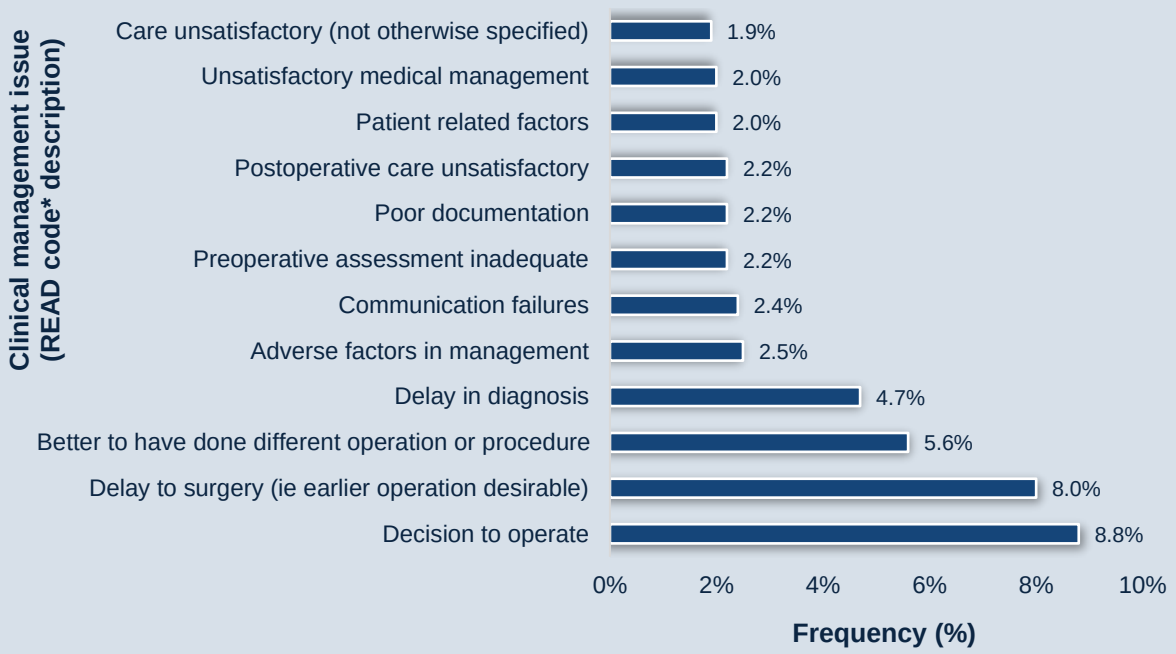
Note: Some 2019 cases still undergoing review so case data unavailable for this report.
Refer to Appendix D.2 for further information on data.

5.3 Frequently Reported Clinical Management Issues

The 12 most common clinical management issues are shown in Figure 25.

Assessors identified more than one clinical management issue in some patients. 'Decision to operate' (8.8%; 52/591) and 'delay to surgery' (8.0%; 47/591), were the two most frequently reported clinical management issues.

Figure 25: Most frequently reported clinical management issues



Note: READ codes are surgical diagnoses categorised using a coded thesaurus of clinical terms (READ codes). READ codes (a precursor to ICD9 coding) form a clinical decision tree containing terms, synonyms, and abbreviations covering all aspects of patient care.
Refer to Appendix D.2 for further information on data.

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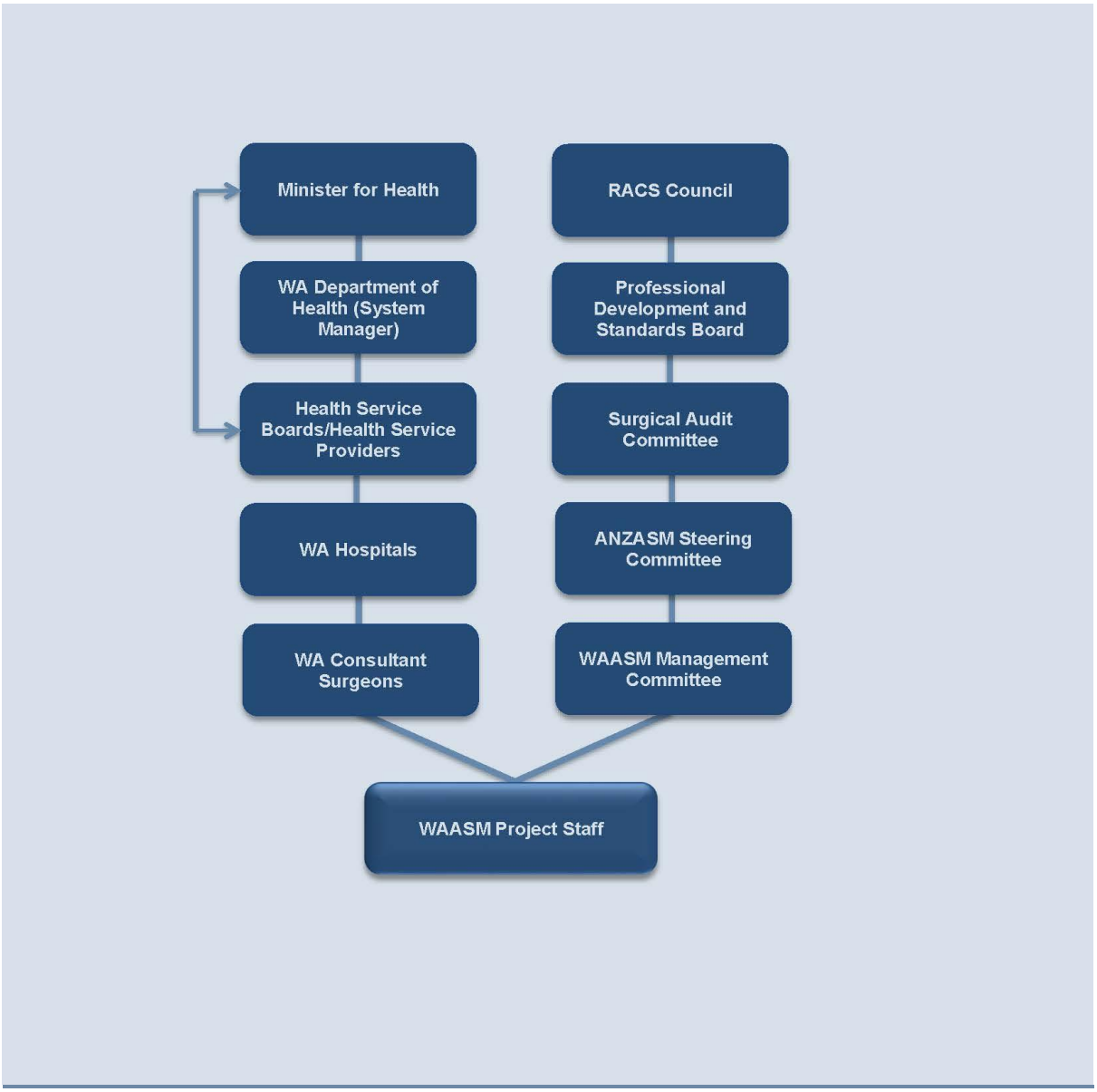
Appendices

Appendix A: Review of 2019 Recommendations

2019 Recommendations	Progress
Hospitals ▪ Implement robust, consultant-based protocols for all transferred patients. ▪ Develop a clinical pathway for patients presenting with acute abdomen.	A plan has been developed for WAASM consultation with hospitals to review and discuss protocols and clinical pathways in relation to these two recommendations.
ANZASM ▪ Modify the surgical case form (SCF) and commence data collection in areas that have become part of contemporary practice. For example, formal documentation for end-of-life care, preoperative assessments in elective and emergency settings, and assessment and documentation of sepsis on admission and administration of antibiotics. ▪ Mandate SCF database fields allowing for better data collection.	Modifications to the current SCF to facilitate additional data collection are currently under discussion by ANZASM management and all state/territory clinical directors. Validation rules were implemented in the October 2019 upgrade to the Fellows Interface (electronic platform used by surgeons to complete SCFs) to ensure that key questions are now compulsory prior to submitting an SCF to the audit. Work is currently underway on further enhancements which will see completion of *all* fields become mandatory before SCF lodgement can be finalised.
WAASM ▪ Undertake a study to determine concordance between first-line assessors, using two independent assessors per case in a representative sample of specialties.	In September 2019, WAASM commenced an FLA concordance study to ascertain the level of consistency between two independent assessors conducting an FLA on the same case. Of particular interest were recommendations for SLAs and identification of clinical management issues. The study comprised a sample of 50% of cases where a primary FLA had been completed between 1 January 2019 and 30 June 2019. The 170 cases identified for the study were selected from the nine specialties represented in FLAs received during the study period. These cases were sent to independent assessors for the purpose of undertaking a second FLA. Of these 170 cases, second FLAs were received from 158 assessors (return rate of 92.9%). Data analysis is complete and the results will be submitted to an academic journal for consideration for publication.

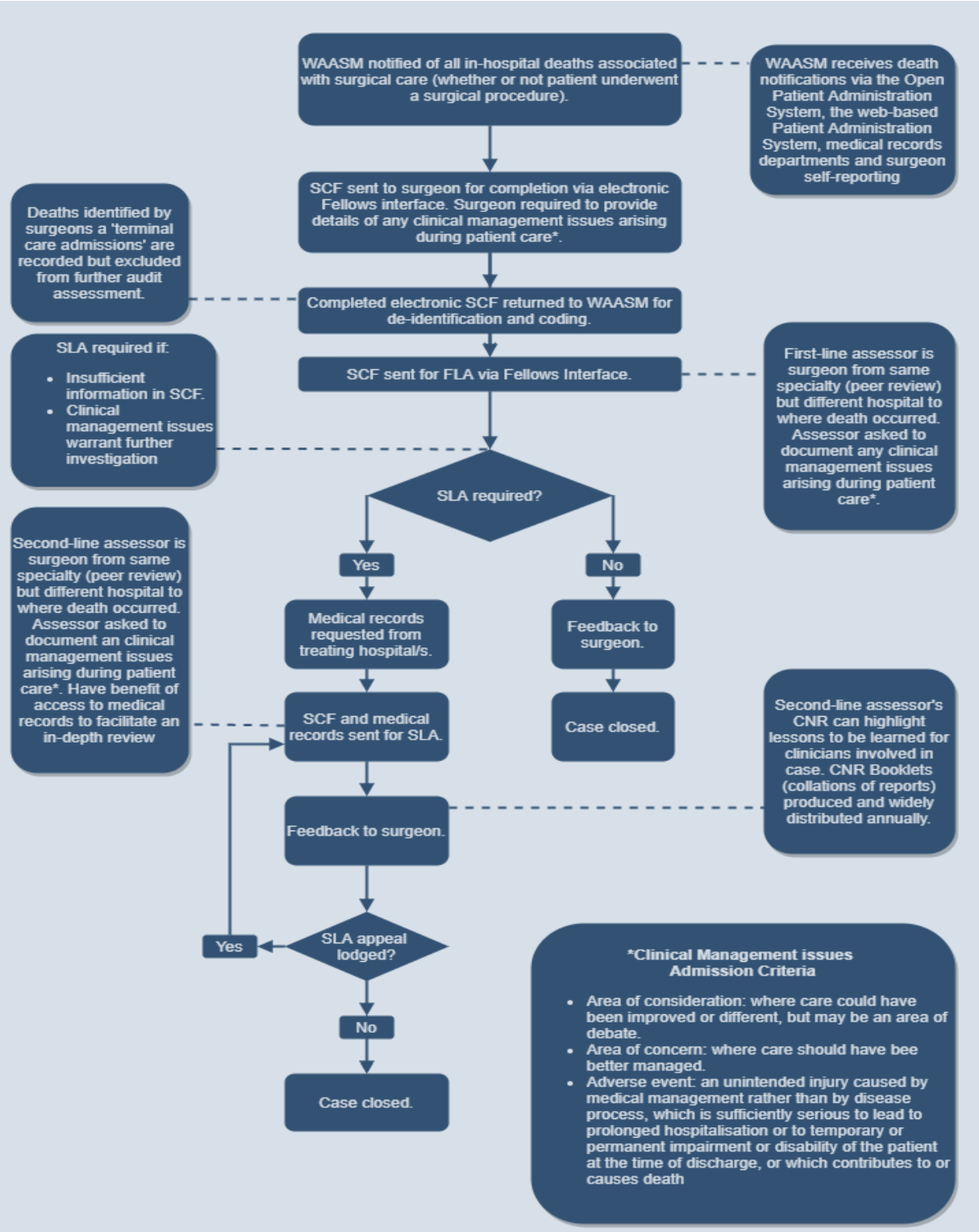
Research ▪ Undertake a longitudinal interstate comparison of number of deaths under a surgeon per 100,000 population to determine the national impact of ANZASM. ▪ WAASM to publish a peer-reviewed publication on the key observations in this report.	In conjunction with ANZASM and regional teams, WAASM is currently examining data from each state/territory audit. A manuscript entitled *"An analysis of patients who died with acute intra-abdominal pathology without undergoing an emergency laparotomy*" has been published as an abstract in the ANZ Journal of Surgery ASC supplement.

Appendix B: WAASM Governance Structure



RACS: Royal Australasian College of Surgeons, WA: Western Australian, ANZASM: Australian and New Zealand Audit of Surgical Mortality, WAASM: Western Australian Audit of Surgical Mortality.

Appendix C: WAASM Audit Process



*See Clinical Management Issues Assessment Criteria
WAASM: Western Australian Audit of Surgical Mortality, SCF: Surgical Case Form, FLA: First-line Assessment, SLA: Second-line Assessment, CNR: Case Note Review.

Appendix D: Data Definitions

Appendix D.1 American Society of Anesthesiologists grade definitions

ASA grade	*Characteristics*
1	A normal healthy patient
2	A patient with mild systemic disease
3	A patient with severe systemic disease
4	A patient with severe systemic disease that is a constant threat to life
5	A moribund patient who is not expected to survive without the operation
6	A declared brain-dead patient whose organs are being removed for donor purposes

Appendix D.2 Figures

Figure 1: Deaths audited by WAASM	
Definition	Counts of deaths reported to WAASM. *Not audited* comprised 'excluded error' and 'lost to follow-up' cases. *Audited* comprised 'finalised' cases [all cases which have completed the entire audit process and terminal care cases] and 'in progress' cases [all 'surgical case pending', 'surgical case submitted', 'surgical case complete', 'first-line assessment pending', 'first-line assessment incomplete', 'first-line assessment complete', 'second-line assessment pending', and 'medical records pending' cases].
Data included	All data collected between 2015 and 2019 (n=2,927).
Data excluded	No exclusions.
Figure 2: Case status by year	
Definition	Deaths falling within WAASM criteria and audit case status by year. *Audit process complete* comprised all cases which have completed the entire audit process. *Pending cases* comprised all 'surgical case pending', 'surgical case submitted', 'surgical case complete', 'first-line assessment pending', 'first-line assessment incomplete', 'first-line assessment complete', 'second-line assessment pending', and 'medical records pending' cases. *Excluded cases* comprised 'excluded terminal care' and lost to follow-up' cases.
Data included	All deaths falling within WAASM criteria (n=2,833).
Data excluded	All 'excluded error' cases (n=94).
Figure 3: WAASM deaths and mortality rate per 100,000 WA population by year	
Definition	Number of deaths falling within WAASM criteria per year and mortality rates per 100,000 WA population.
Data included	All deaths falling within WAASM criteria (n=2,833).
Data excluded	All 'excluded error' cases (n=94).

Figure 4: Death by hospital type by year	
Definition	Percentages of all cases by hospital status by year. *Co-location hospitals* are those that provide both private and publicly-funded surgical services; data for co-location hospitals includes public and private patients.
Data included	All deaths falling within WAASM criteria where hospital status was reported on (n=2,326).
Data excluded	All 'excluded error', 'surgical case pending', 'excluded terminal care' and 'lost to follow-up' cases. Data missing = 6.
Figure 5: Deaths by surgical specialty and hospital admission	
Definition	Percentages of surgical mortality data in relation to surgeon specialty and hospital admission.
Data included	All deaths falling within WAASM criteria where hospital admission was reported on (n=2,317).
Data excluded	All 'excluded error', 'surgical case pending', 'excluded terminal care' and 'lost to follow-up' cases. Data missing = 15.
Figure 6: Deaths by age group and gender	
Definition	Counts of deaths by age groups and gender.
Data included	All deaths falling within WAASM criteria (n=2,833).
Data excluded	All 'excluded error' cases.
Figure 7: Operative and non-operative cases by specialty	
Definition	Percentages of operative and non-operative cases by surgical specialty.
Data included	All deaths falling within WAASM criteria where operative and non-operative status was reported on. Cardiothoracic Surgery (n=188), General Surgery (n=925), Neurosurgery (n=424), Obstetrics & Gynaecology (n=4), Ophthalmology (n=5), Otolaryngology, Head & Neck Surgery (n=26), Oral/Maxillofacial (n=1),Orthopaedic Surgery (n=390), Paediatric Surgery (n=14), Plastic Surgery (n=56), Urology (n=91), Vascular Surgery (n=206).
Data excluded	All 'excluded error', 'surgical case pending', 'excluded terminal care' and 'lost to follow-up' cases. Data missing = 2.
Figure 8: Consultant surgeon making the decision to operate by year	
Definition	Percentages of consultant surgeons making the decision to proceed to surgery by year.
Data included	All deaths falling within WAASM criteria where the number of operations performed was reported (n=2,159).
Data excluded	All 'excluded error', 'surgical case pending', 'excluded terminal care' and 'lost to follow-up' cases. All cases where an operation was not reported.

Figure 9: Consultant surgeon involvement in operations by year	
Definition	Percentages of consultant surgeons operating, assisting and supervising in theatre by year.
Data included	All deaths falling within WAASM criteria where the number of operations performed was reported (n=2,159).
Data excluded	All ‘excluded error’, ‘surgical case pending’, ‘excluded terminal care’ and ‘lost to follow-up’ cases. All cases where an operation was not reported.
Figure 10: Postoperative complications by hospital admission and year	
Definition	Percentages of postoperative complications by hospital admission and year. It is possible for patients to have more than one postoperative complication.
Data included	All deaths falling within WAASM criteria where postoperative complications by hospital admissions was reported (n=481).
Data excluded	All ‘excluded error’, ‘surgical case pending’, ‘excluded terminal care’ and ‘lost to follow- up’ cases. All cases where an operation was not reported and all operative cases where a postoperative complication was not reported. Data missing = 9.
Figure 11: Reasons for not operating by year	
Definition	Percentages of cases with reasons for not operating by year. Some cases reported more than one reason for not operating.
Data included	All non-operative deaths (n=729) falling within WAASM criteria where reasons for no operation were reported.
Data excluded	All ‘excluded error’, ‘surgical case pending’, ‘excluded terminal care’ and ‘lost to follow-up’ cases. All cases where an operation was reported.
Figure 12: Preoperative diagnostic delays	
Definition	Percentages and counts of cases with preoperative diagnostic delays.
Data included	All deaths falling within WAASM criteria where preoperative diagnostic delays were reported on (n= 2,321).
Data excluded	All ‘excluded error’, ‘surgical case pending’, ‘excluded terminal care’ and ‘lost to follow-up’ cases. All cases where no preoperative diagnostic delays were reported. Data missing = 11.
Figure 13: Hospital transfers by year	
Definition	Percentages of hospital transfers by year.
Data included	All deaths falling within WAASM criteria where transfers were reported on (n=2,273).
Data excluded	All ‘excluded error’, ‘surgical case pending’, ‘excluded terminal care’ and ‘lost to follow-up’ cases. Data missing = 59.
Figure 14: Hospital transfer issues	
Definition	Percentages of issues associated with hospital transfers.
Data included	All deaths falling within WAASM criteria where transfer issues were reported (n=702).
Data excluded	All ‘excluded error’, ‘surgical case pending’, ‘excluded terminal care’ and ‘lost to follow-up’ cases. All cases where transfers and transfer issues were not reported. Data missing: ‘inappropriate level of care’ = 50; ‘insufficient clinical information’ = 55; ‘inappropriate transfer’ = 39; ‘delay in transfer’ = 43.

Figure 15: Cases with specific comorbidities	
Definition	Percentages of cases with comorbidities.
Data included	All deaths falling within WAASM criteria where comorbidities were reported on. Some cases reported more than one type of comorbidity.
Data excluded	All 'excluded error', 'surgical case pending', 'excluded terminal care' and 'lost to follow-up' cases. All cases where no comorbidities were reported.
Figure 16: Critical care units use by year	
Definition	Percentages of critical care units (intensive care and high dependency units) use/non-use by year.
Data included	All deaths falling within WAASM criteria where use (n=1,479) and non-use (n=845) of critical care units was reported.
Data excluded	All 'excluded error', 'surgical case pending', 'excluded terminal care' and 'lost to follow-up' cases. Data missing = 8.
Figure 17: DVT prophylaxis use by year	
Definition	Percentages of DVT prophylaxis use/non-use by year.
Data included	All deaths falling within WAASM criteria where use (n=1,833) and non-use (n=461) of DVT prophylaxis was reported.
Data excluded	All 'excluded error', 'surgical case pending', 'excluded terminal care' and 'lost to follow-up' cases. Data missing = 38.
Figure 18: Type of DVT prophylaxis used	
Definition	Percentages of type of DVT prophylaxis used.
Data included	All deaths falling within WAASM criteria where DVT prophylaxis was used. Some cases reported more than one type of DVT prophylaxis used (n=3,382).
Data excluded	All 'excluded error', 'surgical case pending', 'excluded terminal care' and 'lost to follow-up' cases. All cases where non-use of DVT prophylaxis and type of DVT prophylaxis were not reported.
Figure 19: Clinically significant infections	
Definition	Percentages and counts of cases with clinically significant infections.
Data included	All deaths falling within WAASM criteria where clinically significant infections were reported on (n=2,315).
Data excluded	All 'excluded error', 'surgical case pending', 'excluded terminal care' and 'lost to follow-up' cases. All cases where a clinically significant infection was not reported. Data missing = 17.
Figure 20: Type of clinically significant infection reported	
Definition	Percentages of type of clinically significant infections reported.
Data included	All deaths falling within WAASM criteria where type of clinically significant infections was reported (n=693).
Data excluded	All 'excluded error', 'surgical case pending', 'excluded terminal care' and 'lost to follow-up' cases. All cases where a clinically significant infection was not reported. Data missing = 2.

Figure 21: Cases with clinical management issues by year	
Definition	Percentages of cases with clinical management issues as reported by assessors.
Data included	All deaths falling within WAASM criteria using the highest level of assessment in completed cases where clinical management issues were reported on (n=2,268).
Data excluded	All 'excluded error', 'surgical case pending', 'first-line assessment pending', 'second-line assessment pending', 'excluded terminal care' and 'lost to follow-up' cases. All cases where clinical management issues were not reported.
Figure 22: Categories of clinical management issues	
Definition	Counts and percentages of categories of clinical management issues as reported by assessors. Based on the number of incidents of clinical management issues and not the number of patients.
Data included	All deaths falling within WAASM criteria using the highest level of assessment in completed cases where categories of clinical management issues were reported (n=591).
Data excluded	All 'excluded error', 'surgical case pending', 'first-line assessment pending', 'second-line assessment pending', 'excluded terminal care' and 'lost to follow-up' cases. All cases where clinical management issues were not reported.
Figure 23: Assessors' perceived impact of adverse events on clinical outcomes by year	
Definition	Percentages of perceived impact of adverse events by year as reported by assessors. Based on the number of incidents of clinical management issues and not the number of patients.
Data included	All deaths falling within WAASM criteria using the highest level of assessment in completed cases where the perceived impact of adverse events was reported (n=68).
Data excluded	All 'excluded error', 'surgical case pending', 'first-line assessment pending', 'second-line assessment pending', 'excluded terminal care' and 'lost to follow-up' cases. All cases where clinical management issues were not reported. All cases where 'areas for consideration' and 'areas of concern' were reported. Data missing = 1.
Figure 24: Assessors' perceived preventability of adverse events that caused death by year	
Definition	Percentages of perceived preventability of adverse events causing death by year as reported by assessors. Based on the number of incidents of clinical management issues and not the number of patients.
Data included	All deaths falling within WAASM criteria using the highest level of assessment in completed cases where preventability of adverse events causing death was reported (n=43).
Data excluded	All 'excluded error', 'surgical case pending', 'first-line assessment pending', 'second-line assessment pending', 'excluded terminal care' and 'lost to follow-up' cases. All cases where clinical management issues were not reported. All cases where 'areas for consideration' and 'areas of concern' was reported. All cases where adverse events not causing death were reported.

Figure 25: Most frequently reported clinical management issues	
Definition	Percentages and descriptions (in READ code) of the 12 most common clinical management issues as reported by assessors.
Data included	All deaths falling within WAASM criteria where clinical management issues were reported (n=591).
Data excluded	All ‘excluded error’, ‘surgical case pending’, ‘first-line assessment pending’, ‘second-line assessment pending’, ‘excluded terminal care’ and ‘lost to follow-up’ cases. All cases where clinical management issues were not reported.

Appendix D.3 Tables

Table 1: Deaths reported to WAASM by year	
Definition	Counts of deaths reported to WAASM by year.
Data included	All data collected between 2015 and 2019. Total number of deaths reported to WAASM, including ‘excluded error’ cases (n=2,927).
Data excluded	No exclusions.
Table 2: WAASM deaths by specialty	
Definition	Counts and percentages of surgical mortality data in relation to surgeon specialty.
Data included	All deaths falling within WAASM criteria (n=2,833).
Data excluded	All ‘excluded error’ cases (n=94).
Table 3: Peer-review assessments by year	
Definition	Counts of FLAs returned and counts and percentages of cases where SLAs were recommended.
Data included	All deaths falling within WAASM criteria where an FLA was returned.
Data excluded	All ‘excluded error’, ‘surgical case pending’ and ‘excluded terminal care’ cases.