

Royal Australasian College of Surgeons
Northern Territory Audit of Surgical Mortality (NTASM)

NTASM REPORT 2018



ROYAL AUSTRALASIAN
COLLEGE OF SURGEONS





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The information contained in this Annual Report has been prepared by the Royal Australasian College of Surgeons Northern Territory Audit of Surgical Mortality Management Committee, which is a declared quality improvement committee under section 7 (1) of the Health Services (Quality Improvement) Act 1994 (Gazetted 26 July 2005).

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

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CLINICAL DIRECTOR'S REPORT

NTASM contributes to the many facets of surgical learning in the Northern Territory (NT), and beyond.

For surgeons, continual professional learning and development must be paramount in all our activities in order to promote safety and quality improvement in all our health care.

To achieve this, all NT hospitals receive feedback on their NTASM cases - as do the surgeons.

Some of this will change practice where change is needed. There are always unique practice issues in NT and we trust that the comprehensive collection and study of the data in this document will effect best practice process in NT.

To collect the data, every surgical death requires the surgeon to complete a SCF for each surgically-related death. Then all the surgeons will receive feedback following receipt of this document.

A small proportion of NTASM cases will be deemed to require a more in depth assessment and these will also result in feedback to the surgeons involved.

We have researched the process and published on this recently. It is clear that assessors as well as the original surgeons, learn in a substantial way from doing assessments on the NTASM cases of other surgeons.⁽¹⁾

As a Clinical Director, I want to encourage your participation in every way possible so that you will also learn from all the publications that NTASM produces.

We do look forward to learning more and more from this process in the years to come.

Thank you to all those who play their vital roles in each step of the audit process.



Dr John North
NTASM Clinical Director

NTASM MANAGEMENT COMMITTEE CHAIRMAN'S REPORT

The NTASM started in 2010. All NT surgeons and all NT hospitals participate in the audit. In addition, half of the NT RANZCOG Fellows and most anaesthetists participate in the NTASM.

The NTASM is funded by the NT Government Department of Health. We thank the NT Government for its ongoing support.

Significant messages continue to be heard from the NTASM:

- Serious comorbidities were present in 95% of all NTASM patients, especially cardiovascular disease (61%), hepatic disease (26%) and diabetes mellitus (39%).
- Serious comorbidities were strikingly more prevalent in Aboriginal and Torres Strait Islander persons than in non-Aboriginal and Torres Strait Islander persons.
- The median age of death of Aboriginal and Torres Strait Islander persons was 15 years younger than non-Aboriginal and Torres Strait Islander persons (56 years versus 71 years).
- There was no difference in the clinical management indicators with regard to the care provided to Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons, including postoperative communication.
- Consultant Surgeon supervision remains high in the NT: 91% of all decisions to operate were by the Consultant Surgeon; 92% of all operations had a Consultant Surgeon operating, assisting, or in theatre.

An area of concern or adverse event occurred in 19% of NTASM patients. Of these, assessors considered that 56% were definitely preventable. Such critical adverse events create a need for appropriate investigation that considers prevention of future recurrence.

The NTASM can assist in change of practice or change of hospital processes, to prevent recurrence.

Two specific examples for 2017 include the introduction of *A neurosurgical team in NT* and the *Management of bleeding oesophageal varices*: An upper gastrointestinal surgical unit was formed to identify and manage these patients by an elective variceal screening program.

If learning is the primary objective after a critical adverse event, the focus of an investigation should not be on blame or retribution, but rather on reconciliation and review of everyone's tasks and responsibilities after the event. The NTASM can assist with this.

The role of the NTASM is to inform, educate, facilitate change and improve practice, by providing feedback. Surgeons receive written feedback from assessors about their cases.

Surgeons may choose to verbally present their feedback with their peers. They receive an electronic copy of the NTASM annual report, as well as de-identified summaries of second-line assessments in "Lessons from the Audit".

Surgeons also receive the National Case Note Review Booklet, using cases from across Australia. Hospitals participating in NTASM receive clinical governance reports on aggregated, de-identified data, comparing their hospital to other hospitals across Australia.

Delay to making the main surgical diagnosis occurred in 13% of cases. These delays were often attributed to more than one department.

This highlights the importance of feedback from the NTASM not only to surgeons, but to other clinicians, administrators and other departments throughout our hospitals.

Learning from the data remains the primary aim of this audit and we will continue to make this our priority in the coming years.



Dr John Treacy
NTASM Chairman

EXECUTIVE SUMMARY

BACKGROUND

The NTASM is an external, independent, peer-review audit of the process of care associated with surgically-related deaths in the NT. The NTASM started in 2010 and is funded by the NT Government Department of Health. The NTASM has qualified privilege protection under Commonwealth legislation. This report covers surgically-related deaths that occurred from 1 January 2017 to 31 December 2017, and for which the audit process was complete at the census date of 31 July 2018.

The NTASM is principally designed as a feedback mechanism for participating surgeons to encourage reflection on surgical care and practice. The summary data for NTASM reflects a territory that is committed to surgical audit and improving surgical care. Please be aware that denominators may differ because not all of the questions were answered for each case.

SURGEONS

- All surgeons in the NT participated in the NTASM.
- The return rate for SCFs was 97% (94/97). The audit process was complete by the census date for 94 patients (including those reported in error and terminal care admissions). Of these, 86 patients were eligible to be included as the basis of this report.

HOSPITALS

- All hospitals in the NT participated in the audit. This report comprises NTASM data from all hospitals in which a surgically-related death occurred during the audit period.

PATIENTS

- Over the one year audit period there were 97 surgically-related deaths reported to NTASM, with 86 eligible for inclusion.
- In NTASM, 58% (50/86) of patients were male and 42% (36/86) were female.
- Serious comorbidities were present in 95% (82/86) of NTASM patients.
- The presence of hepatic disease (26%; 21/82) was slightly higher than previous years (23%; 73/318).
- Diabetes mellitus (39%; 32/82) was statistically higher in NTASM patients in 2017 compared with previous years (32%; 101/318). [RR = 1.23; 95% CI 0.90 to 1.68]
- Cardiovascular disease (CVD) was the most common comorbidity diagnosed in NTASM patients in 2017 (61%; 50/82). This is similar to the prevalence of CVD in previous years (60%; 192/318).
- NTASM surgeons considered that nearly two thirds of the patients who had surgery were at considerable or expected risk of death.

ABORIGINAL AND TORRES STRAIT ISLANDER PERSONS

- According to the Australian Bureau of Statistics, 30% of the NT population and 3% of the total Australian population are Aboriginal and Torres Strait Islander persons.⁽²⁾
- In NTASM, Aboriginal and Torres Strait Islander persons comprised 36% (31/86) of surgically-related deaths.
- The median age of death of Aboriginal and Torres Strait Islander persons was younger - 56 years; interquartile range (IQR 47 to 70) compared with the median age of non-Aboriginal and Torres Strait Islander persons - 71 years (IQR 63 to 78).

CLINICAL INCIDENTS

- No clinical incidents were noted in 70% (60/86) of patients.
- An area of consideration occurred in 12% (10/86) of patients.
- An area of concern or adverse event occurred in 19% (16/86) of NTASM patients.
- Assessors considered that 56% (9/16) of the areas of concern and adverse events were definitely preventable.
- Patients with an area of concern or adverse event were more likely to be have been an emergency admission (69%; 11/16) than an elective admission (31%; 5/16) .

OPERATIVE DEATHS

In the last admission for NTASM patients:

- No operations were performed in 12% (10/86) of patients.
- A total of 105 operations were performed on 76 patients.
- Multiple operations were performed on 18% (14/76) of patients who had operations.

POSTOPERATIVE COMPLICATIONS

- There were 20 postoperative complications in 75 patients (27%) who died. The incidence of postoperative complications was the same as that of 2016 – 27% (13/49).

USE OF INTENSIVE CARE UNIT (ICU)

- Postoperative admission to an ICU occurred in 68% (52/76) of patients.
- A postoperative unplanned admission to an ICU occurred in 23% (17/74) of patients.

TRAUMA

- Trauma was present in 21% (18/85) of patients. This was similar to the incidence of trauma in patients in 2016 – 24% (16/67).
- 78% (14/18) of trauma was associated with falls.
- 72% (13/18) of trauma was non-Aboriginal and Torres Strait Islander persons.

INFECTION

- Infection was reported in 33% (28/85) of patients who died. This is the same as the incidence of infections in NTASM in 2016 – 33% (22/66)
- Of the patients with infection in 2017, 57% (16/28) acquired the infection before admission and 43% (12/28) acquired the infection during the admission.
- The main types of infection were septicaemia 25% (7/28) and pneumonia 25% (7/28).

RECOMMENDATIONS AND KEY POINTS

Practice and policy

The audit is routine, systematic and clinically relevant, and it can inform hospital and clinical practice. The audit data should be used to:

- review existing clinical activities and hospital processes, to improve delivery of care to patients (see adopted recommendations)
- influence public policy
- identify areas where clinical improvement could be made.

Learning through the audit

It is recognised that the audit provides a surgeon specific yet effective form of learning. The audit should:

- encourage surgeons to be assessors to enhance their own learnings from the audit. This has been shown to lead to change in practice. The number of NT surgeons doing assessments for Queensland has increased
- encourage surgeons to make use of the audit data in research publications. NTASM has provided the “application for research using audit data” to NT trainees and registrars
- identify emerging trends and address them in educational processes such as seminars and themed case note review booklets. The NTASM “Case of the Month” is sent to all NTASM surgeons. NT surgeons are invited to all seminars hosted by the Queensland Audit of Surgical Mortality (QASM)

Patient management

In this report, NTASM shows that most of the patients in NTASM were high-risk patients. Even so, care provided to the surgical patient is high because 70% of patients had no clinical incidents.

- When clinical incidents occurred, and these were considered to be probably or definitely preventable, they occurred in 17% (14/86) of patients. These preventable clinical incidents occurred most frequently in the categories of open surgery, diagnosis related complications, and incorrect therapy. Monitoring of these areas is encouraged.
- Senior surgeon supervision in theatre remains high which ensures high levels of safe high-quality surgery.
- The age at death of Aboriginal and Torres Strait Islander persons remains at least 15 years younger than non-Aboriginal and Torres Strait Islander persons. The NTASM should continue to highlight the need to “close the gap”. The Department of Health should continue to promote all aspects of day to day life that will improve health care in the community.
- The audit shows that infections were acquired in the community in 57% of patients. The NTASM and the Department of Health should continue to promote the importance of early recognition of infection and sepsis.
- Fall prevention in the community needs to be strengthened as 78% of falls occur outside of the hospital.
- Surgeons are encouraged to report back to the audit where there have been changes in practice or changes in hospital processes as a result of the audit. Surgeons are also encouraged to summarise their individual feedback from the audit for presentation at M&M meetings.

Adopted recommendations

NTASM reports and findings have a continuous positive influence on surgical practice. Within the last 12 months the following areas have been improved, or changed, as a result of NTASM findings.

- *A neurosurgical team in NT:* Three consultant neurosurgeons are now working in the Northern Territory.
- *Management of bleeding oesophageal varices:* An upper gastrointestinal surgical unit was formed to identify and manage these patients by an elective variceal screening program.
- *Use of NTASM online:* From 2015, NTASM online has been operational. All surgeons in the NTASM submit SCFs online. This has increased the completeness of the NTASM data and has reduced the number of second-line assessments. This has also led to an improved return time for SCFs. The number of cases submitted in under 10 days has improved from 7% in 2015 to 20% in 2017. Prior to their rotations ending, locum surgeons are beginning to self-report NTASM patients.

1 INTRODUCTION

Key Points

- The NTASM is an independent, peer-review audit of all surgically-related deaths in the NT.
- NTASM aims to provide feedback to surgeons about their practice, and encourage learning about surgical care.
- This report covers the period 1st January 2017 to 31st December 2017, as at the census date of 31st July 2018.
- This report covers 86 completed SCFs (patients).

1.1 BACKGROUND

The Royal Australasian College of Surgeons (RACS) became responsible for the management of the Western Australian Audit of Surgical Mortality (WAASM) in 2006. The WAASM was modelled on the Scottish Audit of Surgical Mortality, which began in 1988. The RACS has expanded the program to all other states and territories under the umbrella of the Australian and New Zealand Audits of Surgical Mortality (ANZASM). The NTASM started participating in 2010. It is funded by the NT Government Department of Health.

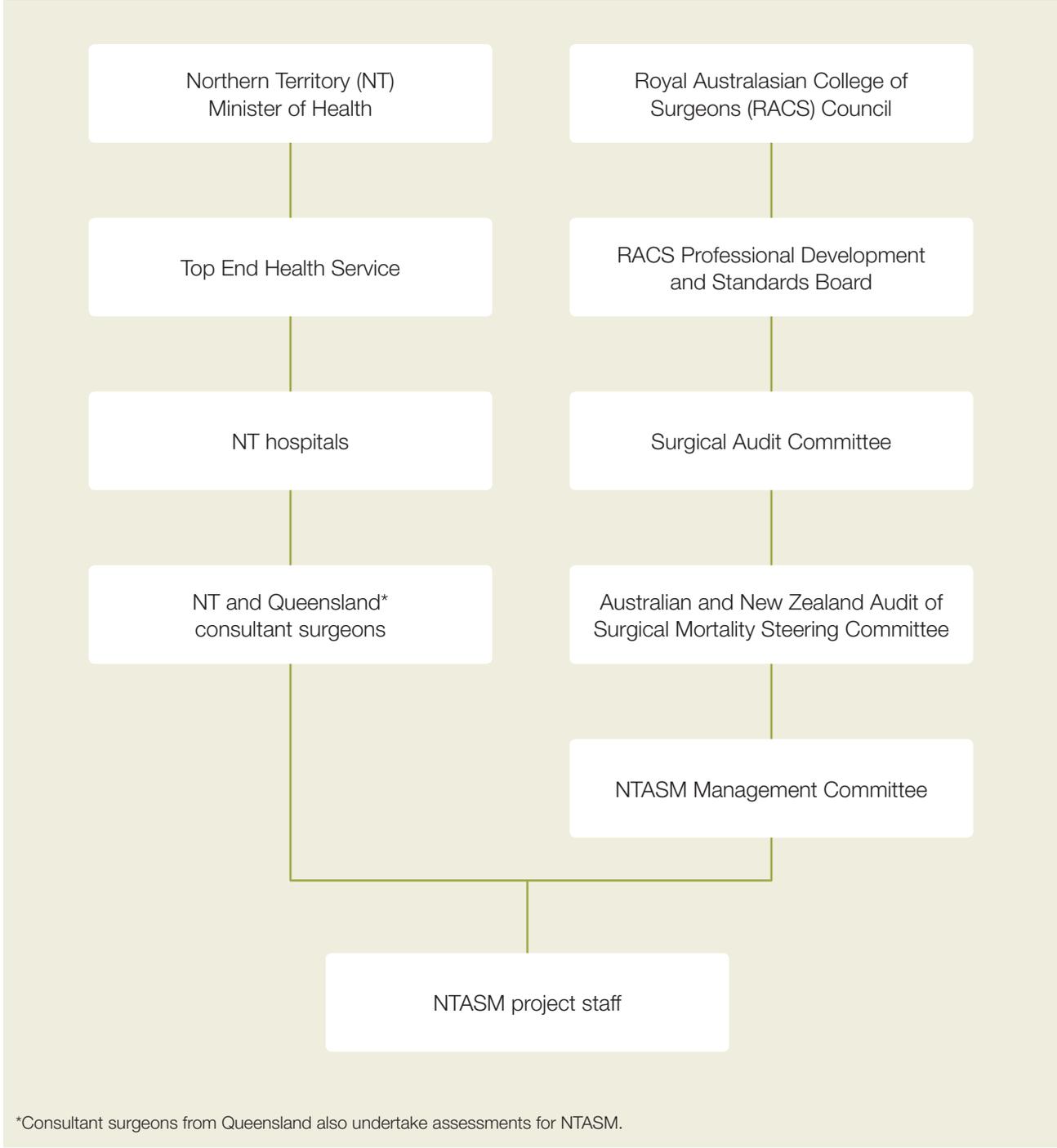
1.2 PROJECT GOVERNANCE

The project governance structure is illustrated in Figure 1. As part of the ANZASM, NTASM has protection under the Commonwealth Qualified Privilege Scheme, under Part VC of the Health Insurance Act 1973 (gazetted 25th July 2016).

All Australian states and territories participate in the national ANZASM process. Information about the state and territory audits is available on the RACS website: www.surgeons.org/ANZASM

The NTASM web page can be found at: www.surgeons.org/NTASM

Figure 1: Northern Territory Audit of Surgical Mortality (NTASM) project governance structure



*Consultant surgeons from Queensland also undertake assessments for NTASM.

1.2.1 Education for surgeons

The NTASM has contributed to the surgical education process in the NT. In particular, the NTASM has:

- managed the audit process for the NT, including the provision of 386 first-line assessment reports and 42 second-line assessment reports to NT surgeons since 2010.
- published 19 volumes of *Lessons from the Audit* in collaboration with the Queensland Audit of Surgical Mortality. The *Lessons from the Audit* series contains case studies that highlight key issues relating to surgical practice. These publications are of interest not only to NT surgeons, but to all who are involved in patient care in the NT. A list of the volumes, their titles and/or themes is provided in Appendix A.
- published an article in the Australia and New Zealand Journal of Surgery entitled Outcomes of from the Northern Territory Audit of Surgical Mortality: Aboriginal deaths. ⁽³⁾

1.2.2 Presentations

- Seminars held in Brisbane and the Gold Coast (Queensland) over the audit period have been attended by some NT surgeons. One seminar was convened by an NT surgeon. The themes for the seminars were:
 - Dilemmas: distance, delay, deteriorating patient (2011)
 - Complex surgical decision making in modern surgical practice (2012)
 - Adverse events – systems or surgeons? (2013)
 - Situational awareness and the surgeon (2014)
 - Operating on the obese patient (2015)
 - The elderly surgical patient and evidence based practice (2016)
 - Captain of the Ship? – a surgeon’s role in safety and quality (2017)
 - Infections in surgical patients (2018).
- Presentations made at the Joint Western Australia/South Australia/NT Annual Scientific meetings during the audit period include:
 - From Scotland to Shoal Bay (2010)
 - Northern Territory surgical patient population differences compared with the rest of Australia and review of new mortality questions (2012)
 - A glimpse at the Northern Territory (2012)
 - Is quality assurance important for surgeons? (2013)
 - Audit is about learning (2014)
 - Improving care for rural and remote communities (2015)
 - Learning from the audits of surgical mortality (2015)
 - Feedback in adult learning (2016)
 - Infections (2018).
- Meetings attended by NTASM staff (Clinical Director, manager and project officer) include:
 - Neville Taylor Research Day, Royal Darwin Hospital (2013)
 - Neville Taylor Research Day, Royal Darwin Hospital (2014)
 - Presentation to the Royal Darwin Hospital surgeons, Royal Darwin Hospital (2014)
 - RACS Northern Territory Trauma Seminar, Darwin (2015)
 - Presentation to the Royal Darwin Hospital surgeons, Royal Darwin Hospital (2016)
 - Presentation to the Royal Darwin Hospital and Darwin Private Hospital obstetricians and gynaecologists, Royal Darwin Hospital (2016)
 - Presentation to the Royal Darwin Hospital and Darwin Private Hospital anaesthetists, Royal Darwin Hospital (2016).
 - Qualified Privilege strategy meeting, ANZASM, Melbourne (2018).

- Department of the Prime Minister and Cabinet meeting about new data sharing and release legislation (2018).
- Presentation from the Queensland Health Data Linkage Symposium (2018).
- An NTASM infections report titled “Infections and NTASM patients” was published and widely distributed amongst NT surgeons and health professionals. The report included NTASM infection data from July 2010 to June 2017 and a case study.
- Dr John Treacy, Chair of the NTASM Management Committee and a NT surgeon, submitted a letter to the NT Minister for Health noting that clinical management issues reported in the NTASM Hospital Report (2017) are within acceptable limits compared with similar hospitals across Australia.
- The NTASM’s manager has been an active member since 2015 in the RACS Reconciliation Group to facilitate the integration of Aboriginal and Torres Strait Islander persons into the RACS workforce, including the surgical workforce. In 2016, the RACS formally formed the Indigenous Health Committee.
- The RACS Foundation for Surgery is supportive of two projects:
 - supporting Aboriginal and Torres Strait Australians aspiring to a career in surgery, and
 - providing essential Trauma Management (EMST) training in Timor Leste.

1.3 NTASM AUDIT PROCESS

1.3.1 Methodology

Surgical or medical records departments in hospitals notify NTASM of all surgical deaths. All patient cases in which a surgeon was responsible for, or had significant involvement in the patient's care are included in the audit, even when the patient did not have a surgical procedure.

The clinical details relating to each case's management are recorded on a standard structured questionnaire known as a Surgical Case Form (SCF), which is completed by the consultant surgeon associated with the case. The completed SCF is de-identified by NTASM staff and sent for first-line assessment to a surgeon from the same specialty.

In NTASM, first- and second-line assessors are peer surgeons from a different state. De-identification, combined with the assessors from outside the NT, ensures that anonymity and impartiality are preserved. The first-line assessor will either close the case or recommend that the case undergo further assessment as a second-line assessment.

Patients may be referred for second-line assessment if:

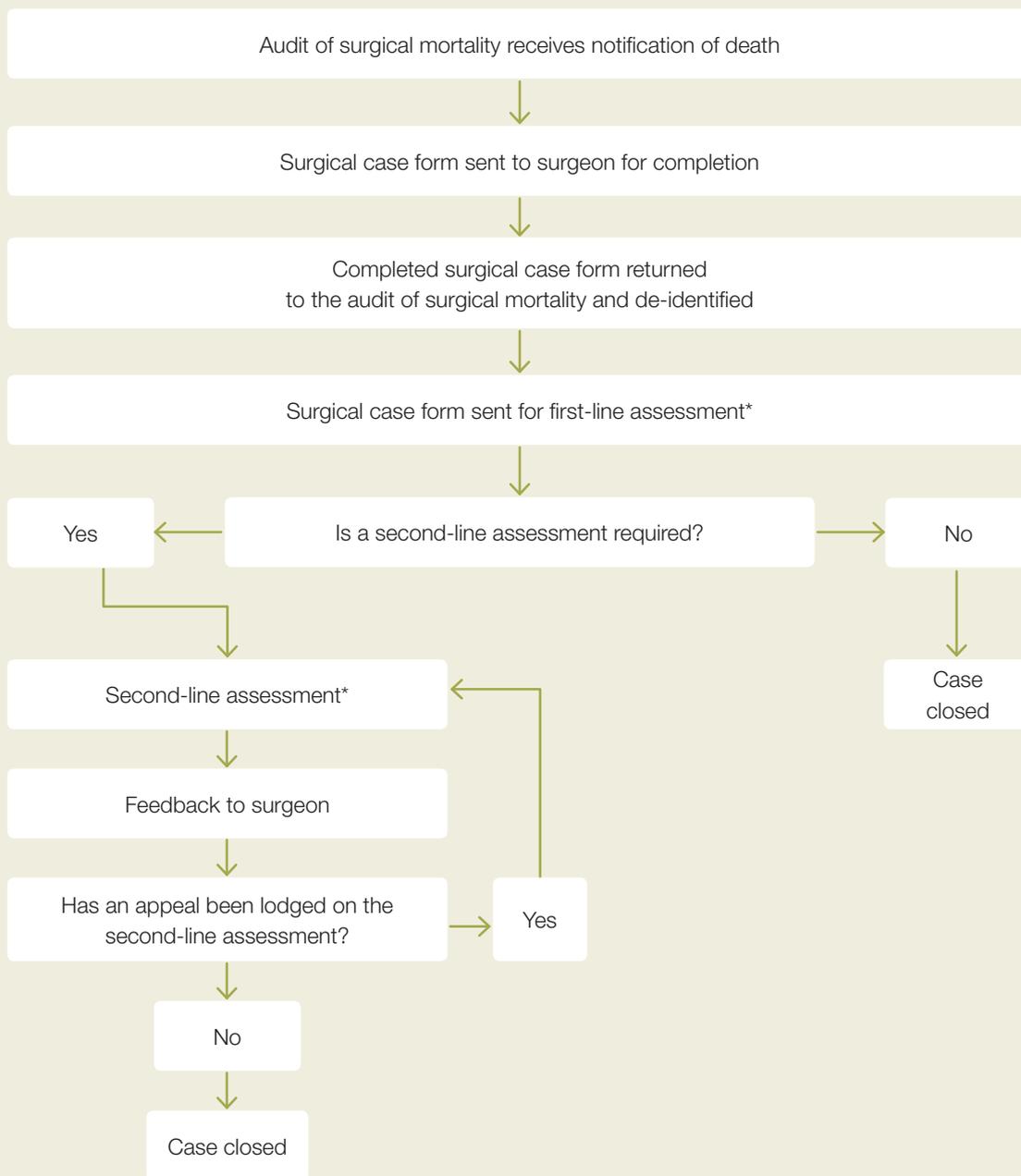
- an area of concern or adverse event is thought to have occurred during the patient's clinical care and warrants further investigation.
- a second-line assessment report could usefully draw attention surgical practice, providing an educational opportunity for the surgeon involved in the case or for a wider audience by using it in a case note review publication.
- the information provided by the consultant surgeon was insufficient and did not allow the first-line assessor to reach a conclusion about the case.

If a second-line assessment is deemed necessary, the second-line assessor is selected by the Clinical Director using the same criteria as used for the first-line assessor. Second-line assessors are generally considered experts in the area under review.

Occasionally a surgeon may appeal the findings from the second-line assessment. In these instances the Clinical Director selects a third assessor to perform another second-line assessment. To date, there have been no third-line reviews in NTASM.

The methodology used by NTASM is outlined in Figure 2.

Figure 2: Northern Territory Audit of Surgical Mortality methodology



*First- and second-line assessors for NTASM are peer surgeons from a different state.

1.3.2 Providing feedback

The role of the NTASM is to inform, educate, facilitate change and improve practice by providing feedback. The NTASM provides feedback to surgeons and hospitals in a variety of ways:

- surgeons receive written feedback from assessors about their patient's cases.
- surgeons receive an electronic copy of the NTASM annual report, also available from the RACS website: www.surgeons.org/ntasm.
- surgeons receive de-identified summaries of second-line assessments in "Lessons from the Audit". They also receive the National Case Note Review Booklet, using patient cases from across Australia.
- hospitals participating in NTASM receive clinical governance reports on aggregated, de-identified data. These compare their hospitals to other hospitals across Australia.
- surgeons have online reports relating to their own audit data at: <https://asm.surgeons.org/mortaudit/>.

1.3.3 Audit inclusion and exclusion criteria

The NTASM audits all deaths that occur in NT hospitals while the patient was under the care of a surgeon. However, patients who are deemed terminal upon admission and do not have operations are excluded from the audit process.

NTASM includes all deaths which meet one of the following criteria:

- the patient was under surgical care (surgical admission), whether or not an operation was performed
- the patient was under a physician's care (medical admission) and subsequently underwent a surgical procedure
- the patient was a gynaecology-related case
- the patient was either possibly or definitely an anaesthetic-related surgical death, or a death which occurred within 48 hours of surgery.

NTASM excludes patients that do not meet the above inclusion criteria.

1.4 REPORTING CONVENTIONS

1.4.1 Reporting clinical incidents

NTASM asks surgeons and assessors to review patient cases and determine if there were any clinical incidents where care could have been better. These are then coded by whether the death was a direct result of the disease process alone, or if aspects of management contributed to the death. If there was a perception that the clinical management may have contributed to death, the clinical incidents are reported against the following criteria.

- **Area of consideration:** where the clinician believes an area of care **could** have been improved or different but recognises that there may be debate about this.
- **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, that is sufficiently serious to:
 - lead to prolonged hospitalisation
 - lead to temporary or permanent impairment or disability of the patient at the time of discharge
 - contribute to or cause death.

The surgeon is also asked to:

- report the impact of the incident on the outcome, that is, whether the incident:
 - made no difference to the death
 - may have contributed to the death
 - caused the death of a patient who would otherwise have been expected to survive.
- give their opinion as to whether the incident was preventable, using the following categories:
 - definitely
 - probably
 - probably not
 - definitely not.
- indicate who the incident was associated with:
 - audited surgical team
 - another clinical team
 - hospital
 - other.

Both first-line and second-line assessors are asked to respond to the same set of questions. This results in a two-level peer-review process for those patients cases that undergo second-line assessment. The second-line assessment is more in-depth and more forensic, as second-line assessors have access to all available patient information through the medical records.

1.4.2 Assessor opinion

The areas of consideration, areas of concern and adverse events contained within this report are events ascribed to the patient by either the first-line or second-line assessor. Throughout the report, first-line and second-line assessors are both referred to as 'assessors'.

Assessors are asked for their opinions on the following:

- the categorisation of the severity of the clinical incident (area of consideration, area of concern or adverse event)
- the effect on outcomes
- the preventability of the clinical incident
- with whom the clinical incident was associated.

1.4.3 Analysis of clinical incidents

All information from NTASM is de-identified. Clinical incident findings are expressed in terms that cannot identify the patient, the surgeon or the hospital.

The NTASM report focuses on areas of concern and adverse events. While data regarding areas of consideration are collected, they are considered to be minor issues regarding treatment.

Patient's cases may be associated with more than one clinical incident. For the analyses, a patient will be assigned the most serious incident.

1.4.4 Data management

This report covers deaths reported to the NTASM from 1st January 2017 to 31st December 2017. All data presented in this report is from the NTASM database. The nature of the audit process means that some patient's cases reported during this period will still be undergoing review as at the census date (31 July 2018). These patient cases will be included in the next report.

Surgeons complete the SCF and first-line assessment online. Hardcopy data from second-line assessments is entered into the system by audit staff. Data are entered and stored in a specifically designed database - a central Structured Query Language server database that includes a reporting engine.

Data are encrypted in the database with Secure Sockets Layer Certificates. All transactions are time stamped and all changes to audit data are written to an archive table, enabling a complete audit trail for each case. Security for this system is high. An integrated workflow rules engine supports the creation of letters, reminders and management reports.

To maintain data integrity, all data are routinely checked against the original SCF and assessment forms by the project manager or another project officer. Data are cleaned using logic testing and manually reviewed before analysis. Variables are checked for extreme or illogical values and corrections are made to the original data.

Once cleaned, the data are downloaded again before analysis. A total of 28 tables are downloaded into Excel and then copied across to Statistical Package for Social Sciences (IBM-SPSS version 24.0) for analysis. A key variable that is common to all tables can be used to combine tables. Generally, frequencies and cross tabulations are used to create the report.

Qualitative analysis is performed using standard techniques. The NTASM project manager and Clinical Director independently classify all qualitative information into groups. These groupings are then compared and any differences discussed until consensus is reached.

In this report the numbers in parentheses (n) in the figures and tables represent the number of patients analysed. The numbers of patients included in each analysis is provided for all tables and figures in the report. Low case numbers for some surgical specialties may compromise confidentiality and the de-identification process. In these circumstances the surgical specialty will not be listed and all deaths will be aggregated under the specialty "Other".

1.4.5 Denominator variation

Denominator variation exists throughout this report, as not all data points were completed in both the surgical case forms and/or assessment forms. When denominator variation exists, this is noted in the relevant section, and the total number of patients used in the analyses.

1.4.6 Statistical analysis

Continuous variables are summarised using medians together with the interquartile range (IQR). The IQR shows the values for the data within the 25% and 75% limits. It overcomes the problems that arise when reporting the range because extreme values are ignored. It represents the middle 50% of values in a rank-ordered series.

The association between two variables: when the outcome has a dichotomous outcome, is calculated using risk ratios (RRs). The RR is an intuitive way to compare the risks for two groups (i.e. it is the ratio of the probability of an event occurring [e.g. developing a disease] in an exposed group compared to the probability of the event occurring in a non-exposed group. If the RR is 1 (or close to 1), it suggests no difference or little difference in risk (incidence in each group is the same). A $RR > 1$ suggests an increased risk of that outcome in the exposed group. A $RR < 1$ suggests a reduced risk in the exposed group.

All RRs are reported with a 95% confidence interval (CI).

Statistical analysis is performed using Statistical Package for Social Sciences (IBM-SPSS version 24.0). Graphs are produced using either SPSS or Microsoft Office Excel (2010).

1.4.7 Northern Territory in-patient data

The Northern Territory in-patient data includes patients admitted to all NT public hospitals during 2017, who had a surgical procedure or operation performed by a surgeon that required a general anaesthetic. These patients may have been admitted by either a physician or a surgeon. The data reported is the last admission for each patient and excludes those patients reported to NTASM.

The in-patient data has been used in this report where appropriate.

The in-patient data were provided by the Northern Territory Government's Data Management & System Reporting, Governance and Business Services (Approval number *DMSR-13143*). NTASM acknowledges Peta Archer, Emidio Coccetti and Thuy Fong in the Northern Territory Department of Health for their work in eliciting data requirements, and development and delivery of data for this project.

2 AUDIT OVERVIEW

Key Points

- There were 97 surgically-related deaths reported to NTASM during 2017.
- The 86 patient cases included in this report have completed the audit review process.

2.1 OVERVIEW OF NTASM PATIENTS

Assessors completed 86 first-line assessments and 13 second-line assessments. An overview of the status of NTASM patient cases is provided in Table 1 below.

By the census date of 31 July 2018:

- three SCFs were pending submission to the audit

Table 1: Overview of NTASM patients in the audit reporting period 2017 (n=97)

Audit report period January – December 2017	Number of patients cases
Closed patient cases	86
Surgical case forms pending submission	3
Excluded (terminal care case)	5
Excluded (error)*	3
Total reported deaths	97

NTASM: Northern Territory Audit of Surgical Mortality

*An error in reporting occurs when NTASM receives notification of a case that does not fulfil the inclusion criteria and cannot be included in the audit.

Note: Only the 86 closed and eligible patients are presented in this report.

3 RESULTS

3.1 CLINICAL INCIDENTS

Key Points

- There were no clinical issues in 70% (60/86) of patients.
- An area of consideration was found in 12% (10/86) of patients.
- An area of concern or an adverse event was found in 19% (16/86) of patients (56% (9/16) were considered definitely preventable).
- Two-thirds of patients with areas of concern or adverse events 69% (11/16), were emergency admissions.
- The most common severe preventable clinical incidents were complications in: surgery; diagnosis; and therapy.

Clinical incidents, as defined by NTASM, were:

- **area of consideration** – where the clinician believes an area of care could have been improved or different but recognises that there may be debate about this
- **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, that is sufficiently serious to:
 - lead to prolonged hospitalisation
 - lead to temporary or permanent impairment or disability of the patient at the time of discharge
 - contribute to or cause death.

First-line and second-line assessors report on clinical incidents for each patient, if noted. Assessors may identify more than one clinical incident per patient. When more than one clinical incident occurred in a patient, the most severe incident was reported.

The most severe clinical incidents are areas of concern and adverse events. These two categories include issues that are specific to surgical care and may relate to hospital or patient management issues. These are the areas of care that were suboptimal and need to be improved.

Over the audit period, assessors reported that:

- there were no clinical incidents in 70% (60/86) of patients
- an area of consideration occurred in 12% (10/86) of patients
- an area of concern occurred in 9% (8/86) of patients
- an area of adverse event occurred in 9% (8/86) of patients.

The total proportion of patients with no criticisms or minor criticisms regarding treatment was 82% (70/86) when no clinical incidents are combined with areas of consideration (the least serious area).

With low patient numbers, estimates of the percentage of patients in each clinical incident category are imprecise, and should be interpreted with caution.

3.1.1 Preventable clinical incidents

Assessors also report on the preventability of clinical incidents. Table 2 shows the preventability of the most severe clinical incidents (areas of concern and adverse events) that occurred in 16 patients.

- 1) About half of the incidents of areas of concern or adverse events were definitely preventable.

Preventability	Number of events (%)
Definitely preventable	9 (56%)
Probably preventable	5 (31%)
Probably not preventable	1 (6%)
Data not available: n=1 (6%).	

- 2) Of the patients with definitely and probably preventable areas of concern or adverse events, the most common categories* of preventable clinical events were:

- open surgery – organ related (5)
- diagnosis related complication (2)
- incorrect therapy (2)

*Clinical incidents were categorised using a coded thesaurus of clinical terms (READ codes). READ codes are a clinical decision tree that contains terms, synonyms and abbreviations covering all aspects of patient care. It is a precursor to ICD9 coding: (Ref: NHS Digital).⁽⁴⁾

Preventable areas of concern and adverse events were associated with various hospital departments.

Assessors indicated that the following hospital departments were associated with the preventable areas of concern and adverse events:

- surgical team (9 events)
- another clinical team (2 events)
- hospital (1 event).

3.1.2 Elective admissions: areas of concern and adverse events as clinical incidents

The type of admission was an important predictor of clinical incidents. When an area of concern or adverse event was reported, it was half as likely to occur in a patient who had an elective admission - 31% (5/16) compared with the occurrence in a patient with an emergency admission 69% (11/16). [RR = 0.54; 95% CI 0.05 to 0.90].

3.1.3 Operation duration: areas of concern and adverse event as clinical incidents

The duration of an operation is a recognised risk factor for surgical patients.⁽⁵⁾ The duration time of the operations with these clinical incidents were:

- 1 hour (3 operations)
- 2 hours (2 operations)
- 3 hours (3 operations)
- 4.5 hours (1 operations)
- 11.1 hours (1 operation)

Of the patients with areas of concern or adverse events, three did not have operations.

3.2 SURGEONS

Key Points

- All NT surgeons participate in the audit.
- Half of the NT RANZCOG Fellows participate in the audit.
- Most anaesthetists participate in the audit.
- The NT relies on locum surgeons to supplement the surgical workforce.
- Consultant surgeons' supervision in theatre in the NT is high.

3.2.1 Overview

- All 28 RACS surgeons in NT participate in the audit.
- Of the 15 RANZCOG Fellows in the NT, 8 participate in the audit. Participation is voluntary.
- Of the 46 Anaesthetists in the NT, 39 (85%) participate in the audit. Participation is voluntary for that professional group.

There were also 15 locum surgeons who participated in the audit in 2017.

Historically, locum surgeons' involvement in the NTASM has been a challenge. With the latest enhancement to the NTASM database, locum surgeons are able to self-generate a notification of death and report the case details at the same time. NTASM proposes that this become standard practice for all locum RACS surgeons.

3.2.2 Audit participation

RACS Fellows – Royal Australasian College Of Surgeons

All of the participating surgeons in NTASM are Fellows of RACS. Surgeons must have their RACS Fellowship to be able to do first-line or second-line assessments. See Table 3 for all surgical specialties participating in the audit.

RANZCOG Fellows - Royal Australian and New Zealand College of Obstetricians and Gynaecologists

All participating obstetricians and gynaecologists are RANZCOG Fellows and participation in the audit is voluntary. They can participate as first- and second-line assessors for gynaecology-related patient cases.

No Obstetrics and Gynaecology patients cases were reported in 2017.

ANZCA Fellows - Australian and New Zealand College of Anaesthetists

Anaesthetists participate voluntarily in the audit. They are ANZCA Fellows, although they may also be accredited General Practice Anaesthetists. Fellows of ANZCA can be first-line or second-line assessors for anaesthetic-related patient cases.

During 2017:

- 20 anaesthetic cases were reported, and 15 (75%) had completed the audit process.
- four cases are pending submission and one case is under assessment.
- NT anaesthetists have assessed eight Tasmanian Audit of Surgical Mortality patients.

Table 3: Participation by specialty in 2017

Specialty	Number participating*
Anaesthetists	39
Surgeons - General Surgery	16
Obstetrics & Gynaecology	8
Surgeons - Orthopaedic Surgery	4
Surgeons - Otolaryngology, Head and Neck Surgery	2
Surgeons - Plastic and Reconstructive Surgery	2
Surgeons - Vascular Surgery	1
Surgeons - Urology	1
Surgeons - Oral and Maxillofacial Surgery	1
Surgeons - Neurosurgery	1
Total	75

*Excluded from this analysis were surgeons who have either retired or left practice in the Northern Territory, and locum surgeons.

3.2.3 Completion of Surgical Case Forms (SCFs)

Surgeons completed 96% (93/97) of all SCFs.

The median time taken to return a SCF was 50 days, ranging from less than 1 day to 188 days.

- 8 SCFs were returned in less than 1 day, and these SCFs were completed online.
- 7 SCFs were returned within 1 week.
- Most of the SCFs were completed by the patient's consultant. See Table 4.

Table 4: Grade of surgeon completing the surgical case form, in order of frequency (n=86)

Surgeon grade	Number of patients (%)
Consultant	78/86 (91%)
IMG	3/86 (4%)
Fellow	2/86 (2%)
SET trainee	2/86 (2%)
Service registrar	1/86 (1%)

SET: Surgical Education and Training; IMG: International Medical Graduate.

3.2.4 Consultant surgeon involvement in operations

Surgeons performed 105 operations on 76 patients in 2017. They performed two or more operations on 14 patients. The maximum number of operations on a single patient was 9.

The level of consultant input into the surgical management of patients was high. Their grades and roles are shown in Table 5.

In 2017:

- consultant surgeons made the decision to operate in 91% (95/105) of operations.
- consultant surgeons operated in 57% (60/105) of operations in 2017. This is slightly lower than in previous years, but it is not statistically significant – for 2011-2016 it was 62% (262/423); [RR = 0.92; 95% CI 0.77 to 1.11]
- consultant surgeons were present in the theatre for 11% (12/105) of operations in 2017. Again, this is slightly lower than in previous years, but it is not statistically significant – for 2011-2016 it was 18% (75/423); [RR = 0.64; 95% CI 0.36 to 1.14]

	Deciding	Operating	Assisting	In theatre
Consultant	91% (95/105)	57% (60/105)	13% (14/105)	11% (12/105)
SET trainee	0% (0/105)	11% (11/105)	20% (21/105)	2% (2/105)
Service registrar	1% (1/105)	7% (7/105)	21% (22/105)	4% (4/105)
IMG	2% (2/105)	4% (4/105)	2% (2/105)	1% (1/105)
Fellow	2% (2/105)	24% (25/105)	17% (18/105)	0% (0/105)

Note: the column percentages do not add up to 100%. In many instances multiple surgeons were performing and assisting during the operation. In addition, the surgeon's role and involvement were not always provided for each operation.
NTASM: Northern Territory Audit of Surgical Mortality; SET: Surgical Education and Training; IMG: International Medical Graduate.

3.2.5 Surgeon supervision in theatre

Consultant surgeon supervision covers assisting and being present in the theatre while SET trainees, IMGs and service registrars are operating. The number of surgical procedures performed by surgeons other than consultants in NTASM is low and the data needs to be interpreted with caution. See Table 6.

In 2017:

- SET trainees performed 11 operations, and in 91% (10/11) of these operations the consultant had made the decision to operate.
- Service registrars performed seven operations, and in 86% (6/7) of these operations the consultant had made the decision to operate.
- IMGs performed four operations, and in 50% (2/4) of these operations the consultant had made the decision to operate.

Table 6. Level of consultant supervision in theatre for SET trainees, IMGs and service registrars (2011-2017)

Consultant assisting and in theatre	Number of operations by year % (n)							Overall
	2011	2012	2013	2014	2015	2016	2017	
Consultant assisting while SET operating	13% (1/8)	0% (0/5)	18% (2/11)	20% (1/5)	0% (0/14)	50% (2/10)	18% (2/11)	13% (8/64)
Consultant in theatre while SET operating	25% (2/8)	0% (0/5)	27% (3/11)	40% (2/5)	0% (0/14)	50% (2/10)	9% (1/11)	16% (10/64)
Consultant assisting while IMG operating	0% (0/3)	0% (0/1)	50-% (1/2)	20% (3/15)	0% (0/1)	0% (0/0)	0% (0/4)	15% (4/26)
Consultant in theatre while IMG operating	67% (2/3)	0% (0/1)	0% (0/2)	20% (3/15)	0% (0/1)	0% (0/0)	0% (0/4)	19% (5/26)
Consultant assisting while Service registrar operating	20% (1/5)	0% (0/2)	0% (0/1)	33% (1/3)	0% (0/4)	0% (2/6)	0% (0/7)	14% (4/28)
Consultant in theatre while Service registrar operating	20% (1/5)	0% (0/2)	0% (0/1)	33% (1/3)	0% (0/4)	33% (2/6)	29% (2/7)	21% (6/28)

SET: Surgical Education and Training; IMG: International Medical Graduate

Numbers are very low, and percentages should be interpreted with caution.

3.2.6 Specialty of surgeon

The NT has a variety of surgical specialties in their hospitals. See Table 7 for the number of patients with operations, admitted for each surgical specialty. Surgically-related deaths primarily occurred in three specialties: General Surgery, Orthopaedic Surgery and Vascular Surgery.

Table 7: Surgical specialty and number of patients admitted (n=86)

Specialty	Number of patients	Percentage of all patients
General Surgery	59	69%
Orthopaedic Surgery	13	15%
Vascular Surgery	6	7%
Other*	8	9%
Total	86	100%

*Other surgical specialties include Neurosurgery, Otolaryngology Head and Neck Surgery, Ophthalmology, Oral and Maxillofacial Surgery and Urology.

In 2017, there were no patient deaths reported for Obstetrics and Gynaecology or Plastic and Reconstructive Surgery.

3.2.7 Surgeon specialty and age distribution of patients

The average age of patients varies depending on the specialty of the surgery.

Vascular Surgery patients who died were older than Orthopaedic and General Surgery patients, as shown in Table 8.

Table 8: Median patient age by assigned surgical specialty (n=86)		
Specialty (number of patients)	Median age (years)	Interquartile range (years)
General Surgery (n=59)	66	51–75
Orthopaedic Surgery (n=13)	70	54–75
Vascular Surgery (n=6)	74	33–84
Other* (n=8)	68	69–81

*Other surgical specialties include Neurosurgery, Otolaryngology Head and Neck Surgery, Ophthalmology, Oral and Maxillofacial Surgery and Urology.

3.2.8 Treating surgeon and assessor views on patient management

To test concordance, the surgeon's view for each case was compared to the first-line assessor's view. In general, their findings were similar.

Surgeons identified intraoperative management as the area requiring the most improvement, whereas assessors considered timing of operations to be the the area that required most improvement. See Table 9.

Table 9: Surgeon and first-line assessor views on areas where patient management could have been improved		
Area in which patient management could have been improved	Surgeons' views (n=76)	First-line assessors' views (n=73)
Preoperative management	7%	11%
Decision to operate	7%	7%
Choice of operation	3%	8%
Timing of operation	7%	14%
Intraoperative management	9%	4%
Grade of surgeon operating	1%	4%
Postoperative care	5%	7%

Note: more surgeons than assessors completed this part of the form and not all questions for each case was answered

3.2.9 Operation duration

The duration of an operation is an important predictor of adverse events in surgical admissions. According to Kable et al.,⁽⁵⁾ as the duration of the operation increases so does the risk of an adverse event.

In the NTASM, operation duration was recorded for 80% (84/105) of operations. There was substantial variation in operation duration for patients who died.

- The median operation duration was 60 minutes (IQR 60 to 150 minutes). (n for 60 minutes = 32); (n for 150 minutes = 6).
- The minimum operation duration was less than 18 minutes.
- The maximum operation duration was 690 minutes – 11 hours.

3.2.10 Surgeon views in retrospect

Surgeons and different actions

Surgeons were asked whether, in retrospect, they would have done anything differently in terms of patient management. This question was not answered for 3 patients.

- In 70% (58/83) of patients, the surgeon would not have changed the patient's management.
- In 30% (25/83) of patients, the surgeon answered that they would have done something differently.

The areas of care identified for improvement by the surgeons covered all aspects of patient management. A sample of comments is provided below.

Patient management

- *Patient should have been a medical admission with surgeons as a consultation team*
- *Registrar should have arranged consultant review earlier*
- *Establish goal of care much earlier*

Preoperative care

- *Should have ordered physician review preoperatively*
- *Performed surgery earlier*

Intra-operative care

- *Surgical team was focussed on haemostasis and should have also monitored products that were used*
- *Improved intraoperative supervision of registrar carrying out the initial surgery*

Decision to perform the operation

- *Reconsider indication for surgery*

Postoperative care

- *Personally checked the patient in recovery*
- *Used a CT scan postoperatively to investigate reason for vomiting.*

3.2.11 Anaesthetic patient cases reported by surgeons

Participation in NTASM by anaesthetists is voluntary.

Since June 2016, all anaesthetic patient cases have been anonymously peer reviewed and feedback has been provided to the responsible consultant anaesthetists.

There are two ways NTASM is notified of anaesthetic-related deaths:

1. surgeons are asked to indicate on the SCF whether they believe there was an anaesthetic component to the patient's death.
2. anaesthetists are able to self-report.

In 2017, two anaesthetists self-reported anaesthetic deaths.

Of all the patients who had operations 27% (20/75) of the deaths were associated with the anaesthesia at some level.

- 1% (1/75) of patients had an anaesthetic component to the death, according to surgeons.
- 26% (19/72) of patients who had an operation died within 48 hours of the last anaesthetic.

3.3 HOSPITALS

Key Points

- All NT hospitals participate in the NTASM, including a day surgery facility.
- In 2017, 13% (11/84) of patients were transferred from one hospital to another.
- 13% (10/76) of all patients had a delay in getting their main surgical diagnosis in time.

The risk of death of hospital surgical patients often depend on external factors as well as their disease status. The factors listed above are reviewed in this section.

3.3.1 Hospital participation

All NT hospitals participate in the NTASM, including a day surgery facility.

Data in this report is from both public and private hospitals that service Central Australia and the whole Top End of the NT.

3.3.2 Hospital admissions

In 2017, 17,460 patients were admitted at least once as in-patients to all Northern Territory hospitals.

In NTASM (2017), the majority of hospital admissions for surgical patients were emergencies – 91% (78/86), while 9% (8/86) of surgical patients were electives.

- Surgeons performed operations on 87% (68/78) of emergency admission patients.
- All the elective patients had operations.
- 13% (11/84) of patients were transferred from one hospital to another. This is similar to the rate in previous years - 12% (40/335).
- Transfer authorities showed appropriate care in all transferred patients, according to surgeons.
[Data not available: n=2]
- Long-distance transfers to NT hospitals are common. The median distance in 2017 was 650 kilometers (km) [IQR 333km to 761km], with a maximum distance of 1,871 kilometers.
- The median transfer distance for 2017, was longer than the median transfer distances in previous years (for 2011-2016, the median was 315 km; IQR 300km to 800km).

3.3.3 Delays in main surgical diagnosis

Delays and errors in diagnosis are important factors that contribute to perioperative death.⁽⁶⁾ In 2017, there was a delay in obtaining the main surgical diagnosis in 13% (10/76) of patients who had operations.

The 2017 some delays can be attributed to more than one department, and were associated with the surgical unit (n=2) and medical unit (n=4). Delays in the main surgical diagnosis were primarily due to unavoidable causes (n=3).

3.3.4 Patients with operations

Surgeons performed operations on more than three-quarters of NTASM surgical patients (88%; 76/86).

- A total of 105 operations were performed on 76 patients.
- 18% (14/76) of patients with operations had more than one operation.

3.3.5 Patients with postoperative complications

Postoperative complications are strong predictors of death.^(7,8) NTASM surgeons reported that 27% (20/75) of patients had a postoperative complication. However, these numbers are low and this data should be interpreted with caution.

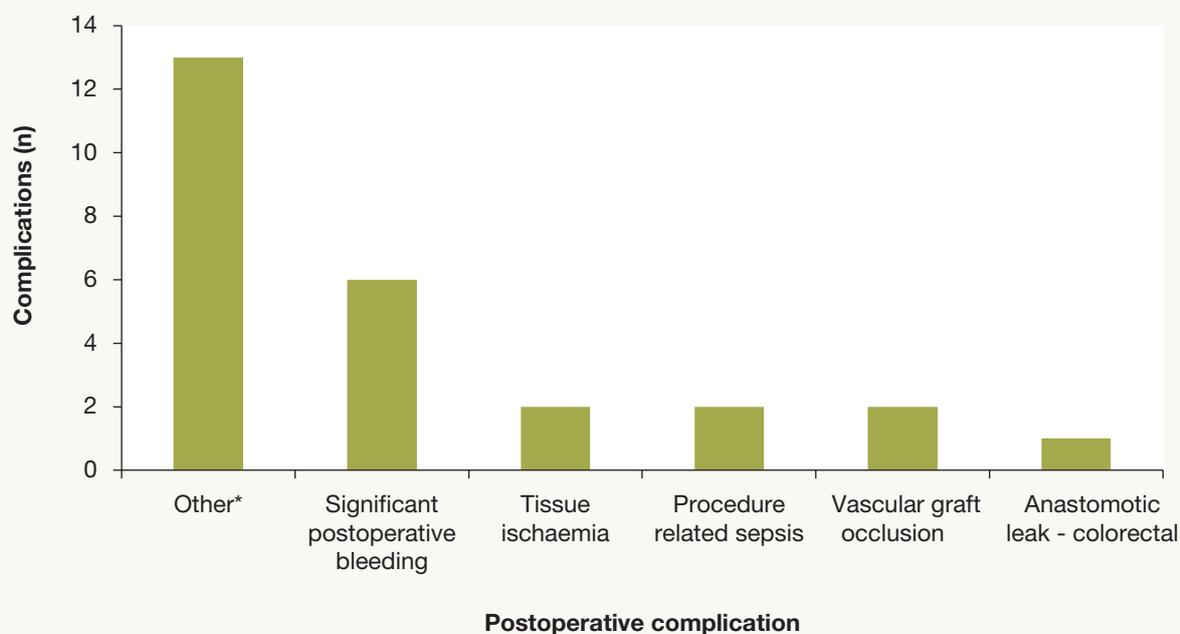
The rate of postoperative complications in 2017 was the same as the rate in 2016 – 27% (13/49).

In the NTASM, 20 patients experienced 26 complications.

As shown in Figure 3, the most frequent postoperative complications were:

- significant postoperative bleeding (n=6)
- tissue ischaemia (n=2)
- procedure-related sepsis (n=2)
- vascular graft occlusion (n=2).

Figure 3: Frequency of NTASM postoperative complications by type (n=26)



NTASM: Northern Territory Audit of Surgical Mortality.

*Includes aspiration pneumonia, gastrointestinal tract bleed, hospital-acquired pneumonia, hypoglycaemia, intraoperative bleeding, intestinal obstruction with perforation, ischaemic bowel, multi-organ infarction, myocardial infarction, pressure ulcer, pulmonary emboli, stroke and wound dehiscence.

3.3.6 ICU admission and unplanned return to theatre

ICUs are essential contributors to surgical care. In high-risk patients, a planned admission to the ICU may decrease the probability of postoperative mortality.⁽⁹⁾

However, both unplanned admissions to ICU and unplanned returns to theatre are strong predictors of death in surgical patients.⁽¹⁰⁻¹²⁾

- In NTASM, 68% (52/76) of patients received care in ICU postoperatively.
- NTASM surgeons believed that none of the patients who did not receive support from ICU or HDU (high dependency unit), should have received such support.
- A postoperative unplanned admission to an ICU occurred in 23% (17/74) of patients. [data missing for 2 patients]
- An unplanned return to theatre occurred in 24% (18/74) of NTASM patients.

3.3.7 Length of hospital stay

The length of stay for surgical patients is determined by many factors, and it is a strong predictor of death.⁽¹⁰⁾

The median length of hospital stay for the patients who died was 14 days (IQR 4 days to 26 days). The longest hospital stay for an NTASM patient was 239 days.

However for NT in-patients, the median length of stay was 1 day (IQR 1 day to 3 days). The longest hospital stay for NT in-patients was 765 days, for a medical admission.

3.4 PATIENTS

Key Points

- Nearly all NTASM patients had serious comorbidities present (95%; 82/86).
- More than half of NTASM patients had cardiovascular disease (61%; 50/82).
- About two-thirds of NTASM patients had been at considerable or expected risk of death prior to surgery.
- Nearly all NTASM patients prior to surgery had severe disease present.

3.4.1 Overview of audited patient deaths

In the year of the report, 17,460 patients were admitted as in-patients to all Northern Territory hospitals.

There were 97 patient deaths notified to NTASM in 2017, and 8 of those were excluded. These 8 exclusions were either terminal care patients (n=5) or patients that had been reported to the audit in error (n=3). NTASM inclusion and exclusion criteria are defined in Section 1.3.3.

Of the reported deaths, 86 have completed the full peer-review process (97%; 86/89).

More males than females were reported to NTASM. There are 11% more males than females in the NT. ⁽¹³⁾

Of the reported deaths, nearly all patients had an emergency admission and comorbidities present. The main characteristics of these audited patient deaths are summarised in Table 10.

Table 10: Characterists of NTASM patients

Characteristics of NTASM patients	n = 86
Median age in years (IQR)	69 (52 – 76)
Male: Female	58% : 42%
Aboriginal and Torres Strait Islander Persons	36%
Emergency Admission	91%
Comorbidities present	95%
Had at least one operation	88%

For the NT in-patient population, (n=17,460), the ratio of the genders (Male 47%: Female 53%) was different compared to the NTASM population (58% Male: Female 42%).

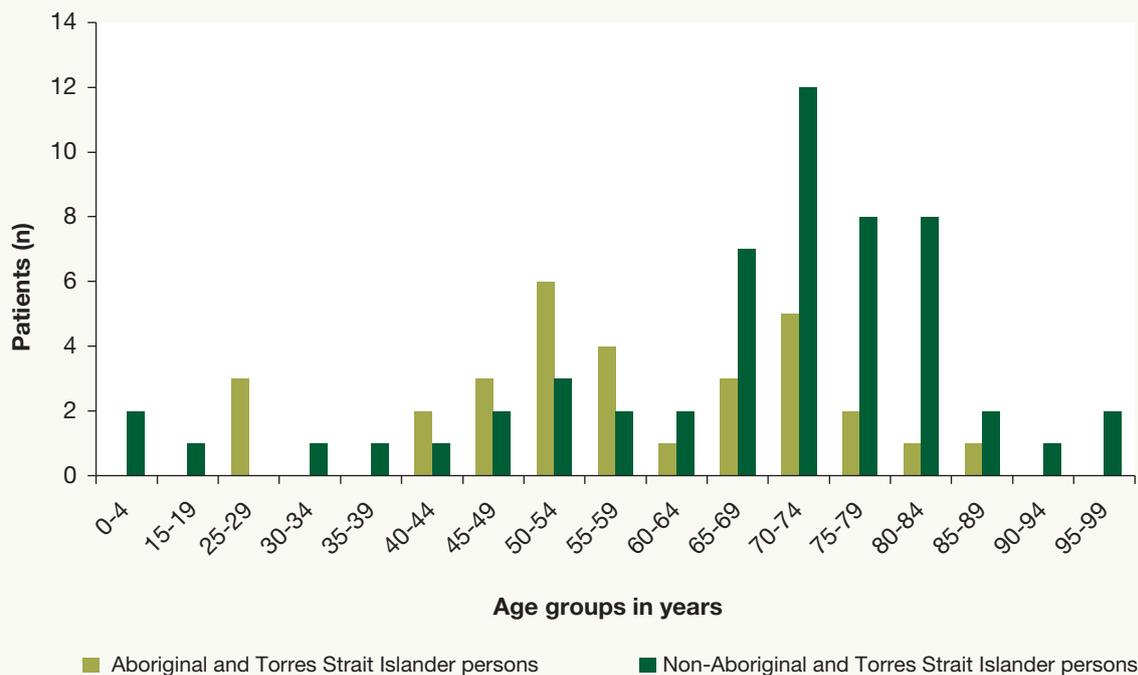
Also in the NT in-patient population, the proportion of emergency admissions (37%) was different compared to the NTASM population (91%).

3.4.2 Age of NTASM patients

From NTASM data, patients admitted under a surgeon who die, Aboriginal and Torres Strait Islander people die younger than non-Aboriginal and Torres Strait Islander people.

In NTASM, there is a difference in the age distributions of the two population groups. See Figure 4.

Figure 4: Comparison of the 4-year age group distribution of Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons (n=86)



- 76% (42/55) of patients aged 60 years and older were non-Aboriginal and Torres Strait Islander persons.
- 58% (18/31) of patients aged 59 years and younger were Aboriginal and Torres Strait Islander persons.
- There were only two Aboriginal and Torres Strait Islander persons older than 80 years.

3.4.3 American Society of Anesthesiologists class

The American Society of Anesthesiologists (ASA) class is an international measure of patient risk used by anaesthetists.⁽¹⁴⁾ In the NT, an ASA class is assigned to the patient by the assisting anaesthetist prior to a procedure.

An ASA class indicating the presence of severe or worse disease (ASA class 3 to 6) was assigned to 92% (66/72) of patients prior to the patient’s going to theatre. See Figure 5.

ASA class definitions*

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

*The American Society of Anesthesiologists (ASA) class. ⁽¹⁴⁾

Figure 5: Distribution of ASA class for NTASM patients (n=76)



Data not available: n=4 (5.3%) of which three were Aboriginal and Torres Strait Islander persons.
 ASA: American Society of Anesthesiologists; NTASM: Northern Territory Audit of Surgical Mortality.

3.4.4 Comorbidities

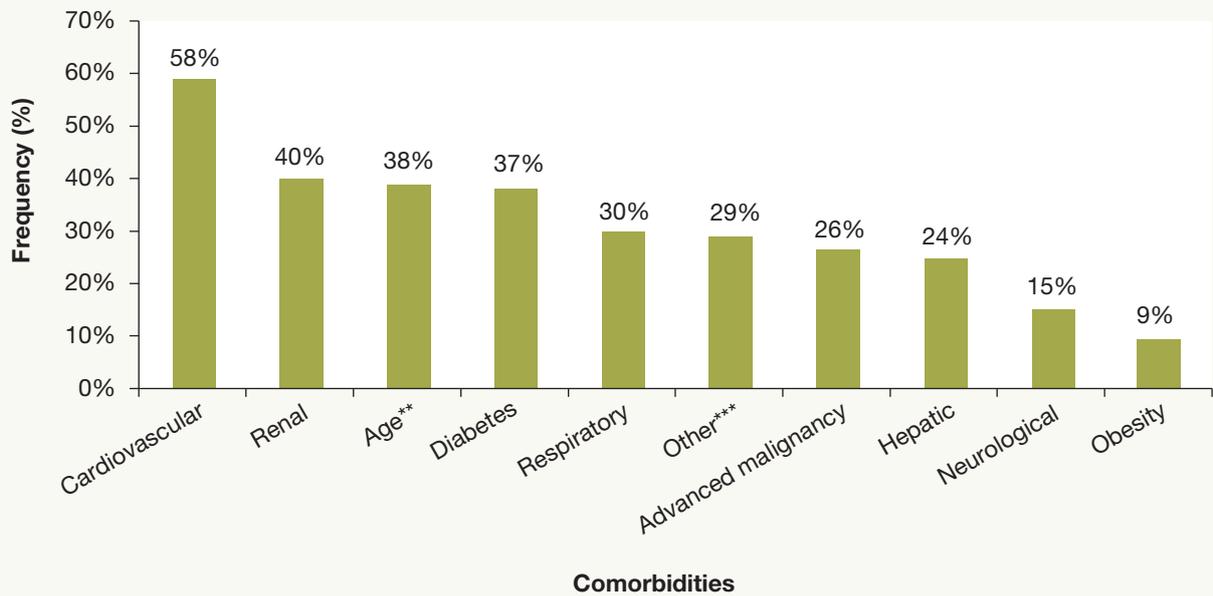
Comorbidities are a stronger predictor of mortality than the type of surgery.⁽⁶⁾ Serious comorbidities were present in 95% (82/86) of NTASM patients.

There were 264 comorbidities in 82 patients, with 62 patients having more than one serious comorbidity.

The median number of comorbidities per patient was 3 (IQR, 2 to 4). Two patients had eight comorbidities.

- Cardiovascular disease, renal disease, age and diabetes were the most common comorbidities in NTASM patients (see Figure 6).

Figure 6: Distribution of comorbidities in patients (n=82)



*The percentages do not total 100% as the median number of comorbidities per patient was 3 (range 1 to 8).

**Advanced age was considered as a factor that increased the risk of death, by surgeons

***The most common 'other' comorbidities were alcohol abuse, coagulopathy, frailty/dementia and malnutrition.

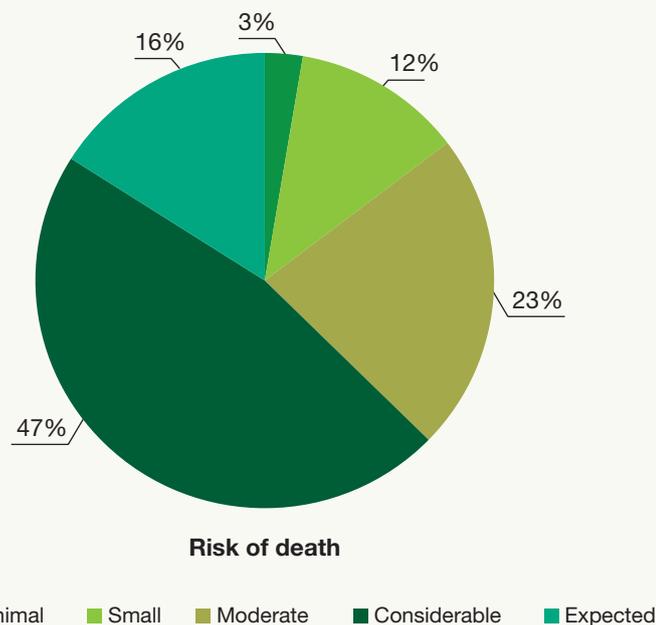
3.4.5 Risk of death

While the risk of surgical mortality is generally low, there are some patients who are at higher risk.^(15,16)

Surgeons were asked to rate the overall risk of death, prior to surgery, for each patient.

The risk of death was considerable or expected in nearly two thirds. See Figure 7.

Figure 7: Proportion of patients at risk of death prior to surgery, as judged by surgeons (n=76).



3.5 ABORIGINAL AND TORRES STRAIT ISLANDER PERSONS

Key Points

- One-third of NTASM patients were Aboriginal and Torres Strait Islander persons.
- Aboriginal and Torres Strait Islander persons in NTASM were younger than non-Aboriginal and Torres Strait Islander persons.
- No differences in clinical management issues were noted between Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons.

3.5.1 Overview

In 2010, NTASM reporting on Aboriginal and Torres Strait Islander status commenced in 2010.

Almost one-third of the population in the NT are Aboriginal and Torres Strait Islander persons, the highest of any Australian state or territory.⁽²⁾ This is also reflected in the surgical audit population.

Of the NTASM patients, 36% (31/86) were Aboriginal and Torres Strait Islander persons.

3.5.2 Aboriginal and Torres Strait Islander persons and age

In NTASM, Aboriginal and Torres Strait Islander persons who died in the perioperative period were younger than non-Aboriginal and Torres Strait Islander persons. See Figure 4.

The difference in the median age of the two population groups was 15 years. See Table 11.

Table 11: Age at death of Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons.

	NTASM (n=86)	
	Age at death of Aboriginal and Torres Strait Islander persons (n=31)	Age at death of non-Aboriginal and Torres Strait Islander persons (n=55)
Median (IQR)	56 years (47–70)	71 years (63–78)
Minimum	25 years	0 years
Maximum	88 years	99 years

Note: extreme ages are included (neonates and elderly)

NTASM: Northern Territory Audit of Surgical Mortality; ANZASM: Australian and New Zealand Audit of Surgical Mortality.

IQR: interquartile range.

In 2017, a positive finding was that the median age of Aboriginal and Torres Strait Islander persons was older than in previous years (2011–2016). For those years (n=136), the median age was 52 years (IQR 44 to 62).

3.5.3 Aboriginal and Torres Strait Islander persons and ASA class

Surgeons/anaesthetists recorded an ASA class of 3 or higher for nearly all Aboriginal and Torres Strait Islander persons - 96% (25/26).

These patients presented with at least mild systemic disease prior to undergoing surgery.

Figure 5 shows the distribution of ASA class for Aboriginal and Torres Strait Islander persons undergoing an operation. These data are not age adjusted.

3.5.4 Aboriginal and Torres Strait Islander persons and comorbidities

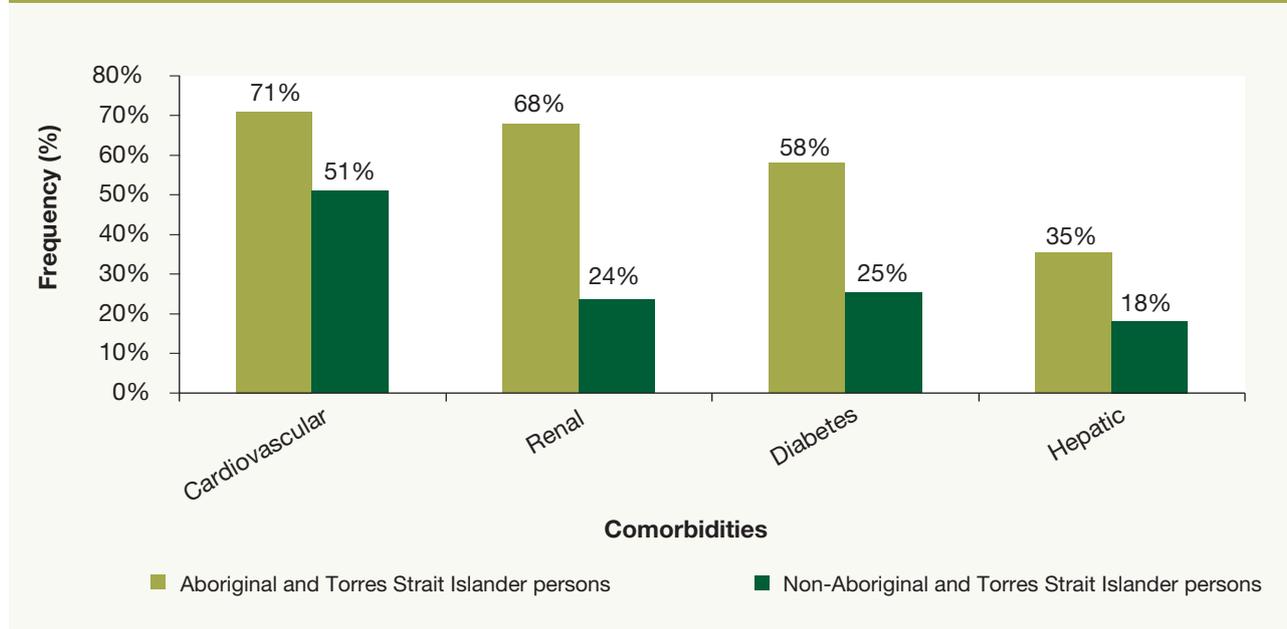
The high prevalence of comorbidities is a problem for the surgical care of Aboriginal and Torres Strait Islander persons. As in all patients, multiple comorbidities make recovering from the stresses of surgery more difficult.

There was a statistical difference in the presence of serious comorbidities in Aboriginal and Torres Strait Islander persons 100% (31/31) and non-Aboriginal and Torres Strait Islander persons 93% (51/55) in the NTASM when not adjusted for age. [RR = 1.08; 95% CI 1.00 to 1.16]

Cardiovascular, renal, diabetes, and hepatic diseases in NTASM patients were strikingly more prevalent in Aboriginal and Torres Strait Islander persons than in non-Aboriginal and Torres Strait Islander persons (see Figure 8).

Aboriginal and Torres Strait Islander persons are at greater risk of liver disease compared with non-Aboriginal and Torres Strait Islander persons.^(17,18)

Figure 8: Comparison of diabetes, renal and hepatic disease in Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons



3.5.5 Aboriginal and Torres Strait Islander persons and risk of death based on surgeons' perceptions

A lower proportion of Aboriginal and Torres Strait Islander persons were at considerable or expected risk of death (54%; 15/28) compared with non-Aboriginal and Torres Strait Islander persons (68%; 32/47). This may be because of the difference in age of the two population groups.

Perioperative management was similar between Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons.

3.5.6 Aboriginal and Torres Strait Islander persons and clinical management

Results were similar for Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons around the need for improved perioperative management. This was also seen in a 2013 publication which showed that surgical care in NTASM patients, as measured by accepted indicators, was equivalent in both groups.⁽³⁾

In patients who had an operation during 2017, there were few issues in the clinical management indicators with regard to the care provided to Aboriginal and Torres Strait Islander persons compared with non-Aboriginal and Torres Strait Islander persons (see Table 12). Communication issues were higher in Aboriginal and Torres Strait Islander persons compared with non-Aboriginal and Torres Strait Islander persons, but these were not statistically significant.

Table 12: Comparison of issues with postoperative care, as reported by surgeons, between Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons in NTASM

Postoperative care	Aboriginal and Torres Strait Islander persons (n=29)*	Non-Aboriginal and Torres Strait Islander persons (n=47)*	Risk ratio (95% CI)
Postoperative complications detected	25% (7/28)	28% (13/47)	0.90 (0.41, 1.99)
Use of DVT prophylaxis	76% (22/29)	84% (38/45)	0.90 (0.70, 1.14)
Unplanned return to theatre	21% (6/28)	26% (12/46)	0.82 (0.35, 1.94)
Unplanned readmission	N/A(0/29)	2% (1/46)	N/A
Fluid balance alterations	3% (1/29)	7% (3/46)	0.53 (0.06, 4.84)
Communication	10%(3/29)	7% (3/46)	1.59 (0.34, 7.34)
Treated in critical care unit	62% (18/29)	72% (34/47)	0.86 (0.61, 1.20)
Unplanned ICU admission	11% (3/28)	30% (14/46)	0.35 (0.11, 1.17)
Different action by surgeon	29% (8/28)	35% (16/46)	0.82 (0.41, 1.67)

DVT: deep vein thrombosis; ICU: intensive care unit; NTASM: Northern Territory Audit of Surgical Mortality.

*Note: not all questions were answered for each case, resulting in denominator variation.

3.6 TRAUMA

Key Points

- Trauma was more prevalent in non-Aboriginal and Torres Strait Islander persons than in Aboriginal and Torres Strait Islander persons.
- Trauma was most commonly due to falls.

3.6.1 Trauma overview

Trauma occurred in 21% (18/85) of NTASM patients. This was similar to the incidence of trauma patients in 2016 – 24% (16/67).

Of these patients, a higher proportion were non-Aboriginal and Torres Strait Islander persons 72% (13/18) than Aboriginal and Torres Strait Islander persons 28% (5/18). [RR =0.38; 95% CI 0.17 to 0.85].

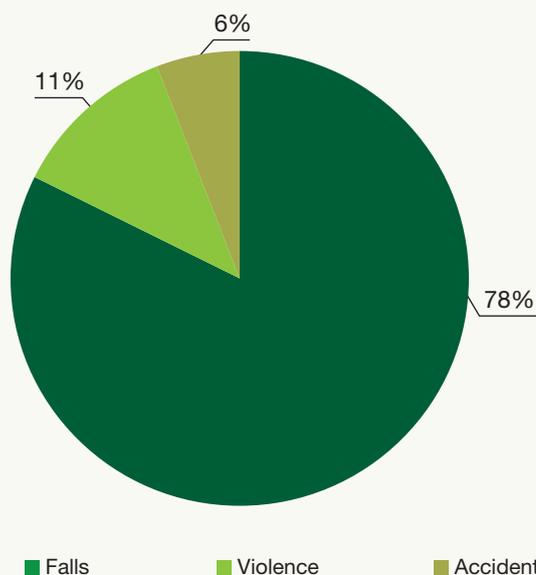
Trauma was most commonly associated with falls, 78% (14/18). The distribution of trauma in NTASM is seen in Figure 9. The NTASM trauma patients who had falls were elderly with a median age of 73 years (IQR 70 to 82).

During 2017, there was only one NTASM trauma case that was associated with a road traffic accident 6% (1/18). Official statistics regarding fatalities due to motor vehicle accidents are nearly three times higher in the NT than for the rest of Australia. ⁽¹⁹⁾ Data is missing for one trauma case.

Violence was associated with 11% (2/18) of NTASM trauma patients. The numbers for accidents and violence are too low to compare with other data.

The data relating to trauma should be interpreted with care as numbers are low.

Figure 9: Distribution of causes of trauma (n=18)



3.6.2 Trauma – falls

Falls were the most frequent cause of trauma, accounting for 78% (14/18) of patients with documented trauma. Of these falls patients 75% were aged over 70 years.

- 64% (9/14) of the falls occurred at home
- 14% (2/14) of the falls occurred in a care facility
- 14% (2/14) of falls were due to other causes, such as sport or recreation
- 7% (1/14) of the falls occurred in hospital.

3.7 INFECTIONS

Key Points

- NTASM patients who were Aboriginal and Torres Strait Islander persons were more likely to present to hospital with an existing infection.

3.7.1 Overview

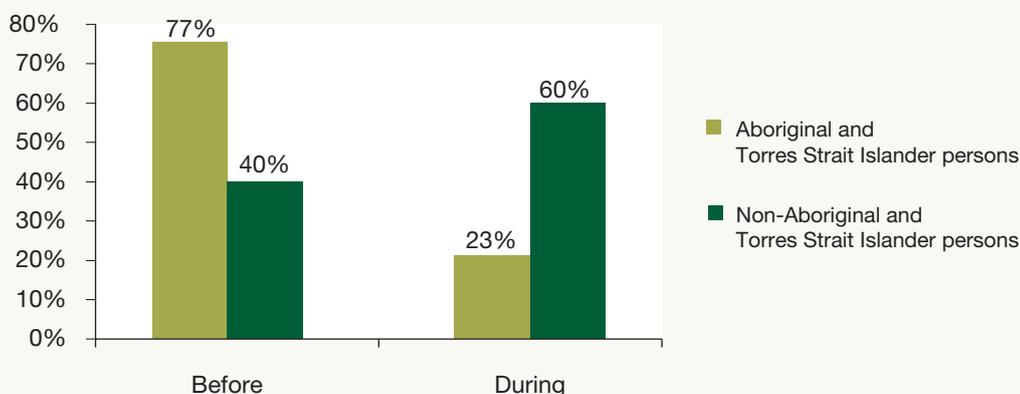
All ANZASM regions, except for New South Wales, started collecting infection data in 2012. During 2017, in NTASM, a clinically significant infection was present in 28 patients - 33% (28/85) and was not recorded for one patient. This is the same as the incidence of infections in NTASM in 2016 – 33% (22/66).

About half of these infections were acquired prior to admission - 57%(16/28).

In NTASM, Aboriginal and Torres Strait Islander persons (77%; 10/13) were two times more likely to have acquired the infection prior to admission compared with non-Aboriginal and Torres Strait Islander persons (40%; 6/15), [RR = 1.92; 95% CI 0.97 to 3.82]. This was not statistically significant. Figure 10 provides an overview of the timing of infection acquisition for Aboriginal and Torres Strait Islander patients and non-Aboriginal and Torres Strait Islander patients in NTASM.

The data relating to infections should be interpreted with care as numbers are low.

Figure 10: Proportion of Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons with infections acquired before and during admission (n=24)



3.7.2 Infections and operations

Operations were performed on 86% (24/28) of NTASM patients who died with a clinically significant infection. Of these patients:

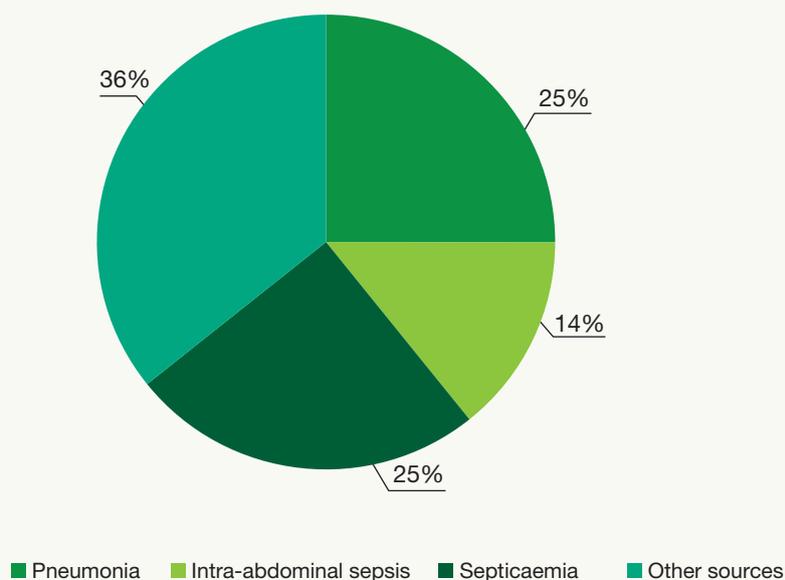
- 1 patient had a surgical site infection
- 1 patient acquired an infection preoperatively
- 10 patients acquired an infection postoperatively

(Note: data not available: n=12 patients)

3.7.3 Infection

A clinically significant infection was present at death in 28 patients. For the patients with an infection, infections from other sources - 36% (10/28) were the most common. Septicaemia - 25% (7/28), pneumonia - 25% (7/28), and intra-abdominal sepsis – 14% (4/28) were less frequent (Figure 11).

Figure 11: Types of infection acquired before or during the admission (n=28)



3.7.4 Types of infection positively identified

Only half of the NTASM patients who died with a clinically significant infection present had an organism identified as the cause of the infection. These were identified in ten Aboriginal and Torres Strait Islander persons and six non-Aboriginal and Torres Strait Islander persons, but not all the organism names were stated.

Of the stated organisms, the most common were:

- *Streptococcus pyogenes* (group A, n = 4)
- *Pseudomonas* (n = 3)
- *Staphylococcus aureus* (n = 2)
- *Escherichia coli* (n = 2).

Streptococcus pyogenes (group A) is well documented as the leading causative organism in necrotising fasciitis⁽²⁰⁾ - a severe disease of sudden onset that spreads rapidly.

ACKNOWLEDGEMENTS

Thank you to the NT government for funding the NTASM.

Thank you to all surgeons who comprehensively complete their SCFs.

Thank you to all assessors who diligently complete their assessments.

Thank you to the Chairman, Dr John Treacy, for his leadership and support.

Thank you to the management committee of the NTASM for their wisdom and counsel.

Thank you to the staff of NTASM, who manage the process in a systematic way.

Dr John North FRACS

NTASM Clinical Director

NTASM MANAGEMENT COMMITTEE MEMBERS

Dr John Treacy	Chair, NTASM Management Committee & Chair, NT State Committee
Dr Janak Mehta	Orthopaedic Representative for RACS
Dr Ollapallil Jacob	Director of Surgery, Alice Springs Hospital
Dr John North	Clinical Director, NTASM
Dr John Quinn	Executive Director Surgical Affairs, Australia
Dr Mahiban Thomas	Director of Surgical Services, Top End Health Service
Dr Philip Toonson	Supervisor Surgical Training, Royal Darwin Hospital
Dr Shiby Ninan	Plastic Surgeon, Royal Darwin Hospital
Dr Sanjay Kalgutkar	General Surgeon, Royal Darwin Hospital
NT Department of Health representative	
Penny Parker	Director Safety & Quality, Top End Health Service
Anaesthesia representatives	
Dr Phil Blum	Deputy Director, Department of Anaesthesia, Top End Health Service and NT representative for the ANZCA mortality subcommittee
Dr Peter Harbison	Consultant Anaesthetist, Department of Anaesthesia, Royal Darwin Hospital and Darwin Private Hospital
Obstetrics and Gynaecology representatives	
Dr Jane Thorn	Staff Specialist Obstetrician and Gynaecologist, Royal Darwin Hospital
Dr Margaret O'Brien	Director of Obstetrics and Gynaecology, Royal Darwin Hospital

NTASM STAFF

Dr John North	Clinical Director
Therese Rey-Conde	Project Manager
Jenny Allen	Senior Project Officer
Sonya Faint	Senior Project Officer
Candice Postin	Project Officer
Kyrsty Webb	Administration Officer

NTASM SUPPORT STAFF

Gayle Eccles	Surgical Audit Officer (Royal Darwin Hospital)
Helen Blackadder	Clinical Audit and Quality Manager Perioperative (Royal Darwin Hospital)
Francine Riessen	Health Information Manger (Darwin Private Hospital)
Janine Wapper	Acting Health Information Services Manager (Alice Springs Hospital)

CONSULTANT STATISTICIAN

Dr Robert Ware	Menzies Health Institute Queensland, Griffith University
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NT GOVERNMENT'S DATA MANAGEMENT & SYSTEM REPORTING, GOVERNANCE AND BUSINESS SERVICES

Peta Archer	Data analyst
Emidio Coccetti	Data analyst
Thuy Fong	Data analyst

SHORTENED FORMS

ANZASM	Australian and New Zealand Audit of Surgical Mortality
ANZCA	Australian and New Zealand College of Anaesthetists
ASA	American Society of Anesthesiologists
CI	confidence interval, usually at 95%
CVD	cardiovascular disease
HDU	high dependency unit
Km	Kilometers
ICU	intensive care unit
IMG	International Medical Graduate
IQR	interquartile range
M&M	Morbidity and Mortality
MRSA	Methicillin-resistant Staphylococcus aureus
NT	Northern Territory
NTASM	Northern Territory Audit of Surgical Mortality
RACS	Royal Australasian College of Surgeons
RANZCOG	Royal Australian and New Zealand College of Obstetricians and Gynaecologists
RR	risk ratio
SCF	surgical case form
SET	Surgical Education and Training
WAASM	Western Australian Audit of Surgical Mortality

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APPENDIX A: LESSONS FROM THE AUDIT

Volume	Title/Theme
Vol 1	Cardiac
Vol 2	Perforated T-cell gastric lymphoma undergoing chemotherapy
Vol 3	Bronchial stump leak
Vol 4	Abdominal sepsis following elective laparoscopic ventral hernia repair
Vol 5	Serious multi-trauma patients demand serious measures
Vol 6	Multiple systems - multiple obstructions to best patient care?
Vol 7	Decision before incision!
Vol 8	Death after endoscopy - 'surgical audit' or not?
Vol 9	Not in that institution...please!
Vol 10	History and examination are still important for surgeons.
Vol 11	Communication (theme)
Vol 12	Preoperative management issues (theme)
Vol 13	The obese patient (theme)
Vol 14	Operation should not have been performed (theme)
Vol 15	Postoperative complications (theme)
Vol 16	Fluid balance (theme)
Vol 17	The elderly surgical patient (theme).
Vol 18	Infections (theme)
Vol 19	General Surgery (theme)
Vol 20	Vascular Surgery (theme)

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The information contained in this Annual Report has been prepared by the Royal Australasian College of Surgeons Northern Territory Audit of Surgical Mortality Management Committee, which is a declared quality improvement committee under section 7 (1) of the Health Services (Quality Improvement) Act 1994 (Gazetted 26 July 2005).

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