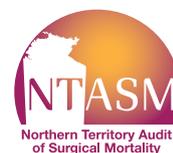
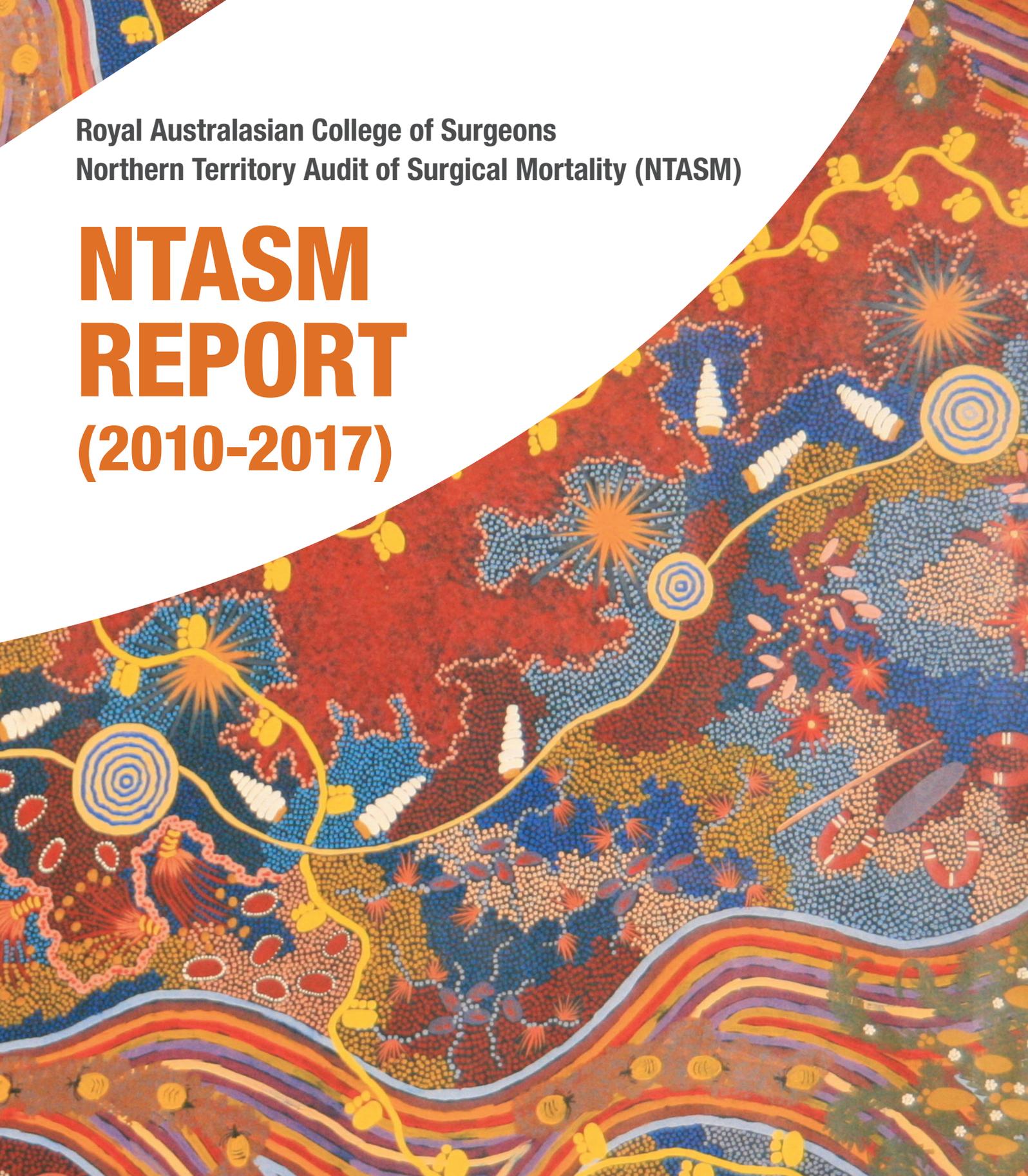


Royal Australasian College of Surgeons
Northern Territory Audit of Surgical Mortality (NTASM)

NTASM REPORT (2010-2017)





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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

The Northern Territory Audit of Surgical Mortality (NTASM) continues to contribute to many facets of surgical learning. This must remain central to all of our practices. If we cease to learn, we effectively cease to function in a professional manner. Patients will suffer as a consequence.

All Northern Territory (NT) hospitals expect feedback from their government-funded audit. This NTASM report fulfils, in part, this expectation. Significant deficits that are identified by the audit will clearly drive appropriate and necessary change.

It is encouraging that NTASM has been able to contribute to change in practice in NT hospitals now that all surgeons embrace the audit process. What is particularly promising out of the audit process feedback reports, is the potential ability to effect change within the hospital system on issues that remain unique to the NT.

NT surgeons complete a surgical case form (SCF) for each surgically-related death. This provides an opportunity for self-reflection and self-directed learning. They also receive feedback from peer assessors. The de-identified peer review system has been very well received by NT surgeons.

The assessors, particularly second-line assessors, also learn from this systematic peer review process. Many regard themselves as being key participants in this valuable feedback and learning process.

For the NTASM, learning from its processes will always be a priority.

As the NTASM Clinical Director, I will always encourage and welcome your comments. In particular, we would like to know if you have changed any of your practices as a result of the NTASM review and feedback reports.

Thank you, once again, to all who play vital roles at each and every step in the audit.

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



Dr John North
NTASM Clinical Director

NTASM MANAGEMENT COMMITTEE CHAIR'S REPORT

It has been said that surgery without audit is like playing cricket without keeping the score. Surgeons must keep the score, out of respect for those who have died and their loved ones, as well as for all patients and the community as a whole. The NTASM confirms that NT surgeons truly are keeping score. Results show that we are winning in some areas but not in others.

Areas of improvement continue to be highlighted in the audit, and these include the need to improve communication between surgical and clinical teams.

Aboriginal and Torres Strait Islander persons die younger than non-Aboriginal and Torres Strait Islander persons, by a median of 17 years in this report. In addition, their rates of comorbidities remain high, especially liver and kidney disease and diabetes mellitus. Encouragingly, no differences in clinical management issues were noted between Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons.

NTASM reports have identified alcohol abuse as a factor in deaths associated with violence and falls. Alcohol-related harm has had, and continues to have, devastating consequences for the NT community. The audit will continue to advocate for the inclusion of "alcohol abuse" as a comorbidity in the surgical case form (SCF). As a result of findings from the NTASM, recommendations have been made to the NT Minister for Health to reduce alcohol outlet density and restrict trading hours. In addition, a recommendation has been made to routinely collect data on hospital presentations related to alcohol in NT hospitals.

Good results are demonstrated in this report. Clinical management issues are comparable with other regions throughout Australia. In the NTASM, 22% of patients had a postoperative complication, which is significantly lower than the national ANZASM rate of 34%. However, the NTASM numbers are low and this data should be interpreted with caution. Consultant surgeon supervision is high. The decision to operate is largely made by consultants (86%), while consultant surgeons operate, assist or are in theatre for 92% of operations.

The NTASM continues to grow in strength. The NTASM now has participation not only from all NT surgeons, but also gynaecologists and anaesthetists in the NT.



Dr John Treacy
NTASM Chair

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 July 2010 to 30 June 2017.

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.

SURGEONS

- All surgeons in the NT participated in the NTASM.
- The return rate for SCFs was 98.0% (450/459). The audit process was complete by the census date for 396 cases, and these cases form the basis of this report.

HOSPITALS

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

PATIENTS

- Over the 7 year audit period there were 459 surgically-related deaths reported to NTASM.
- In NTASM, 65% (258/396) of patients were male and 35% (138/396) were female. In the national Australian and New Zealand Audit of Surgical Mortality (ANZASM), 55% (18,525/33,438) of patients were male.⁽¹⁾
- Serious comorbidities were present in 80.5% (318/395) of patients.
- Hepatic disease (23.0%; 73/318) was three times higher in NTASM patients compared with national ANZASM patients (8.2%; 2,347/28,701).⁽¹⁾
- Diabetes (31.8%; 101/318) was higher in NTASM patients compared with national ANZASM patients (19.4%; 5,557/28,701).⁽¹⁾
- NTASM surgeons considered that more than half of the patients (64.7%; 193/298) were at considerable or expected risk of death prior to surgery. This is similar to the risk surgeons reported in ANZASM patients (62.5%; 15,987/25,581).⁽¹⁾

ABORIGINAL AND TORRES STRAIT ISLANDER PERSONS

- According to the Australian Bureau of Statistics, 3% of the total Australian population and 30% of the NT population are Aboriginal and Torres Strait Islander persons.⁽²⁾
- In NTASM, Aboriginal and Torres Strait Islander persons comprised 37.1% (147/396) of surgically-related deaths.
- The median age of death of Aboriginal and Torres Strait Islander persons was younger (53 years; interquartile range [IQR] 44 to 64) compared with the median age of non-Aboriginal and Torres Strait Islander persons (70 years; IQR 57 to 78).

CLINICAL INCIDENTS

- No clinical incidents were noted in 74.7% (296/396) of patients.
- An area of concern or adverse event occurred in 10.1% (40/396) of NTASM patients compared with 11.0% (3,655/33,356) of ANZASM patients.⁽¹⁾
- Assessors considered that 37.5% (15/40) of the areas of concern and adverse events were definitely preventable.
- An area of consideration occurred in 15.2% (60/396) of patients.

OPERATIVE DEATHS

In the last admission for NTASM patients:

- at least one operation was undertaken on 76.0% (301/396) of patients.
- a total of 506 operations were performed on 301 patients.
- multiple operations were performed on 31.9% (96/301) of patients who underwent an operation.

POSTOPERATIVE COMPLICATIONS

- There were 93 postoperative complications. A postoperative complication occurred in 22.3% (67/300) of patients. The number of complications ranged from one to four per patient.

USE OF INTENSIVE CARE UNIT (ICU)

- Postoperative admission to an ICU occurred in 70.1% (209/298) of patients.
- A postoperative unplanned admission to an ICU occurred in 18.2% (52/285) of patients.

TRAUMA

- Trauma was present in 28.8% (99/344) of patients.
- 56.6% (56/99) of trauma cases were associated with falls.
- 24.2% (24/99) of trauma cases were associated with road traffic accidents.
- 64.6% (64/99) of trauma cases were non-Aboriginal and Torres Strait Islander persons.

INFECTION

- Infection was reported in 35.8% (120/335) of cases.
- Of the patients with infection, 60.7% (71/117) acquired the infection prior to admission and 39.3% (46/117) acquired the infection during the admission. [data missing for three patients]
- Of the patients with infection, the main types of infections were septicaemia (37.3%; 44/118) and pneumonia (28.0%; 33/118). [data missing for two patients]
- A surgical site infection was reported for two patients.

RECOMMENDATIONS

Practice and policy

The audit is routine, systematic and clinically relevant. It can inform hospital and clinical practice.

The audit data should be used to:

- review existing clinical activities and hospital processes
- influence public policy
- identify areas where clinical improvement can be made.

Learning through the audit

It is recognised that the audit provides surgeons with an alternative form of learning.

The audit should:

- encourage surgeons to be assessors to enhance their own learnings from the audit
- encourage surgeons to make use of the audit data in research publications
- identify emerging trends and address them in educational processes such as seminars and themed case note review booklets
- include “alcohol abuse” as a comorbidity in the SCF.

Patient management

Most of the patients in NTASM were high-risk patients.

- Clinical incidents were considered to be probably or definitely preventable in 38% of cases. These preventable clinical incidents occurred most frequently in the categories of patient assessment, delays and suboptimal therapy. They were most commonly associated with the surgical and clinical teams. To reduce the incidence of preventable incidents, surgeons are encouraged to discuss these at morbidity and mortality reviews.
- 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 and its work.
- Of the deaths reported to NTASM, 10% (31/304) were orthopaedic patients. Most of these patients were under the care of locum surgeons. NTASM also notes that locum surgeons are mainly orthopaedic surgeons. NTASM recommends that permanent positions need to be created for orthopaedic surgeons in the NT. This would lead to improved management and care for orthopaedic patients.

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 neurosurgeon in Darwin**
Results from the NTASM Report 2010-16 showed that of those persons who died following an operation, severe head injury and/or hypoxic brain injury plus traumatic subdural haemorrhage were frequent surgical diagnoses on admission. This demonstrated the need for a resident neurosurgeon in the NT to help manage and treat emergency neurosurgery cases. A consultant neurosurgeon is now working in the Northern Territory.
- **Management of bleeding oesophageal varices**
Results from the NTASM identified that death from bleeding varices, resultant from alcohol-induced liver cirrhosis, is a significant cause of death in the NT, particularly in Aboriginal and Torres Strait Islander persons. An upper gastrointestinal surgical unit was formed to identify and manage these patients by an elective variceal screening program.
- **NTASM online**
All surgeons in the NTASM submit SCFs online. This has increased the completeness of the NTASM data and has improved the return time for cases by at least 4 days. Locum surgeons are beginning to self-report cases prior to the end of their rotation.

Addressed recommendations

- **Management of bleeding oesophageal varices**
A recommendation has also been made to recruit a nurse to assist in the variceal screening program conducted in the new upper gastrointestinal surgical unit. The requirement of an additional nursing position has been acknowledged by the Royal Darwin Hospital administration and Top End Health. The position is pending.
- **Alcohol-induced trauma**
NTASM reports have identified alcohol abuse as a factor in deaths associated with violence, and falls. Recommendations have been made to the NT Minister for Health to reduce alcohol outlet density and restrict trading hours. This has been formally acknowledged by the NT Minister of Health. Pressure has been placed on new liquor retailers having to limit their floor space and restrict opening hours.

In addition, a recommendation has been made to routinely collect data on alcohol-related hospital presentations in NT hospitals. This has been approved, in principle, by the hospital administrators and is supported by the hospital emergency department.

1 INTRODUCTION

Key Points

- The NTASM is an independent peer review audit of the processes of care associated with all surgically-related deaths in the NT.
- The primary aim of NTASM is to provide feedback to surgeons about their practice, and to encourage learning about surgical care.
- This report covers the audit period 1 July 2010 to 30 June 2017, as at the census date of 31 July 2017.
- This report is an analysis of 396 cases that have completed the full audit process.
- This report makes comparisons between NTASM cases and cases in the national ANZASM report (2016).¹

1.1 BACKGROUND

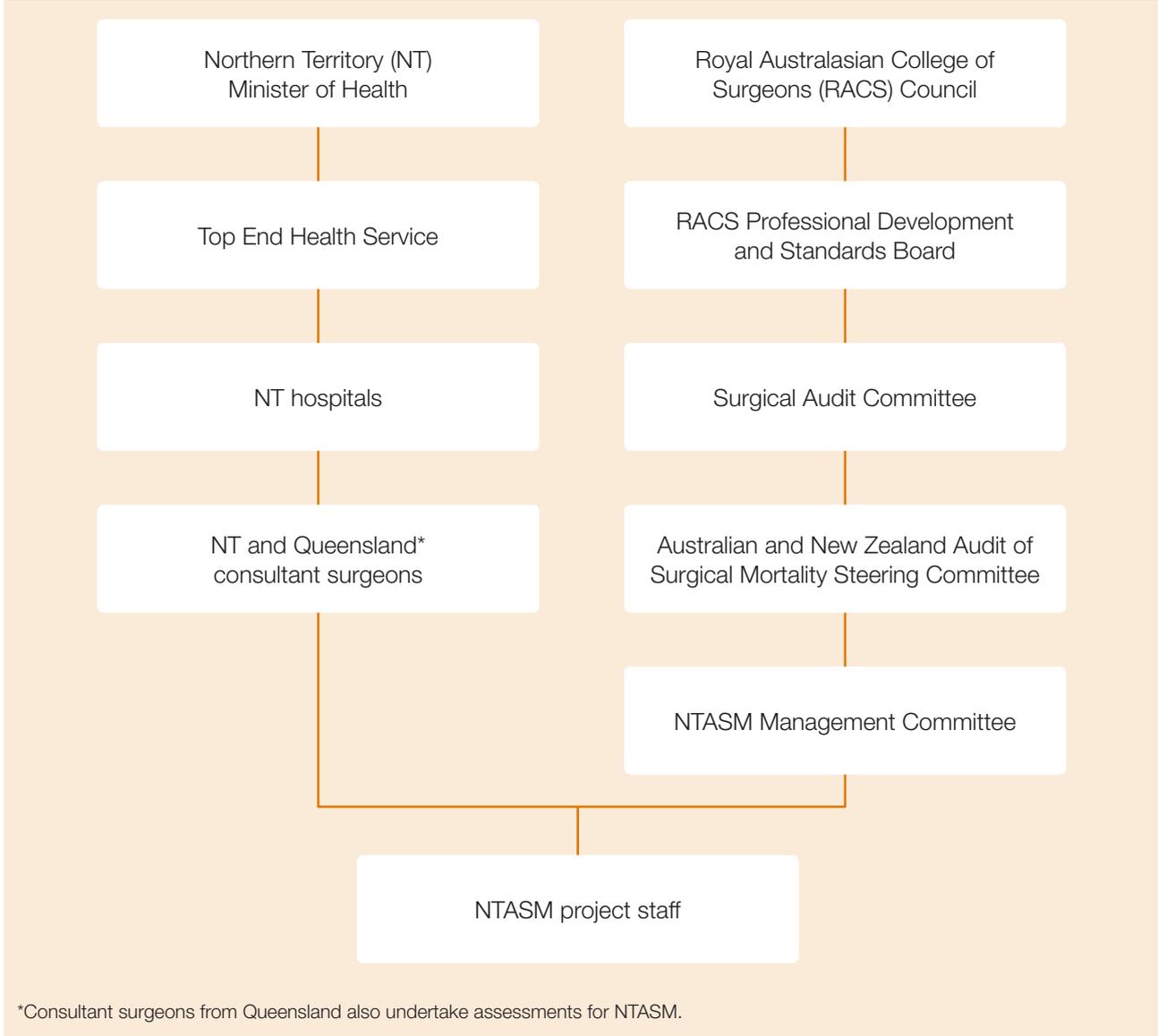
The Royal Australasian College of Surgeons (RACS) became responsible for the management of the Western Australian Audit of Surgical Mortality (WAASM) in 2006. The WAASM was modelled on the Scottish Audit of Surgical Mortality, which began in 1988. The RACS has expanded the program to all other states 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.

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 398 first-line assessment reports and 50 second-line assessment reports to NT surgeons.
- published 18 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. This publication is of interest not only to NT surgeons, but to all who are involved in patient care in the NT, from emergency department managers to hospital executive teams. A list of the volumes, their titles and/or themes is provided in Appendix A.

1.2.2 Presentations, publications and commendations

- Dr Jacob, a surgeon at the Alice Springs Hospital and the Alice Springs representative on the NTASM management committee, was awarded the Aboriginal and Torres Strait Islander Health Medal by RACS in 2015.
- Dr Treacy, a NT surgeon and Chair of the NTASM Management Committee, was the lead author of an article published in the Australian and New Zealand Journal of Surgery titled “Outcomes from the Northern Territory Audit of Surgical Mortality: Aboriginal deaths”.⁽³⁾ The article used NTASM data and showed that the standard of surgical care was the same for Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons. The article highlighted that an age gap at the time of death still exists between Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons.

Findings from the study prompted a letter from the NTASM to the federal government. The Minister for Indigenous Affairs subsequently acknowledged the NTASM age gap and equivalency in the standard of surgical care for Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons.

- Seminars held in Brisbane and the Gold Coast (Queensland) over the audit period have been well attended by NT surgeons. One session was convened by an NT surgeon. The seminars have focused on the following issues:
 - Queensland 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 & evidence-based practice (2016)
 - Captain of the Ship? – a surgeon’s role in safety and quality (2017).
- 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 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).
- 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).
- The NTASM's manager was an active member of the 2015 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.
- 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 Treacy, chair of the NTASM Management Committee and an 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.

1.3 NTASM AUDIT PROCESS

1.3.1 Methodology

The NTASM is directly notified of all in-hospital surgically-related deaths via the surgical or medical records departments of participating NT hospitals. All cases in which a surgeon was responsible for, or had significant involvement in, the care of the patient are included in the audit, irrespective of whether the patient underwent a surgical procedure.

The clinical details relating to the management of each case are recorded on a standard structured questionnaire known as an SCF, which is completed by the consultant surgeon associated with the case. The completed SCF is de-identified by NTASM and sent for first-line assessment to a surgeon of the same specialty.

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

Cases may be referred for second-line assessment if:

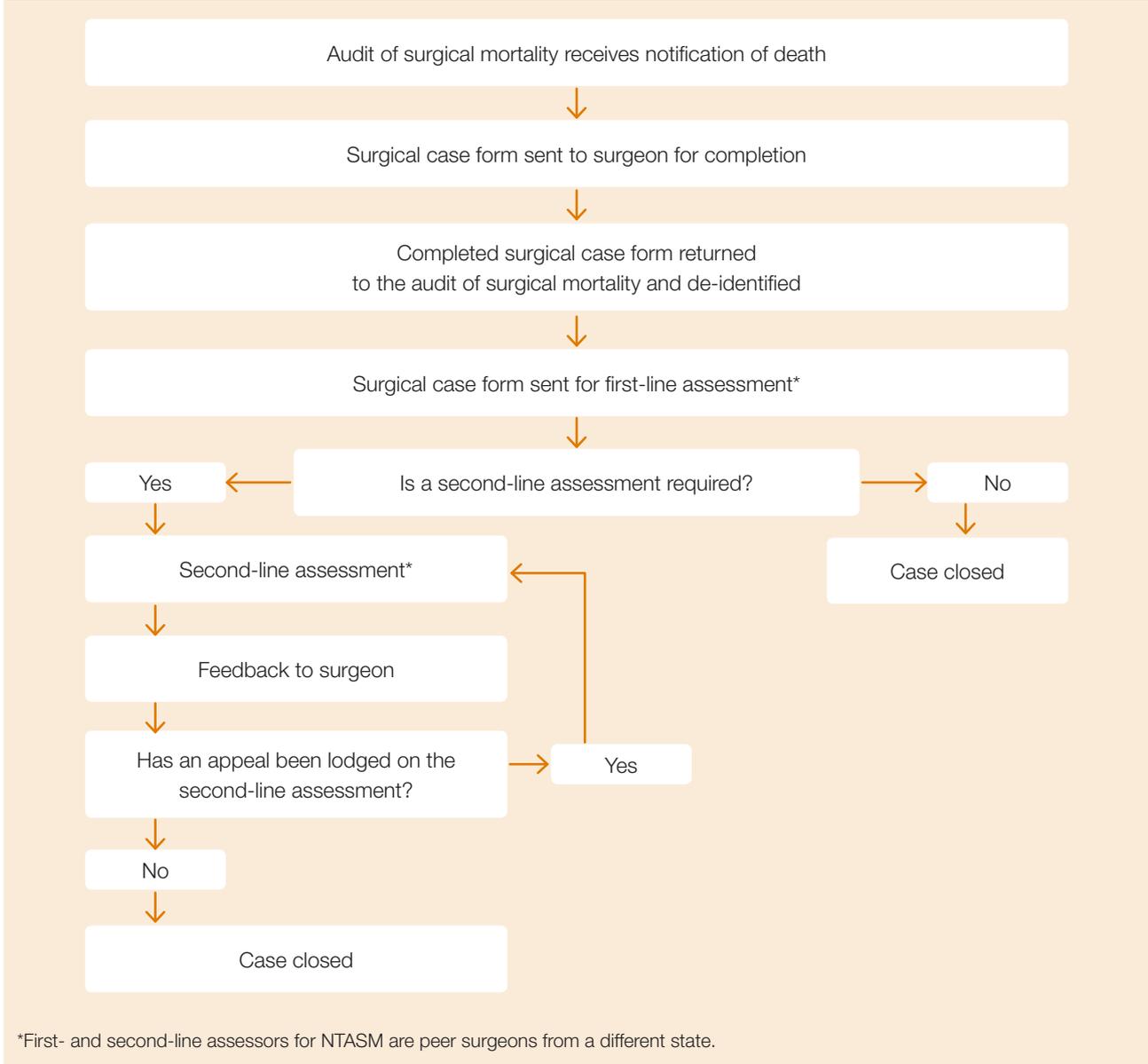
- an area of concern or adverse event is thought to have occurred during the clinical care of the patient and warrants further investigation.
- a second-line assessment report could usefully draw attention to an area of surgical practice, providing an educational opportunity for the surgeon involved in the case or for a wider audience as part of 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 based on the same criteria as used for the first-line assessor. Second-line assessors are generally considered experts in the area under review.

On occasion, a surgeon may appeal the findings of the second-line assessment. In these instances the clinical director selects a third assessor to perform a second-line assessment. The same criteria raised by the first-line assessor again form the basis of the review. 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



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, as outlined below.

- Surgeons receive written feedback from assessors regarding their cases.
- Surgeons receive the NTASM report. The report is also available from the NTASM section of the RACS website: www.surgeons.org/ntasm.
- Surgeons receive de-identified summaries of second-line assessments from cases in the form of the *Lessons from the Audit* series. Surgeons also receive the National Case Note Review Booklet, which comprises case studies drawn from cases across Australia.
- Hospitals participating in NTASM receive clinical governance reports on aggregated, de-identified data comparing their hospital to the averages of other hospitals across Australia.
- Surgeons can view reports relating to their own audit data and assessments online 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 before admission and do not have operations are excluded from the full audit process.

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

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

Cases that do not meet the inclusion criteria are excluded from the audit by the notifying hospital. A case will also be excluded in instances where the NTASM is notified of a death but subsequently decides that the case does not fall within the inclusion criteria.

1.4 REPORTING CONVENTIONS

1.4.1 Reporting clinical incidents

Surgeons and assessors are asked to review the case and determine whether there were any clinical incidents where care could have been improved. These are then classified in relation to whether the death was a direct result of the disease process alone, or if aspects of management of the patient might have contributed to that outcome. If there was a perception that the clinical management may have contributed to death, the clinical incidents are reported against the following hierarchical 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 death
 - may have contributed to 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.

First- and second-line assessors are asked to respond to the same matrix of questions as part of the review process. This results in a two-level peer-review process for those 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- or second-line assessor. Throughout the report, first- 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

Clinical incident findings are expressed in terms that cannot identify the patient, the surgeon or the hospital.

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

Cases may be associated with more than one clinical incident. Some of the clinical incident analysis is undertaken per case. For these analyses, a case with more than one clinical incident will be assigned the most serious incident.

1.4.4 Data management

This report covers deaths reported to the NTASM from 1 July 2010 to 30 June 2017. Seven years of data collection is included in this report. All data presented in this report is from the NTASM database unless otherwise specified. The nature of the audit process means that some cases reported during this period will still be undergoing review as at the census date (31 July 2017). These cases will be included in the next report.

Surgeons can complete the SCF and first-line assessment online, while data from paper forms 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 cases analysed. As not all data points were completed, the total number of cases used in the analyses varies. The numbers of cases 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 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).

1.4.6 Data comparisons

In this report the NTASM data are compared with the national ANZASM Report 2016⁽¹⁾ and its associated dataset. National and state-based comparisons against NTASM data provide context to the NTASM data in this report. These comparisons allow an easy assessment of healthcare standards overall, and may assist the NT Department of Health with future program planning aimed at improving the safety and quality of surgical care in the NT.

2 AUDIT OVERVIEW

Key Points

- There were 459 surgically-related deaths reported to NTASM over the 7 years of the audit.
- All 396 cases included in this audit have completed the full audit review process.

2.1 OVERVIEW OF NTASM CASES

An overview of NTASM cases is provided in Table 1 below. Assessors completed 398 first-line assessments and 50 second-line assessments.

By the census date of 31 July 2017:

- 9 SCFs were pending
- 2 first-line assessments were pending
- 2 second-line assessments were pending
- 12.6% (50/396) of audited cases had undergone second-line assessment.

Table 1: Overview of NTASM cases in the audit reporting period 2010 to 2017 (n=459)

Audit report period 2010–2017	Number of cases
Closed cases	396
Surgical case forms pending	9
Cases with first-line assessments complete (awaiting second-line assessment)	2
First-line assessments pending	2
Excluded (terminal care case)	35
Excluded (error)*	15
Total reported deaths	459

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.

3 RESULTS

3.1 CLINICAL INCIDENTS

Key Points

- No clinical issues were identified in 74.7% (296/396) of patients.
- An area of concern or adverse event occurred in 10.1% (40/396) of patients.
- An area of consideration occurred in 15.2% (60/396) of patients.
- Assessors considered that of the areas of concern and adverse events 37.5 % (15/40) were definitely preventable.

Clinical incidents, as defined by NTASM, include:

- **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- and second-line assessors report on the occurrence of clinical incidents for each patient. Assessors may identify more than one clinical incident per patient. In this report when more than one clinical incident occurred in a patient, the most severe incident has been reported.

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

Over the 7 year audit period, assessors reported that:

- there were no clinical incidents in 74.7% (296/396) of patients
- an area of consideration occurred in 15.2% (60/396) of patients
- an area of concern occurred in 6.3% (25/396) of patients.
- an area of adverse event occurred in 3.8% (15/396) of patients.

When no clinical incidents are combined with areas of consideration, the total number of patients with no or minor criticisms or suggestions regarding treatment was 89.9% (356/396).

The proportion of NTASM patients for whom an area of concern or adverse event was identified (10.1%; 40/396) was lower than that for ANZASM patients (11.0%; 3,655/33,356)⁽¹⁾. The difference was not statistically significant (RR 0.92; 95% CI 0.68 to 1.24).

Assessors also report on the preventability of clinical incidents. Table 2 shows the preventability of most severe clinical incidents (areas of concern and adverse events) that occurred in 40 patients.

- Of the patients with areas of concern or adverse events, assessors felt 37.5% (15/40) of those events were definitely preventable.

Preventability	Number of cases
Definitely preventable	15 (39%)
Probably preventable	17 (43%)
Probably not preventable	7 (18%)
Data not available: n=1 (2.5%).	

Of the 32 definitely and probably preventable areas of concern and adverse events, the most common categories* were:

Patient assessment problems (9)

- Choice of operation
- Decision to operate
- Delay in diagnosis
- Preoperative preparation.

Delays (6)

- Delay in recognising postoperative complication
- Delay to transfer to the ICU
- Delay in seeking surgical input
- Delay to diagnosis – malignancy missed on computed tomography scan
- Delay to operation.

Suboptimal therapy (6)

- Incorrect placement of tubes/drains
- Fluid balance concerns
- No documentation of drug administration
- No documentation of discussion with patient
- Procedure performed in unstable patient
- Postoperative care.

Communication failures (3)

Diagnosis-related complication (2)

Radiological surgery – technical (2)

Open surgery – organ related (1)

Laparoscopic surgery – technical (1)

Drugs related factors (1)

Patient related factors (1)

Preventable areas of concern and adverse events were associated with various teams and hospital departments. They may also be associated with more than one team or department. Assessors indicated that the following teams and hospital departments were associated with the 32 preventable areas of concern and adverse events:

- surgical team (20 patients)
- another clinical team (16 patients)
- hospital (1 patient)
- other causes (ICU, radiology and an initial procedure; 3 patients).

*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⁾

3.2 SURGEONS

Key Points

- All NT surgeons participated in the audit.
- Half of the NT RANZCOG fellows participated in the audit.
- Most anaesthetists have participated in the audit since 6 June 2016.
- The NT relies on locum surgeons to supplement the surgical workforce.
- The number of consultant surgeons supervising in theatre in the NTASM is high.

3.2.1 Overview

- All 28 NT surgeons participated in the audit.
- Of the 15 RANZCOG fellows in the NT, 8 participated in the audit. Participation is voluntary.
- Of the 46 anaesthetists in the NT, 37 have agreed to participate in the audit. Participation is voluntary.

There were also 15 locum surgeons who participated in the audit. Historically, locum surgeon 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 becomes standard practice for all locum surgeons when a death occurs while they are still at the hospital.

3.2.2 Audit participation

Table 3 highlights audit participation by specialty.

RACS Fellows

All of the participating surgeons are Fellows of RACS. Surgeons must have their RACS Fellowship in order to perform first- and second-line assessments.

Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG) Fellows

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

- No Obstetrics and Gynaecology cases were reported.
- NT obstetricians and gynaecologists have acted as assessors for Obstetrics and Gynaecology cases for the Queensland Audit of Surgical Mortality.

Australian and New Zealand College of Anaesthetists (ANZCA) Fellows

Participation in the audit is voluntary for anaesthetists. Participating anaesthetists are ANZCA Fellows, although they may also be accredited general practice anaesthetists. Fellows of ANZCA can participate as first- and second-line assessors for anaesthetic-related cases.

- 11 anaesthetic cases were reported, of which 8 (72.7%) have completed the audit process.
- NT anaesthetists have assessed eight Tasmanian Audit of Surgical Mortality cases.

Table 3: Participation by specialty

Specialty	Number participating*
Anaesthetists	37
General Surgery	16
Obstetrics & Gynaecology	8
Orthopaedic Surgery	4
Otolaryngology, Head and Neck Surgery	2
Plastic and Reconstructive Surgery	2
Vascular Surgery	1
Urology	1
Oral and Maxillofacial Surgery	1
Total	72

*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 SCFs

As at the census date, 98.0% (450/459) of all SCFs had been completed and returned to NTASM.

- The median time taken to return a SCF was 56 days, ranging from less than 1 day to 654 days.
- 10 SCFs were returned in less than 1 day, and these SCFs were completed online.
- 36 SCFs were returned within 1 week.
- For those cases that had completed the audit process, most of the SCFs were completed by the consultant in charge of the case (see Table 4 below).

Table 4: Grade of surgeon completing the surgical case form (n=396)

Surgeon grade	Number of cases
Consultant	337/396 (85%)
Fellow	18/396 (5%)
SET trainee	16/396 (4%)
IMG	14/396 (4%)
Service registrar	11/396 (2%)

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

3.2.4 Consultant surgeon involvement in operations

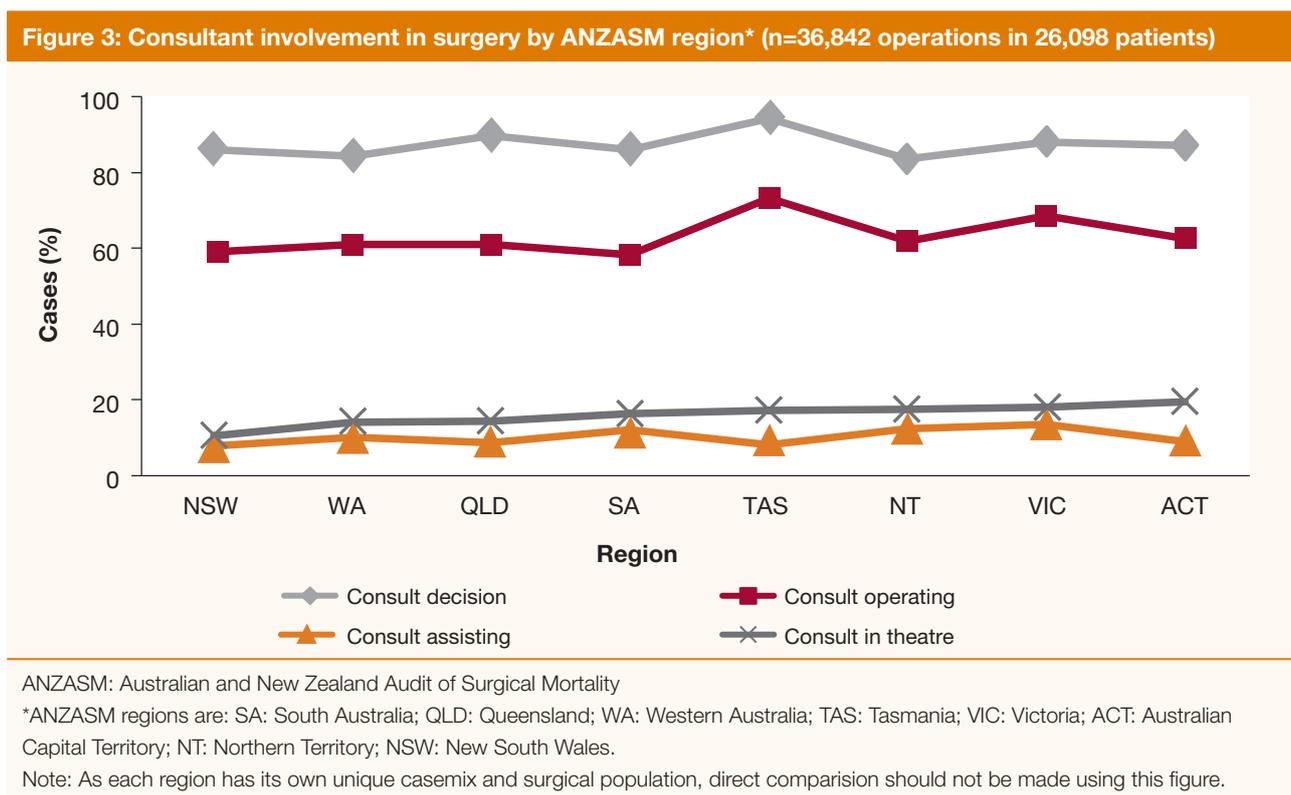
In total there were 506 operations performed on 301 patients. Two or more operations were performed on 96 patients, with the number of operations for these patients ranging from 2 to 12. The level of consultant input into the surgical management of patients was high. The distribution of grades of NTASM surgeons and their roles in the operating theatre is shown in Table 5. An overview of consultant involvement in surgery by region is shown in Figure 3.

- Consultant surgeons made the decision to operate in 85.6% (433/506) of operations.
- The consultant surgeon operated in 62.6% (317/506) of operations.
- As two of the participating hospitals are teaching hospitals, it was expected that Surgical Education and Training (SET) trainees and service registrars would be deciding to operate as well as performing operations. The rate of SET trainees deciding was 3.3% (17/506) in NTASM.

Table 5: Grade of NTASM surgeon deciding, operating, assisting or in theatre

	Deciding	Operating	Assisting	In theatre
Consultant	86% (433/506)	63% (317/506)	12% (61/506)	17% (88/506)
SET trainee	3% (17/506)	12% (62/506)	21% (105/506)	3% (17/506)
Service registrar	1% (6/506)	5% (26/506)	14% (70/506)	2% (12/506)
IMG	2% (9/506)	4% (22/506)	7% (22/506)	1% (2/506)
Fellow	2% (11/506)	15% (78/506)	12% (59/506)	2% (12/506)
GP surgeon	0% (0/506)	0% (0/506)	0% (0/506)	0% (0/506)

Note: the column percentages do not add up to 100%. In many cases 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; GP: general practice.



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. Supervision in the NT is comparable with other regions in ANZASM (see Figure 3).

- SET trainees performed 62 operations, and in 87.1% (54/62) of these operations the consultant made the decision to operate.
 - The SET trainee was assisted by the consultant in 9.7% (6/62) of these operations.
 - The consultant was present in the operating theatre for 14.5% (9/62) of the operations.
- IMGs performed 22 operations, and in 72.7% (16/22) of these operations the consultant made the decision to operate.
 - The IMG was assisted by the consultant in 18.2% (4/22) of these operations.
 - The consultant was present in the operating theatre for 22.7% (5/22) of the operations.
- Service registrars performed 26 operations, and in 73.1% (19/26) of these operations the consultant made the decision to operate.
 - The service registrar was assisted by the consultant in 7.7% (2/26) of these operations.
 - The consultant was present in the operating theatre for 19.2% (5/26) of the operations.

3.2.6 Specialty of surgeon

An overview of the number of patients admitted for each surgical specialty is provided in Table 6. Although there are surgeons of various specialties working in the NT, surgically-related deaths primarily occurred in three specialties: General Surgery, Orthopaedic Surgery and Vascular Surgery.

Table 6: Surgical specialty and number of patients admitted (n=396)		
Specialty	Number of patients	Percentage of patients
General Surgery	314	79%
Orthopaedic Surgery	39	10%
Vascular Surgery	25	6%
Other*	18	5%
Total	396	100%

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

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

Orthopaedic Surgery patients who died were older than General Surgery and Vascular Surgery patients, as shown in Table 7.

Table 7: Median patient age by assigned surgical specialty (n=396)		
Specialty	Median age (years)	Interquartile range (years)
General Surgery (n=314)	62	47–73
Orthopaedic Surgery (n=39)	75	62–85
Vascular Surgery (n=25)	68	61–75
Other* (n=16)	66	48–70

*Other surgical specialties include Neurosurgery, Otolaryngology Head and Neck Surgery, Ophthalmology, Oral and Maxillofacial Surgery and Urology. [data missing for 2 patients].

3.2.8 Treating surgeon and assessor views on patient management

A comparison of surgeon and assessor views on the areas in which patient management could have been improved is provided in Table 8. The surgeon's views for each case are compared with those of the first-line assessor. In general, there was strong agreement between the views of the surgeons and those of the first-line assessors.

Surgeons identified the *decision to operate* as the area requiring the most improvement. Assessors reviewing cases considered *preoperative management* to be the area requiring the most improvement.

Table 8: 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=333)	First-line assessors' views (n=379)
Preoperative management	7%	11%
Decision to operate	8%	6%
Choice of operation	3%	5%
Timing of operation	7%	6%
Intraoperative management	4%	5%
Grade of surgeon operating	1%	2%
Postoperative care	4%	5%

Note: more assessors than surgeons completed this part of the form.

3.2.9 Operation duration

Duration of 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 81.4% (412/506) of operations. There was substantial variation in the time spent in theatre for patients who died in the perioperative period.

- The median operation duration was 97 minutes (IQR 60 to 120 minutes).
- The minimum operation duration was less than 10 minutes.
- The maximum operation duration was 540 minutes.
- Of the operations performed, 13.8% (57/412) had a duration of 180 minutes or more.

Clinical incidents were twice as likely to occur in NTASM patients when the operation duration was 180 minutes or more (36.8%; 21/57) compared with operations of less than 180 minutes duration (16.3%; 58/355 - RR 2.26; 95% CI 1.49 to 3.41)

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 19 cases.

- In 82.0% (309/377) of cases the surgeon would not have changed the patient's management.
- In 18.0% (68/377) of cases 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 had a joint admission with surgical and medical teams.*
- *Contributed more actively to management strategy.*
- *Asked a family/community member to act as a health advocate to guide the patient in their decision making.*

Preoperative care

- *Earlier endoscopy / imaging may have allowed diagnosis sooner.*
- *Earlier cardiology input and management would have been preferred.*

Choice of procedure

- *Choice of procedure.*
- *Possibly placed a biliary stent at the first operation.*

Decision to perform the operation

- *The decision to perform the procedure considering the extensive comorbidities of the patient.*
- *I should have been more persuasive and counselled the patient not to have the operation.*
- *The patient's young age was a compelling factor in my decision to operate.*

Postoperative care

- *Early referral to palliative care and return to community care facility.*
- *Fluid imbalance may have slightly hastened this frail elderly patient's outcome.*

3.2.11 Anaesthetic cases reported by surgeons

Surgeons are asked to indicate on the SCF whether they believe there was an anaesthetic component to the patient's death. Participation in NTASM by anaesthetists is voluntary. Reportable anaesthetic deaths in the NTASM are identified when a surgeon indicates there was an anaesthetic component to the death (definitely or possibly), or if the death occurred within 48 hours of the last anaesthetic. Anaesthetists are also able to self-report anaesthetic deaths to the NTASM. Since June 2016, all anaesthetic cases are anonymously peer reviewed and feedback is provided to the consultant anaesthetist responsible for the case.

Prevalence of possible or likely anaesthetic component to death in NTASM:

- 1.7% (5/297) of cases were thought to have an anaesthetic component to the death.
- 3.7% (11/297) of cases were thought to have possibly had an anaesthetic component to the death.
- 33.5% (90/269) of deaths occurred within 48 hours of the last anaesthetic.

The prevalence of cases thought to have an anaesthetic component associated with the death was similar in ANZASM: ⁽¹⁾

- 1.5% (373/25,622) of cases were thought to have an anaesthetic component to the death.
- 6.0% (1,544/25,622) of cases were thought to have possibly had an anaesthetic component to the death.
- 26.4% (4,696/17,802) of deaths occurred within 48 hours of the last anaesthetic.

3.3 HOSPITALS

Key Points

- All NT hospitals participated in the NTASM, including a day surgery facility.
- Interhospital transfer was required for 12.7% (49/386) of patients.
- A delay in obtaining the main surgical diagnosis occurred in 9.0% (35/388) of cases.

3.3.1 Hospital participation

All hospitals, and the one day surgery facility, in the NT participated in NTASM. Data in this report is from public and private hospitals that service Central Australia and the whole Top End of the Northern Territory.

3.3.2 Hospital admissions

The majority of hospital admissions were emergencies. Emergency admissions comprised 92.5% (358/387) of all hospital admissions while elective admissions comprised 7.5% (29/387). [data not available: n=9]

- Operations were performed on 89.7% (26/29) of elective admission patients.
- Operations were performed on 74.3% (266/358) of emergency admission patients.
- Interhospital transfers occurred in 12.7% (49/386) of patients. [data not available: n=10]
- Transfer was considered appropriate in 93.5% of patients (43/46) and delayed in 11.1% of patients (5/45).
- Of the patients who were transferred, 93.9% (46/49) had appropriate levels of care during the transfer and sufficient information was provided by the transferring hospital to the receiving hospital. [data not available: n=3]
- The geographical location of tertiary hospitals in the NT results in long distance interhospital transfers. The median distance was 315 kilometers (IQR 300 to 761), with a maximum distance of 1500 kilometers.

3.3.3 Delays in main surgical diagnosis

Delays and errors in diagnosis are important factors that contribute to perioperative death.⁽⁶⁾ There was a delay in obtaining the main surgical diagnosis in 9.0% (35/388) of cases. Data was not available for eight patients.

These delays, which often can be attributed to more than one department, were associated with the surgical unit (n=14) and medical unit (n=7).

Delays in the main surgical diagnosis were primarily due to unavoidable causes (n=11), inexperienced staff (n=9) and misinterpretation of results (n=4). Other reasons for delay were related to disease pathology (unusual, rare or atypical disease), patient factors (transfer, optimisation and delayed presentation) and the hospital.

3.3.4 Surgical diagnosis

For the patients who had an operation (n=301), the most frequent surgical diagnoses on admission were:

- malignancy (n=43)
- peripheral vascular disease and/or leg ulcers or cellulitis (n=41)
- severe head injury and/or hypoxic brain injury, traumatic subdural haemorrhage (n=40)
- diverticulitis, peritonitis, ischaemic bowel and/or intestinal obstruction or perforation (n=37)
- upper gastrointestinal bleeding, haematemesis and/or bleeding oesophageal varices (n=29)
- fractured neck of femur (n=21)
- cerebral haemorrhage (intracerebral, subarachnoid; n=19)

- necrotising fasciitis (n=17)
- septicaemia or septic shock (n=11)
- cirrhosis, hepatitis, liver disease (n=13)
- cholecystitis, cholangitis (n=10)
- infective arthritis, osteomyelitis (n=7)
- ruptured and non-ruptured abdominal aortic aneurysm (n=7)
- infected wounds (n=6)

3.3.5 Cases with operations

An operation was performed on three-quarters of NTASM patients (76.0%; 301/396).

- A total of 506 operations were performed on 301 patients.
- Of the patients with operations, more males (65.8%; 198/301) than females (34.2%; 103/301) had operations.
- More than one operation was performed on 31.9% (96/301) of patients.

The high rate of returns to theatre may be explained by debridement of skin or muscle being the most common operation. Debridement of skin or muscle often requires repeat operations.

3.3.6 Cases with postoperative complications

Postoperative complications are strong predictors of death.^(7,8) NTASM surgeons reported that 22.3% (67/300) of patients had a postoperative complication. However, the NTASM numbers are low and this data should be interpreted with caution.

This rate of complications is significantly lower than the ANZASM rate of 33.9% (8,675/25,596).⁽¹⁾ (RR 0.66 ;95% CI 0.53 to 0.81).

In the NTASM, 67 patients experienced 93 complications. The number of complications per patient ranged from 1 to 4.

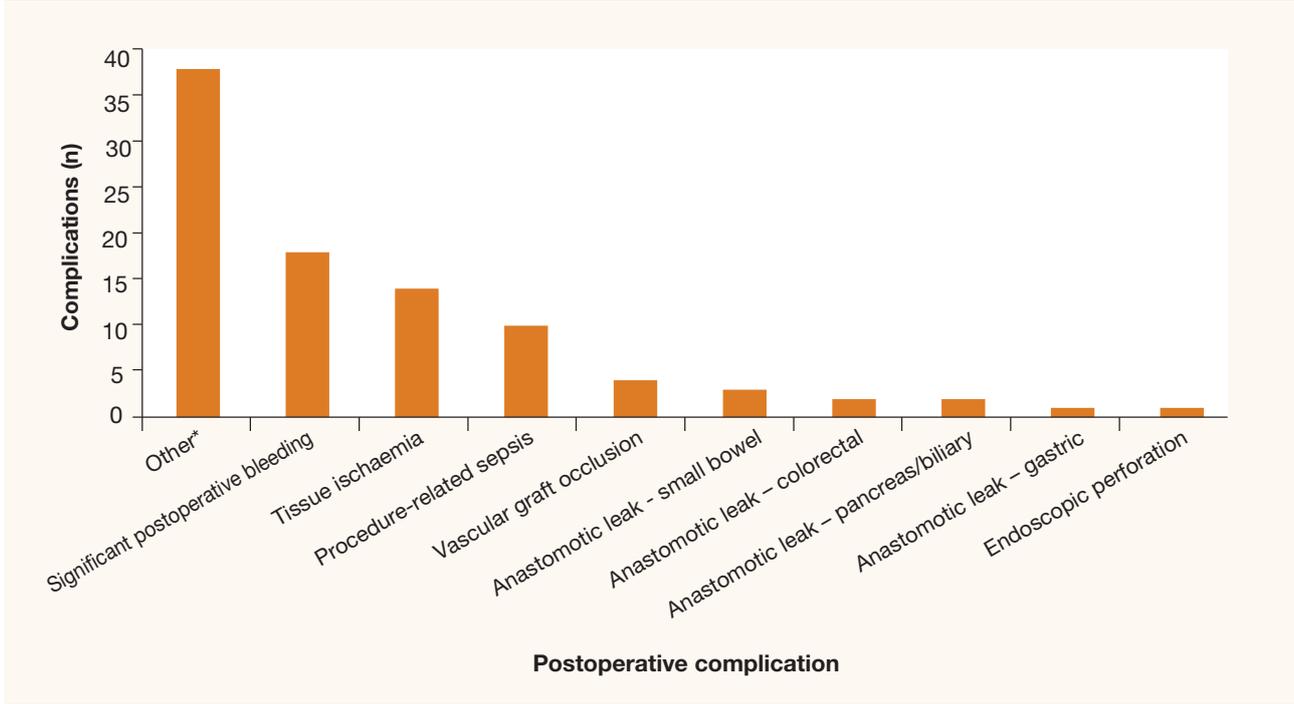
Of the patients with complications, more than half (65.7%; 44/67) had one complication and 26.9% (18/67) had two complications.

Of the patients with two or more complications, 66.7% (12/18) had a significant postoperative bleed and 72.2% (13/18) had more than one operation (maximum six operations).

As shown in Figure 4, the most frequent complications were:

- significant postoperative bleeding (n=18)
- tissue ischaemia (n=14)
- procedure-related sepsis (n=10)
- anastomotic leak, including small bowel, gastric, colorectal and pancreas/biliary (n=9)
- vascular graft occlusion (n=4)
- endoscopic perforation (n=1)

Figure 4: Frequency of NTASM postoperative complications by type (n=93)



NTASM: Northern Territory Audit of Surgical Mortality.

*Includes acute myocardial infarction, alleged pulmonary embolism and bleeding from drain site, anastomotic leak of small bowel, aspiration pneumonia, bleeding after second operation, colonic infarct and ischaemic hepatitis, deep vein thrombosis and pulmonary embolism, disseminated intravascular coagulation, extensive gastric cancer infiltration, failure to heal, failure of adhesion and collapse of mucous fistula, liver failure, lung collapse and infection, multiorgan failure, necrotising fasciitis of abdominal wall, percutaneous transhepatic cholangiography related perforation, perforated peptic ulcer, pneumonia, pneumothorax after insertion of portacath, postoperative ileus, prolonged ileus and respiratory failure, respiratory failure with pulmonary embolism, secondary brain injury, small bowel ischaemia, small bowel obstruction, spinal cord infarction, tongue swelling, wound haematoma and wound dehiscence.

3.3.7 ICU admission

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

- Care in an ICU was received postoperatively by 70.1% (209/298) of patients. [data missing for 30 patients]
- A postoperative unplanned admission to an ICU occurred in 18.2% (52/285) of patients. [data missing for 43 patients]
- In 7.9% (7/89) of cases in which the patient did not receive support from an ICU or high dependency unit, the surgeon believed that the patient should have received such support.

3.3.8 Unplanned returns to theatre

Unplanned returns to theatre and unplanned admissions to an ICU are each strong predictors of death in surgical patients.⁽¹⁰⁻¹²⁾ The rate of unplanned returns to theatre was higher for NTASM patients compared with ANZASM patients.

An unplanned return to theatre occurred in 19.2% (55/287) of NTASM cases, compared with 16.0% (4,026/25,196) of ANZASM cases.⁽¹⁾

The difference in returns to theatre between NTASM and ANZASM cases was not statistically significant (RR 1.20; 95% CI 0.94 to 1.52).

3.3.9 Length of hospital stay

The length of stay for surgical patients is determined by many factors.⁽¹⁰⁾ Most patients, who died, were in hospital for a short time before they died, with 18.9% (75/396) of patients admitted to hospital for 1 day or less. NTASM patients had a similar average length of hospital stay to ANZASM patients (see Table 9).

Table 9: Days in hospital (length of stay) before death in NTASM and ANZASM		
Length of hospital stay	NTASM n=396	ANZASM n=33,449
Median (IQR)	7 days (2–21)	8 days (3–19)
Minimum	<1 day	<1 day
Maximum	230 days	1 166 days

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

3.4 PATIENTS

Key Points

- NTASM patients were younger than those in other regions of Australia.
- The proportion of NTASM patients with hepatic disease was three times that of ANZASM patients.
- The proportion of NTASM patients with diabetes mellitus was twice that of ANZASM patients.

3.4.1 Overview of patients

During the 7 years of the audit 459 patient deaths have been reported, of which 50 were excluded. The excluded cases were either terminal care cases (n=35) or cases that were reported to the audit in error (n=15). NTASM inclusion and exclusion criteria are defined in Section 1.3.3.

Of the reported deaths, 396 have completed the full peer-review process (96.8%; 396/409).

3.4.2 Gender

There were more males than females in both NTASM and ANZASM. But in NTASM, there were 10% more males compared with ANZASM. An overview of the gender distribution in NTASM and ANZASM is shown in Table 10.

Table 10: Gender distribution of NTASM patients compared with ANZASM patients

	Males	Females
NTASM	65% (258/396)	35% (138/396)
ANZASM	55% (18,525/33,438)	45% (14,913/33,438)

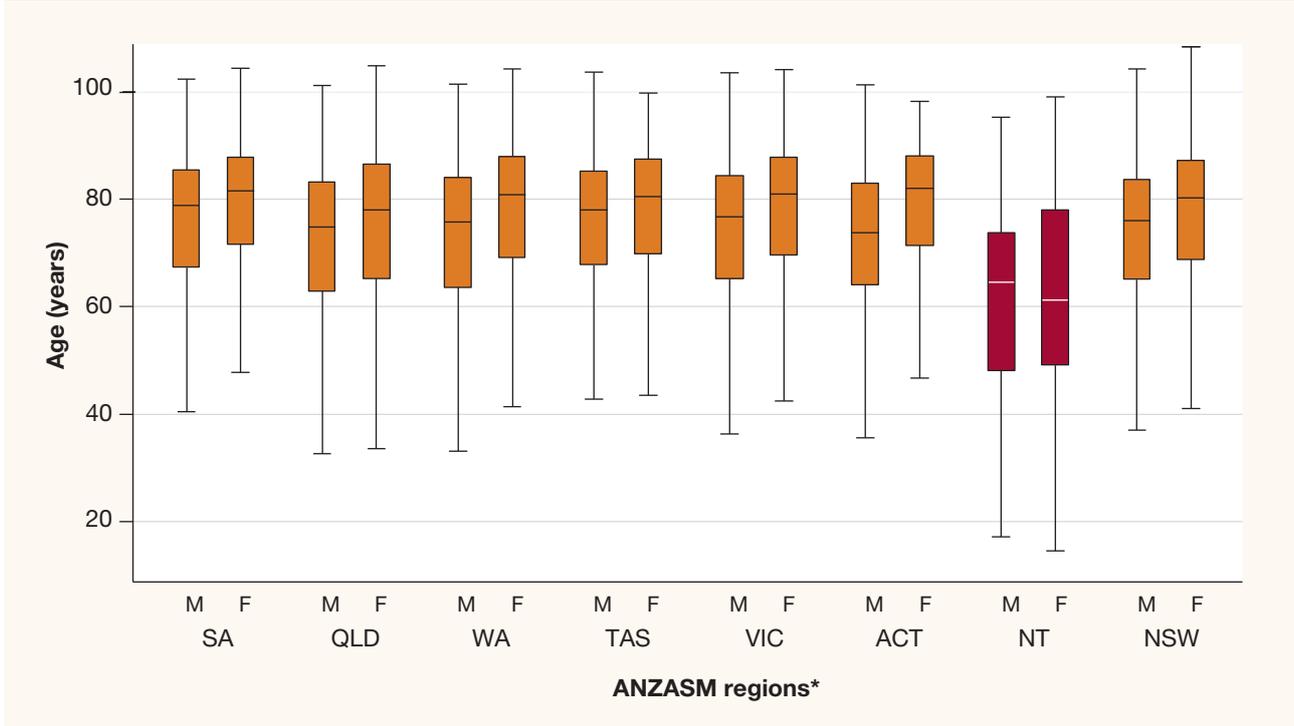
NTASM: Northern Territory Audit of Surgical Mortality (n=396).

ANZASM: Australian and New Zealand Audit of Surgical Mortality (n=33,438)

The median age distribution by gender in the box-and-wisker plot of Figure 5 shows that for NT patients:

- the minimum age was lower compared with other regions, for both males and females.
- the middle 50% of ages was lower than that for national ANZASM regions.
- the median age for males was higher than females which was different from the other regions.

Figure 5: Median age distribution by gender and ANZASM region (n=33,447)



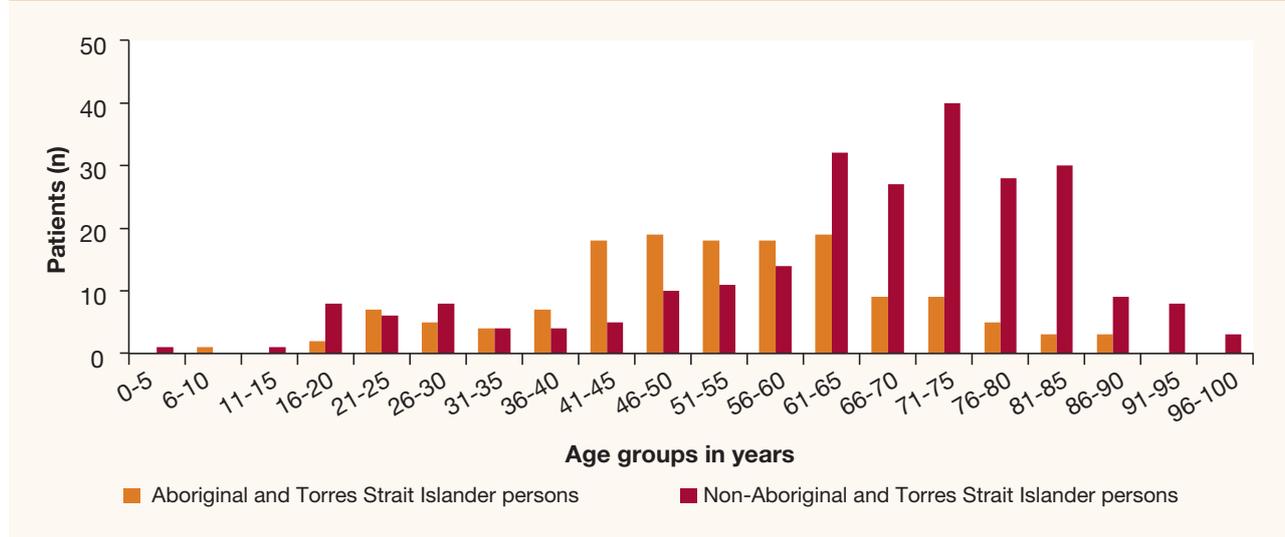
Note: neonates excluded. Data not available: n=3 (<1%).
M: male; F: female.
ANZASM : Australian and New Zealand Audit of Surgical Mortality;
*ANZASM regions are SA: South Australia; QLD: Queensland; WA: Western Australia; TAS: Tasmania; VIC: Victoria; ACT: Australian Capital Territory; NT: Northern Territory; NSW: New South Wales.

In the above box-and-whisker plot figure the central box represents the values from the lower to upper quartile (25th to 75th percentile). The middle line represents the median value. The vertical line extends from the minimum to the maximum value, excluding extreme values.

3.4.3 Age of NTASM patients

In NTASM there is a difference in the age distribution of Aboriginal and Torres Strait Islander patients compared with non-Aboriginal and Torres Strait Islander patients. An overview of the age distribution (in 5-year intervals) of NTASM patients is shown in Figure 6.

Figure 6: Comparison of the 5-year age group distribution of Aboriginal and Torres Strait Islander patients and non-Aboriginal and Torres Strait Islander patients (n=396)



- 78.7% (177/225) of patients aged 61 years and older were non-Aboriginal and Torres Strait Islander persons.
- In patients aged 60 years and younger, 57.9% (99/171) were Aboriginal and Torres Strait Islander persons.
- There were eight Aboriginal and Torres Strait Islander persons older than 80 years, but none were older than 89 years.

3.4.4 American Society of Anesthesiologists class

The American Society of Anesthesiologists (ASA) class is an international measure of patient risk used by anaesthetists.⁽¹³⁾ In the NT, an ASA class is assigned to the patient by the assisting anaesthetist prior to a procedure being undertaken.

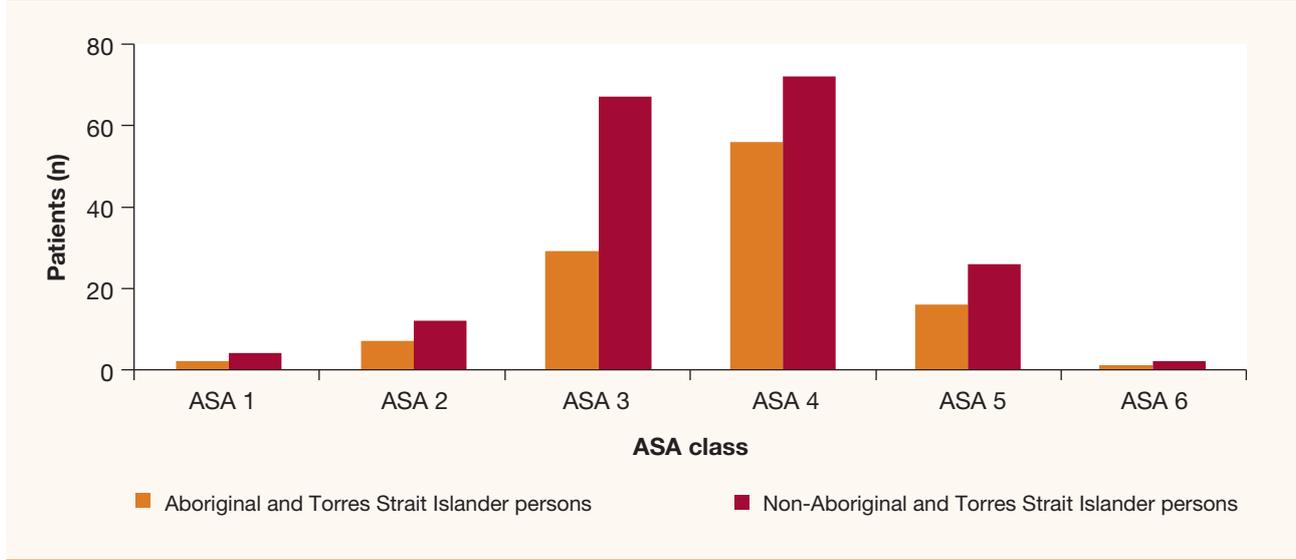
An ASA class indicating the presence of severe disease (ASA class 3 to 6) was assigned to 91.5% (269/294) of patients prior to the patient going to theatre (Figure 7). This is similar to the number of patients in ANZASM who were assigned an ASA class of 3 to 6 (90.3%; 28,165/31,205).⁽¹⁾

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. ⁽¹³⁾

Figure 7: Distribution of ASA class for NTASM patients (n=294)



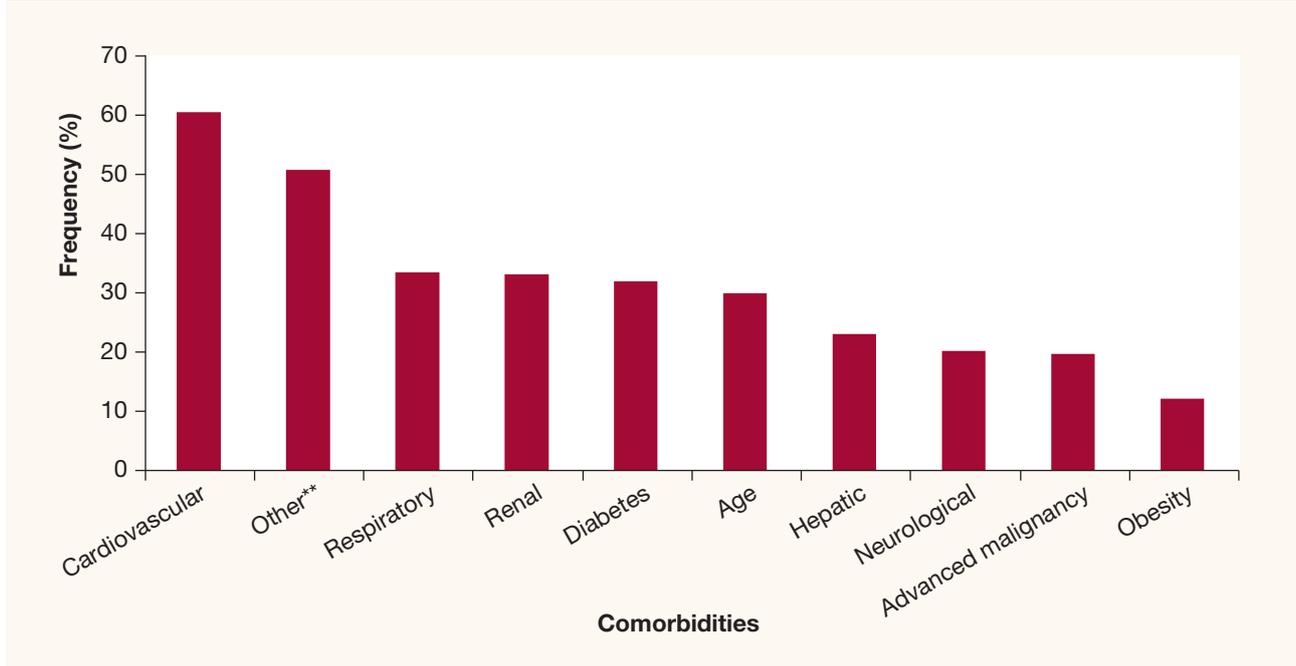
Data not available: n=7.
 ASA: American Society of Anesthesiologists; NTASM: Northern Territory Audit of Surgical Mortality.

3.4.5 Comorbidities

Comorbidities are a stronger predictor of mortality than the type of surgery.⁽⁶⁾ Serious comorbidities were present in 80.5% (318/395) of NTASM patients. There were 997 comorbidities in 318 patient, with 270 patients having more than one serious comorbidity. Of NTASM patients with comorbidities, the median number of comorbidities per patient was 3 (IQR, 2 to 4). Two patients had eight comorbidities.

- The median number of comorbidities for ANZASM patients was also 3.⁽¹⁾
- Cardiovascular disease, respiratory disease, renal disease and diabetes were the most common comorbidities in NTASM patients (see Figure 8).
- The comorbidities of cardiovascular disease, respiratory disease and age were higher in ANZASM patients than in NTASM patients (see Figure 9).

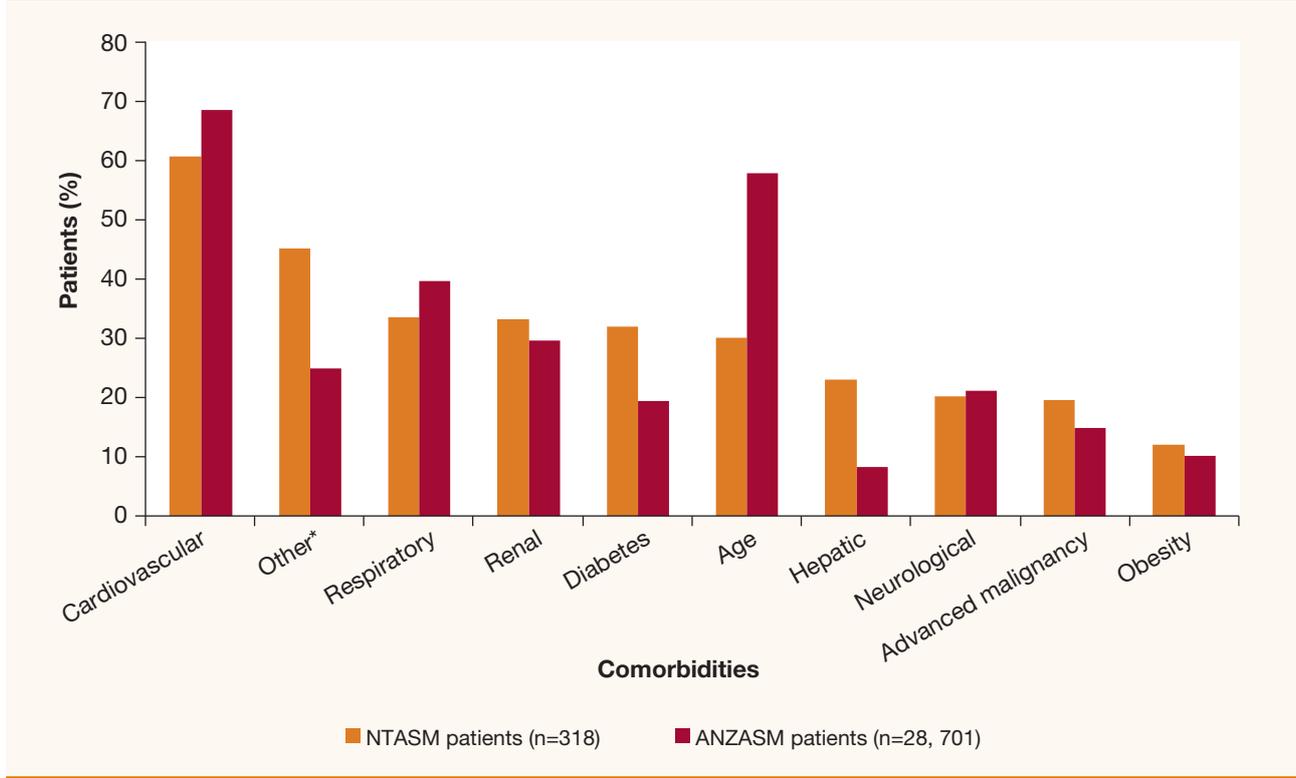
Figure 8: Distribution of comorbidities in patients(n 318)*



*The percentages do not total 100% as the median number of comorbidities per patient was 3 (range 1 to 8).
 **The most common 'other' comorbidities were alcohol abuse, malnutrition, mental health/dementia, vascular disease, heavy smoking, coagulopathy and hypertension.

- The proportion of NTASM patients with hepatic disease (23.0%; 73/318) was nearly three times higher than the proportion of ANZASM patients with hepatic disease (8.2%; 2,347/28,701).⁽¹⁾ (RR 2.81; 95% CI 2.29 to 3.45).
- The proportion of NTASM patients with diabetes mellitus (31.8%; 101/318) was significantly higher than the proportion of ANZASM patients with diabetes mellitus (19.4%; 5,557/28,701).⁽¹⁾ (RR 1.64; 95% CI 1.39 to 1.93).
- NTASM patients had a reduced risk of cardiovascular disease (60.4%; 192/318) compared with ANZASM patients (68.2%; 19,586/28,701).⁽¹⁾ (RR 0.88; 95% CI 0.81 to 0.97). This may be an effect of the younger age of NTASM patients.

Figure 9: Distribution of comorbidities in NTASM patients compared with ANZASM patients



NTASM: Northern Territory Audit of Surgical Mortality; ANZASM: Australian and New Zealand Audit of Surgical Mortality
 *Other comorbidities in both NTASM and ANZASM patients covered a wide range. In NTASM patients these included active smoking, alcohol abuse, anaemia, anticoagulation, chronic alcoholism, Child B cirrhosis, Child C cirrhosis, coagulopathy, dementia, hepatitis C, human immunodeficiency virus, ischaemic heart disease, malnutrition, peripheral vascular disease and sepsis. In ANZASM patients they included alcohol abuse, anaemia, anticoagulation, bowel ischaemia, cachexia, cellulitis, coagulopathy, dementia, human immunodeficiency virus/acquired immunodeficiency syndrome, malnutrition, motor neurone disease, polymyalgia rheumatic, rheumatoid arthritis, sepsis and systemic lupus erythematosus.

3.4.5.1 Alcohol abuse

Based on the informal reporting of alcohol abuse, NTASM patients were five times more likely to have it reported than ANZASM patients (see Table 11). Some surgeons choose to report alcohol abuse as an “other” comorbidity, although it is not a formal comorbidity question. Evidence of alcohol abuse is based on professional opinion and judgement.

The reported rate in NTASM patients may be related to the hepatic disease comorbidity.

Table 11: Informal reporting of alcohol abuse as a proportion of “other” comorbidities in NTASM and ANZASM patients			
	NTASM	ANZASM	Risk Ratio (95% CI)
Alcohol abuse	32% (46/142)	6% (509/8002)	5.09* (3.95, 6.55)

*Statistically significant
 ANZASM: Australian and New Zealand Audit of Surgical Mortality; CI: confidence interval; NTASM: Northern Territory Audit of Surgical Mortality.

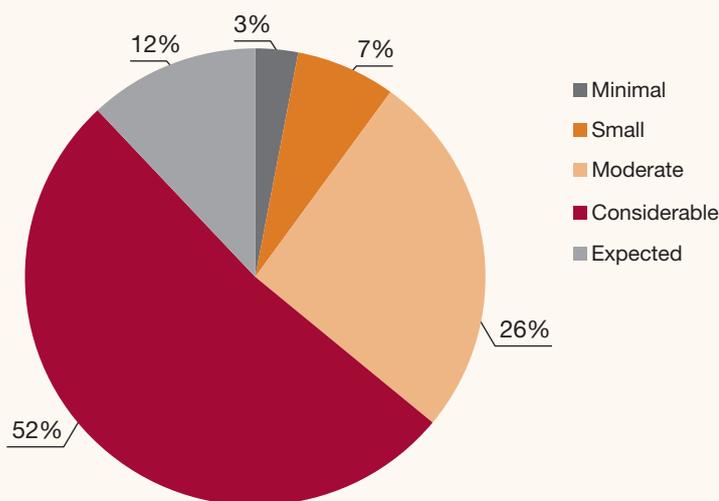
3.4.6 Risk of death

While the risk of surgical mortality is generally low, there are patients who are at a higher risk.^(14,15)

Surgeons were asked to rate the overall risk of death, prior to surgery, for each patient. The distribution of the risk of death is shown in Figure 10.

- The risk of death was considerable or expected in 64.8% (193/298) of patients, similar to the risk reported in ANZASM patients (62.5%; 15,987/25,581).⁽¹⁾

Figure 10: Proportion of patients at risk of death prior to surgery, as perceived by surgeons (n=298)



Data not available: n=3.

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 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

Data reporting for Aboriginal and Torres Strait Islander persons status in the NTASM commenced in July 2010. Data reporting for Aboriginal and Torres Strait Islander persons status in the national ANZASM regions commenced in January 2011. ANZASM has limited Aboriginal and Torres Strait Islander persons status data from Western Australia and Tasmania. ANZASM has no Aboriginal and Torres Strait Islander persons status data from New South Wales.

Since 2011, surgically-related deaths of Aboriginal and Torres Strait Islander patients have predominantly occurred in Queensland (37.4%; 157/419), the NT (32.9%; 138/419) and South Australia (14.3%; 60/419). The remaining 64 deaths occurred in the other regions.⁽¹⁾

For the analyses in this section, all of the ANZASM cases involving an Aboriginal and Torres Strait Islander person (since 2011) are compared with all NTASM cases involving an Aboriginal and Torres Strait Islander person.

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 was reflected in the surgical audit population, with the NTASM having a higher percentage of Aboriginal and Torres Strait Islander persons than the ANZASM.

- 37.1% (147/396) of NTASM patients were Aboriginal and Torres Strait Islander persons.
- 2.8% (419/14,787) of ANZASM patients were Aboriginal and Torres Strait Islander persons.⁽¹⁾

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. This was also seen in ANZASM patients, as shown in Table 12.
- The difference in the median age of Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons was 17 years in NTASM and 23 years in ANZASM.⁽¹⁾

The age distribution of Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons is shown in Table 12.

Table 12: Age at death of Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons in both NTASM and ANZASM

	NTASM n=396		ANZASM n=11,291	
	Age at death of Aboriginal and Torres Strait Islander persons (n=147)	Age at death of Median non- Aboriginal and Torres Strait Islander persons (n=249)	Age at death of Aboriginal and Torres Strait Islander persons (n=419)	Age at death of non-Aboriginal and Torres Strait Islander persons (n=14,368)
Median (IQR)	53 years (44–64)	70 years (57–78)	55 years (43–65)	78 years (66–85)
Minimum	9 years	0 years	0 years	0 years
Maximum	89 years	99 years	99 years	105 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.

3.5.3 Aboriginal and Torres Strait Islander persons and ASA class

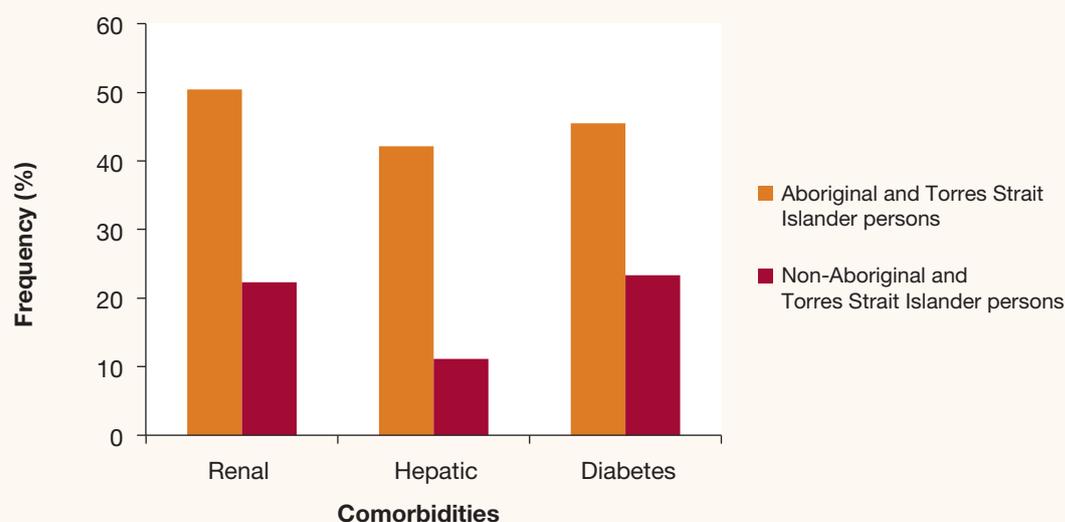
- An ASA class of 3 or higher was recorded for 91.9% (102/111) of Aboriginal and Torres Strait Islander persons. At a minimum, these patients presented with severe disease prior to undergoing surgery. Figure 7 shows the distribution of ASA class for Aboriginal and Torres Strait Islander persons. This data are not age adjusted.
- In ANZASM, an ASA class of 3 or higher was present in 90.9% (279/307) of Aboriginal and Torres Strait Islander persons who had an operation.⁽¹⁾ These data are not age adjusted.

3.5.4 Aboriginal and Torres Strait Islander persons and comorbidities

Diabetes, renal and hepatic diseases in NTASM patients were more prevalent in Aboriginal and Torres Strait Islander persons compared with non-Aboriginal and Torres Strait Islander persons (see Figure 11).

The prevalence of comorbidities is a problem for the surgical care of Aboriginal and Torres Strait Islander persons. Aboriginal and Torres Strait Islander persons are at greater risk of liver disease compared with non-Aboriginal and Torres Strait Islander persons.⁽¹⁶⁾

Figure 11: Comparison of diabetes, renal and hepatic disease in Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons



When age was not adjusted, there was no statistical difference in the presence of serious comorbidities in Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons in both the NTASM and ANZASM (see Table 13).

Table 13: Comparison of serious comorbidities in Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons in NTASM and ANZASM

	NTASM patients with serious comorbidities present n (%)*	ANZASM patients with serious comorbidities present n (%)*
Aboriginal and Torres Strait Islander persons	82% (121/146)	86% (361/419)
Non-Aboriginal and Torres Strait Islander persons	79% (197/249)	90% (12,883/14,368)
Risk ratio (95% CI)	1.05 (0.95, 1.15)	0.96 (0.92, 1.00)

*Missing comorbidity data: n=1 (NTASM), n=43 (ANZASM).

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

When patient age in NTASM was capped at 50 years or younger, a considerable difference emerged between Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons. As shown in Table 14, younger Aboriginal and Torres Strait Islander persons were twice as likely to have serious comorbidities compared with younger non-Aboriginal and Torres Strait Islander persons (RR 2.45; 95% CI 1.50 to 4.01).

Similar findings were reported in a publication exploring health-related behaviours as predictors of mortality and morbidity in Australian Aboriginal persons.⁽¹⁷⁾

Table 14: Age adjusted comparison of serious comorbidities in Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons in NTASM

	NTASM patients with serious comorbidities present	
	50 years or younger n (%)	51 years or older n (%)
Aboriginal and Torres Strait Islander persons	68% (42/62)	94% (79/84)
Non-Aboriginal and Torres Strait Islander persons	28% (13/47)	91% (184/202)
Risk ratio (95% CI)	2.45* (1.50, 4.01)	1.03 (0.96, 1.10)

CI: confidence interval; NTASM: Northern Territory Audit of Surgical Mortality.

*Statistically significant

3.5.5 Aboriginal and Torres Strait Islander persons and risk of death

Based on surgeon perception, a higher proportion of Aboriginal and Torres Strait Islander persons were at considerable or expected risk of death (74.1%; 83/112) compared with non-Aboriginal and Torres Strait Islander persons (59.1%; 110/186). An overview of the risk of death is shown in Table 15.

Table 15: Surgeon perception of the risk of death for Aboriginal and Torres Strait Islander persons compared with non-Aboriginal and Torres Strait Islander persons (n=301)

Risk of death	Aboriginal and Torres Strait Islander persons (n=113)*	Non-Aboriginal and Torres Strait Islander persons (n=188)*
Minimal	1% (1/112)	4% (8/186)
Small	4% (4/112)	9% (16/186)
Moderate	21% (24/112)	28% (52/186)
Considerable	61% (69/112)	47% (87/186)
Expected	13% (14/112)	12% (23/186)

*Data not available: n=3 (1.0%)

3.5.6 Aboriginal and Torres Strait Islander persons and clinical management

In patients who had an operation, 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 (see Table 16 and Table 17).

A 2013 publication showed that surgical care in NTASM patients, as measured by accepted indicators, was equivalent in both groups.⁽⁹⁾ This is similar to what was reflected in the ANZASM.⁽¹⁾ There appears to be a small difference between Aboriginal and Torres Strait Islander persons in NT and non-Aboriginal and Torres Strait Islander persons than there is in the rest of Australia, particularly in the timing of the operation (see Table 16).

Table 16: Comparison of areas requiring improvement in management of surgical care, as perceived by surgeons, between Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons in NTASM and ANZASM

Areas for improvement in management of surgical care	NTASM (n=301)			ANZASM (n=11,756)		
	Aboriginal and Torres Strait Islander persons (n=113)*	Non-Aboriginal and Torres Strait Islander persons (n=188)*	Risk ratio (95% CI)	Aboriginal and Torres Strait Islander persons (n=314)	Non-Aboriginal and Torres Strait Islander persons (n=11,442)	Risk ratio (95% CI)
Preoperative management	7% (8/110)	7% (13/183)	1.02 (0.43, 2.39)	9% (29/314)	7% (780/11,442)	1.35 (0.95, 1.93)
Choice of operation	4% (4/110)	3% (6/183)	1.11 (0.32, 3.84)	3% (9/314)	2% (245/11,442)	1.34 (0.69, 2.58)
Timing of operation	8% (9/111)	8% (14/182)	0.93 (0.41, 2.16)	8% (25/314)	5% (603/11,442)	1.51** (1.03, 2.22)
Decision to operate	7% (8/111)	9% (17/185)	0.78 (0.35, 1.76)	8% (24/314)	7% (781/11,442)	1.12 (0.76, 1.65)
Intraoperative management	4% (4/111)	5% (9/184)	0.74 (0.23, 2.34)	3% (8/314)	3% (334/11,442)	0.87 (0.44, 1.74)
Postoperative care	3% (3/108)	5% (9/182)	0.56 (0.16, 2.03)	4% (14/314)	5% (546/11,442)	0.93 (0.56, 1.57)

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

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

** Statistically significant difference between the two groups at the $p < 0.05$ level

Table 17: 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 and ANZASM

Postoperative care	NTASM (n=301)		ANZASM (n=11,756)	
	Aboriginal and Torres Strait Islander persons (n=113)*	Non-Aboriginal and Torres Strait Islander persons (n=188)*	Aboriginal and Torres Strait Islander persons (n=314)	Non-Aboriginal and Torres Strait Islander persons (n=11,442)
Postoperative complications detected	16% (18/112)	26% (49/188)	27% (85/314)	34% (3,849/11,442)
Use of DVT prophylaxis	67% (73/112)	83% (148/179)	73% (229/314)	82% (9,438/11,442)
Unplanned return to theatre	18% (19/106)	20% (36/181)	20% (62/314)	16% (1,800/11,442)
Unplanned readmission	3% (3/104)	3% (5/179)	3% (8/314)	3% (378/11,442)
Fluid balance alterations	6% (6/103)	10% (17/175)	8% (26/314)	9% (1,009/11,442)
Communication	11% (11/103)	9% (16/178)	7% (22/314)	4% (481/11,442)
Treated in critical care unit	70% (78/111)	70% (131/187)	76% (238/314)	68% (7,787/11,442)
Unplanned ICU admission	17% (18/104)	19% (34/181)	18% (58/314)	19% (2,228/11,442)
Different action by surgeon	22% (24/108)	21% (37/180)	20% (64/314)	16% (1,832/11,442)

ANZASM: Australian and New Zealand Audit of Surgical Mortality; 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 prevalence was similar in NTASM patients and ANZASM patients.
- Trauma was more prevalent in non-Aboriginal and Torres Strait Islander persons compared with Aboriginal and Torres Strait Islander persons.
- Trauma was most commonly due to falls.
- The data relating to trauma should be interpreted with care because numbers are low.

3.6.1 Trauma overview

Data on trauma is currently collected by four ANZASM regions: the NT, Queensland, Western Australia and Victoria.

Trauma has a similar prevalence in NTASM and ANZASM, with 28.8% (99/344) of NTASM patients and 27.4% (3,192/11,659) of ANZASM patients⁽¹⁾ presenting with trauma. The difference in trauma presentations for NTASM and ANZASM was not significant (RR 1.05, 95% CI 0.89 to 1.24).

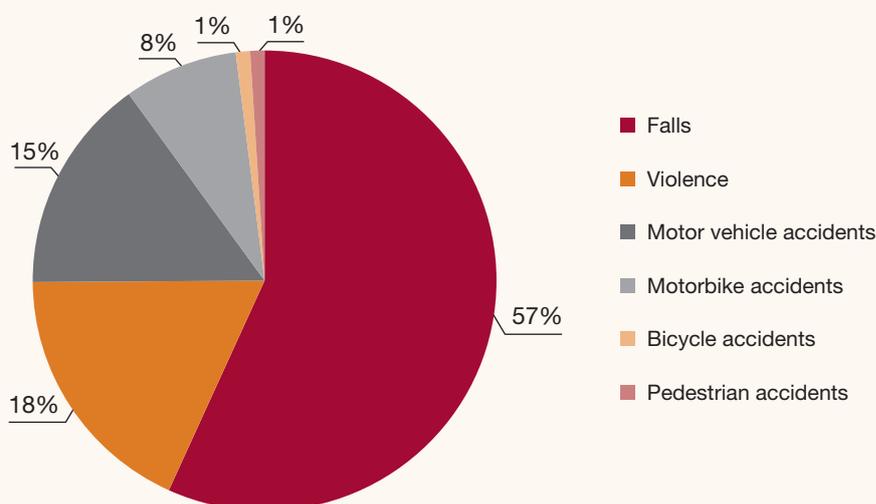
In NTASM, of the patients who presented with trauma, a higher proportion were non-Aboriginal and Torres Strait Islander persons (64.6%; 64/99) than Aboriginal and Torres Strait Islander persons (35.4%; 35/99) .

The distribution of trauma in NTASM is seen in Figure 12. Trauma was most commonly associated with falls, both in NTASM patients (56.6%, 56/99) and ANZASM patients (80.5%; 2,570/3,192).⁽¹⁾ However, NTASM trauma patients who had falls were younger (median 71 years; IQR 59 to 77) than ANZASM patients (median 85 years; IQR 77 to 90).⁽¹⁾

One-quarter of NTASM trauma cases were associated with motor vehicle accidents (24.2%; 24/99). Official statistics regarding fatalities due to motor vehicle accidents are nearly three times higher in the NT than for the rest of Australia.⁽¹⁸⁾ The difference between the official statistics and NTASM data are most likely due to road deaths occurring at the accident scene rather than in hospital.

Violence was associated with 18.2% (18/99) of NTASM trauma cases. The numbers for accidents and violence are too low to compare with national data.

Figure 12: Distribution of causes of trauma (n=99)



3.6.2 Trauma – falls

Falls were the most frequent cause of trauma, accounting for 56.6% (56/99) of patients with documented trauma.

- 53.6% (30/56) of the falls occurred at home.
- 14.3% (8/56) of the falls occurred in hospital.
- 10.7% (6/56) of the falls occurred in a care facility.
- 19.6% (11/56) of falls were due to other causes, such as sport or recreation.
- 1.8% (1/56) of falls occurred in an unknown location.

Falls occurred in a higher proportion of ANZASM trauma patients (80.5%; 2,570/3,192).

The median age of NTASM patients who experienced a fall was 70 years (IQR 55 to 78).

The median age of ANZASM patients who experienced a fall was considerably older at 85 years (IQR 77 to 90).⁽¹⁾

3.6.3 Trauma – road traffic accidents

Road traffic accidents were the cause of 24 trauma cases (15 motor vehicle accidents, 7 motorbike accidents, 1 bicycle accident and 1 pedestrian death). The median age of the 24 patients who were involved in a traffic accident was 30 years. Ages for this group ranged from 16 years to 68 years.

3.6.4 Trauma – violence

Violence was the cause of 18 trauma cases (5 self harm, 3 domestic violence, 3 public violence and 7 unknown or another form of violence). The median age of the 18 patients who experienced violence was 43 years. Ages for this group ranged from 19 years to 71 years.

3.7 INFECTIONS

Key Points

- Infection rates in NTASM patients were similar to those in ANZASM patients.
- NTASM patients were statistically more likely to present to hospital with an existing infection compared with ANZASM patients.
- Care should be used in the interpretation of infection data as numbers are low.

3.7.1 Overview

Infection data has been collected in ANZASM since 2012. In NTASM, a clinically significant infection was present in 120 patients and in 5,267 ANZASM patients. The difference in infection rates is not significantly different (35.8%; 120/335 vs 34.2%; 5,267/15,404. RR 1.05; 95% CI 0.91 to 1.21).

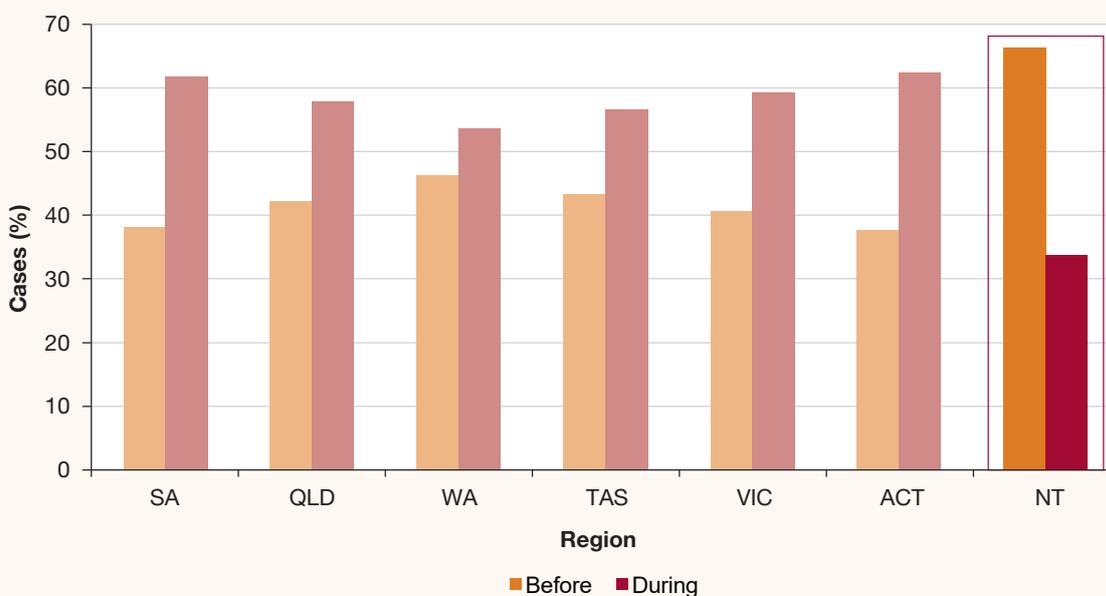
3.7.2 Infections and time of acquisition

(Note: NTASM data were not available for three patients regarding when the infection was acquired and for two patients regarding the type of infection)

The onset of infections was statically different between NTASM and ANZASM. Two thirds of NTASM patients (60.7%; 71/117) acquired their infections prior to admission, while less than half of ANZASM patients (41.8%; 2,128/5,093) acquired their infections prior to admission.⁽¹⁾ (RR 1.45; 95% CI 1.25 to 1.69).

An overview of when patients acquired infections, by ANZASM region, is provided in Figure 13.

Figure 13: Proportion of patients with infections acquired before and during admission by ANZASM region (n=15,404)



Data not available: n=174 (3%)

ANZASM: Australian and New Zealand Audit of Surgical Mortality

ANZASM regions are: SA: South Australia; QLD: Queensland; WA: Western Australia; TAS: Tasmania; VIC: Victoria; ACT: Australian Capital Territory; NT: Northern Territory [ANZASM data excludes New South Wales]

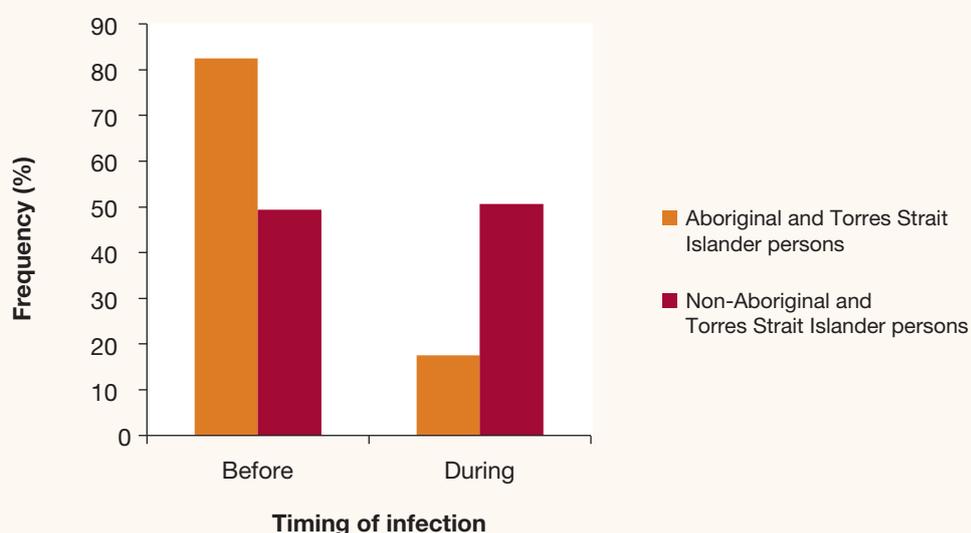
3.7.3 Infections and time of acquisition in Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons

The onset of infections was statistically different between Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons in NTASM.

Nearly all Aboriginal and Torres Strait Islander persons acquired their infections prior to admission (82.5%; 33/40) compared with non-Aboriginal and Torres Strait Islander persons (49.4%; 38/77), RR 1.67 (95% CI 1.28 to 2.18).

Figure 14 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.

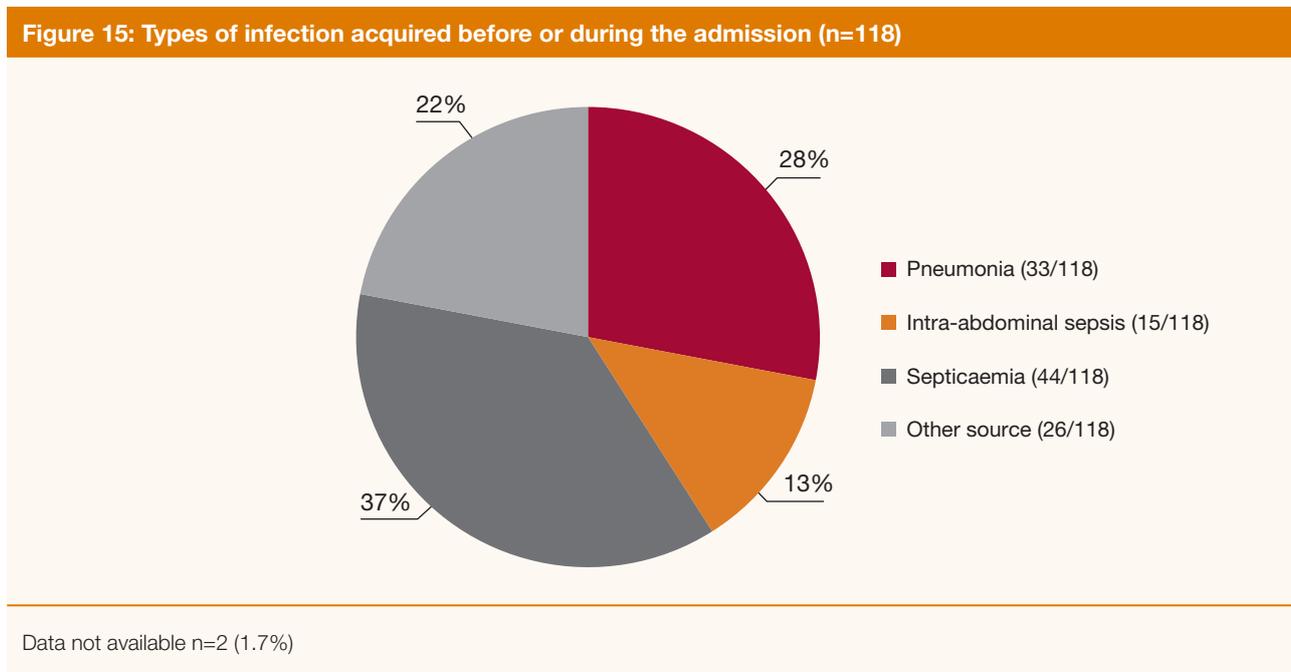
Figure 14: Proportion of Aboriginal and Torres Strait Islander persons and non-Aboriginal and Torres Strait Islander persons with infections acquired before and during admission (n=120)



3.7.4 Types of Infection

The types of infections are classified into four groups; pneumonia, intra-abdominal sepsis, septicaemia and other sources. A third of infections were classified as septicaemia (37.3%; 44/118).

Figure 15 shows the types of infections by classification.



3.7.5 Types of infection positively identified

The types of infections with organisms positively identified in NTASM patients were similar to those identified in ANZASM patients.

Methicillin-resistant *Staphylococcus aureus* (MRSA), *Staphylococcus aureus* and *Escherichia coli* were the most frequently identified organism in both NTASM patients and ANZASM patients. These organisms accounted for 31.2% (34/109) of infections in NTASM patients and 47.0% (986/2,097) of infections in ANZASM patients.⁽¹⁾

In NTASM, MRSA occurred in 14 patients and *Staphylococcus aureus* occurred in 11 patients. MRSA occurred in seven Aboriginal and Torres Strait Islander persons and seven non-Aboriginal and Torres Strait Islander persons. MRSA has been well documented as a community-acquired infection in the NT.⁽¹⁹⁻²¹⁾

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Thank you to the chairman, Dr John Treacy, for his leadership and support in many ways.

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

Dr John North

NTASM Clinical Director

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NTASM STAFF

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NTASM SUPPORT STAFF

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Dr Robert Ware	Menzies Health Institute Queensland, Griffith University
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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
ICU	intensive care unit
IMG	International Medical Graduate
IQR	interquartile range
MRSA	Methicillin-resistant <i>Staphylococcus aureus</i>
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)



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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).