Health Quality & Safety Commission New Zealand
*Kupu Taurangi Hauora o Aotearoa*

POMRC
Perioperative Mortality Review Committee

# Perioperative Mortality in New Zealand:

## Sixth report of the Perioperative Mortality Review Committee

## Report to the Health Quality & Safety Commission New Zealand

June 2017

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# Foreword

As the Chair of the Health Quality & Safety Commission (the Commission), I am pleased to introduce the sixth report of the Perioperative Mortality Review Committee (POMRC), which presents perioperative mortality rates in New Zealand for selected clinical areas.

As a mortality review committee, the POMRC has a responsibility to review deaths that occur after surgery, as defined by its terms of reference.[1] By reviewing deaths, the POMRC aims to identify and address systemic factors that may contribute to these deaths, and make recommendations to improve processes and practice within health services and communities.

The sixth report considers two special topics. In the first topic, the POMRC investigated the relationship between socioeconomic deprivation (poverty) and perioperative mortality. The key finding was that people living in more deprived areas (areas with greater poverty) had higher rates of perioperative mortality than people living in less deprived areas. The second topic is perioperative mortality following abdominal aortic aneurysm repair. The POMRC found that one type of repair (endovascular repair) had a lower mortality rate at 30 days than the other (open repair).

After reviewing the data, the POMRC and the mortality review committees' Māori Caucus have made a number of recommendations in this report. Broadly, these recommendations support the reduction of inequities in perioperative mortality. They also emphasise the need to improve access to medical and surgical care, and the quality of that care, both before and after surgery.

To provide more in-depth data about perioperative mortality, the POMRC is developing a local review and data collection system. Five district health boards are currently trialling a web-based system. Findings from the local review system will allow the POMRC to carry out better analysis and make more targeted recommendations. This work supports the vision of the Commission and the POMRC to improve the depth and breadth of information on perioperative mortality in New Zealand.

Part of the Commission's work is to monitor and assess the quality and safety of health and disability support services, provide informed public comment, and facilitate sector and public debate. This report is an excellent contribution to this work. It will help clinicians, surgeons, and consumers and their families and whānau make informed decisions about their surgery.

The POMRC report also includes infographics for the first time, making information more accessible to consumers and the public.

On behalf of the Commission, I congratulate Dr Leona Wilson, the members of the POMRC and the many other individuals who have worked on this excellent report.

I would also like to join Dr Wilson in acknowledging the grief and loss that families and whānau experience with the death of a loved one. The POMRC is committed to highlighting areas for improvement in perioperative care and reducing avoidable deaths after surgery.

Professor Alan Merry ONZM FRSNZ
*Chair, Health Quality & Safety Commission*

1 www.hqsc.govt.nz/our-programmes/mrc/pomrc/about-us/terms-of-reference.

# Chair's Introduction

I am pleased to present the sixth report of the Perioperative Mortality Review Committee (POMRC). The POMRC is a statutory committee that reviews perioperative deaths and reports to the Health Quality & Safety Commission.

Approximately one in twenty deaths in New Zealand fall within the POMRC's scope. In 2015, there were 31,608 deaths, and 4.3% of these (1354) occurred within 30 days of surgery. Some of these perioperative deaths were 'expected', for example, surgery as a last resort in a life-or-death situation. Others may have been avoidable with earlier intervention or better medical and surgical care.

I would like to acknowledge the deep loss that each family and whānau experiences when a loved one dies after surgery. By reviewing perioperative mortality, we can help to improve perioperative care and prevent avoidable deaths in the future.

New Zealand's rates of perioperative mortality are similar to other OECD countries (see Table 23 in this report for international comparisons), but there is still room for improvement. In particular, Māori and people living in the most socioeconomically deprived areas have persistently higher rates of perioperative mortality. This inequity may be caused by a number of reasons, including that Māori and people living in high deprivation may have poorer access to health care, more risk factors and lower quality of medical and surgical care before, during and after surgery.

In this report, the POMRC has included a special topic on socioeconomic deprivation. It found that perioperative mortality increased as deprivation increased. Additionally, as deprivation increased, the proportion of admissions with general anaesthesia that were acute increased. People living in quintile 5 areas had 14% more elective admissions than people living in quintile 1 areas, but twice as many acute admissions than people living in quintile 1 areas. This is concerning because mortality is greater following acute admissions than elective admissions.

The POMRC believes a patient's ethnicity and socioeconomic status should not influence their outcome after surgery. The POMRC recommends future research should investigate the socioeconomic and ethnic inequities in: 1) perioperative mortality, and 2) acute versus elective surgery rates. Additionally, the POMRC recommends people should have equitable access to high-quality health care so conditions that require surgery are identified promptly.

The second special topic in this report is perioperative mortality following abdominal aortic aneurysm (AAA) repair. This is an area with changing clinical practice. AAAs affect a large number of people, a proportion of whom die perioperatively. The POMRC found the same inequities in perioperative outcomes following AAA repair as for socioeconomic deprivation. It also found that mortality was higher following an open repair than an endovascular repair.

The POMRC recommends all patients who need an elective AAA repair should have the option of an endovascular procedure, if they are anatomically suitable. The risks and benefits of each repair type, as well the risks and benefits of no operation (if appropriate), should be discussed with the patient.

The POMRC has also repeated two recommendations from its fifth report: 1) that all patients should have their American Society of Anesthesiologists (ASA) status recorded in their clinical anaesthetic record, and 2) that the risk of dying perioperatively (and of serious complications) should be discussed with all patients contemplating an operation with a significant risk.

At a regional meeting of the Lancet Commission on Global Surgery in 2015, New Zealand was credited with having the best perioperative mortality data in the world. The POMRC is further developing New Zealand's perioperative mortality data by introducing a local system for reviewing perioperative deaths. This system is currently being trialled in pilot sites across five DHBs. This national web-based system will allow the POMRC to collate the review findings at a national level, and to share with others the important quality improvement themes and lessons learned from the reviews.

In addition to the two special topics, mortality for the selected tracking procedures and clinical areas from previous reports are extended here for 2010–2015. These tracking procedures and clinical areas include: same or next day mortality following general anaesthesia; 30-day mortality following general anaesthesia; perioperative mortality for those classified as ASA 4 and 5 (very unwell); perioperative mortality for those classified as ASA 1 or 2 (not unwell) following an elective admission; weekend versus weekday mortality; cholecystectomy; hip and knee arthroplasty; colorectal resection; coronary artery bypass graft; and percutaneous transluminal coronary angioplasty,

The POMRC has also woven a number of composite case stories throughout the report. Most of these are based on themes extracted from multiple reviews in the National Reportable Events database. The clinical lessons included in the cases offer valuable considerations for strengthening the quality of postoperative care and helping to prevent perioperative deaths.

The POMRC considered including some other new clinical areas in this report (eg, urosepsis). However, for these areas, the diagnosis coding definitions for the national inpatient database (National Minimum Dataset) are not specific enough. The POMRC's local system for reviewing perioperative deaths will help to address this issue, and increase the quality and depth of the information currently available to the POMRC.

This year, the POMRC and Safe Surgery New Zealand are jointly hosting a workshop entitled 'Making the wise choice simple'. This workshop will include discussions about how to change clinical practice, equity issues, understanding the influence of patient characteristics on mortality risk, and weighing up whether to do a high-risk surgery.

The sixth report outlines the outcomes for New Zealand patients having operations in New Zealand hospitals. The POMRC provides information here to help patients, their whānau, and their clinicians make the best choices for themselves.

Dr Leona Wilson ONZM
*Chair, Perioperative Mortality Review Committee*

# Introduction from Consumer Representative

There is no pain greater than grief over the loss of a loved one, but when there is the added mental anguish of knowing that that death was preventable it becomes almost unbearable. The Perioperative Mortality Review Committee (the POMRC) is an independent committee that reviews deaths of New Zealanders after they have had surgery, with a view to reducing avoidable deaths.

The first special topic in this year's report is abdominal aortic aneurysm (AAA) repair. An AAA develops when the main blood vessel for the abdomen and lower body (aorta) has a weakness in its wall, which causes a section of the wall to swell and increases its risk of bursting. It is estimated that more than five percent of the New Zealand population aged over 55 years have an AAA.

AAAs do not always show symptoms. However, if you can feel a strong pulse below your ribs and above your naval, you may have an AAA, and you should see your doctor urgently. They may do an ultrasound or other scans to check.

If you do have an AAA, it may be small and at low risk of bursting. In this case, your doctor will suggest lifestyle changes that can help to reduce the risk. If your AAA is large enough to be at risk of bursting, you may need surgery to repair the AAA.

There are two ways to repair an AAA:

- open surgical repair – the surgeon goes through your abdomen to repair the wall of the aorta from the outside
- endovascular repair – a stent is passed through a blood vessel in your groin and into the aorta. The stent is attached to the aorta's wall from the inside.

The type of repair depends on the skill and experience of the surgeon performing the surgery, as well as physical factors, like the shape of your aorta.

The POMRC's report found:

- in emergency (acute) operations, 20 in 100 people died in the 30 days after an AAA repair
- in planned (elective/waiting list) operations, 3 in 100 people died in the 30 days after an AAA repair
- for both emergency and planned AAA repair operations, people were three times more likely to die in the 30 days after surgery if they had an open repair rather than an endovascular repair
- studies of AAA repair have found that, two years after surgery, there is no difference between the death rates for each repair type.

If you are considering an AAA repair, ask your surgeon these questions:

- Do I really need this operation?
- What are the risks?
- Can I have an endovascular repair?
- How can I best care for my health before my surgery, and reduce the surgical risk (eg, quitting smoking, reducing high blood pressure)?
- What happens if I do not undergo surgery?

The POMRC's second special topic in this report is the relationship between poverty (measured with the New Zealand 'Deprivation Index') and deaths after surgery.

The POMRC found that people who live in more deprived areas (areas with greater poverty) are more likely to die after surgery than people who live in less deprived areas.

The reasons for this include that people who live in more deprived areas are more likely to have:

- other illnesses at the time of surgery
- emergency (acute) rather than planned (elective) surgery (more people die during or after emergency surgery)
- less access to hospitals and surgeons that do complicated operations
- longer waiting times between admission to hospital and having surgery
- more risk factors at the time of surgery, like smoking and obesity.

The POMRC considers that no one should have a better or worse outcome after surgery because of their ethnicity or level of deprivation. Its position is in line with the New Zealand Triple Aim, which includes 'improved health and equity for all populations' and 'improved quality, safety and experience of care'. The POMRC has recommended there should be more research into the reasons for, and ways to reduce inequities due to ethnicity and deprivation.

It has been a privilege to be a member of the POMRC and work with its members and advisors. The team constantly strives for better health outcomes for New Zealanders who undergo surgery.

R Vigor-Brown

*Consumer Representative, Perioperative Mortality Review Committee*

# The Relationship between Poverty and Deaths after Surgery

POMRC
Perioperative Mortality Review Committee

## Summary of the Perioperative Mortality Review Committee's Sixth Annual Report findings

### Poverty is measured with the 'Deprivation Index':[2]

It is based on:

Employment

Income

Education

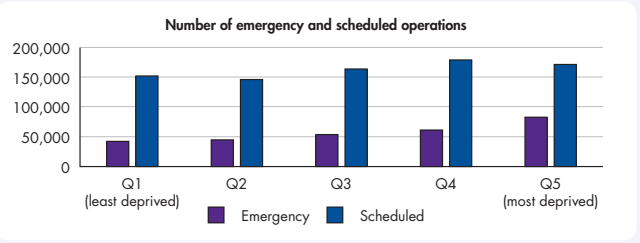
Housing

**The population is divided into five equal-sized groups (called 'quintiles'), from** least deprived (QUINTILE 1) TO most deprived (QUINTILE 5).

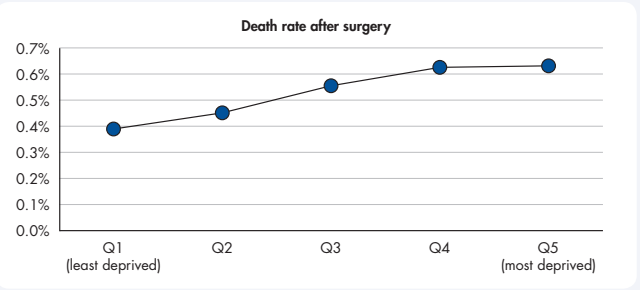
**20%** of the population live in the most deprived areas, but make up **23%** of all surgery in NZ[3] and **27%** of deaths after surgery.[4]

### As deprivation increases:[5]

The number of operations increases, especially emergency surgery




Deaths after surgery increase




### For people in the most deprived areas:

The chance of dying after surgery[6] depends on:

**AGE: 45+**
AT LEAST
**1.7X**
THOSE < 44

EMERGENCY ADMISSIONS:
**6.7x**
than scheduled admissions

ETHNICITY:
MĀORI
**16%**
GREATER RISK
than NZ European

**ILLNESS: at least 15x GREATER RISK**
for those who have a life-threatening illness

The higher surgical death rate for people living in poverty may be because they are more likely to:

- have emergency surgery (which has a higher death rate than planned surgery)[7]
- be more sick at the time of surgery[8]
- have less access to hospitals that can do complicated surgery[9]
- have more risk factors, like smoking and obesity.[10]

2 Atkinson J, Salmond C, Crampton P. 2014. *NZDep2013 index of deprivation.* Dunedin: University of Otago. URL: https://assets.documentcloud.org/documents/1158587/research-report.pdf (accessed 12 April 2017).

3 Defined by the POMRC as hospital admissions with general anaesthesia.

4 Defined as deaths within 30 days of general anaesthesia.

5 Data for 2010–2015.

6 Adjusted for other sociodemographic (age, gender, ethnicity, socioeconomic deprivation) and clinical (repair type, admission type, illness severity) factors.

7 Ambur V, Taghavi S, Kadakia S, et al. 2017. Does socioeconomic status predict outcomes after cholecystectomy? *The American Journal of Surgery* 213(1): 100–4. URL: https://doi.org/10.1016/j.amjsurg.2016.04.012 (accessed 12 April 2017).

Sandiford P, Mosquera D, Bramley D. 2011. Trends in incidence and mortality from abdominal aortic aneurysm in New Zealand. *British Journal of Surgery* 98(5): 645–51. URL: https://doi.org/10.1002/bjs.7461 (accessed 12 April 2017).

Shi WY, Yap C-H, Newcomb AE, et al. 2014. Impact of socioeconomic status and rurality on early outcomes and mid-term survival after CABG: Insights from a multicentre registry. *Heart, Lung and Circulation* 23(8): 726–36. URL: https://doi.org/10.1016/j.hlc.2014.02.008 (accessed 12 April 2017).

8 Ambur V, Taghavi S, Kadakia S, et al. 2017. Does socioeconomic status predict outcomes after cholecystectomy? *The American Journal of Surgery* 213(1): 100–4. URL: https://doi.org/10.1016/j.amjsurg.2016.04.012 (accessed 12 April 2017).

Ancona C, Agabiti N, Forastiere F, et al. 2000. Coronary artery bypass graft surgery: socioeconomic inequalities in access and in 30 day mortality. A population-based study in Rome, Italy. *Journal of Epidemiology and Community Health* 54(12): 930–5.

Clement ND, Muzammil A, MacDonald D, et al. 2011. Socioeconomic status affects the early outcome of total hip replacement. *Journal of Bone & Joint Surgery,* British Volume 93–B(4): 464. URL: https://doi.org/10.1302/0301-620X.93B4.25717 (accessed 12 April 2017).

9 Dueck AD, Kucey DS, Johnston KW, et al. 2004. Survival after ruptured abdominal aortic aneurysm: Effect of patient, surgeon, and hospital factors. *Journal of Vascular Surgery* 39(6): 1253–60. URL: https://doi.org/10.1016/j.jvs.2004.02.006 (accessed 12 April 2017).

Osler M, Iversen LH, Borglykke A, et al. 2011. Hospital variation in 30-day mortality after colorectal cancer surgery in Denmark: The contribution of hospital volume and patient characteristics. *Annals of Surgery* 253(4). URL: http://journals.lww.com/annalsofsurgery/Fulltext/2011/04000/Hospital_Variation_in_30_Day_Mortality_After.14.aspx (accessed 12 April 2017).

10 Shi WY, Yap C-H, Newcomb AE, et al. 2014. Impact of socioeconomic status and rurality on early outcomes and mid-term survival after CABG: Insights from a multicentre registry. *Heart, Lung and Circulation* 23(8): 726–36. URL: https://doi.org/10.1016/j.hlc.2014.02.008 (accessed 12 April 2017).

# Deaths after Abdominal Aortic Aneurysm Repair

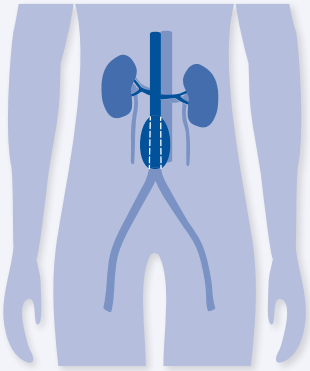
POMRC
Perioperative Mortality Review Committee

Summary of the Perioperative Mortality Review Committee's Sixth Annual Report findings

## What is an abdominal aortic aneurysm (also called AAA)?

- The abdominal aorta is a vessel that carries blood to the lower half of the body.
- An AAA is when the wall of the aorta is weakened and bulges, and is at risk of bursting.

**MORE THAN 5%** of the population **OVER 55** has one.[11]



## Signs of an AAA:

- If you have one:
  - you might not feel any different
  - it might not be at risk of bursting.
- If you can feel a strong heartbeat between your ribs and your belly button, you should see your doctor. They may do an ultrasound or other scans to check.

## REPAIR

If your AAA is small and at low risk of bursting, your doctor will talk with you about **LIFESTYLE CHANGES** like stopping smoking and managing high blood pressure

| | Chance of dying after AAA repair [12] |
|---|---|
| If your AAA is at risk of bursting, you might be scheduled for surgery | 1 in 50 |
| If your AAA isn't noticed and bursts, you might have emergency surgery | 1 in 5 |

**AAA repair in New Zealand is as safe as in other OECD countries.**

## The chance of dying[13] after AAA repair depends on:

**AGE:** 80+

**2X**

greater risk than **UNDER 65s**

**ILLNESS:**
**AT LEAST 4X**
GREATER RISK
for those with a
**life-threatening illness**

**Type of repair: OPEN REPAIR 4X GREATER RISK** than endovascular repair

## REPAIR TYPES

There are two types of repair. Each type depends on patient suitability, and hospital/surgeon capability.

**Open repair:**

goes through the abdomen and repairs the aorta from the outside.

**Endovascular repair:**

a syringe pushes a tube up through a vessel in the groin, and the aorta is repaired from the inside.

## Ask your surgeon if endovascular repair is an option for you

11 Khashram M, Jones GT, Roake JA. 2015. Prevalence of abdominal aortic aneurysm (AAA) in a population undergoing computed tomography colonography in Canterbury, New Zealand. European Journal of Vascular and Endovascular Surgery 50(2): 199–205. URL: https://doi.org/10.1016/j.ejvs.2015.04.023 (accessed 12 April 2017).

12 Defined by the POMRC as deaths within 30 days of AAA repair.

13 Adjusted for other sociodemographic (age, gender, ethnicity, socioeconomic deprivation) and clinical (repair type, admission type, illness severity) factors.

# Executive Summary

The Perioperative Mortality Review Committee (POMRC) is a statutory committee that reviews and reports on perioperative deaths with a view to reducing perioperative mortality and morbidity, and supporting continuous quality and safety improvements in New Zealand.

The POMRC's definition of *perioperative deaths* includes:

- deaths that occurred after an operative procedure, either within 30 days after the operative procedure, or after 30 days of the procedure but before discharge from hospital to a home or rehabilitation facility
- deaths that occurred while under the care of a surgeon in hospital even though an operation was not undertaken.

For the purposes of the POMRC's definition of perioperative deaths, an *operative procedure* refers to any procedure requiring anaesthetic (local, regional or general) or sedation. This includes a broad range of diagnostic and therapeutic procedures carried out in designated endoscopy or radiology rooms, such as gastroscopies, colonoscopies, and cardiac or vascular angiographic procedures.

## Perioperative mortality in New Zealand for two new special topics

In this report the POMRC has examined perioperative mortality in New Zealand for two special topics: 30-day mortality following abdominal aortic aneurysm (AAA) repair, and perioperative mortality of people living in areas with high socioeconomic deprivation.

The POMRC selected AAA repair as a special topic this year because it is an area with changing clinical practice, with the use of endovascular repair for AAA increasing internationally (Steuer et al 2016). Additionally, AAAs affect a large number of people. More than 5% of the New Zealand population aged over 55 years have an AAA (Khashram et al 2015), and more than 800 people are newly hospitalised for AAA each year (Sandiford et al 2011).

The POMRC selected socioeconomic deprivation as a special topic in this report because the POMRC's previous reports have found that perioperative mortality rates are highest for people living in deprived areas. It is the POMRC's position that a person's socioeconomic status should not influence his or her outcome after surgery.

## Key findings from special topics

For the two special topics in this report, as with other special topics previously examined, higher 30-day mortality rates were consistently associated with:

- increasing age
- comorbidities and poorer overall health status (higher Charlson Comorbidity Index (CCI) scores and American Society of Anesthesiologists (ASA) scores)
- emergency (acute) admissions into hospital.

The following key findings were observed for each new area examined.

*Perioperative mortality and socioeconomic deprivation*

In New Zealand during 2009–2013:[14]

- The number of admissions and perioperative mortality increased as socioeconomic deprivation increased.
- People living in the most deprived areas had 14% more elective admissions than people living in the least deprived areas, and twice as many acute admissions than people living in the least deprived areas.

In New Zealand during 2010–2014, for the 20% of the population who lived in the most socioeconomically deprived areas in New Zealand:

- There were 289,387 admissions in which general anaesthesia was performed. The 30-day mortality rate was 0.58%. The numbers of deaths and admissions each year were generally stable over the five-year period.
- For both acute and elective admissions, cardiovascular causes and neoplasms were the most common underlying reasons for mortality.
- Acute admissions made up 29% of all admissions and 74% of all deaths following one or more general anaesthetics. Mortality was higher following acute admissions (1.48%) than elective admissions (0.14%).
- Perioperative mortality rates were significantly higher for Māori, and this difference was significant after adjusting for sociodemographic and clinical factors.
- Common diagnoses for acute admissions with at least one general anaesthetic included skin abscesses, acute appendicitis, and fractures. Common diagnoses for elective/waiting list admissions included dental caries, otitis media, joint disorders, diseases of the tonsils/adenoids and inguinal hernia.

Studies from other countries have also found higher perioperative mortality for people with high socioeconomic deprivation.

*Thirty-day mortality following AAA repair*

In New Zealand during 2010–2014:

- There were 2,226 admissions for AAA repair. Thirty-day mortality over this five-year period was 7.7% (171 deaths). The numbers of deaths and admissions each year were generally stable over the five-year period.
- Acute admissions made up 31% of all admissions for AAA repair and 79% of all deaths in the 30 days following AAA repair. The mortality rate was higher following acute admissions (19.59%) than elective/waiting list admissions (2.11%).
- Forty-one percent of acute admissions were for a ruptured AAA.
- There were 1,269 open repairs and 899 endovascular repairs for AAA. The majority (82%) of acute admissions for AAA repair underwent an open repair. Half (48%) of elective admissions for AAA repair underwent an open repair.
- Mortality was higher following an open repair than an endovascular repair. In acute admissions, mortality was 22.40% following an open procedure, and 7.09% following an endovascular procedure. In elective/waiting list admissions, mortality was 3.42% following an open procedure and 1.04% following an endovascular procedure.
- Māori had more acute admissions relative to elective admissions (ie, a greater acute versus elective admission ratio) for AAA repair than New Zealand Europeans. Similarly, people living in areas with high socioeconomic deprivation had a greater acute versus elective admission ratio than people living in less deprived areas.

Mortality rates following AAA repair in New Zealand were similar to those observed overseas.

14 The data comparing perioperative mortality between deprivation levels during 2010–2014 is not yet finalised. This report presents comparative data between high and low deprivation for admissions during 2009–2013 (based on data from the last POMRC report; POMRC 2016), and descriptive data for people in the most deprived areas for admissions during 2010–2014.

## Sixth report recommendations

The following recommendations were informed by data presented in this report. The first five recommendations were developed by the POMRC. The last four recommendations were developed by the Māori Caucus, convened by the Health Quality & Safety Commission, and are endorsed by the POMRC.

### Recommendations by the POMRC

#### *Better documentation*

**Recommendation 1:** All patients should have their ASA status recorded in their clinical anaesthetic record. *Note: Recording of ASA status has improved on previous years. This recommendation is repeated from the 2016 report.*

> *Rationale:* Accurate ASA scores are important because they allow estimates of perioperative mortality for various procedures to be adjusted for patient disease severity. Adjusting for ASA scores provides a better indication of the extent to which mortality might be due to aspects of the procedure and perioperative care.

#### *Further research and research funding*

**Recommendation 2:** A patient's ethnicity and socioeconomic status should not influence his or her outcome after surgery. Future research should investigate the socioeconomic and ethnic inequities in: a) perioperative mortality, and b) acute versus elective surgery rates. This research should explore both the underlying causes of these inequities and ways to reduce these inequities.

> *Rationale:* The POMRC found that people who identified as Māori and people who lived in areas of high deprivation had higher rates of acute admissions for surgery than elective admissions, compared with non-Māori and low deprivation. Acute surgery had a higher mortality rate than elective surgery.

#### *Improvements to care*

**Recommendation 3:** People should have equitable access to high-quality health care so conditions that require surgery are identified promptly. DHBs should investigate programmes to increase access to both primary care and medical and surgical specialists. This should be supported by the Ministry of Health.

> *Rationale:* There were differences between population groups in rates of acute versus elective surgery. Increased access to health services may lead to earlier detection of conditions that require surgery. As a result, the surgery can be planned (elective), ensuring that the appropriate discussions are had with the patient and their whānau, the patient is properly prepared, and the hospital has the optimal resources available. Given that mortality is significantly higher following acute surgery than elective surgery, patient outcomes should improve if surgery is planned.

**Recommendation 4:** The option of an endovascular repair should be considered for all patients who need an elective abdominal aortic aneurysm (AAA) repair. The risks and benefits of each repair type, as well the risks and benefits of no operation (if appropriate), should be discussed with the patient. *Note: Although endovascular repair has lower mortality than open repair for patients in the short term (30 days following surgery), there is no evidence of a difference in mortality rates in the longer term (more than two years) and reintervention rates for endovascular repair are higher.*

> *Rationale:* The POMRC found that endovascular AAA repair had a lower mortality rate than open repair. Recent meta-analyses have found that endovascular repair has a lower mortality rate than open repair in elective admissions. There are only a few studies that compare endovascular and open repair in emergency admissions, and the findings so far are inconclusive.

**Recommendation 5:** The risk of dying perioperatively (and of serious complications) should be discussed with all patients contemplating an operation with a significant risk (eg, ruptured AAA repair). *Note: There is currently no consensus of the level of risk at which these discussions should take place. 'Significant risk' may vary depending on the operation, patient characteristics, and patient and whānau expectations.*[15]
*This recommendation is repeated from the 2016 report.*

*Rationale:* The POMRC found that some surgery types and patient characteristics result in higher rates of perioperative mortality than others.

## Recommendations by the Māori Caucus for future research

The Māori Caucus recommends that further investigation is undertaken by the POMRC, and/or that the POMRC promote further investigation be undertaken by appropriate health research agencies, as follows:

**Recommendation 6:** Investigate the factors and pathways that led Māori patients to the point of surgery, and how these factors could be influenced to improve patient outcomes and reduce the need for surgery.

**Recommendation 7:** Investigate whether the level of care and medical and surgical expertise provided was appropriate for the severity and nature of the condition being treated for Māori patients.

**Recommendation 8:** Investigate whether travel distance from usual place of residence to the place of surgery affects Māori perioperative mortality. Factors to be considered should include rurality, access to services, and travel outside their DHB area.

**Recommendation 9:** Investigate the experience of Māori patients and their sense of wellbeing during their:

a) preoperative management and care

b) hospital inpatient stay

c) post-discharge care in the 30 and 90 days following surgery.

Note that this investigation should include both quantitative and qualitative analysis, and consider:

- whether or not Māori patients receive high-quality advice that supports them to make the best decisions for themselves as to whether to proceed with surgery or not
- quality of care during inpatient stay
- mortality outcomes for Māori, compared with non-Māori non-Pacific as the comparator group, at 30 days and at 90 days.

The POMRC endorses these recommendations from the Māori Caucus.

15 See the recent decision by the Health & Disability Commissioner, who found that the risk of surgery based on the patient's characteristics should be discussed with the patient: http://www.hdc.org.nz/decisions--case-notes/commissioner's-decisions/2015/12hdc00779.

## World Health Organization surgical care metrics

The POMRC continues to monitor the two World Health Organization (WHO) public health metrics for surgical care included in previous reports: day-of-surgery mortality rate and inpatient mortality rate. These two metrics are reported for all surgical procedures during 2010–2015:

- day-of-surgery mortality rate: 0.12%
- inpatient mortality rate: 0.37%.

Future work will continue to explore and expand the use of WHO metrics as standardised indicators for surgical care in New Zealand. This is part of the POMRC's long-term approach to compare New Zealand data with other international jurisdictions.

## Data limitations

Data in this report was sourced from the National Minimum Dataset (NMDS) and the National Mortality Collection (NMC). The NMDS and NMC data sets have limitations associated with clinical coding accuracy and data completeness. Both data sets are dependent on the quality of clinical records and classification systems.

Some private day-stay or outpatient hospitals, facilities and in-rooms do not report any surgical or procedural events to the NMDS. The Ministry of Health is unable to estimate the extent to which the NMDS undercounts events from private surgical or procedural day-stay or outpatient hospitals, facilities or in-rooms. The data in this report is likely to undercount some private hospital events, and the magnitude of this undercount is difficult to quantify.

Small variation in the data sets over time can also result in slight variations in the mortality and hospitalisation rates included in each of the POMRC's reports. This variation can be caused by delays in data being entered into the NMDS and NMC databases, and also by changes in clinical coding over time. Such variation limits the ability to compare findings between time periods of interest.

Additional information on data limitations is provided in Appendix 3 of this report.

# Perioperative Mortality Data

## Developing local systems for perioperative mortality review in New Zealand

The aim of the Perioperative Mortality Review Committee's (POMRC's) Tier 1 project is to develop local multidisciplinary perioperative review systems in New Zealand. Once established, local review systems will enable the POMRC to collect in-depth clinical and contextual information on perioperative deaths from public and private hospitals throughout the country. Reviewing in-depth information allows common themes, at both the clinical and systems levels, to be identified. Identifying these themes will result in a deeper understanding of the potentially preventable factors underlying perioperative deaths. Findings from local reviews will also inform local quality improvement initiatives.

Since the previous report, five pilot sites have been trialling local review processes in partnership with the POMRC. These pilot sites are Waikato District Health Board (DHB), Whanganui DHB, Waitemata DHB, Counties Manukau DHB and Nelson Marlborough DHB. These pilot sites were selected so the POMRC could trial the local review processes in health care institutions with varying patient demographics. In the last year, the pilot has focused on ensuring that the information entered into the database can be collected efficiently and can be analysed to identify common themes.

A working group consisting of members from the POMRC, representatives from the pilot sites, and clinical leaders from Southern Cross Group (private hospital network) has been established to oversee and guide the development of the review and data submission processes.

### *Developing a web-based national perioperative reporting system*

The POMRC is developing a national web-based system that will allow consistent reporting at a local level. This system will also enable the POMRC to collate information from local reviews of perioperative deaths, and then disseminate key themes and quality improvement lessons nationally. The pilot sites are currently trialling the web-based Tier 1 form, which will be used by local groups to record information from their reviews of perioperative deaths.

In the next year, the POMRC will recruit additional hospitals to provide Tier 1 information on perioperative deaths, with the ultimate goal of collecting information on all perioperative deaths from all hospitals in New Zealand.

## Improving the quality of perioperative data

### *Reviewing the National Minimum Dataset*

In parallel with the Tier 1 project work, the POMRC continues to work to improve the quality of national data collected on perioperative deaths. Currently, the POMRC publishes information on perioperative mortality using data from the National Minimum Dataset (NMDS), which receives the coded discharge data from health care institutions throughout the country. In the forthcoming stages of this workstream, the Tier 1 project will use NMDS data to identify perioperative deaths, to confirm whether these cases fall within the POMRC's scope, and to provide additional data not available in the NMDS.

### *Comparing administrative and clinical registry data sources*

Although the NMDS contains mostly complete information on all publicly funded day and inpatient hospital admission events (occurring at both public and private hospitals), the NMDS contains incomplete information on privately funded hospital events at private hospitals. To assess how private hospital admissions data missing from the NMDS might affect estimates of perioperative mortality, the POMRC compared elective hip and knee joint arthroplasty data obtained from the New Zealand Joint Registry against data from the NMDS. The New Zealand Joint Registry is a clinical register; it captures information on all admission events for arthroplasty procedures collected from both public and private hospitals in New Zealand. The POMRC's comparison of these two data sources revealed that a number of additional procedures included in the New Zealand Joint Registry were absent from the NMDS, and similarly a small number of procedures were included in the NMDS only. Although the number of recorded arthroplasty procedures was higher in the

New Zealand Joint Registry than in the NMDS, the 30-day mortality estimates for 2007–2011 hip and knee arthroplasty procedures were similar for both data sources (Hider et al 2016).

In future, options for linking data from both the NMDS and the New Zealand Joint Registry will be explored. The New Zealand Joint Registry, being a clinical register, contains more detailed information on hip and knee arthroplasty procedures compared with the NMDS, including details of revision procedures and devices used. Combining information across the NMDS and the New Zealand Joint Registry could provide a more complete understanding of the patients who undergo these treatments and their outcomes.

### *Improving ASA score records*

The American Society of Anesthesiologists (ASA) Physical Status Classification System score is strongly associated with perioperative mortality – evident in both this report and previous reports from the POMRC. Accurate ASA scores are important because they allow estimates of perioperative mortality for various procedures to be adjusted for patient disease severity. Adjusting for ASA scores provides a better indication of the extent to which mortality might be due to aspects of the procedure and perioperative care.

In this report, low recording rates of ASA classification continue to be an issue for New Zealand, with significant numbers of undocumented ASA scores observed in the analyses of 30-day mortality following a general anaesthetic (about 20% of acute admissions and 30% of elective admissions). The reporting of ASA scores has improved: in 2009, ASA scores were recorded for 63.7% of admissions with a general anaesthetic, which increased to 77.8% of admissions in 2015.

## Recommendations

The POMRC recommends that:

**Recommendation 1:** All patients should have their ASA status recorded in their clinical anaesthetic record.

> *Rationale:* Accurate ASA scores are important because they allow estimates of perioperative mortality for various procedures to be adjusted for patient disease severity. Adjusting for ASA scores provides a better indication of the extent to which mortality might be due to aspects of the procedure and perioperative care.

# Perioperative Mortality and Socioeconomic Deprivation

This chapter investigates the relationship between socioeconomic deprivation (measured by the New Zealand Deprivation Index (NZDep)) and 30-day mortality following an admission with at least one general anaesthetic. It uses information from the National Minimum Dataset (NMDS) (calculated using National Health Index data) and the National Mortality Collection (NMC). Detailed information about data sources and methods are presented in Appendix 3.

## Socioeconomic deprivation

The purpose of this chapter is to investigate the relationship between deprivation and perioperative mortality, and to describe the perioperative mortality of the 20% of the population who live in the most socioeconomically deprived areas[16] in New Zealand.

The POMRC selected socioeconomic deprivation as a special topic in this report because the POMRC's previous reports have shown that perioperative mortality rates are highest for people living in deprived areas. It is the POMRC's position that a person's socioeconomic status should not influence his or her outcome after surgery.

Socioeconomic deprivation in New Zealand is typically measured with NZDep2013 (Atkinson et al 2014), which used New Zealand 2013 Census data to calculate the relative deprivation of an area. The variables that the NZDep used were:

- people aged 0–64 with no access to the internet at home
- people aged 18–64 receiving a means-tested benefit
- people living in households with income below an income threshold (adjusted for household size)
- people aged 18–64 unemployed
- people aged 18–64 without any qualifications
- people not living in own home
- people aged 0–64 living in a single-parent family
- people living in households below a bedroom occupancy threshold (adjusted for household size)
- people with no access to a car.

NZDep is often divided into quintiles, with quintile 1 being the 20% least deprived areas (by population) in New Zealand, and quintile 5 being the 20% most deprived areas in New Zealand. Caution must be used when interpreting NZDep, as it is a score given to an area that is based on the average deprivation of all of the people living in an area. As a result, individuals will experience different levels of deprivation than others in the same NZDep area, but will have the same NZDep score.

The data comparing perioperative mortality between deprivation quintiles during 2010–2014 is not yet finalised. This report presents comparative data between deprivation quintiles for admissions during 2009–2013 (based on data from the last POMRC report; POMRC 2016), and descriptive data for people in the most deprived (quintile 5) areas for admissions during 2010–2014.

16 Areas with the 20% highest NZDep scores by population (Atkinson et al 2014).

## Recommendations

The POMRC recommends that:

**Recommendation 2:** A patient's ethnicity and socioeconomic status should not influence his or her outcome after surgery. Future research should investigate the socioeconomic and ethnic inequities in: a) perioperative mortality, and b) acute versus elective surgery rates. This research should explore both the underlying causes of these inequities and ways to reduce these inequities.

> *Rationale:* The POMRC found that people who identified as Māori and people who lived in areas of high deprivation had higher rates of acute admissions for surgery than elective admissions, compared with non-Māori and low deprivation. Acute surgery had a higher mortality rate than elective surgery.

**Recommendation 3:** People should have equitable access to high-quality health care so conditions that require surgery are identified promptly. DHBs should investigate programmes to increase access to both primary care and medical and surgical specialists. This should be supported by the Ministry of Health.

> *Rationale:* There were differences between population groups in rates of acute versus elective surgery. Increased access to health services may lead to earlier detection of conditions that require surgery. As a result, the surgery can be planned (elective), ensuring that the appropriate discussions are had with the patient and their whānau, the patient is properly prepared, and the hospital has the optimal resources available. Given that mortality is significantly higher following acute surgery than elective surgery, patient outcomes should improve if surgery is planned.

### Key findings

In New Zealand during 2009–2013:

- The number of admissions and perioperative mortality increased as deprivation increased.
- People living in the most deprived (quintile 5) areas had 14% more elective admissions than people living in the least deprived (quintile 1) areas, and twice as many acute admissions than people living in the least deprived (quintile 1) areas.

In New Zealand during 2010–2014, for the 20% of the population who lived in the most socioeconomically deprived areas (quintile 5) in New Zealand:

- There were 289,387 admissions in which general anaesthesia was performed. The 30-day mortality rate was 0.58%. The numbers of deaths and admissions each year were generally stable over the five-year period.
- For both acute and elective admissions, cardiovascular causes and neoplasms were the most common underlying reasons for mortality.
- Acute admissions made up 29% of all admissions and 74% of all deaths following one or more general anaesthetics. Mortality was higher following acute admissions (1.48%) than elective admissions (0.14%).
- For both acute and elective admissions, mortality was highest on the day after a procedure.
- For both acute and elective admissions, mortality was significantly higher for those aged 45 years and over, those with an ASA score of 3 or more, and those with a Charlson Comorbidity Index (CCI) score of 1 or more. These differences were significant after adjusting for sociodemographic factors (age, gender, ethnicity, NZDep decile) and clinical factors (ASA score, CCI score).
- Perioperative mortality rates were significantly higher for Māori, and this difference remained after adjusting for sociodemographic and clinical factors.

- Common diagnoses for acute admissions with at least one general anaesthetic included skin abscesses, acute appendicitis, and fractures. Common diagnoses for elective/waiting list admissions included dental caries, otitis media, joint disorders, diseases of the tonsils/adenoids and inguinal hernia.

Studies from other countries have also found higher perioperative mortality for people with high socioeconomic deprivation.

## International literature

Socioeconomic status is usually associated with higher perioperative mortality in the international literature, consistent with the POMRC's findings.

### *Measures of socioeconomic deprivation*

Socioeconomic deprivation is measured in a variety of ways. Some studies have directly measured socioeconomic status (eg, by using the individual's income or level of education). Others use area measures of socioeconomic status (similar to NZDep), by using the average socioeconomic status of the area in which a person lives as a proxy for their socioeconomic status. Irrespective of the measure used, a number of studies have found that greater socioeconomic status is associated with higher perioperative mortality.

### *Thirty-day mortality following general anaesthesia*

A literature search found no studies have investigated the effect of socioeconomic deprivation on all 30-day mortality following a general anaesthetic. However, a number of studies have identified socioeconomic disparities in mortality following specific surgical procedures. Compared with people living in low deprivation, people living in high deprivation have a greater 30-day or inpatient mortality after cardiac surgery (Dalén et al 2015), coronary artery bypass surgery (Ancona et al 2000; LaPar et al 2012), lung resection (LaPar et al 2011), colorectal resection (Burns et al 2011; Hoehn et al 2017; Morris et al 2011), cholecystectomy (Ambur et al 2017), and surgery for brain tumour (Momin et al 2012).

There have been some studies that have found no difference in perioperative mortality by socioeconomic deprivation. A study in Australia of survival following coronary artery bypass graft (CABG) surgery found that there was no difference between advantaged and disadvantaged groups for 30-day or seven-year mortality (Shi et al 2014).

### *Possible causes of socioeconomic inequities in perioperative mortality rates*

International research suggests that socioeconomic inequities in perioperative mortality may be underpinned by several factors, including that people in high socioeconomic deprivation (versus low socioeconomic deprivation):

- are more likely to experience 'failure to rescue' (death after a complication that could have been treated) (Reames et al 2014)[17]
- are more likely to have comorbidities and greater illness severity at presentation for surgery (Ambur et al 2017;[17] Ancona et al 2000; Clement et al 2011)
- are more likely to receive acute surgery than elective surgery (Ambur et al 2017;[17] Sandiford et al 2012; Shi et al 2014)
- are less likely to access high-volume surgeons (Dueck et al 2004) and hospitals (Osler et al 2011) – high-volume surgeons and hospitals often have better outcomes
- have longer waiting times between admission and surgery (Barone et al 2009)
- have greater incidence of risk factors like smoking and obesity (Shi et al 2014).

17 **Study from a country with a publicly funded health care system.** Note that the majority of the studies cited above are from countries with a health care system that is predominantly privately funded, rather than publicly funded as in New Zealand. Findings from privately funded health care systems may not be as comparable to New Zealand.

## Composite case 1: Acute laparotomy and Hartman's procedure

Mrs A, a 77-year-old widow, presented to hospital acutely with a large bowel obstruction secondary to a recto-sigmoid cancer. She had experienced worsening tiredness, weight loss and some abdominal pain, but had not seen her GP in the last 12 months because of the difficulty in getting to the practice (she lived alone without any social support).

An urgent operation was considered essential. As a result, the assessment and consent discussion were limited. No friends or family were available to support her in the discussion of the options for treatment.

Although Mrs A had no known illnesses, she had smoked 20 cigarettes per day for 40 years. She also had a history suggestive of ischaemic heart disease, congestive heart failure and chronic lung disease. Given her presentation, the surgeon recommended an acute laparotomy and Hartman's procedure, to which she agreed. The operation proceeded uneventfully and, after recovery, Mrs A was transferred to a general ward. On the second day after surgery she became increasingly unwell, and was transferred to intensive care with an acute chest infection and increasing renal impairment. She continued to deteriorate, and died of multi-organ failure five days later.

Her case was reviewed by a multidisciplinary team at the hospital. The review concluded there had been inadequate consideration of the effect of her frailty as well as her pre-existing illnesses. In retrospect, a less invasive procedure to relieve the obstruction should have been considered (eg, a stent). More consideration should have been given to the best treatment to offer a frail, elderly person. The review also noted the effect of socioeconomic deprivation and frailty on Mrs A's health and access to medical care, and how the resulting delay in access to care had reduced her ability to withstand the challenge of an operation.

## Composite case 2: Strangulated inguinal hernia repair

Mr B, a 70-year-old man, presented to a regional hospital with a strangulated inguinal hernia, having been unwell for one week prior to presentation. His hernia was repaired, and he was discharged home. One week after discharge he returned to hospital acutely, having become increasingly unwell since the surgery. By the time he got to hospital he had a small bowel obstruction and renal failure, aspiration pneumonia and a significant metabolic acidosis. Due to the severity of his condition he was transferred to a major centre, but suffered a cardiac arrest shortly after arrival and died.

His case was reviewed by a multidisciplinary team at the hospital. At the review, the effect of delayed presentation to hospital was discussed. It was noted there can be multiple barriers to accessing medical care for people who are socioeconomically deprived, especially those who live in rural areas.

## Perioperative mortality and socioeconomic deprivation

*Admissions and mortality following general anaesthesia, by socioeconomic deprivation*

In New Zealand during 2009–2013, as deprivation increased, the number of admissions with general anaesthesia increased, and the 30-day mortality rate following these admissions increased (Table 1, Figure 1).

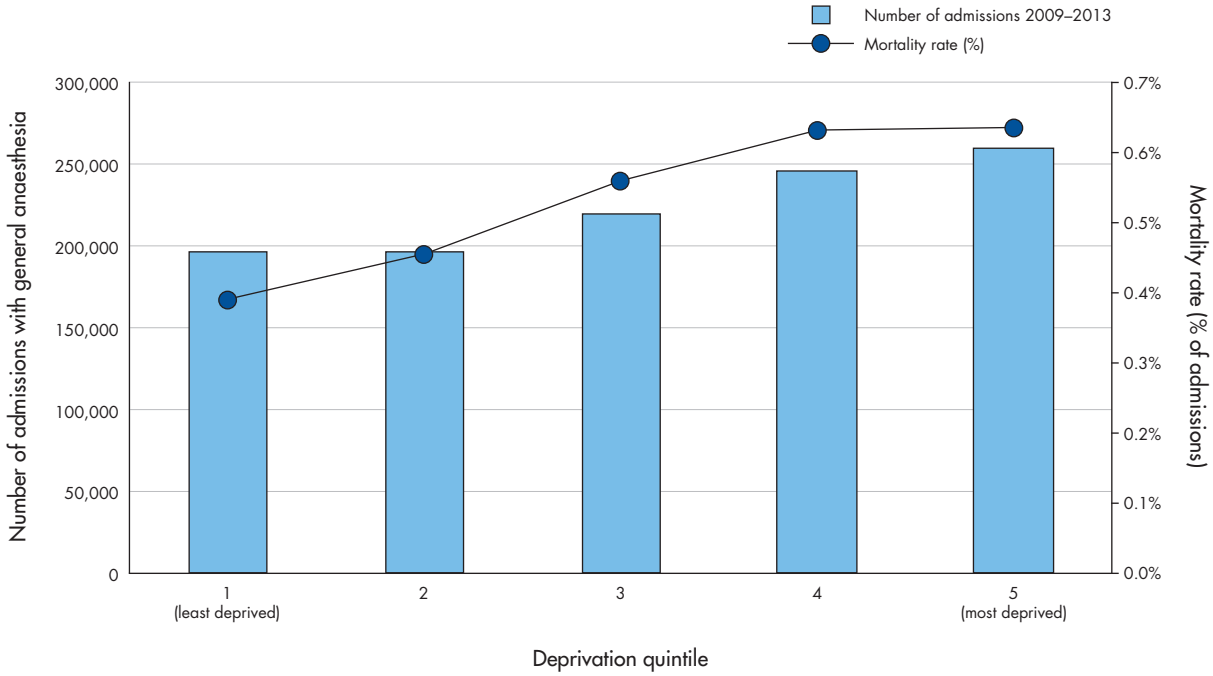
This relationship remained after adjusting for other sociodemographic and clinical factors. For elective admissions, people living in the most deprived (quintile 5) areas had 1.18 times greater odds of mortality than people living in quintile 1 (least deprived) areas for acute admissions. These odds increased to 1.46 for elective admissions (POMRC 2016).

Table 1: Number of admissions and 30-day mortality following general anaesthesia, by deprivation quintile, New Zealand 2009–2013

| DEPRIVATION QUINTILE | Deaths | Admissions | Mortality rate (%) |
|---|---|---|---|
| 1 (least deprived) | 768 | 196,950 | 0.39 |
| 2 | 894 | 196,887 | 0.45 |
| 3 | 1,227 | 219,215 | 0.56 |
| 4 | 1,549 | 245,247 | 0.63 |
| 5 (most deprived) | 1,647 | 259,609 | 0.63 |
| All deprivation quintiles | 6,085 | 1,117,908 | 0.54 |

**Numerator:** NMC: Deaths within 30 days of a general anaesthetic.
**Denominator:** NMDS: Hospital admissions with one or more general anaesthetics 2009–2013 (as published in the POMRC's fifth report; POMRC 2016).

Figure 1: Number of admissions and 30-day mortality following general anaesthesia, by deprivation quintile, New Zealand 2009–2013




**Numerator:** NMC: Deaths within 30 days of a general anaesthetic.
**Denominator:** NMDS: Hospital admissions with one or more general anaesthetics 2009–2013 (as published in previous POMRC report; POMRC 2016).

*Admissions and mortality following general anaesthesia, for people living in the most deprived areas, by year*

In New Zealand during 2010–2014, there were 1,676 deaths within 30 days of a general anaesthetic among people living in the most deprived (quintile 5) areas. The overall mortality for the five-year period was 0.58% of admissions (Table 2). The annual mortality rate was between 0.54% and 0.62% of admissions.

Table 2: Annual number of admissions with general anaesthesia and deaths within 30 days of general anaesthesia, for people living in the most deprived (quintile 5) areas, New Zealand 2010–2014

| DISCHARGE YEAR | Deaths | Admissions | Mortality rate (%) |
|---|---|---|---|
| **People living in most deprived (quintile 5) areas** | | | |
| 2010 | 323 | 57,267 | 0.56 |
| 2011 | 361 | 57,901 | 0.62 |
| 2012 | 335 | 57,199 | 0.59 |
| 2013 | 337 | 57,719 | 0.58 |
| 2014 | 320 | 59,301 | 0.54 |
| Total 2010–2014 | 1,676 | 289,387 | 0.58 |

**Numerator:** NMC: Deaths within 30 days of a general anaesthetic.
**Denominator:** NMDS: Hospital admissions with one or more general anaesthetics among people living in quintile 5 areas 2010–2014.

*Admissions and mortality following general anaesthesia, by socioeconomic deprivation and admission type*

In New Zealand during 2010–2014, as deprivation increased, the proportion of admissions with general anaesthesia that were acute increased (Table 3, Figure 2). People living in the most deprived (quintile 5) areas had 14% more elective admissions than people living in the least deprived (quintile 1) areas, but twice as many acute admissions than people living in quintile 1 areas.

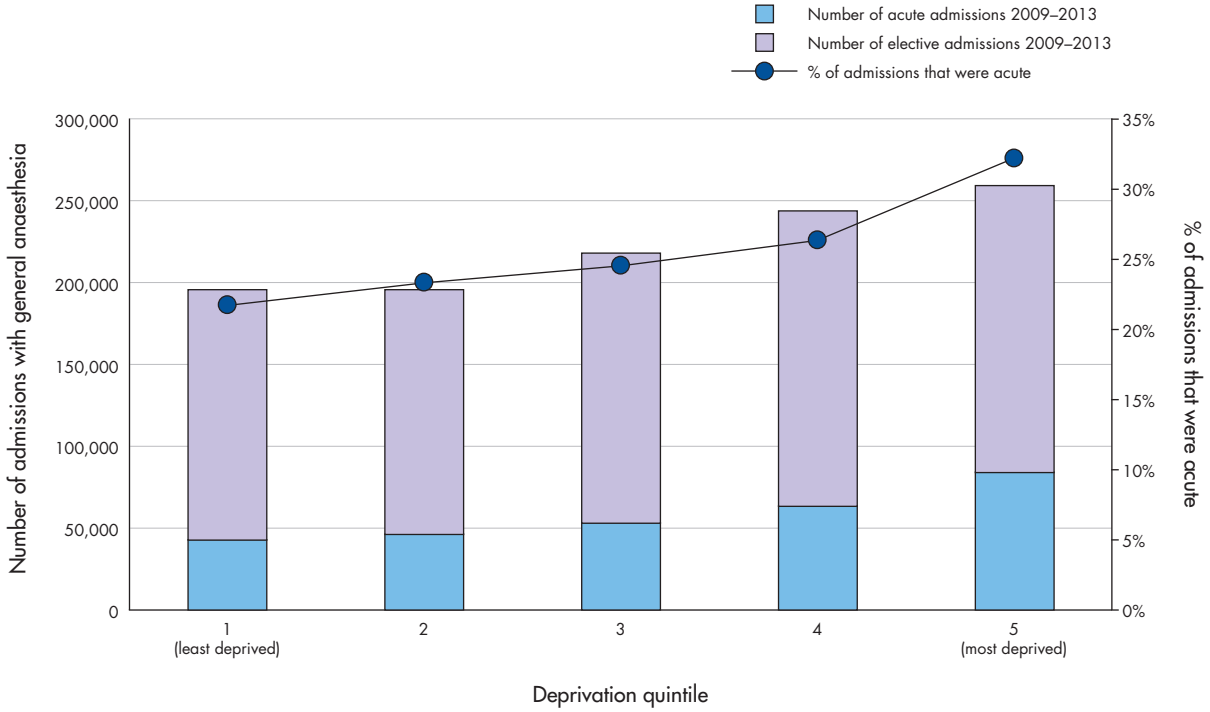
As noted earlier in this report, the data that the POMRC uses is missing some surgical operations in private hospitals. However, how many are missing is hard to quantify. It is possible that some of the difference in acute and elective admissions between people living in high and low deprivation is caused by differences in private hospital use.

Table 3: Number of admissions with general anaesthesia and the percentage of those admissions that were acute, by deprivation quintile and admission type, New Zealand 2009–2013

| DEPRIVATION QUINTILE | Acute admissions | Elective admissions | Percentage of admissions that were acute (%) |
|---|---|---|---|
| 1 (least deprived) | 42,748 | 154,202 | 21.7 |
| 2 | 45,955 | 150,932 | 23.3 |
| 3 | 53,610 | 165,605 | 24.5 |
| 4 | 64,500 | 180,747 | 26.3 |
| 5 (most deprived) | 83,688 | 175,921 | 32.2 |
| All deprivation quintiles | 290,501 | 827,407 | 26.0 |

**Data source:** NMDS: Hospital admissions with one or more general anaesthetics 2009–2013 (as published in the POMRC's fifth report; POMRC 2016).

Figure 2: Number of admissions with general anaesthesia and the percentage of those admissions that were acute, by deprivation quintile, New Zealand 2009–2013




**Data source:** NMDS: Hospital admissions with one or more general anaesthetics 2009–2013 (as published in previous POMRC report; POMRC 2016).

*Admissions with general anaesthesia for people living in the most deprived areas, by admission type*

For people living in the most deprived (quintile 5) areas, acute admissions made up 29% of all admissions and 74% of all deaths following one or more general anaesthetics. Mortality was higher following acute admissions (1.48%) than elective/waiting list admissions (0.14%).

*Admissions with general anaesthesia by admission type and primary diagnosis*

In New Zealand during 2010–2014, for people living in the most deprived areas (quintile 5), the most common primary diagnoses for acute admissions with general anaesthesia were a skin abscess, acute appendicitis, and various fractures (Table 4). For elective admissions, the most common diagnosis was dental caries, with 13,269 admissions, followed by otitis media, disorders of the tonsils and adenoids, other joint disorders, and inguinal hernias.

Table 4: Hospital admissions with general anaesthesia for people living in the most deprived (quintile 5) areas, by primary diagnosis and admission type, New Zealand 2010–2014

| PRIMARY DIAGNOSIS | Number: Total 2010–2014 | Number: Annual average | Percentage of admissions (%) |
|---|---|---|---|
| **People living in most deprived (quintile 5) areas** | | | |
| **Acute** | | | |
| Cutaneous abscess | 7,552 | 1,510.4 | 9.1 |
| Acute appendicitis | 5,316 | 1,063.2 | 6.4 |
| Fracture of lower leg | 3,888 | 777.6 | 4.7 |
| Fracture of forearm | 3,372 | 674.4 | 4.0 |
| Fracture of femur | 2,782 | 556.4 | 3.3 |
| Cholelithiasis | 2,540 | 508.0 | 3.0 |
| Fracture of wrist | 2,018 | 403.6 | 2.4 |
| Complications of procedures | 1,870 | 374.0 | 2.2 |
| Fracture of shoulder and upper arm | 1,814 | 362.8 | 2.2 |
| Open wound of wrist and hand | 1,768 | 353.6 | 2.1 |
| Perianal abscess | 1,576 | 315.2 | 1.9 |
| Fracture of skull or facial bones | 1,368 | 273.6 | 1.6 |
| Other diagnoses | 47,529 | 9,505.8 | 57.0 |
| Total acute | 83,393 | 16,678.6 | 100.0 |
| **Public hospital semi-acute** | | | |
| Abortion | 2,135 | 427.0 | 8.5 |
| Fracture of wrist | 1,218 | 243.6 | 4.8 |
| Other diagnoses | 21,787 | 4,357.4 | 86.7 |
| Total public hospital semi-acute | 25,140 | 5,028.0 | 100.0 |
| **Elective/waiting list** | | | |
| Dental caries | 13,269 | 2,653.8 | 7.3 |
| Otitis media | 8,115 | 1,623.0 | 4.5 |
| Other joint disorders | 7,131 | 1,426.2 | 3.9 |
| Disorders of tonsils and adenoids | 6,751 | 1,350.2 | 3.7 |
| Inguinal hernia | 5,119 | 1,023.8 | 2.8 |
| Excessive menstruation | 4,143 | 828.6 | 2.3 |
| Internal derangement of knee | 4,028 | 805.6 | 2.2 |
| Arthrosis of knee | 3,254 | 650.8 | 1.8 |
| Breast cancer | 2,987 | 597.4 | 1.7 |
| Arthrosis of hip | 2,965 | 593.0 | 1.6 |
| Disorders of nose and mouth | 2,627 | 525.4 | 1.5 |
| Shoulder lesions | 2,334 | 466.8 | 1.3 |
| Contraceptive management | 2,199 | 439.8 | 1.2 |
| Urolithiasis | 2,037 | 407.4 | 1.1 |
| Perforation of the tympanic drum | 1,992 | 398.4 | 1.1 |
| Other diagnoses | 111,891 | 22,378.2 | 61.9 |
| Total elective/waiting list | 180,842 | 36,168.4 | 100.0 |

**Data source:** NMDS: Hospital admissions with one or more general anaesthetics among people living in quintile 5 areas 2010–2014.

*Thirty-day mortality following general anaesthesia for people living in the most deprived areas, by cause of death*

In New Zealand during 2010–2014, for all admission types, cardiovascular causes and neoplasms were the most common underlying reasons for mortality within 30 days of general anaesthesia, followed by gastrointestinal conditions, falls, and diabetes (Table 5).

Table 5: Thirty-day mortality following general anaesthesia for people living in the most deprived (quintile 5) areas, by admission type and main underlying cause of death, New Zealand 2010–2013

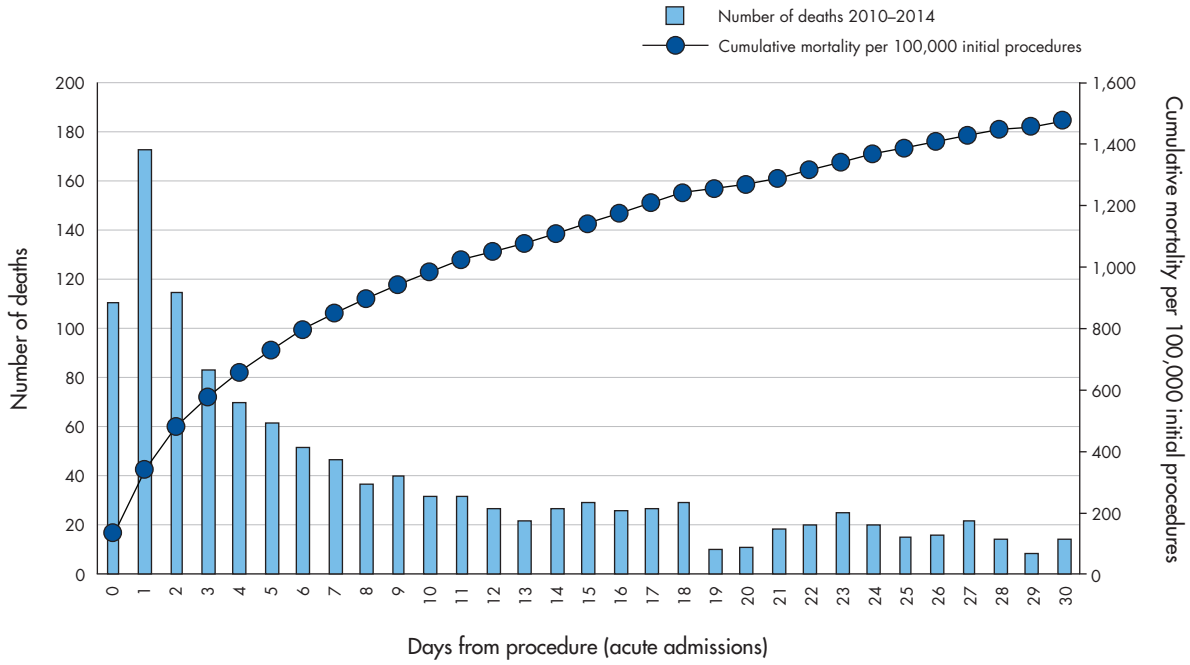
| MAIN UNDERLYING CAUSE OF DEATH | Total deaths 2010–2013 | Annual average | Percentage of deaths in category (%) |
|---|---|---|---|
| **People living in most deprived (quintile 5) areas** | | | |
| **Acute admissions** | | | |
| Neoplasms | 208 | 41.6 | 16.9 |
| Other cardiovascular causes | 162 | 32.4 | 13.1 |
| Gastrointestinal disorders | 110 | 22.0 | 8.9 |
| Fall | 72 | 14.4 | 5.8 |
| Myocardial infarction | 70 | 14.0 | 5.7 |
| Other ischaemic heart disease | 62 | 12.4 | 5.0 |
| Diabetes | 56 | 11.2 | 4.5 |
| Other injuries/external causes | 44 | 8.8 | 3.6 |
| Respiratory | 31 | 6.2 | 2.5 |
| Dementia/Alzheimer's/CNS degeneration | 12 | 2.4 | 1.0 |
| Other causes | 5 | 1.0 | 0.4 |
| No cause available | 402 | 80.4 | 32.6 |
| Total acute | 1234 | 246.8 | 100.0 |
| **Public hospital semi-acute** | | | |
| Neoplasms | 28 | 5.6 | 14.5 |
| Ischaemic heart disease | 13 | 2.6 | 6.7 |
| Other cardiovascular | 13 | 2.6 | 6.7 |
| Other causes | 16 | 3.2 | 8.3 |
| No cause available | 123 | 24.6 | 63.7 |
| Total semi-acute | 193 | 38.6 | 100.0 |
| **Elective/waiting list admissions** | | | |
| Neoplasms | 63 | 12.6 | 25.3 |
| Other cardiovascular causes | 38 | 7.6 | 15.3 |
| Ischaemic heart disease | 33 | 6.6 | 13.3 |
| Gastrointestinal disorders | 9 | 1.8 | 3.6 |
| Non-insulin dependent diabetes | 9 | 1.8 | 3.6 |
| Respiratory | 6 | 1.2 | 2.4 |
| Other causes | 7 | 1.4 | 2.8 |
| No cause available | 84 | 16.8 | 33.7 |
| Total elective/waiting list | 249 | 49.8 | 100.0 |

**Data source:** NMC: Deaths among people living in quintile 5 areas and within 30 days of a general anaesthetic 2010–2013, as recorded in the NMDS. Underlying cause of death was not available for 2014 admissions.

*Thirty-day mortality following general anaesthesia for people living in the most deprived areas, by day from procedure*

In New Zealand during 2010–2014, among acute admissions for people living in the most deprived (quintile 5) areas, the greatest number of deaths occurred within the first two days of the procedure (Figure 3). The number of deaths decreased over the first 10 days after the procedure, but occurrences remained throughout the 30-day period. Similarly, the greatest number of deaths also occurred one day after the procedure for elective/waiting list admissions, and the numbers also fluctuated over the remaining 30-day period after falling during the first five days (Figure 4).

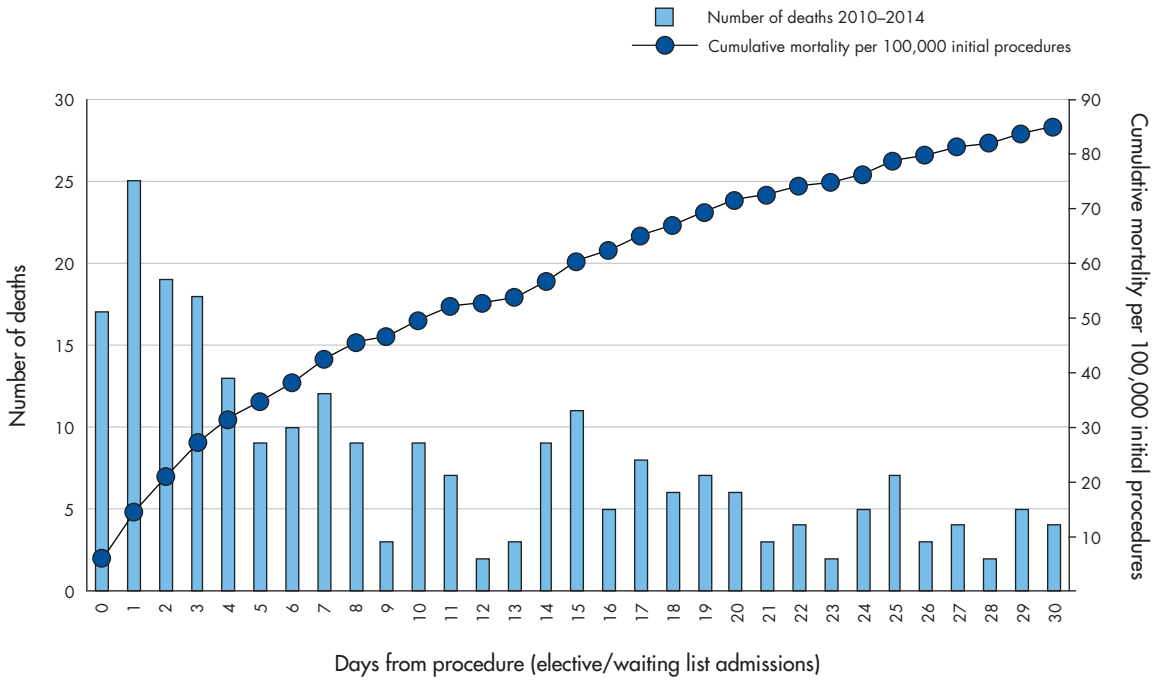
Figure 3: Thirty-day mortality following acute admissions with general anaesthesia, for people living in the most deprived (quintile 5) areas, by day from procedure, New Zealand 2010–2014




**Numerator:** NMC: Deaths occurring within 30 days among acute admissions after general anaesthesia among those living in quintile 5 areas, as recorded in NMDS.

**Denominator:** NMDS: Acute admissions among people living in most deprived areas who undergo at least one general anaesthetic.

Figure 4: Thirty-day mortality following elective admissions with general anaesthesia, for people living in the most deprived (quintile 5) areas, by day from procedure, New Zealand 2010–2014




**Numerator:** NMC: Deaths occurring within 30 days among elective admissions after general anaesthesia among those living in quintile 5 areas, as recorded in NMDS.

**Denominator:** Elective/waiting list admissions among people living in most deprived areas who undergo at least one general anaesthetic.

## Thirty-day mortality following general anaesthesia for people living in the most deprived areas, by sociodemographic and clinical factors

### *All admissions combined*

Between 2010 and 2014, mortality rates in the 30 days following general anaesthesia for people living in the most deprived areas (quintile 5) were significantly higher for:

- acute admissions (compared with elective admissions)
- people aged 45 years or older (compared with people aged 0–44 years)
- people who identified as Māori (compared with New Zealand European)
- people who were sicker, ie, people:
    - with an ASA score of 3, 4 or 5, or no recorded score (compared with an ASA score of 1 or 2)
    - with a CCI score of 1 or more (compared with a score of zero) (Table 6).

These factors were significant after adjusting for sociodemographic factors (age, gender, ethnicity, and socioeconomic deprivation) and clinical factors (ASA score and CCI score).

*Acute admissions*

For acute admissions, mortality rates in the 30 days following general anaesthesia for people living in the most deprived areas (quintile 5) were significantly higher for:

- people aged 45 years or older (compared with people aged 0–44 years)
- people with an ASA score of 3 or more, or no recorded score (compared with an ASA score of 1 or 2)
- people who were sicker, ie, people:
    - with an ASA score of 3 or more, or no recorded score (compared with an ASA score of 1 or 2)
    - with a CCI score of 1 or more (compared with a score of zero) (Table 7).

These factors were significant after adjusting for sociodemographic factors and clinical factors.

*Elective/waiting list admissions*

For elective admissions, mortality rates in the 30 days following general anaesthesia for people living in the most deprived areas (quintile 5) were significantly higher for:

- people aged 45 years or older (compared with people aged 0–44 years)
- males (compared with females)
- people who identify as Māori (compared with New Zealand European)
- people who were sicker, ie, people:
    - with an ASA score of 3 or more, or no recorded score (compared with an ASA score of 1 or 2)
    - with a CCI score of 1 or more (compared with a score of zero) (Table 8).

These factors were significant after adjusting for sociodemographic factors and clinical factors.

Table 6: Thirty-day mortality following admissions with general anaesthesia for people living in the most deprived (quintile 5) areas, by age group, admission type, gender, ASA score, ethnicity and CCI score, New Zealand 2010–2014

| VARIABLE | CATEGORY | Number of deaths | Number of admissions | Mortality per 100,000 admissions | Mortality per 100 admissions (%) | Univariate OR | 95% CI | Multivariate OR | 95% CI |
|---|---|---|---|---|---|---|---|---|---|
| **People living in most deprived (quintile 5) areas** | | | | | | | | | |
| **All admissions** | | | | | | | | | |
| Age group | 0–44 years | 237 | 172,243 | 137.60 | 0.14 | 1.00 | | 1.00 | |
| | 45–64 years | 416 | 71,214 | 584.15 | 0.58 | 4.26* | 3.64–5.00 | 1.70* | 1.42–2.03 |
| | 65–79 years | 591 | 35,801 | 1,650.79 | 1.65 | 12.18* | 10.47–14.17 | 3.13* | 2.61–3.75 |
| | 80+ years | 432 | 10,129 | 4,264.98 | 4.26 | 32.33* | 27.56–37.93 | 6.13* | 5.02–7.48 |
| Admission type | Elective/waiting list | 249 | 180,842 | 137.69 | 0.14 | 1.00 | | 1.00 | |
| | Acute | 1,234 | 83,393 | 1,479.74 | 1.48 | 10.89* | 9.50–12.49 | 6.65* | 5.75–7.69 |
| | Arranged in public | 193 | 25,140 | 767.70 | 0.77 | 5.61* | 4.65–6.77 | 3.24* | 2.64–3.96 |
| Gender | Male | 884 | 138,842 | 636.69 | 0.64 | 1.00 | | 1.00 | |
| | Female | 792 | 150,544 | 526.09 | 0.53 | 0.83 | 0.75–0.91 | 1.01 | 0.91–1.12 |
| First ASA score | 1–2 | 133 | 172,454 | 77.12 | 0.08 | 1.00 | | 1.00 | |
| | 3 | 506 | 35,368 | 1,430.67 | 1.43 | 18.81* | 15.53–22.77 | 4.24* | 3.44–5.24 |
| | 4 | 589 | 5,831 | 10,101.18 | 10.10 | 145.58* | 120.37–176.07 | 15.73* | 12.69–19.51 |
| | 5 | 103 | 215 | 47,906.98 | 47.91 | H* | H | H* | H |
| | Not stated | 329 | 75,501 | 435.76 | 0.44 | 5.67* | 4.64–6.94 | 5.01* | 4.06–6.18 |
| Ethnicity | NZ European | 949 | 137,284 | 691.27 | 0.69 | 1.00 | | 1.00 | |
| | Māori | 457 | 85,167 | 536.59 | 0.54 | 0.78 | 0.69–0.87 | 1.16* | 1.01–1.32 |
| | Pacific | 194 | 43,276 | 448.29 | 0.45 | 0.65 | 0.55–0.76 | 0.82* | 0.69–0.98 |
| | Other | 56 | 18,597 | 301.12 | 0.30 | 0.43 | 0.33–0.57 | 0.72* | 0.53–0.96 |
| Charlson Comorbidity Index | 0 | 344 | 245,693 | 140.01 | 0.14 | 1.00 | | 1.00 | |
| | 1 or 2 | 550 | 29,220 | 1,882.27 | 1.88 | 13.68* | 11.95–15.66 | 4.32* | 3.70–5.05 |
| | > 2 | 782 | 14,474 | 5,402.79 | 5.40 | 40.73* | 35.84–46.29 | 8.56* | 7.32–10.02 |

**Numerator:** NMC: Deaths among people living in quintile 5 areas 2010–2014 and within 30 days of a general anaesthetic, as recorded in the NMDS.
**Denominator:** NMDS: Admissions with one or more general anaesthetics listed in any of the first 90 procedures.
* Significantly different from reference category. **ASA score:** First listed ASA score per admission. **CI:** Confidence interval. **Ethnicity – Other:** Includes Asian, Indian, Middle Eastern, Latin American, African, and admissions with no recorded ethnicity. **OR:** Odds ratio. **H:** Odds ratios suppressed due to high mortality rates. **Note:** Caution should be used in interpreting ORs where mortality exceeds 10% (see Appendix 3 for details).

Table 7: Thirty-day mortality following acute admissions with general anaesthesia for people living in the most deprived (quintile 5) areas, by age group, gender, ASA score, ethnicity and CCI score, New Zealand 2010–2014

| VARIABLE | CATEGORY | Number of deaths | Number of admissions | Mortality per 100,000 admissions | Mortality per 100 admissions (%) | Univariate OR | 95% CI | Multivariate OR | 95% CI |
|---|---|---|---|---|---|---|---|---|---|
| **People living in most deprived (quintile 5) areas** | | | | | | | | | |
| **Acute** | | | | | | | | | |
| Age group | 0–44 years | 165 | 55,719 | 296.13 | 0.30 | 1.00 | | 1.00 | |
| | 45–64 years | 296 | 15,930 | 1,858.13 | 1.86 | 6.37* | 5.26–7.72 | 1.62* | 1.31–2.01 |
| | 65–79 years | 420 | 7,893 | 5,321.17 | 5.32 | 18.92* | 15.78–22.69 | 2.84* | 2.28–3.53 |
| | 80+ years | 353 | 3,851 | 9,166.45 | 9.17 | 33.97* | 28.15–40.99 | 5.51* | 4.36–6.96 |
| Gender | Male | 638 | 44,316 | 1,344.89 | 1.34 | 1.00 | | 1.00 | |
| | Female | 596 | 39,077 | 1,525.19 | 1.53 | 1.06 | 0.95–1.19 | 1.08 | 0.95–1.22 |
| First ASA score | 1–2 | 79 | 56,127 | 140.75 | 0.14 | 1.00 | | 1.00 | |
| | 3 | 348 | 11,082 | 3,140.23 | 3.14 | 23.00* | 18.00–29.39 | 5.08* | 3.88–6.66 |
| | 4 | 492 | 3,267 | 15,059.69 | 15.06 | 125.78* | 98.88–159.99 | 20.79* | 15.86–27.25 |
| | 5 | 97 | 194 | 50,000.00 | 50.00 | H* | H | H* | H |
| | Not stated | 216 | 12,721 | 1,697.98 | 1.70 | 12.25* | 9.46–15.87 | 6.68* | 5.10–8.75 |
| Ethnicity | NZ European | 704 | 32,999 | 2,133.40 | 2.13 | 1.00 | | 1.00 | |
| | Māori | 321 | 27,996 | 1,146.59 | 1.15 | 0.53 | 0.47–0.61 | 1.09 | 0.93–1.27 |
| | Pacific | 149 | 16,635 | 895.70 | 0.90 | 0.42 | 0.35–0.50 | 0.81 | 0.66–1.00 |
| | Other | 48 | 5,024 | 955.41 | 0.96 | 0.44 | 0.33–0.59 | 0.86 | 0.62–1.19 |
| Charlson Comorbidity Index | 0 | 237 | 69,473 | 341.14 | 0.34 | 1.00 | | 1.00 | |
| | 1 or 2 | 421 | 8,426 | 4,996.44 | 5.00 | 15.36* | 13.08–18.04 | 3.90* | 3.25–4.70 |
| | > 2 | 576 | 5,494 | 10,484.16 | 10.48 | 34.21* | 29.33–39.91 | 7.04* | 5.85–8.48 |

**Numerator:** NMC: Deaths among people living in quintile 5 areas 2010–2014 and within 30 days of a general anaesthetic during an acute admission, as recorded in the NMDS.
**Denominator:** NMDS: Admissions with one or more general anaesthetics listed in any of the first 90 procedures.
* Significantly different from reference category. **ASA score:** First listed ASA score per admission. **CI:** Confidence interval. **Ethnicity – Other:** Includes Asian, Indian, Middle Eastern, Latin American, African, and admissions with no recorded ethnicity. **OR:** Odds ratio. **H:** Odds ratios suppressed due to high mortality rates.

Table 8: Thirty-day mortality following elective admission with general anaesthesia by people living in the most deprived (quintile 5) areas, by age group, gender, ASA score, ethnicity and CCI score, New Zealand 2010–2014

| VARIABLE | CATEGORY | Number of deaths | Number of admissions | Mortality per 100,000 admissions | Mortality per 100 admissions (%) | Univariate OR | 95% CI | Multivariate OR | 95% CI |
|---|---|---|---|---|---|---|---|---|---|
| **People living in most deprived (quintile 5) areas** | | | | | | | | | |
| **Elective/waiting list** | | | | | | | | | |
| Age group | 0–44 years | 18 | 98,073 | 18.35 | 0.02 | 1.00 | | 1.00 | |
| | 45–64 years | 62 | 51,221 | 121.04 | 0.12 | 6.60* | 3.91–11.16 | 3.06* | 1.77–5.27 |
| | 65–79 years | 113 | 25,838 | 437.34 | 0.44 | 23.93* | 14.55–39.36 | 7.31* | 4.25–12.58 |
| | 80+ years | 56 | 5,710 | 980.74 | 0.98 | 53.95* | 31.70–91.82 | 14.05* | 7.72–25.54 |
| Gender | Male | 143 | 84,050 | 170.14 | 0.17 | 1.00 | | 1.00 | |
| | Female | 106 | 96,792 | 109.51 | 0.11 | 0.64* | 0.50–0.83 | 0.73* | 0.56–0.94 |
| First ASA score | 1–2 | 40 | 102,069 | 39.19 | 0.04 | 1.00 | | 1.00 | |
| | 3 | 103 | 20,682 | 498.02 | 0.50 | 12.77* | 8.86–18.40 | 3.03* | 2.06–4.45 |
| | 4 | 37 | 1,600 | 2,312.50 | 2.31 | 60.38* | 38.51–94.68 | 8.37* | 5.18–13.55 |
| | Not stated | 69 | 56,484 | 122.16 | 0.12 | 3.12* | 2.11–4.61 | 3.23* | 2.17–4.80 |
| Ethnicity | NZ European | 155 | 94,813 | 163.48 | 0.16 | 1.00 | | 1.00 | |
| | Māori | 66 | 48,377 | 136.43 | 0.14 | 0.83 | 0.63–1.11 | 1.50* | 1.10–2.05 |
| | Pacific | 20 | 21,613 | 92.54 | 0.09 | 0.57* | 0.36–0.90 | 1.10 | 0.67–1.79 |
| | Other | 3 | 11,911 | 25.19 | 0.03 | 0.15* | 0.05–0.48 | 0.35 | 0.11–1.12 |
| Charlson Comorbidity Index | 0 | 63 | 156,911 | 40.15 | 0.04 | 1.00 | | 1.00 | |
| | 1 or 2 | 76 | 16,769 | 453.22 | 0.45 | 11.33* | 8.11–15.84 | 5.03* | 3.51–7.21 |
| | > 2 | 110 | 7,162 | 1,535.88 | 1.54 | 38.84* | 28.47–52.98 | 13.05* | 9.13–18.64 |

**Numerator:** NMC: Deaths among people living in quintile 5 areas 2010–2014 and within 30 days of a general anaesthetic during an elective admission, as recorded in the NMDS.
**Denominator:** NMDS: Elective hospital admissions with one or more general anaesthetics listed in any of the first 90 procedures.
* Significantly different from reference category. **ASA score:** First listed ASA score per admission. **CI:** Confidence interval. **Ethnicity – Other:** Includes Asian, Indian, Middle Eastern, Latin American, African, and admissions with no recorded ethnicity. **OR:** Odds ratio.

## Background: Hospital admissions with one or more general anaesthetics among people living in most deprived (quintile 5) areas

*Admissions with general anaesthesia by admission type and procedure type*

During 2010–2014, among acute admissions with general anaesthesia for residents in low decile areas, the most frequent primary procedure was an incision or drainage of the skin and subcutaneous tissue. Laparoscopic appendectomy and cholecystectomy were also frequent procedures (Table 9). In relation to elective/waiting list admissions, myringotomy with insertion of bilateral tubes was the most frequently performed procedure followed by cholecystectomy and then tonsillectomy and adenoidectomy.

Table 9: Hospital admissions with general anaesthesia for people living in the most deprived (quintile 5) areas, by primary procedure and admission type, New Zealand 2010–2014

| PRIMARY PROCEDURE | Number: Total 2010–2014 | Number: Annual average | Percent of admissions (%) |
|---|---|---|---|
| **People living in most deprived (quintile 5) areas** | | | |
| **Acute** | | | |
| Incision and drainage of skin and subcutaneous tissue | 8,638 | 1,727.6 | 10.4 |
| Laparoscopic appendicectomy | 4,882 | 976.4 | 5.9 |
| Cholecystectomy | 2,658 | 531.6 | 3.2 |
| Other debridement of skin and subcutaneous tissue | 2,146 | 429.2 | 2.6 |
| Curettage and evacuation of uterus | 1,809 | 361.8 | 2.2 |
| Appendicectomy | 1,648 | 329.6 | 2.0 |
| Excisional debridement soft tissue | 1,554 | 310.8 | 1.9 |
| Open reduction of fracture of ankle | 1,393 | 278.6 | 1.7 |
| Internal fixation of fracture of trochanteric or subcapital femur | 1,328 | 265.6 | 1.6 |
| Incision and drainage of breast | 1,328 | 265.6 | 1.6 |
| Other procedures | 56,009 | 11,201.8 | 67.2 |
| Total acute | 83,393 | 16,678.6 | 100.0 |
| **Public hospital semi-acute** | | | |
| Curettage and evacuation of uterus | 2,923 | 584.6 | 11.6 |
| Emergency lower segment caesarean section | 1,281 | 256.2 | 5.1 |
| Magnetic resonance imaging of brain | 1,017 | 203.4 | 4.0 |
| Other procedures | 19,919 | 3,983.8 | 79.2 |
| Total public hospital semi-acute | 25,140 | 5,028.0 | 100.0 |
| **Elective/waiting list** | | | |
| Myringotomy with insertion of tube bilateral | 7,114 | 1,422.8 | 3.9 |
| Cholecystectomy | 4,263 | 852.6 | 2.4 |
| Tonsillectomy with adenoidectomy | 4,032 | 806.4 | 2.2 |
| Dilation and curettage of uterus | 3,791 | 758.2 | 2.1 |
| Repair of bilateral inguinal hernia | 3,476 | 695.2 | 1.9 |
| Total arthroplasty of hip unilateral | 2,957 | 591.4 | 1.6 |
| Tonsillectomy without adenoidectomy | 2,954 | 590.8 | 1.6 |
| Total arthroplasty of knee unilateral | 2,770 | 554.0 | 1.5 |
| Arthroscopy of knee | 2,376 | 475.2 | 1.3 |
| Excision of lesion of breast | 2,250 | 450.0 | 1.2 |
| Other procedures | 144,859 | 28,971.8 | 80.1 |
| Total elective/waiting list | 180,842 | 36,168.4 | 100.0 |

**Data source:** NMDS: Hospital admissions with one or more general anaesthetics among people living in quintile 5 areas 2010–2014.

# Thirty-Day Mortality following Abdominal Aortic Aneurysm Repair

This chapter uses information from the NMDS and the NMC to review 30-day mortality following an abdominal aortic aneurysm (AAA) repair. Detailed information about data sources and methods are presented in Appendix 3.

## AAA repair

An AAA develops when the main blood vessel for the abdomen and lower body (aorta) has a weakness in its wall, which causes a section of it to swell. Although the true prevalence in New Zealand is unknown, a recent study found that 6.9% of people aged over 55 years had an AAA, in a sample of people undergoing computed tomography colonography for gastrointestinal symptoms in New Zealand (Khashram et al 2015). Another study found that in 2008, 833 people were newly hospitalised for AAA in New Zealand, and there were 171 hospital deaths related to AAA (Sandiford et al 2011).

An 'AAA repair' is a procedure in which the weak wall of the aorta is repaired or supported, either when it is intact but at risk of rupturing (usually done electively), or when it has ruptured (usually done as an emergency). There are currently two methods of AAA repair: open surgical repair, and endovascular repair in which a stent is inserted through the groin and advanced up into the aorta. Endovascular repair was first introduced in the 1990s, and its use has increased since (see Steuer et al 2016 for a review). Patient factors and suitability, as well as surgeon skill and experience, can influence which type of repair is performed.

The purpose of this chapter is to provide a comprehensive summary of perioperative mortality following AAA repair in New Zealand. The POMRC selected AAA repair as a special topic this year because it is an area with changing clinical practice, with the use of endovascular repair for AAA increasing internationally (Steuer et al 2016). Additionally, AAAs affect a large number of New Zealanders.

## Recommendations

The POMRC recommends that:

**Recommendation 4:** The option of an endovascular repair should be considered for all patients who need an elective abdominal aortic aneurysm (AAA) repair. The risks and benefits of each repair type, as well the risks and benefits of no operation (if appropriate), should be discussed with the patient. *Note: Although endovascular repair has lower mortality than open repair for patients in the short term (30 days following surgery), there is no evidence of a difference in mortality rates in the longer term (more than two years) and reintervention rates for endovascular repair are higher.*

*Rationale:* The POMRC found that endovascular AAA repair had a lower mortality rate than open repair. Recent meta-analyses have found that endovascular repair has a lower mortality rate than open repair in elective admissions. There are only a few studies that compare endovascular and open repair in emergency admissions, and the findings so far are inconclusive.

**Recommendation 5:** The risk of dying perioperatively (and of serious complications) should be discussed with all patients contemplating an operation with a significant risk (eg, ruptured AAA repair). *Note: There is currently no consensus of the level of risk at which these discussions should take place. 'Significant risk' may vary depending on the operation, patient characteristics, and patient and whānau expectations.*[18]
*This recommendation is repeated from the 2016 report.*

*Rationale:* The POMRC found that some surgery types and patient characteristics result in higher rates of perioperative mortality than others.

## Waitemata DHB's AAA screening pilot for Māori

### *Background*

Screening with a one-off abdominal ultrasound prevents AAA deaths by detecting, monitoring and repairing aneurysms before they rupture. The UK and Sweden have population-based screening programmes for AAA, but New Zealand does not. Māori develop AAA and die from AAA eight years earlier than New Zealand Europeans (Sandiford et al 2012), however the prevalence of AAA in Māori is unknown.

To improve equity of outcomes and inform national policy, Waitemata DHB began funding an AAA screening pilot for Māori in 2016.

### *Objective*

The objective of the screening pilot was to determine the prevalence of AAA, and the cost-effectiveness and acceptability of AAA screening for Māori.

### *Methods*

The Waitemata DHB pilot was done in close collaboration with primary care (three general practices), a local Māori provider (Te Ha Oranga) and Auckland DHB's vascular service.

All Māori men aged 55–74 years and Māori women aged 60–74 years who were enrolled in the participating general practices were eligible for screening. Cultural support and transport assistance was provided by Te Ha Oranga. The general practices invited patients to participate, provided AAA screening and referred patients with aneurysms to the vascular service. Aneurysms were defined as aortic diameters of 30mm or greater in men and 27mm or greater in women; aortas greater than 26mm were referred for monitoring.

### *Results*

Of the 593 patients invited to screening between June and November 2016, 465 attended (overall participation rate of 78%). In total, 21 AAAs were detected in the pilot. The highest prevalence of AAA was in men aged 60–74 years at 2.5% (95% CI 0.6–4.9%) and in women aged 65–74 at 3.9% (95% CI 1.0–7.8%). The pilot found AAA screening in Māori men was cost-effective.[19]

18 See the recent decision by the Health & Disability Commissioner, who found that the risk of surgery based on the patient's characteristics should be discussed with the patient: http://www.hdc.org.nz/decisions--case-notes/commissioner's-decisions/2015/12hdc00779.

19 Cost-effectiveness estimates were performed by adapting a model developed in the UK. The incremental cost-effectiveness ratio (ICER) was estimated to be $21,000 per quality-adjusted life-year. In New Zealand, interventions with an ICER of less than $45,000 per quality-adjusted life year (QALY) are considered to be cost-effective.

### *Conclusion*

This was the first investigation of population-based AAA prevalence in Māori. The pilot had the explicit intention of reducing inequity and making a small but important contribution to reducing the life expectancy gap for Māori. The pilot demonstrated that high participation rates can be achieved with careful design. AAA screening appears to be a feasible, acceptable and cost-effective intervention in New Zealand.

### *Ongoing work*

Following the success of the pilot, AAA screening was extended to include all eligible Māori enrolled across Waitemata and Auckland DHB areas. The extension included the addition of atrial fibrillation screening, which is a risk factor for stroke. The extension will also examine whether 27mm is more appropriate than 30mm as the definition of an AAA in women.


### *Acknowledgements*

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## Key findings

In New Zealand during 2010–2014:

- There were 2,226 admissions for AAA repair. Thirty-day mortality over this five-year period was 7.7% (171 deaths). The numbers of deaths and admissions each year were generally stable over the five-year period.
- Acute admissions made up 31% of all admissions for AAA repair and 79% of all deaths following AAA repair. The mortality rate was higher following acute admissions (19.59%) than elective/waiting list admissions (2.11%).
- Forty-one percent of acute admissions were for a ruptured AAA.
- There were 1,269 open repairs and 899 endovascular repairs for AAA. The majority (82%) of acute admissions for AAA repair underwent an open repair. Half (48%) of elective admissions for AAA repair underwent an open repair.
- Mortality was higher following an open repair than an endovascular repair. In acute admissions, mortality was 22.40% following an open repair, and 7.09% following an endovascular repair. In elective/waiting list repair, mortality was 3.42% following an open repair and 1.04% following an endovascular procedure.
- Māori had more acute admissions relative to elective admissions (ie, a higher percentage of admissions that were acute) for AAA repair than New Zealand Europeans. Similarly, people living in areas with high socioeconomic deprivation had a greater percentage of acute admissions than people living in less deprived areas.
- For acute admissions, mortality peaked on the day of AAA repair. For elective admissions, mortality was highest in the five days following repair.
- Mortality rates following acute admissions were significantly higher for people who underwent an open repair (compared with an endovascular repair), people aged 80 years or older (compared with people aged 0–64 years) and people with an ASA score of 4 or 5 (compared with an ASA score of 1 or 2). These differences were significant after adjusting for the effects of other sociodemographic factors (age, gender, ethnicity and socioeconomic deprivation) and clinical factors (ASA score and CCI score).
- Mortality rates following elective admissions were significantly higher for people who underwent an open repair (compared with an endovascular repair), people with an ASA score of 4 (compared with

an ASA score of 1 or 2) and people with a CCI score of 3 or more (compared with a CCI score of 2 or less). These differences were significant after adjusting for sociodemographic factors and clinical factors.

- New Zealand's perioperative mortality rates following AAA repair were comparable to the rates observed internationally.

## International literature

With the increasing use of endovascular repair to treat AAAs (Steuer et al 2016), there has been a large amount of research into the outcomes of endovascular versus open repair following AAA.

For elective repairs, most studies have found that endovascular repair has lower mortality than open repair in the shorter term (less than 30 days). For emergency repairs, the difference in mortality following open repair and endovascular repair is less conclusive. For both elective and emergency repairs, longer-term mortality (more than two years) is the same following both endovascular and open repair.

The POMRC's analysis differs from the international literature in that it compares acute admissions (mix of ruptured and symptomatic but intact AAAs) with elective admissions (mostly intact AAAs), while the international literature usually compares repair of ruptured AAAs with intact AAAs. The POMRC's comparison of acute and elective admissions is consistent with the methodology employed in previous POMRC reports, which have examined perioperative mortality associated with other procedures, populations and complications.

As a result of this difference in methodology, the POMRC's reported 30-day mortality rate for acute admissions (open repair: 22%; endovascular repair: 7%) is lower than the 30-day and in-hospital rates reported in the international literature for ruptured AAAs (open repair: 30–40%; endovascular repair: 20–30%). However, a recent study using New Zealand vascular registry data found that, for ruptured AAAs, mortality following open repair was 36% and mortality following endovascular repair was 18%, which is comparable to the rates reported internationally (Taylor et al 2016).

The POMRC's reported 30-day mortality rate for elective admissions (open repair: 3.4%; endovascular repair: 1.0%) is comparable to the rates reported in the international literature for intact AAAs (open repair: 3–5%; endovascular repair: 1–2%).

The literature below is divided by study type: administrative data (data collected routinely by hospitals and government departments), and randomised and case-control trials. These have been separated because the different data sources allow us to draw different conclusions and present different results. The POMRC's analysis is based on administrative data, and presents our best estimate of perioperative mortality in New Zealand. Administrative data cannot be used to draw causal inferences between an intervention (ie, AAA repair) and its outcome (ie, mortality), unlike randomised controlled trials. However, randomised controlled trials often have poor 'external validity' – that is, their findings are sometimes not generalisable to clinical practice because they study only a specific patient population.

### *Intact AAA repair*

#### ***Short-term outcomes***

##### Studies using administrative data

Mani and colleagues' (2011) analysis of vascular registry data from 2005 to 2009 across nine countries – Australia, Denmark, Finland, Hungary, Italy, Norway, Sweden, Switzerland, and the UK – found that the 30-day or in-hospital mortality rate after an intact AAA repair was 3.5% for open repair, significantly higher than 1.4% for endovascular repair. Australia's mortality rates in this study were 3.8% and 1.3%, respectively. Similarly, in the United States, an analysis of the National Inpatient Sample 2000–2010 found an in-hospital mortality rate of 4% for open repair and 1% for endovascular repair (Schermerhorn et al 2012).

##### Randomised and case-control trials

Meta-analyses of randomised and case-control trials have found similar results to the studies based on administrative data. A Cochrane review and meta-analysis of five randomised controlled trials found that the 30-day or in-hospital mortality rate after an intact AAA repair was 4.2% for open repair, significantly higher than 1.4% for endovascular repair (Paravastu et al 2014). Other meta-analyses have found similar results (Dangas et al 2012; Qadura et al 2013; Stather et al 2013).

### *Longer-term outcomes*

Although endovascular repair has lower mortality than open repair in the short term, there appears to be no difference in perioperative mortality in the longer term (two years or more) (Dangas et al 2012; Paravastu et al 2014; Qadura et al 2013; Stather et al 2013). Additionally, there is evidence that endovascular repair has a higher reintervention rate than open repair (Dangas et al 2012; Paravastu et al 2014). These longer-term outcomes should be interpreted with caution, as patient factors may affect the results. Additionally, endovascular device design is changing (eg, to improve the seal between the stent and the aorta's wall), so the long-term outcomes of the studies above may not be as applicable to the devices used today.

*Ruptured AAA repair*

### *Short-term outcomes*

#### Studies using administrative data

Mani and colleagues' (2011) analysis across nine countries – Australia, Denmark, Finland, Hungary, Italy, Norway, Sweden, Switzerland, and the UK – found that the 30-day or in-hospital mortality rate after a ruptured AAA repair was 33% for open repair, significantly higher than 20% for endovascular repair. Australia's mortality rates in this study were 33% and 23%, respectively.

Similarly, an analysis of Sweden's vascular registry data found that 30-day mortality after a ruptured AAA repair was 30% for open repair and 22% for endovascular repair (Gunnarsson et al 2016). In the United States, an analysis of the National Inpatient Sample from 2000–2010 found an in-hospital mortality rate of 41% for open repair and 27% for endovascular repair (Schermerhorn et al 2012).

#### Randomised and case-control trials

Because of the ethical issues surrounding emergency treatment, randomised controlled trials have only recently been used to investigate the differences between endovascular and open repair for ruptured AAAs. A recent Cochrane review of three randomised controlled trials found no significant difference in perioperative mortality between open and endovascular repair (30-day mortality of 36% and 34%, respectively), and cautioned that more research is needed before endovascular repair can be recommended as the preferred option for ruptured AAAs (Badger et al 2016).

### *Longer-term outcomes*

A literature review by Patelis and colleagues (2016) found that there was no difference in long-term (three months to six months) mortality between endovascular and open repair for ruptured AAAs. A meta-analysis of three recent randomised controlled trials of repair of ruptured AAAs found that there was a non-significant trend for lower mortality after endovascular repair compared with open repair at one year (Sweeting et al 2015).

## Composite case 3: Elective abdominal aortic aneurysm repair

Mr C, a 73-year-old man, presented for an elective repair of an abdominal aortic aneurysm (AAA). Endovascular repair was rejected because of anticipated problems with insertion, so open repair with insertion of a graft was planned. On assessment Mr C was noted to have high blood pressure, controlled atrial fibrillation, moderate renal impairment (possibly related to long-term use of anti-inflammatory painkillers for arthritis) and mild lung disease from heavy smoking over the last 30 years.

Mr C's repair and initial recovery was uneventful. However, on the third night after surgery he became increasingly confused, was breathless and had a low level of oxygen in his blood. Initially, it was diagnosed as a chest infection, given his smoking history. However, the next day, an electrocardiogram (ECG) and blood tests revealed Mr C had sustained a heart attack. The cardiologists assessed him immediately and did a coronary angiogram. Although an infarct was confirmed, no treatable lesions were identified. Mr C continued to deteriorate and died one day later.

At the multidisciplinary team mortality review, they discussed whether the option of an endovascular graft should have been pursued more vigorously for Mr C, given his significant risk factors for acute postoperative myocardial infarction. They concluded an endovascular graft should always be an option if anatomically appropriate for the patient, especially if significant postoperative complications are predicted. They also noted a postoperative heart attack is more likely to have no associated chest pain, and other symptoms and signs, such as acute onset breathlessness, may be the presenting feature.

## Composite case 4: Acute abdominal aortic aneurysm repair

Mr D came to hospital as an emergency after collapsing with sudden abdominal pain going through to his back. On arrival in the emergency department, a provisional diagnosis of ruptured AAA with hypotensive shock was made. Mr D had significant comorbidities, including severe renal impairment, angina with two previous heart attacks, and a smoking habit resistant to advice on cessation. Despite these comorbidities, because of the imminent risk to his life, he was offered surgery, which he accepted.

Mr D was rushed to radiology for investigation, and on confirmation of the diagnosis of ruptured AAA, was rushed to theatre for open repair. The operation and anaesthetic proceeded well until the clamp was released after the graft had been inserted. There was significant bleeding and his blood pressure suddenly dropped. Despite aggressive resuscitation, his blood pressure could not be increased. He then developed ECG signs of an acute myocardial infarction, resistant to resuscitation. Two hours later he was pronounced dead.

The family arrived in the hospital shortly after Mr D died. During the discussion with the surgeon and anaesthetist, they expressed disbelief that Mr D had died due to a heart attack during the operation, believing he was healthy despite his illnesses and smoking.

At the multidisciplinary team mortality review, they discussed the management of patients who present for urgent surgery when there is inadequate time for full consideration of the risks as well as the benefits of surgery. They agreed timely diagnosis of an operative condition such as AAA (before it ruptures) allows better consideration of the risks and benefits of any (or no) procedure to treat the AAA. It also allows the procedure to be undertaken in a planned (elective) fashion, with optimal preoperative preparation of the patient and far lower risk of perioperative mortality. They discussed the negative effect on families of patients having acute operations with significant risks when families are not able to be contacted prior to operations.

### Thirty-day mortality following AAA repair

*Mortality by year*

There were 2,226 admissions for AAA repair between 2010 and 2014. Thirty-day mortality over this five-year period was 7.7% (171 deaths). The numbers of deaths and admissions each year were generally stable over the five-year period.

Table 10: Annual numbers of hospital admissions and 30-day mortality following AAA repair, New Zealand 2010–2014

| DISCHARGE YEAR | Deaths | Admissions | Mortality rate (%) |
|---|---|---|---|
| 2010 | 36 | 421 | 8.25 |
| 2011 | 34 | 454 | 8.03 |
| 2012 | 35 | 471 | 7.53 |
| 2013 | 32 | 444 | 7.64 |
| 2014 | 34 | 436 | 8.87 |
| Total 2010–2014 | 171 | 2,226 | 7.68 |

**Numerator:** NMC: Deaths within 30 days of an AAA repair, as recorded in the NMDS.
**Denominator:** NMDS: Hospital admissions with an AAA repair listed in any of the first 90 procedures.

*Admissions by admission type and primary diagnosis*

Of all acute admissions for AAA in New Zealand during 2010–2014, 41% were for a ruptured AAA.

Table 11: Hospital admissions for AAA repair by primary diagnosis and admission type, New Zealand 2010–2014

| PRIMARY DIAGNOSIS | Admissions | Annual average number of admissions | % of admissions |
|---|---|---|---|
| **Acute** | | | |
| Abdominal aortic aneurysm and rupture | 283 | 56.6 | 41.1 |
| Abdominal aortic aneurysm without rupture | 365 | 73.0 | 53.0 |
| Other diagnoses | 41 | 8.2 | 6.0 |
| All acute admissions | 689 | 137.8 | 100.0 |
| **Public hospital semi-acute** | | | |
| Abdominal aortic aneurysm and rupture | 7 | 1.4 | 9.9 |
| Abdominal aortic aneurysm without rupture | 60 | 12.0 | 84.5 |
| Other diagnoses | 4 | 0.8 | 5.6 |
| All semi-acute admissions | 71 | 14.2 | 100.0 |
| **Elective/waiting list** | | | |
| Abdominal aortic aneurysm and rupture | 8 | 1.6 | 0.5 |
| Abdominal aortic aneurysm without rupture | 1,436 | 287.2 | 98.0 |
| Other diagnoses | 22 | 4.4 | 1.5 |
| All elective admissions | 1,466 | 293.2 | 100.0 |
| Total admissions | 2,226 | 445.2 | 100.0 |

**Data source:** NMDS: Hospital admissions with an AAA repair listed in any of the first 90 procedures.

*Admissions and mortality by admission and repair type*

In New Zealand during 2010–2014, there were 1,304 open repairs and 935 endovascular repairs for AAA. The majority (82%) of acute admissions for AAA repair underwent an open repair. Half (48%) of elective admissions for AAA repair underwent an open repair.

Mortality was higher following an open repair than an endovascular repair (Table 12). In acute admissions, mortality was 22.40% following an open repair, and 7.09% following an endovascular repair. In elective admissions, mortality was 3.42% following an open repair and 1.04% following an endovascular repair.

Table 12: Admissions and 30-day mortality for AAA repair by repair type and admission type, New Zealand 2010–2014

| ADMISSION TYPE | Open repair | | | Endovascular repair | | |
|---|---|---|---|---|---|---|
| | Deaths | Admissions | Mortality rate (%) | Deaths | Admissions | Mortality rate (%) |
| Acute | 127 | 567 | 22.40 | 9 | 127 | 7.09 |
| Elective | 24 | 702 | 3.42 | 8 | 772 | 1.04 |

**Numerator:** NMC: Deaths within 30 days of an AAA repair, as recorded in the NMDS.
**Denominator:** NMDS: Hospital admissions with an AAA repair listed in any of the first 90 procedures.
**Note:** There were five acute admissions with one death and eight elective/waiting list admissions with one death that included both an open and an endovascular procedure. Semi-acute admissions (five deaths) are excluded from the table above.

*Admissions and mortality by repair type and patient age*

In New Zealand during 2010–2014, mortality following AAA repair was highest for those aged over 80 years (Table 13) compared with those aged 79 years and under.

For those aged 64 years and under, mortality was similar for both open (4.26%) and endovascular repair (5.71%), although numbers were small. For those aged 65 years and older, mortality was higher following open repair than endovascular repair. For those aged 65–79 years (inclusive), mortality was 11.20% following open repair and 1.27% following endovascular repair. For those aged 80 years or older, mortality was 19.23% following open repair and 1.91% following endovascular repair.

Table 13: Admissions and 30-day mortality for AAA repair by repair type and age group, New Zealand 2010–2014

| AGE GROUP | Open repair | | | Endovascular repair | | |
|---|---|---|---|---|---|---|
| | Deaths | Admissions | Mortality rate (%) | Deaths | Admissions | Mortality rate (%) |
| 0–64 | 8 | 188 | 4.26 | 4 | 70 | 5.71 |
| 65–79 | 93 | 830 | 11.20 | 7 | 551 | 1.27 |
| 80+ | 55 | 286 | 19.23 | 6 | 314 | 1.91 |
| All ages | 156 | 1,304 | 11.96 | 17 | 935 | 1.82 |

**Numerator:** NMC: Deaths within 30 days of an AAA repair, as recorded in the NMDS.
**Denominator:** NMDS: Hospital admissions with an AAA repair listed in any of the first 90 procedures.
**Note:** There were 13 admissions and two deaths with both an open and an endovascular repair.

*Admissions and mortality by repair type and ASA classification*

In New Zealand during 2010–2014, mortality was highest among those with an ASA score of 4 or 5 (highest disease severity) compared with those with an ASA score of 1 or 2 (lowest disease severity), regardless of procedure type (Table 14). Across all ASA groups, mortality was higher among those undergoing open repair than endovascular repair. One quarter of admissions had no recorded ASA score.

Table 14: Admissions and 30-day mortality for AAA repair by repair type and ASA classification, New Zealand 2010–2014

| ASA SCORE | Open repair | | | Endovascular repair | | |
|---|---|---|---|---|---|---|
| | Deaths | Admissions | Mortality rate (%) | Deaths | Admissions | Mortality rate (%) |
| 1–2 (lowest disease severity) | 7 | 237 | 2.95 | 0 | 195 | 0.00 |
| 3 | 30 | 468 | 6.41 | 6 | 474 | 1.27 |
| 4–5 (highest disease severity) | 79 | 278 | 28.42 | 7 | 89 | 7.87 |
| Not stated | 40 | 321 | 12.46 | 4 | 177 | 2.26 |
| All ASA scores | 156 | 1,304 | 11.96 | 17 | 935 | 1.82 |

**Numerator:** NMC: Deaths within 30 days of an AAA repair, as recorded in the NMDS.
**Denominator:** NMDS: Hospital admissions with an AAA repair listed in any of the first 90 procedures.
**Note:** There were 13 admissions and two deaths with both an open and an endovascular repair.

*Admissions and mortality by repair type, admission type and patient ethnicity*

In New Zealand during 2010–2014, people who identified as Māori had a greater percentage of admissions that were acute compared with New Zealand European (Table 15).

Table 15: Number of admissions for AAA repair and the percentage of those admissions that were acute, by ethnicity, New Zealand 2010–2014

| ETHNICITY | Acute admissions | Elective admissions | Percentage of admissions that were acute (%) |
|---|---|---|---|
| NZ European | 574 | 1291 | 30.8 |
| Māori | 61 | 99 | 38.1 |

**Data source:** NMDS: Hospital admissions with an AAA repair listed in any of the first 90 procedures.
**Note:** Other ethnicities not shown due to small numbers.

In New Zealand during 2010–2014, most deaths and most admissions occurred among people who identified as New Zealand European (150 deaths and 1,935 admissions; Table 16).

The mortality rate was highest (22.73%) among those with an ethnicity other than NZ European, Māori or Pacific although the numbers of people undergoing AAA repair with these ethnicities were relatively small.

Table 16: Admissions and 30-day mortality for AAA repair by repair type and ethnicity, New Zealand 2010–2014

| ETHNICITY | Open repair | | | Endovascular repair | | |
|---|---|---|---|---|---|---|
| | Deaths | Admissions | Mortality rate (%) | Deaths | Admissions | Mortality rate (%) |
| NZ European | 135 | 1,102 | 12.16 | 16 | 833 | 1.92 |
| Māori | 12 | 106 | 11.32 | < 3 | 62 | < 4.84 |
| Pacific | 4 | 30 | 13.33 | 0 | 16 | 0.00 |
| Other | 5 | 22 | 22.73 | 0 | 10 | 0.00 |

**Numerator:** NMC: Deaths within 30 days of an AAA repair.
**Denominator:** NMDS: Hospital admissions with an AAA repair listed in any of the first 90 procedures.
**Note:** There were 13 admissions and two deaths with both an open and an endovascular repair. 'Other' ethnicities includes Asian, Middle Eastern, Latin American, African, and admissions with no recorded ethnicity.

*Admissions and mortality by repair type and socioeconomic deprivation*

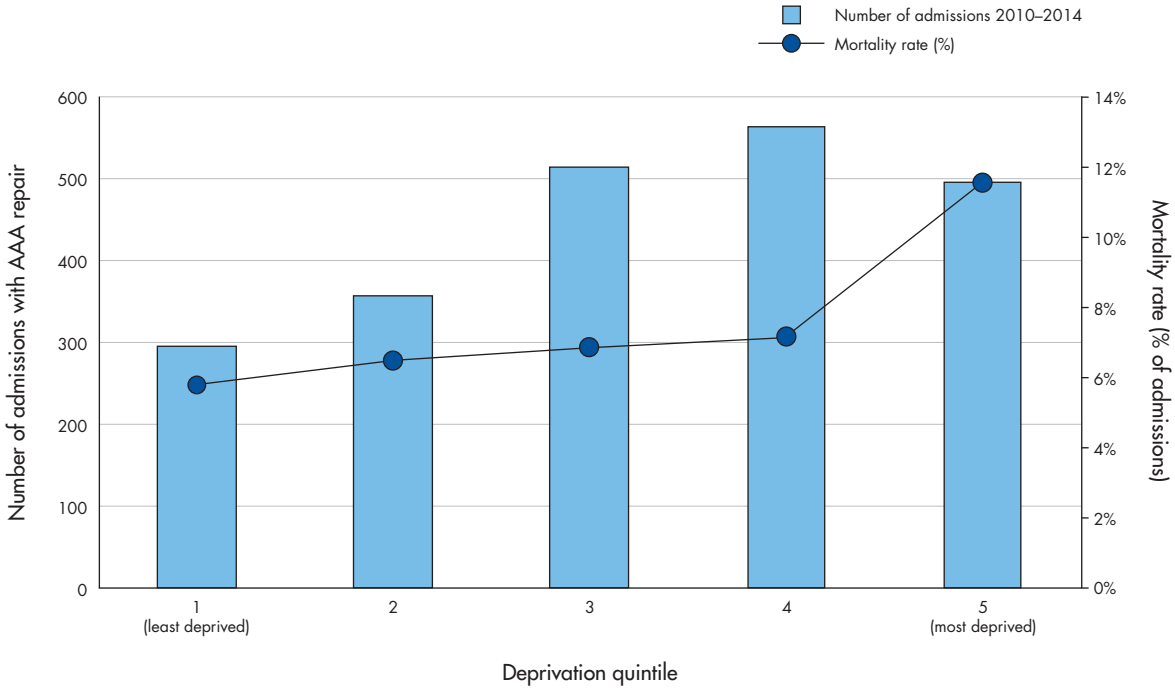
In New Zealand during 2010–2014, for open repair procedures there was a higher proportion of deaths among admissions for people who lived in the most deprived (quintile 5) areas (Table 17). The proportion of deaths was also higher for endovascular repair, but the numbers of deaths were small across the quintiles of deprivation for that procedure.

Table 17: Admissions and 30-day mortality for AAA repair by repair type and deprivation quintile, New Zealand 2010–2014

| DEPRIVATION QUINTILE | Open repair | | | Endovascular repair | | |
|---|---|---|---|---|---|---|
| | Number of deaths | Number of admissions | Mortality rate (%) | Number of deaths | Number of admissions | Mortality rate (%) |
| 1 (least deprived) | 15 | 167 | 8.58 | < 3 | 128 | < 2.20 |
| 2 | 20 | 219 | 9.13 | 3 | 139 | 2.16 |
| 3 | 32 | 283 | 11.31 | 3 | 231 | 1.30 |
| 4 | 36 | 335 | 10.75 | 4 | 227 | 1.76 |
| 5 (most deprived) | 51 | 290 | 17.55 | 6 | 206 | 2.92 |

**Numerator:** NMC: Deaths within 30 days of an AAA repair, as recorded in the NMDS.
**Denominator:** NMDS: Hospital admissions with an AAA repair listed in any of the first 90 procedures.
**Note:** There were 13 admissions and two deaths with both an open and an endovascular procedure. There were 10 admissions and two deaths with no recorded deprivation score. These are excluded from the table above.

Figure 5: Number of admissions and 30-day mortality following AAA repair, by socioeconomic deprivation, New Zealand 2010–2014

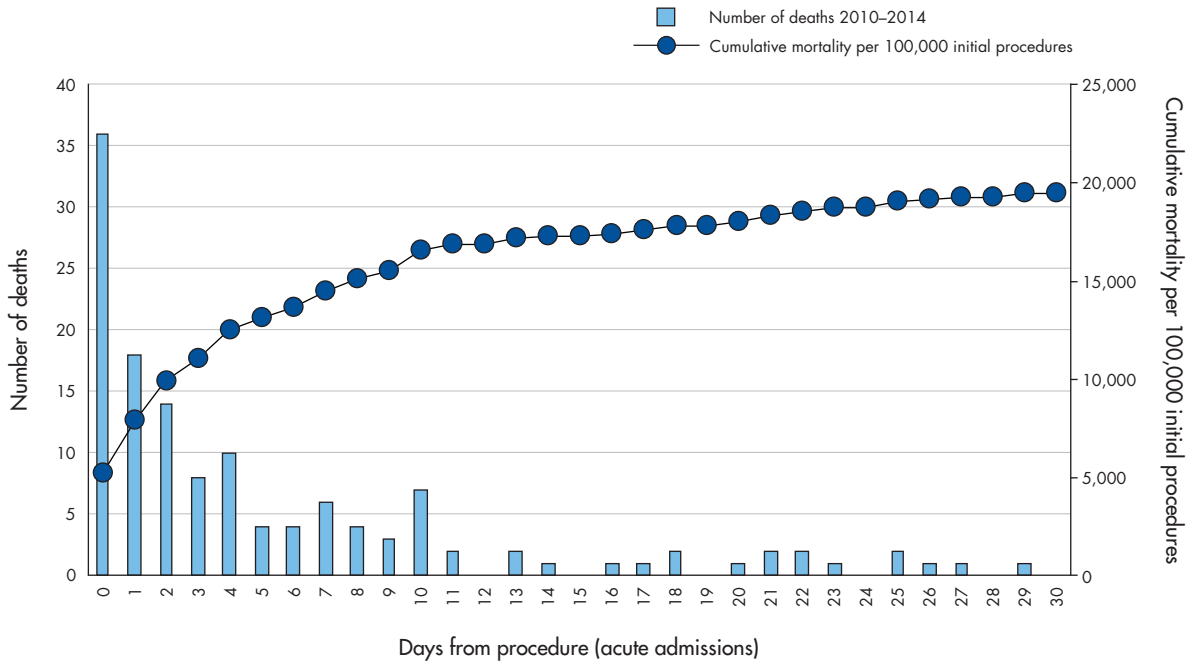



**Numerator:** NMC: Deaths occurring within 30 days of a AAA repair, as recorded in NMDS.
**Denominator:** NMDS: admissions with an AAA repair listed in any of the first 90 procedures.

### *Mortality following AAA repair by day from procedure*

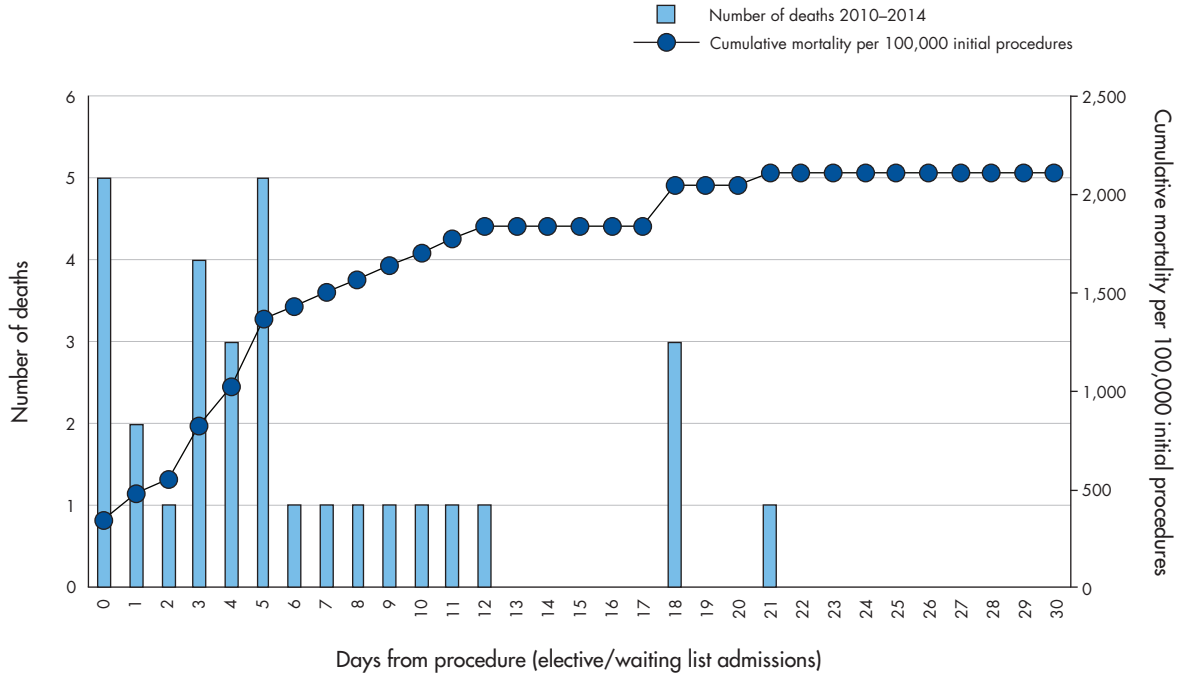
In New Zealand during 2010–2014, mortality peaked on the day of AAA repair for acute admissions (Figure 6). For elective admissions, mortality was highest in the five days following repair (Figure 7).

## Figure 6: Mortality following acute admissions for AAA repair by day from procedure, New Zealand 2010–2014




**Numerator:** NMC: Deaths occurring within 30 days of an acute AAA repair, as recorded in NMDS.
**Denominator:** NMDS: Acute admissions with an AAA repair listed in any of the first 90 procedures.

## Figure 7: Mortality following elective admissions for AAA repair by day from procedure, New Zealand 2010–2014




**Numerator:** NMC: Deaths occurring within 30 days of an elective/waiting list AAA repair, as recorded in NMDS.
**Denominator:** NMDS: Elective/waiting list admissions with an AAA repair listed in any of the first 90 procedures.

## Admissions and mortality by clinical and sociodemographic factors

### *All admissions*

Between 2010–2014, mortality rates in the 30 days following AAA repair (Table 18) were significantly higher for:

- acute admissions (compared with elective admissions)
- people who underwent an open repair (compared with an endovascular repair)
- people aged 80 years or older (compared with people aged 0–64 years)
- people with a CCI score of 3 or more (compared with two or less)
- people with an ASA score of 4 or 5 (compared with an ASA score of 1 or 2).

These differences were significant after adjusting for the effects of other sociodemographic factors (age, gender, ethnicity and socioeconomic deprivation) and clinical factors (admission type, repair type, ASA score and CCI score).

### *Acute admissions*

For acute admissions, mortality rates in the 30 days following AAA repair (Table 19) were significantly higher for:

- people who underwent an open repair (compared with an endovascular repair)
- people aged 80 years or older (compared with people aged 0–64 years)
- males (compared with females)
- people with an ASA score of 4 or 5 (compared with an ASA score of 1 or 2).

These differences were significant after adjusting for sociodemographic factors and clinical factors.

### *Elective admissions*

For elective admissions, mortality rates in the 30 days following AAA repair (Table 20) were significantly higher for:

- people who underwent an open repair (compared with an endovascular repair)
- people with an ASA score of 4 (compared with an ASA score of 1 or 2)
- people with a CCI score of 3 or more (compared with two or less).

These differences were significant after adjusting for sociodemographic factors and clinical factors.

Table 18: Mortality following AAA repair by repair type, age group, gender, admission type, ASA score, ethnicity, CCI score, and NZDep quintile, New Zealand 2010–2014

| VARIABLE | CATEGORY | Number of deaths | Number of admissions | Mortality per 100,000 admissions | Mortality rate (%) | Univariate OR | 95% CI | Multivariate OR | 95% CI |
|---|---|---|---|---|---|---|---|---|---|
| **AAA repair** | | | | | | | | | |
| **All admissions** | | | | | | | | | |
| Admission type | Elective/waiting list | 31 | 1,466 | 2,114.60 | 2.11 | 1.00 | | 1.00 | |
| | Acute | 135 | 689 | 19,593.61 | 19.59 | 11.28* | 7.54–16.87 | 4.35* | 2.74–6.92 |
| Repair type | Endovascular | 15 | 922 | 1,626.90 | 1.63 | 1.00 | | 1.00 | |
| | Open | 156 | 1,304 | 11,963.19 | 11.96 | 8.22* | 4.80–14.05 | 4.17* | 2.35–7.40 |
| Age group | 0–64 years | 11 | 252 | 4,365.08 | 4.37 | 1.00 | | 1.00 | |
| | 45–64 years | 97 | 1,333 | 7,276.82 | 7.28 | 1.59 | 0.86–2.93 | 1.94 | 0.99–3.80 |
| | 80+ years | 58 | 570 | 10,175.44 | 10.18 | 2.29* | 1.21–4.33 | 2.66* | 1.30–5.41 |
| Gender | Male | 119 | 1,715 | 6,938.78 | 6.94 | 1.00 | | 1.00 | |
| | Female | 47 | 440 | 10,681.82 | 10.68 | 1.64* | 1.15–2.32 | 1.46 | 0.98–2.19 |
| First ASA score | 1–2 | 6 | 422 | 1,421.80 | 1.42 | 1.00 | | 1.00 | |
| | 3 | 33 | 887 | 3,720.41 | 3.72 | 2.36* | 1.04–5.35 | 1.78 | 0.76–4.13 |
| | 4 | 53 | 291 | 18,213.06 | 18.21 | 13.10* | 5.87–29.27 | 4.43* | 1.90–10.33 |
| | 5 | 32 | 64 | 50,000.00 | 50.00 | H* | H | H* | H |
| | Not stated | 42 | 491 | 8,553.97 | 8.55 | 5.88* | 2.62–13.21 | 3.64* | 1.58–8.39 |
| Ethnicity | European | 144 | 1,865 | 7,721.18 | 7.72 | 1.00 | | 1.00 | |
| | Māori | 12 | 160 | 7,500.00 | 7.50 | 1.02 | 0.57–1.84 | 1.01 | 0.52–1.97 |
| | Pacific | 4 | 43 | 9,302.33 | 9.30 | 1.14 | 0.40–3.23 | 0.35 | 0.09–1.32 |
| | Other | 5 | 30 | 16,666.67 | 16.67 | 2.22 | 0.84–5.86 | 1.40 | 0.45–4.38 |
| Charlson Comorbidity Index | 1 or 2 | 94 | 1,595 | 5,893.42 | 5.89 | 1.00 | | 1.00 | |
| | > 2 | 72 | 560 | 12,857.14 | 12.86 | 2.40* | 1.75–3.31 | 1.74* | 1.21–2.51 |
| NZDep quintile | 1 (least deprived) | 16 | 286 | 5,594.41 | 5.59 | 1.00 | | 1.00 | |
| | 2 | 22 | 339 | 6,489.68 | 6.49 | 1.20 | 0.62–2.33 | 1.17 | 0.57–2.39 |
| | 3 | 35 | 504 | 6,944.44 | 6.94 | 1.28 | 0.69–2.35 | 1.34 | 0.69–2.60 |
| | 4 | 37 | 536 | 6,902.99 | 6.90 | 1.32 | 0.72–2.40 | 1.08 | 0.56–2.09 |
| | 5 (most deprived) | 54 | 478 | 11,297.07 | 11.30 | 2.24* | 1.26–3.98 | 1.83 | 0.97–3.47 |

**Numerator:** NMC: Deaths occurring within 30 days of an AAA repair, as recorded in the NMDS.
**Denominator:** NMDS: Admissions with an AAA repair listed in any of the first 90 procedures.
* Significantly different from reference category. CI: Confidence interval. **OR:** Odds ratio. **Ethnicity – Other:** Includes Asian, Indian, Middle Eastern, Latin American, African, and admissions with no recorded ethnicity.
**H:** Odds ratio supressed due to high mortality rate. **Note:** Caution should be observed when interpreting ORs where mortality exceeds 10% (see Appendix 3 for details).

Table 19: Mortality following acute AAA repair by repair type, age group, gender, ASA score, ethnicity, CCI score, and NZDep quintile, New Zealand 2010–2014

| VARIABLE | CATEGORY | Number of deaths | Number of admissions | Mortality per 100,000 admissions | Mortality rate (%) | Univariate OR | 95% CI | Multivariate OR | 95% CI |
|---|---|---|---|---|---|---|---|---|---|
| **AAA repair** | | | | | | | | | |
| **Acute admissions** | | | | | | | | | |
| Repair type | Endovascular | 8 | 122 | 6,557.38 | 6.56 | 1.00 | | 1.00 | |
| | Open | 127 | 567 | 22,398.59 | 22.40 | H* | H | H* | H |
| Age group | 0–64 years | 10 | 100 | 10,000.00 | 10.00 | 1.00 | | 1.00 | |
| | 65–79 years | 74 | 393 | 18,829.52 | 18.83 | 2.09* | 1.04–4.21 | 2.01 | 0.94–4.29 |
| | 80+ years | 51 | 196 | 26,020.41 | 26.02 | H* | H | H* | H |
| Gender | Male | 95 | 538 | 17,657.99 | 17.66 | 1.00 | | 1.00 | |
| | Female | 40 | 151 | 26,490.07 | 26.49 | H* | H | H* | H |
| First ASA score | 1–2 | 5 | 67 | 7,462.69 | 7.46 | 1.00 | | 1.00 | |
| | 3 | 16 | 178 | 8,988.76 | 8.99 | 1.22 | 0.43–3.48 | 0.94 | 0.32–2.80 |
| | 4 | 48 | 218 | 22,018.35 | 22.02 | H* | H | H* | H |
| | 5 | 32 | 64 | 50,000.00 | 50.00 | H* | H | H* | H |
| | Not stated | 34 | 162 | 20,987.65 | 20.99 | H* | H | H* | H |
| Ethnicity | European | 117 | 574 | 20,383.28 | 20.38 | 1.00 | | 1.00 | |
| | Māori | 8 | 61 | 13,114.75 | 13.11 | 0.59 | 0.27–1.27 | 0.77 | 0.33–1.79 |
| | Pacific | 4 | 23 | 17,391.30 | 17.39 | 0.82 | 0.27–2.46 | 0.34 | 0.08–1.36 |
| | Other | 5 | 18 | 27,777.78 | 27.78 | H | H | H | H |
| Charlson Comorbidity Index | 1 or 2 | 80 | 463 | 17,278.62 | 17.28 | 1.00 | | 1.00 | |
| | > 2 | 55 | 226 | 24,336.28 | 24.34 | H* | H | H* | H |
| NZDep quintile | 1 (least deprived) | 13 | 92 | 14,130.43 | 14.13 | 1.00 | | 1.00 | |
| | 2 | 13 | 91 | 14,285.71 | 14.29 | 1.01 | 0.44–2.32 | 0.77 | 0.32–1.85 |
| | 3 | 28 | 136 | 20,588.24 | 20.59 | H | H | H | H |
| | 4 | 33 | 175 | 18,857.14 | 18.86 | 1.41 | 0.70–2.84 | 1.12 | 0.53–2.38 |
| | 5 (most deprived) | 46 | 186 | 24,731.18 | 24.73 | H* | H | H | H |

**Numerator:** NMC: Deaths occurring within 30 days of an acute AAA repair, as recorded in the NMDS.
**Denominator:** NMDS: Acute admissions with an AAA repair listed in any of the first 90 procedures.
* Significantly different from reference category. CI: Confidence interval. **OR:** Odds ratio. **Ethnicity – Other:** Includes Asian, Indian, Middle Eastern, Latin American, African, and admissions with no recorded ethnicity. **H:** Odds ratio supressed due to high mortality rate. **Note:** Caution should be observed when interpreting ORs where mortality exceeds 10% (see Appendix 3 for details).

Table 20: Mortality following elective AAA repair by repair type, age group, gender, ASA score, ethnicity, CCI score, and NZDep quintile, New Zealand 2010–2014

| VARIABLE | CATEGORY | Number of deaths | Number of admissions | Mortality per 100,000 admissions | Mortality rate (%) | Univariate OR | 95% CI | Multivariate OR | 95% CI |
|---|---|---|---|---|---|---|---|---|---|
| **AAA repair** | | | | | | | | | |
| **Elective/waiting list** | | | | | | | | | |
| Repair type | Endovascular | 7 | 764 | 916.23 | 0.92 | 1.00 | | 1.00 | |
| | Open | 24 | 702 | 3,418.80 | 3.42 | 3.83* | 1.64–8.94 | 4.24* | 1.77–10.17 |
| Age group | 0–64 years | S | 152 | S | S | 1.00 | | 1.00 | |
| | 65–79 years | 23 | 940 | 2,446.81 | 2.45 | 3.79 | 0.51–28.25 | 3.14 | 0.46–24.24 |
| | 80+ years | 7 | 374 | 1,871.66 | 1.87 | 2.88 | 0.35–23.61 | 3.10 | 0.36–26.59 |
| Gender | Male | 24 | 1,177 | 2,039.08 | 2.04 | 1.00 | | 1.00 | |
| | Female | 7 | 289 | 2,422.15 | 2.42 | 1.19 | 0.51–2.80 | 1.05 | 0.43–2.56 |
| First ASA score | 1–2 | S | 355 | S | S | 1.00 | | 1.00 | |
| | 3 | 17 | 709 | 2,397.74 | 2.40 | 8.90* | 1.15–65.61 | 6.90 | 0.90–52.98 |
| | 4 | 5 | 73 | 6,849.32 | 6.85 | 26.03* | 2.99–226.3 | 19.35* | 2.12–176.3 |
| | Not stated | 8 | 329 | 2,431.61 | 2.43 | 8.82* | 1.10–70.93 | 7.53 | 0.92–61.02 |
| Ethnicity | European | 27 | 1,291 | 2,091.40 | 2.09 | 1.00 | | 1.00 | |
| | Māori | 4 | 99 | 4,040.40 | 4.04 | 1.97 | 0.68–5.75 | 1.59 | 0.50–5.07 |
| Charlson Comorbidity Index | 1 or 2 | 14 | 1,132 | 1,236.75 | 1.24 | 1.00 | | 1.00 | |
| | > 2 | 17 | 334 | 5,089.82 | 5.09 | 1.49* | 1.24–1.78 | 3.12* | 1.48–6.59 |
| NZDep quintile | 1 (least deprived) | 3 | 194 | 1,546.39 | 1.55 | 1.00 | | 1.00 | |
| | 2 | 9 | 248 | 3,629.03 | 3.63 | 2.40 | 0.64–8.98 | 2.18 | 0.57–8.43 |
| | 3 | 7 | 368 | 1,902.17 | 1.90 | 1.24 | 0.32–4.83 | 1.13 | 0.28–4.55 |
| | 4 | 4 | 361 | 1,108.03 | 1.11 | 0.71 | 0.16–3.22 | 0.68 | 0.15–3.19 |
| | 5 (most deprived) | 8 | 292 | 2,739.73 | 2.74 | 1.79 | 0.47–6.80 | 1.46 | 0.36–5.83 |

**Numerator:** NMC: Deaths occurring within 30 days of an elective AAA repair, as recorded in the NMDS.
**Denominator:** NMDS: Elective admissions with an AAA repair listed in any of the first 90 procedures.
* Significantly different from reference category. CI: Confidence interval. **OR:** Odds ratio. **S:** Rate suppressed due to small numbers. **Note:** Categories with no deaths are not shown.

# Commentary and Recommendations from the Māori Caucus

The analysis presented in this report shows that Māori have higher rates of perioperative mortality compared with non-Māori non-Pacific populations. Key findings specifically relevant to Māori are outlined below, followed by recommendations for investigating potential contributing factors to higher Māori perioperative mortality.

## Perioperative mortality and socioeconomic deprivation

The POMRC's analysis focused on people living in the most deprived (quintile 5) areas with an admission to hospital with general anaesthesia. Within this group, Māori had a greater proportion of admissions that were acute (versus elective) than New Zealand Europeans (Table 6).

For acute admissions of people living in the most deprived areas, the unadjusted perioperative mortality rate for Māori was approximately half the rate for New Zealand Europeans. However, there was no statistically significant difference between Māori and New Zealand Europeans if the mortality rate was adjusted for age, gender, ASA score and CCI (Table 7).

For elective admissions of people living in the most deprived areas, the unadjusted perioperative mortality rate for Māori was similar to the rate for New Zealand Europeans. However, Māori had a 50% higher perioperative mortality rate than New Zealand Europeans when the rate was adjusted for age, gender, ASA score and CCI score (Table 8).

## AAA repair

The POMRC found that crude and adjusted rates of perioperative mortality following AAA repair for Māori were not statistically significantly different from rates for New Zealand Europeans (Table 18). This was true for both acute (Table 19) and elective admissions (Table 20). However, this may be in part because of small numbers (150 acute and elective admissions for Māori during 2010–2014). Māori had a greater proportion of admissions for AAA repair that were acute (versus elective) than New Zealand Europeans (Table 15).

Studies of ethnic inequities in New Zealand have investigated the overall mortality from AAA, rather than the perioperative mortality following AAA repair as in the POMRC's analysis. These studies have found that Māori are approximately twice as likely to die from AAA than New Zealand Europeans, irrespective of whether a repair is performed (Nair et al 2012; Sandiford et al 2012).

Consistent with the POMRC's analysis, Sandiford and colleagues (2012) found that Māori had a greater acute (versus elective) repair rate compared with non-Maori. From their results, the researchers suggested that AAA in Māori is identified at a similar stage as in other ethnicities, but that Māori may have a higher rate of acute surgery because of poorer monitoring or faster development of AAA. The researchers concluded that the inequity in AAA mortality rates (irrespective of whether a repair is performed) for Māori was probably driven by the differences in acute and elective repair rates.

Nair and colleagues (2012) hypothesised that inequities in AAA mortality for Māori may be caused by Māori generally having more risk factors (eg, smoking and high blood pressure) for AAA. Additionally, they suggested that poorer access to primary care services and care in hospital may also affect rates for Māori.

## Recommendations

The Māori Caucus is convened by the Health Quality & Safety Commission to provide expert Māori opinion and advice to the mortality review committees. The POMRC consulted with the Caucus on the findings of the special topics in this report.

The Māori Caucus supported the POMRC view that a person's ethnicity and socioeconomic status should not influence his or her outcome following surgery. It has made a number of recommendations to investigate potential contributing factors to the inequitable perioperative mortality rates for Māori, with a view to reducing Māori mortality. These recommendations were informed by the findings in this report, the expert knowledge of Māori Caucus members, and other relevant research.

## Recommendations by the Māori Caucus for future research

The Māori Caucus recommends that further investigation is undertaken by the POMRC, and/or that the POMRC promote further investigation be undertaken by appropriate health research agencies, as follows.

**Recommendation 6:** Investigate the factors and pathways that led Māori patients to the point of surgery, and how these factors could be influenced to improve patient outcomes and reduce the need for surgery.

**Recommendation 7:** Investigate whether the level of care and medical and surgical expertise provided was appropriate for the severity and nature of the condition being treated for Māori patients.

**Recommendation 8:** Investigate whether travel distance from usual place of residence to the place of surgery affects Māori perioperative mortality. Factors to be considered should include rurality, access to services, and travel outside their DHB area.

**Recommendation 9:** Investigate the experience of Māori patients and their sense of wellbeing during their:

a) preoperative management and care

b) hospital inpatient stay

c) post-discharge care in the 30 and 90 days following surgery.

Note that this investigation should include both quantitative and qualitative analysis, and consider:

- whether or not Māori patients receive high-quality advice that supports them to make the best decisions for themselves as to whether to proceed with surgery or not
- quality of care during inpatient stay
- mortality outcomes for Māori, compared with non-Māori non-Pacific as the comparator group, at 30 days and at 90 days.

The POMRC endorses these recommendations by the Māori Caucus.

## Progress toward previous Māori Caucus recommendations

*Comment from the POMRC*

In the POMRC's previous report, the Māori Caucus made two recommendations to the POMRC for better data analysis:

a) The impact that the Māori population age structure has on analyses of Māori perioperative mortality should be investigated.

b) The Charlson Comorbidity Index should be considered to strengthen future analyses and better understand how severity of illness impacts Māori perioperative mortality.

The POMRC has since addressed both of these recommendations.

*Investigating the impact of the Māori age structure on analyses*

The POMRC examined whether logistic regression modelling produces a different result to age standardisation, and found that there is little difference between the results of each calculation.

Age standardisation becomes difficult when other factors (eg, gender, deprivation) are also investigated. Logistic regression does not have this problem. Another limitation of direct age standardisation is that it generates different results depending on the choice of standard population.

Problems can arise with people's interpretation of the age-standardised rate, particularly if they do not appreciate that it is not a true rate but a comparative estimate of the rate when a standard population has the same age-specific rates as the study population.

As a result, the POMRC has agreed to continue to use logistic regression modelling in its analyses. Because the population's age structure is changing, the POMRC has agreed to repeat this check every two years.

*Including the Charlson Comorbidity Index in multivariate analyses*

The POMRC now includes the Charlson Comorbidity Index as a variable in the multivariate analyses for special topics.

# Perioperative Mortality for Selected Clinical Areas

This chapter presents the key findings from selected clinical areas included in previous POMRC reports – reported here for the six-year period 2010–2015. This is part of the POMRC's approach to tracking perioperative mortality over time.

The clinical areas that POMRC tracks over time are:

- mortality following general anaesthesia:
  - same or next day mortality
  - 30-day inpatient mortality
  - 30-day mortality (in or out of hospital)
  - 30-day mortality in admissions with an ASA score of 4 or 5
  - 30-day mortality in elective admissions with an ASA score of 1 or 2
  - 30-day mortality by day of the week
- mortality in the 30 days following:
  - cholecystectomy
  - hip arthroplasty
  - knee arthroplasty
  - colorectal resection
  - coronary artery bypass graft (CABG) surgery
  - percutaneous transluminal coronary angioplasty (PTCA).

## Data notes and limitations

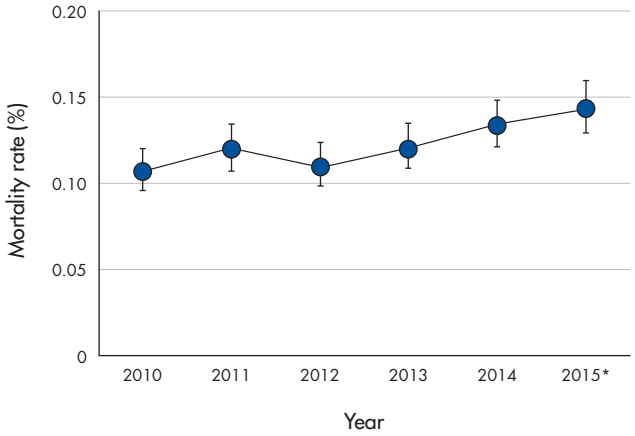
The rates presented are 'crude rates' and are not adjusted for clinical or sociodemographic factors. Error bars denote the 95% confidence interval for mortality estimates. The reporting from healthcare institutions (DHBs and private hospitals) has increased over this time, which may influence changes in the rates between years. Note that for all of these graphs, the mortality rate in 2015 is provisional, due to delays in coded data being entered into NMDS and NMC. Statistical significance is therefore noted for the linear trend in mortality rates between 2010 and 2014, and is set at $p < 0.05$. Data tables for the graphs below are provided in Appendix 1.

## MORTALITY FOLLOWING GENERAL ANAESTHESIA

**Same or next day mortality following general anaesthesia, crude rate 2010–2015**

- This measure provides a general indicator of the quality of perioperative care close to the time of anaesthesia and surgery, and is one of the WHO's measures of surgical safety.
- There were 1,803 deaths over the six-year period. Three quarters of these deaths followed acute admissions.
- There was a significant increasing trend in mortality between 2010 and 2014 (p = 0.01). The mortality rate increased slightly from 0.11% 2010 to 0.13% in 2014.

Mortality within one day of general anaesthesia, crude rate 2010–2015

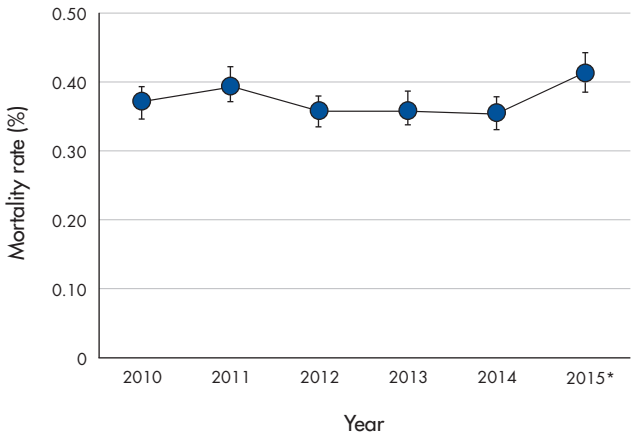



* Provisional data

**In-hospital mortality following general anaesthesia, crude rate 2010–2015**

- This measure is one of the WHO's measures of surgical safety. It provides a general indicator of the quality of perioperative care in hospital in the 30 days following surgery.
- The mortality rate over the six-year period was 0.37% of admissions.
- There was no significant trend in the rate between 2010 and 2014.

In-hospital mortality following general anaesthesia, crude rate 2010–2015

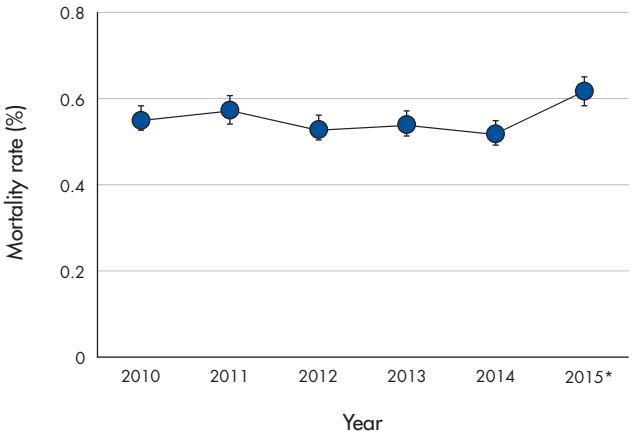



* Provisional data

**Mortality in the 30 days following general anaesthesia, crude rate 2010–2015**

- This measure provides a general indicator of the quality of perioperative care in the 30 days following surgery.
- There were 8,241 deaths over the six-year period. Most of these deaths followed acute admissions.
- The mortality rate over the six-year period was 0.55% of admissions.
- Acute admissions had a higher 30-day mortality rate (0.81%) than elective admissions (0.20%).
- There was no significant trend in the rate between 2010 and 2014.

Mortality within 30 days of general anaesthesia, crude rate 2010–2015



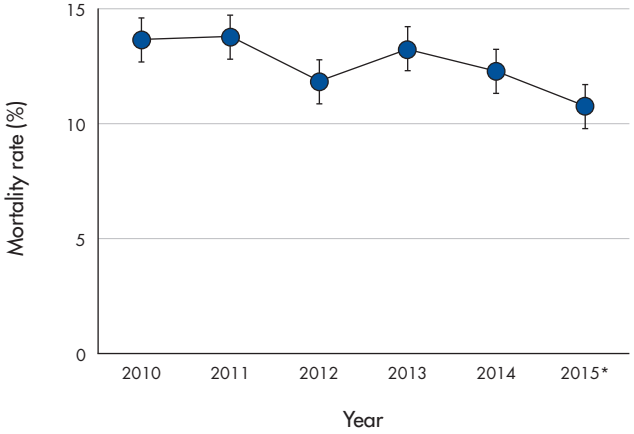

* Provisional data

## MORTALITY FOLLOWING GENERAL ANAESTHESIA

**Thirty-day mortality following general anaesthesia in admissions with an ASA score of 4 or 5, crude rate 2010–2015**

- People with an ASA score of 4 or 5 have a life-threatening condition and may be more likely to die without surgery.
- There were 3,548 deaths within 30 days of general anaesthesia during 2010–2015. Mortality was 12.58% of admissions.
- Mortality was higher for admissions with an ASA score of 5 (48.79% over the six-year period) and higher for acute admissions (18.07%).
- There was a significant decreasing trend in mortality between 2010 and 2014 (p = 0.03). The mortality rate decreased from 13.9% in 2010 to 12.3% in 2014.

Mortality within 30 days of anaesthesia for patients with ASA score of 4 or 5, crude rate 2010–2015

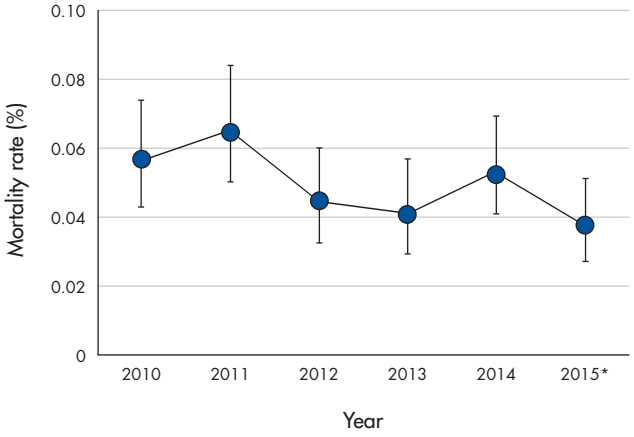



* Provisional data

**Thirty-day mortality following general anaesthesia in elective admissions with an ASA score of 1 or 2, crude rate 2010–2015**

- Mortality in elective admissions with an ASA score of 1 or 2 is important to track over time as these patients have a low risk of death and postoperative complications.
- There were 265 deaths over the six-year period. Mortality was 0.05%.
- There was no significant trend in the rate between 2010 and 2014.

Mortality within 30 days of anaesthesia for patients with an ASA score of 1 or 2 (elective admissions only), crude rate 2010–2015

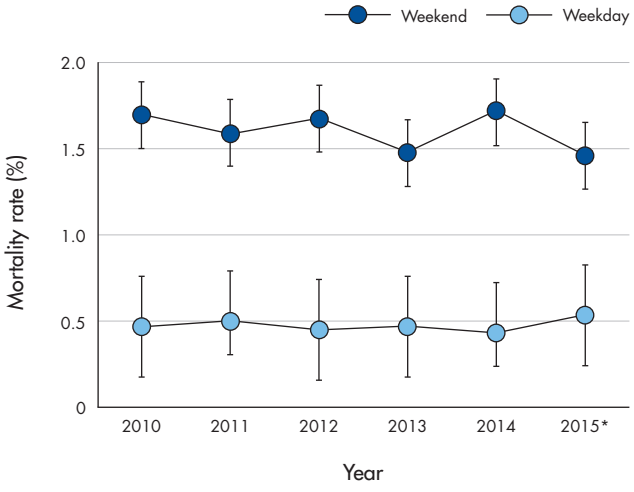



* Provisional data

**Thirty-day mortality following general anaesthesia, by day of the week, crude rate 2010–2015**

- The 30-day mortality rate following general anaesthesia on the weekend was approximately three times higher than on a weekday.
- The mortality rate in 2014 was not statistically significantly different to the mortality rate in 2010.
- The ratio of weekend versus weekday mortality was greater for elective admissions (2.69) than acute admissions (1.05).
- There was no significant trend in the weekend and weekday rates between 2010 and 2014.

Mortality within 30 days of anaesthesia, by day of the week, crude rate 2010–2015



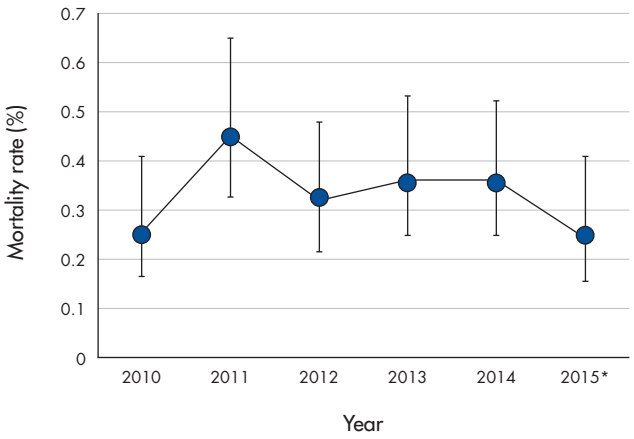

* Provisional data

## MORTALITY FOLLOWING SPECIFIC PROCEDURES

### Thirty-day mortality following cholecystectomy, crude rate 2010–2015

- Cholecystectomy is a common procedure that is undertaken at a wide range of hospitals and is associated with a relatively large number of deaths.
- There were 133 deaths over the six-year period. The mortality rate was 0.33% of admissions.
- The mortality rate was lower following a laparoscopic procedure (0.09% of admissions) than an open procedure (3.26%) or a laparoscopic procedure converted to an open procedure (0.87%).
- Acute admissions had a higher mortality rate (0.58%) than elective admissions (0.22%).
- There was no significant trend in the rate between 2010 and 2014.

Mortality within 30 days of cholecystectomy, crude rate 2010–2015

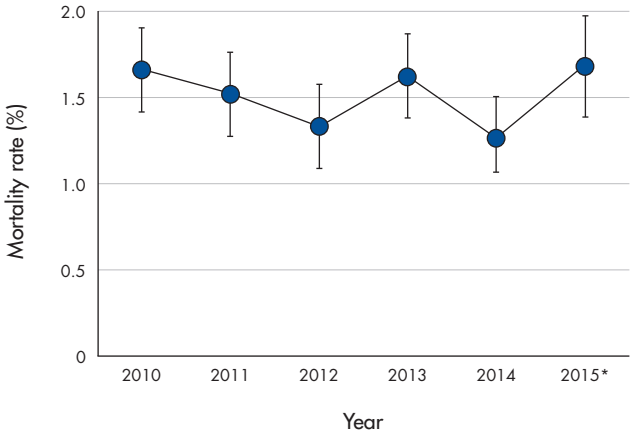



* Provisional data

### Thirty-day mortality following hip arthroplasty, crude rate 2010–2015

- The use of hip arthoplasty is increasing with the ageing population.
- There were 803 deaths over the six-year period. The mortality rate was 1.51% of admissions.
- Acute admissions had a higher 30-day mortality rate (7.31%) than elective/waiting list admissions (0.18%).
- There was no significant trend in the rate between 2010 and 2014.

Mortality within 30 days of hip arthroplasty, crude rate 2010–2015

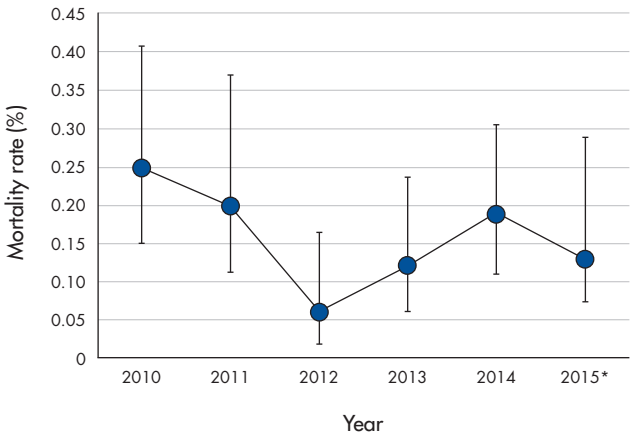



* Provisional data

### Thirty-day mortality following knee arthroplasty, crude rate 2010–2015

- The POMRC monitors mortality following knee arthroplasty because the use of this procedure is increasing with the ageing population.
- There were 62 deaths over the six-year period. The mortality rate was 0.16% of admissions.
- Almost all (95%) admissions were elective admissions.
- There was no significant trend in the rate between 2010 and 2014.

Mortality within 30 days of knee arthroplasty, crude rate 2010–2015



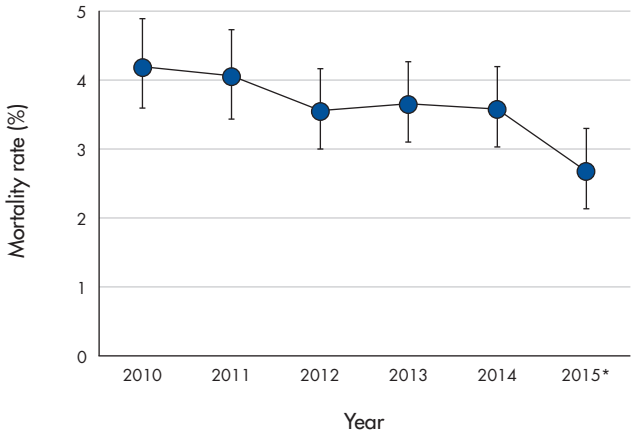

* Provisional data

## MORTALITY FOLLOWING SPECIFIC PROCEDURES

**Thirty-day mortality following colorectal resection, crude rate 2010–2015**

- There were 782 deaths over the six-year period. The mortality rate was 3.69% of admissions.
- Acute admissions had a higher mortality rate (8.09%) than elective/waiting list admissions (1.87%).
- There was no significant trend in the rate between 2010 and 2014.

Mortality within 30 days of colorectal resection, crude rate 2010–2015

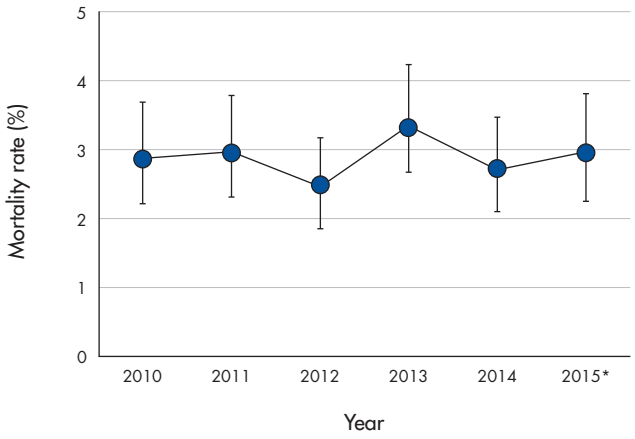



* Provisional data

**Thirty-day mortality following coronary artery bypass graft (CABG) surgery, crude rate 2010–2015**

- CABG is used relatively frequently to treat ischaemic heart disease and has higher mortality than other procedures.
- There were 336 deaths over the six-year period. The mortality rate was 2.87% of admissions.
- Acute admissions had a higher mortality rate (4.38%) than elective admissions (2.29%).
- There was no significant trend in the rate between 2010 and 2014.

Mortality within 30 days of CABG surgery, crude rate 2010–2015

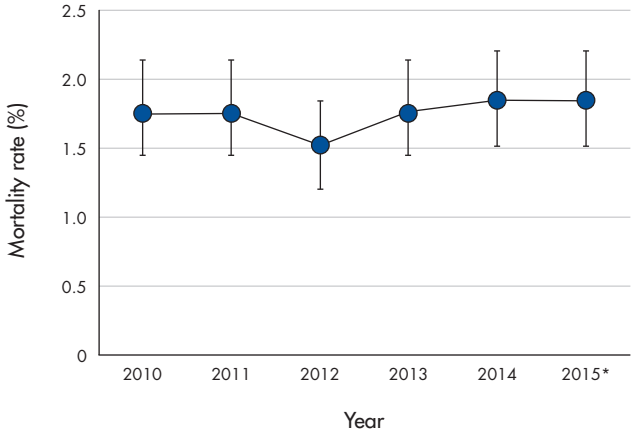



* Provisional data

**Thirty-day mortality following percutaneous transluminal coronary angioplasty (PTCA), crude rate 2010–2015**

- PTCA is used relatively frequently to treat ischaemic heart disease and has higher mortality than other procedures.
- There were 577 deaths over the six-year period. Mortality was 1.76% of admissions.
- Acute admissions had a higher mortality rate (2.46%) than elective admissions (0.66%).
- There was no significant trend in the rate between 2010 and 2014.

Mortality within 30 days of PTCA, crude rate 2010–2015




* Provisional data

# Perioperative Mortality for Special Topics in the Fifth Report

In this section, the POMRC updates its findings on the two special topics in its last report.

## Data notes and limitations

As with the previous chapter, the rates presented are 'crude rates' and are not adjusted for clinical or sociodemographic factors. The reporting from health care institutions (DHBs and private hospitals) has increased over this time, which may influence changes in the rates between years. Note that the mortality rate in 2015 is provisional, due to delays in coded data being entered into NMDS and NMC. Statistical significance is therefore noted for the linear trend in mortality rates between 2010 and 2014.

## Day-of-the-week mortality

The POMRC selected day-of-the-week mortality as a special topic in its last report because of the growing international evidence that procedures on the weekend have higher mortality compared with weekday procedures. This increased mortality risk associated with weekend admissions and procedures has become widely known as the 'weekend effect'. The underlying causes of the weekend effect are multi-factorial, and likely due to the complex interplay of patient- and care-related factors.

### *Updated findings 2010–2015*

In New Zealand during 2010–2015 in the 30 days following general anaesthesia or a neuraxial block:

- Mortality following procedures on the weekend was approximately three times higher than weekday procedures.
- There was no significant trend in the weekend and weekday rates between 2010 and 2014 (Table 21).
- The ratio of weekend versus weekday mortality was greater for elective admissions (2.69) than acute admissions (1.05).

Table 21: Thirty-day mortality by day of the week, New Zealand 2010–2015

| YEAR | Weekend | | | Weekday | | | Weekend: Weekday mortality ratio |
|---|---|---|---|---|---|---|---|
| | Admissions | Deaths | Mortality rate (%) | Admissions | Deaths | Mortality rate (%) | |
| **Acute** | | | | | | | |
| 2010 | 12,861 | 232 | 1.80 | 45,652 | 728 | 1.59 | 1.13 |
| 2011 | 12,995 | 229 | 1.76 | 46,332 | 840 | 1.81 | 0.97 |
| 2012 | 13,373 | 240 | 1.79 | 45,932 | 736 | 1.60 | 1.12 |
| 2013 | 13,288 | 215 | 1.62 | 46,541 | 807 | 1.73 | 0.94 |
| 2014 | 13,140 | 249 | 1.89 | 46,925 | 729 | 1.55 | 1.22 |
| *2015** | *12,950* | *198* | *1.53* | *47,626* | *772* | *1.62* | *0.94* |
| **2010–2015** | **78,607** | **1,363** | **1.73** | **279,008** | **4,612** | **1.65** | **1.05** |
| **All admission types** | | | | | | | |
| 2010 | 15,051 | 257 | 1.71 | 228,503 | 1,093 | 0.48 | 3.56 |
| 2011 | 15,363 | 247 | 1.61 | 233,506 | 1,179 | 0.50 | 3.22 |
| 2012 | 15,483 | 261 | 1.69 | 234,153 | 1,056 | 0.45 | 3.76 |
| 2013 | 15,289 | 228 | 1.49 | 240,166 | 1,157 | 0.48 | 3.10 |
| 2014 | 15,672 | 273 | 1.74 | 247,787 | 1,092 | 0.44 | 3.95 |
| *2015** | *14,847* | *219* | *1.48* | *198,456* | *1,091* | *0.55* | *2.69* |
| **2010–2015** | **91,705** | **1,485** | **1.62** | **1,382,571** | **6,668** | **0.48** | **3.38** |

**Numerator:** NMC: Weekday or weekend deaths occurring within 30 days of a general anaesthetic or neuraxial block.
**Denominator:** NMDS: Admissions with at least one general anaesthetic or neuraxial block.
**Note:** Mortality following elective admissions is not shown, as the number of deaths following elective admissions on the weekend is too low to be reliable. The number of deaths and admissions in 2015 appears lower than previous years due to delays in coded data being entered into NMDS and NMC.
* Provisional data.

## Thirty-day mortality following general anaesthesia

Thirty-day mortality following general anaesthesia provides an important measure of perioperative deaths. Before the POMRC's last report, the POMRC was only able to analyse same or next day mortality following general anaesthesia. This measure provided a less stable mortality estimate, as it is impacted more by the events occurring during or immediately after surgery. Thirty-day mortality rates, on the other hand, are influenced by aspects of perioperative care that take place over the weeks following surgery. Because of the nature of the administrative data collected in New Zealand, we are able to capture those deaths that occur after discharge from hospital but still within 30 days after surgery. The POMRC will continue to monitor 30-day mortality in its future reports.

### *Updated findings 2010–2015*

In New Zealand during 2010–2015, in the 30 days following general anaesthesia:

- There were 8,241 deaths (0.55% of admissions). Most of these deaths occurred among acute admissions and at public hospitals.
- The annual mortality rate varied between 0.52% and 0.60% of admissions each year (Table 22).
- Elective admissions had a lower mortality rate (0.20%) than acute admissions (0.81%).

Table 22: Thirty-day mortality following hospital admission with one or more general anaesthetics by year, New Zealand 2010–2015

| YEAR | Deaths | Admissions | Mortality per 100 admissions (%) |
|---|---|---|---|
| 2010 | 1,350 | 243,554 | 0.55 |
| 2011 | 1,426 | 248,869 | 0.57 |
| 2012 | 1,317 | 249,636 | 0.53 |
| 2013 | 1,385 | 255,455 | 0.54 |
| 2014 | 1,365 | 263,459 | 0.52 |
| *2015** | *1,354* | *225,400* | *0.60* |
| **2010–2015** | | | |
| Acute | 6,009 | 741,834 | 0.81 |
| Elective/waiting list | 2,166 | 1,097,553 | 0.20 |
| **Overall** | **8,241** | **1,486,373** | **0.55** |

**Numerator:** NMC: Deaths within 30 days of a general anaesthetic, as recorded in the NMDS.
**Denominator:** NMDS: Hospital admissions with at least one general anaesthetic.
**Note:** The number of deaths and admissions in 2015 appears lower than in previous years due to delays in coded data being entered into the NMDS and NMC.
* Provisional data.

# International Comparisons

This chapter compares perioperative mortality rates in New Zealand with international perioperative mortality rates for selected clinical areas that the POMRC tracks over time. Mortality for previously reported clinical areas are summarised in Table 23, along with the two new topics included in this report.

In-depth summaries of the international literature for this report's two special topics (AAA repair and socioeconomic deprivation) are presented in their respective chapters. In-depth summaries of the international literature for all of the procedures and clinical areas that the POMRC tracks over time are presented in the POMRC's fifth report (POMRC 2016).

Comparing perioperative mortality in New Zealand with other published studies is challenging because the timeframe within which mortality is measured varies widely. Medium- and longer-term mortality rates are generally poorly reported at a national level in the literature (Jawad et al 2016), and some of the studies reviewed for this chapter either reported deaths within 48 hours, deaths within seven days, or in-hospital mortality before discharge. However, for some procedures, a significant proportion of patients die outside of hospital within 30 days of discharge. These patients die from complications related to infection and the quality of postoperative care outside of hospital. This is why in-hospital rates are generally lower than 30-day mortality rates, and can actually underestimate 30-day perioperative mortality rates by up to 30% (Ariyaratnam et al 2015).

New Zealand is one of the few countries that is able to capture these perioperative deaths because the hospital administrative data set can be linked with mortality data using the National Health Index. Capturing these deaths is important because for some procedures (eg, those involving shorter hospital stays) in-hospital mortality rates can only provide an indicator of the quality and safety of intraoperative care and the early stages of postoperative care.

Table 23: Perioperative mortality in New Zealand and international comparisons: Selected tracking procedures and clinical areas, 2007–2015

| SELECTED TRACKING CLINICAL AREAS | 30-day mortality rate, 2010–2015 | International comparisons |
|---|---|---|
| General anaesthesia – same or next day mortality (WHO) | 0.12% | NZ same or next day mortality rates are similar to the rate obtained in meta-analysis of perioperative mortality (0.12% across 87 studies, most of which reported mortality following surgical procedures within the first 24–48 hours of procedure) (Bainbridge et al 2012). |
| General anaesthesia – inpatient 30-day mortality (WHO) | 0.37% | The NZ rate is slightly lower than the rates reported for:<br>• **Netherlands** – 1.34% (Noordzij et al 2010). |
| General anaesthesia – 30-day mortality | 0.55% | The NZ rate is lower than the rates reported for:<br>• **US** – 1.76% (Yu et al 2011); 1.34% for all non-cardiac surgery (Glance et al 2012)<br>• **Sweden** – 1.8% excluding day surgery, cardiac surgery, neurosurgery, radiological and obstetric procedures (Jawad et al 2016). |
| Day-of-the-week mortality – acute | Weekdays 1.65%<br>Weekends 1.73% | The NZ perioperative mortality rate following acute procedures on the weekend is lower than:<br>• **England/UK** – 5.2% for weekend admissions and 4.9% for weekday (Aylin et al 2010); 6.53% for weekday admissions and 7.06% for weekend admissions (Mohammed et al 2012); although no weekend effect for critical care admissions, 28.9% weekday compared with 28.8% weekend admissions (Arulkumaran et al 2017)<br>• **Netherlands** – 4.6% for Saturday or Sunday admissions, compared with 4.1% for Monday admissions (Ruiz et al 2015)<br>• **USA** – 2.9–3.0% for Saturday or Sunday admissions and 2.6% for Monday admissions (Ruiz et al 2015)<br>• **Australia** – 3.6% for Saturday or Sunday admissions and 3.6% for Monday admissions (ie, no weekend effect) (Ruiz et al 2015). |
| Day-of-the-week mortality – elective | Weekdays 0.13%<br>Weekends 0.35% | The NZ perioperative mortality rate following elective procedures on the weekend is lower than:<br>• **England** – 0.74% for weekend and 0.82% for Friday admissions, compared with 0.55% for Monday (Aylin et al 2013); 0.77% for weekend compared with 0.52% for weekday public hospital admissions (Mohammed et al 2012)<br>• **Netherlands** – 1.88% for Saturday and 1.35% for Sunday admissions, compared with 0.57% for Monday (Ruiz et al 2015)<br>• **USA** – 1.66% for Saturday and 1.31% for Sunday admissions, compared with 0.33% for Monday (Ruiz et al 2015)<br>• **Australia** – 1.32% for Saturday and 1.31% for Sunday admissions, compared with 0.32% for Monday (Ruiz et al 2015). |
| Cholecystectomy – overall | 0.33% | The NZ rate is comparable to the rates reported for:<br>• **US** – 0.53% (Ingraham et al 2010)<br>• **Sweden** – 0.15% (Sandblom et al 2015)<br>• **Denmark** – 0.27% (Harboe and Bardram 2011). |
| Hip arthroplasty – overall | 1.51% | Pooled 30-day rate from meta-analysis all total hip arthroplasty procedures* (0.30%) (Berstock et al 2014). Pooled mortality rate of 0.63% for total and partial hip replacements* (Singh et al 2011). |
| Hip arthroplasty – elective | 0.18% | The NZ rate is similar or slightly lower than the rates for total hip replacements* reported for:<br>• **US** – 0.35% (Belmont, Goodman, Hamilton et al 2014); 0.13% (Illingworth et al 2015)<br>• **UK** – 90-day mortality, 0.29% (Hunt et al 2013). |

| SELECTED TRACKING CLINICAL AREAS | 30-day mortality rate, 2010–2015 | International comparisons |
|---|---|---|
| Knee arthroplasty – elective | 0.13% | The NZ rate is similar to pooled international 30-day mortality rate of 0.29% (Singh et al 2011).<br>The NZ rate is similar to the rates reported for:<br>• **US** – 0.18% (Belmont, Goodman, Waterman et al 2014)<br>• **UK** – 0.24%, total knee replacements (Liddle et al 2014). |
| Coronary artery bypass graft (CABG) – overall | 2.87% | The NZ rate is similar to the rates reported for:<br>• **US** – 2.0–5.0% in a review of published studies on perioperative and in-hospital mortality following CABG surgery (Aranki et al 2014); 2.4% (ElBardissi et al 2012); 2.1% (D'Agostino et al 2016)<br>• **Denmark** – 2.44% (Hansen et al 2015); 3.0% (1.0% in those aged < 65 years and 8.0% in those aged > 80 years (Thorsteinsson et al 2015)<br>• **Italy** – 2.40% (D'Errigio et al 2013)<br>• **Japan** – 2.15% (Sakata et al 2012); 2.5% (20.7% for emergent/unexpected CABG) (Miyata et al 2011). |
| Coronary artery bypass graft (CABG) – acute | 4.38% | The NZ rate is lower than the rate reported for:<br>• **Japan** – 8.79% (Sakata et al 2012); 20.7% for emergent/unexpected (Miyata et al 2011). |
| Coronary artery bypass graft (CABG) – elective | 2.29% | • **Japan** – 1.12% (Sakata et al 2012). |
| Percutaneous transluminal coronary angioplasty (PTCA) | 1.76% | NZ mortality rates are similar to those observed internationally:<br>• **US** – in-hospital mortality 1.0% (Lichtman et al 2014) and 1.27% (Peterson et al 2010), depending on admission status (higher rates for acute procedures) (Lichtman et al 2014; Brennan et al 2013; Peterson et al 2010). |
| Colorectal resection – overall | 3.69% | NZ 30-day mortality rates are similar to those observed internationally:<br>• **UK** – 8.5% for acute/elective procedures combined (Byrne et al 2013). |
| Colorectal resection – elective | 1.87% | • **US** – 1.7% following elective colorectal resection (Gabre-Kidan et al 2014)<br>• **Denmark** – 2.8% in 2011 (for elective colorectal cancer procedures) (Iversen et al 2014)<br>• **UK** – 3.3% for elective colorectal resection (in-hospital mortality only) (Mamidanna et al 2012). |
| Abdominal aortic aneurysm (AAA) repair – ruptured | 2010–2014<br>Open: 35.7%<br>Endovascular: 17.9%<br>(Taylor et al 2016) | The NZ rate is similar to the rates following ruptured repairs reported for:<br>• **nine OECD countries** – 32.6% for open, 19.7% for endovascular repair (Mani et al 2011)<br>• **Australia** – 30-day in-hospital 33% for open, 22.6% for endovascular repair (Mani et al 2011)<br>• **US** – 41% for open, 27% for endovascular (Schermerhorn et al 2012). |
| AAA repair – elective/intact | 2010–2014 Elective<br>Open: 3.42%<br>Endovascular: 0.92% | The NZ elective rate is similar to the rates following intact repairs reported for:<br>• **nine OECD countries** – 3.5% for open, 1.4% for endovascular repair (Mani et al 2011)<br>• **Australia** – 30-day in-hospital 3.8% for open, 1.3% for endovascular repair (Mani et al 2011)<br>• **US** – 4% for open, 1% for endovascular repair (Schermerhorn et al 2012). |

WHO = World Health Organization

* Mortality rates for total hip replacements are presumed to mostly represent elective procedures and rates for hip fractures are presumed to represent acute admissions.

# World Health Organization (WHO) Metrics in New Zealand

In 2009, the WHO published the *WHO Guidelines for Safe Surgery 2009*, in which they proposed a set of standardised public health metrics for the routine surveillance of surgical care (WHO 2009). The WHO metrics incorporate both systems-level surveillance measures and patient-level surveillance measures for assessing both access to, and the quality of, surgical care (WHO 2009).

Reporting using the WHO metrics is increasingly being adopted by other countries throughout the world. This chapter describes the POMRC's work to date in applying the WHO metrics for routine surveillance of surgical safety in New Zealand.

## WHO metrics

There are increasing efforts to improve the standardisation of data collection and reporting to enable international comparisons with other jurisdictions. The POMRC has focused on two of the WHO's proposed surveillance metrics for surgical care: the day-of-surgery and postoperative inpatient death ratios (Table 24).

Table 24: WHO's proposed standardised public health metrics for surgical care analysed by the POMRC (WHO 2009)

| WHO METRIC | Definition | Rationale for use |
|---|---|---|
| Day-of-surgery death ratio* | Number of deaths on the day of surgery, regardless of cause, divided by number of surgical procedures in a given year or period, reported as a percentage | This ratio allows health care systems to assess performance and have a snapshot of the health status of a population. |
| Postoperative in-hospital death ratio | Number of deaths in hospital following surgery, irrespective of cause and limited to 30 days, divided by the number of surgical procedures done in a given year, reported as a percentage | Understanding this ratio provides an understanding of the risks associated with surgical interventions. |

* This measure corresponds to the POMRC's measure of 'same or next day mortality following general anaesthesia'.

Table 25 presents results to describe the total number of inpatient surgical procedures provided in New Zealand (2010–2015), the proportion of same-day deaths and the proportion of inpatient deaths related to the admissions. The number of inpatient surgical procedures is defined as admissions in which patients have undergone at least one general anaesthetic during their inpatient stay.

Table 25: WHO metrics and perioperative mortality by year, New Zealand 2010–2015

| YEAR | Admissions with at least one general anaesthetic | Deaths on same day as operation (deaths within one day of general anaesthetic) | Day-of-surgery mortality rate per 100,000 (% of all admissions) | In-hospital deaths (within 30 days of general anaesthetic) | In-hospital mortality rate per 100,000 (% of all admissions) |
|---|---|---|---|---|---|
| 2010 | 243,554 | 261 | 107 (0.11%) | 901 | 370 (0.37%) |
| 2011 | 248,869 | 299 | 120 (0.12%) | 986 | 396 (0.4%) |
| 2012 | 249,636 | 275 | 110 (0.11%) | 892 | 357 (0.36%) |
| 2013 | 255,455 | 310 | 121 (0.12%) | 919 | 360 (0.36%) |
| 2014 | 263,459 | 354 | 134 (0.13%) | 931 | 353 (0.35%) |
| 2015 | 225,400 | 304 | 135 (0.13%) | 881 | 391 (0.41%) |
| 2010–2015 | 1,486,373 | 1,803 | 121 (0.12%) | 5,510 | 371 (0.37%) |

**Numerator – Day-of-surgery mortality rate:** NMC: Deaths occurring on the same day of general anaesthesia, as recorded in the NMDS.
**Numerator – In-hospital mortality rate:** NMDS: Deaths occurring in hospital within 30 days of general anaesthesia.
**Denominator:** NMDS: Admissions with general anaesthesia listed in any of the first 90 procedures.
**Note:** The number of deaths and admissions in 2015 appears lower than previous years due to delays in coded data being entered into NMDS and NMC.

# Appendices

## Appendix 1: Data tables for selected previously reported clinical areas

This section presents the supplementary data tables for the POMRC's previously reported clinical areas. Note the rates presented are 'crude rates' and are not adjusted for clinical or sociodemographic factors. The reporting from health care institutions (DHBs and private hospitals) has increased over this time, which may influence changes in the rates between years. Note for all of these tables, the mortality rate in 2015 is provisional, due to delays in coded data being entered into the NMDS and NMC.

Table 26: Same or next day mortality following hospital admission with one or more general anaesthetics by year, New Zealand 2010–2015

| YEAR | Deaths | Admissions | Mortality per 100 admissions (%) |
|---|---|---|---|
| 2010 | 261 | 243,554 | 0.11 |
| 2011 | 299 | 248,869 | 0.12 |
| 2012 | 275 | 249,636 | 0.11 |
| 2013 | 310 | 255,455 | 0.12 |
| 2014 | 354 | 263,459 | 0.13 |
| *2015** | *304* | *225,400* | *0.13* |
| **2010–2015** | | | |
| Acute | 1,311 | 357,616 | 0.37 |
| Elective/waiting list | 492 | 1,097,553 | 0.04 |
| **Overall** | **1,803** | **1,486,373** | **0.12** |

**Numerator:** NMC: Deaths occurring on the same day of general anaesthesia, as recorded in the NMDS.
**Denominator:** NMDS: Admissions with general anaesthesia listed in any of the first 90 procedures.
* Provisional data.

Table 27: Inpatient mortality following hospital admissions with general anaesthesia by year, New Zealand 2010–2015

| YEAR | Deaths | Admissions | Mortality per 100 admissions (%) |
|---|---|---|---|
| 2010 | 901 | 243,554 | 0.37 |
| 2011 | 986 | 248,869 | 0.40 |
| 2012 | 892 | 249,636 | 0.36 |
| 2013 | 919 | 255,455 | 0.36 |
| 2014 | 931 | 263,459 | 0.35 |
| *2015** | *881* | *225,400* | *0.41* |
| **2010–2015** | **5,510** | **741,834** | **0.37** |

**Numerator:** NMC: Deaths occurring during inpatient stay, as recorded in the NMDS.
**Denominator:** NMDS: Admissions with general anaesthesia listed in any of the first 90 procedures.
**Note:** The number of deaths and admissions in 2015 appears lower than previous years due to delays in coded data being entered into NMDS and NMC.
* Provisional data.

Table 28: Thirty-day mortality following hospital admissions with general anaesthesia by year, New Zealand 2010–2015

| YEAR | Deaths | Admissions | Mortality per 100 admissions (%) |
|---|---|---|---|
| 2010 | 1,350 | 243,554 | 0.55 |
| 2011 | 1,426 | 248,869 | 0.57 |
| 2012 | 1,317 | 249,636 | 0.53 |
| 2013 | 1,385 | 255,455 | 0.54 |
| 2014 | 1,365 | 263,459 | 0.52 |
| *2015** | *1,354* | *225,400* | *0.60* |
| **2010–2015** | | | |
| Acute | 6,009 | 741,834 | 0.81 |
| Elective/waiting list | 2,166 | 1,097,553 | 0.20 |
| **Overall** | **8,241** | **1,486,373** | **0.55** |

**Numerator:** NMC: Deaths occurring on the same day of general anaesthesia, as recorded in the NMDS.
**Denominator:** NMDS: Admissions with general anaesthesia listed in any of the first 90 procedures.
* Provisional data.

Table 29: Thirty-day mortality following hospital admissions with general anaesthesia and an ASA score of 4 or 5 by year, New Zealand 2010–2015

| YEAR | Deaths | Admissions | Mortality per 100 admissions (%) |
|---|---|---|---|
| 2010 | 591 | 4,302 | 13.74 |
| 2011 | 624 | 4,507 | 13.85 |
| 2012 | 533 | 4,485 | 11.88 |
| 2013 | 616 | 4,654 | 13.24 |
| 2014 | 606 | 4,917 | 12.32 |
| *2015** | *578* | *5,343* | *10.82* |
| **2010–2015** | | | |
| Acute | 2,984 | 16,517 | 18.07 |
| Elective/waiting list | 247 | 7,839 | 3.15 |
| ASA 5 | 435 | 867 | 48.79 |
| **Overall** | **3,548** | **28,207** | **12.58** |

**Numerator:** NMC: Deaths within 30 days of a general anaesthetic or neuraxial block among patients with an ASA score of 4 or 5.
**Denominator:** NMDS: Admissions with an ASA score of 4 or 5 and at least one general anaesthetic or neuraxial block.
* Provisional data.

Table 30: Thirty-day mortality following elective admission with a first ASA score of 1 or 2 by year, New Zealand 2010–2015

| YEAR | Deaths | Admissions | Mortality per 100 admissions (%) |
|---|---|---|---|
| 2010 | 47 | 83,760 | 0.06 |
| 2011 | 57 | 87,474 | 0.07 |
| 2012 | 39 | 89,087 | 0.04 |
| 2013 | 36 | 89,142 | 0.04 |
| 2014 | 50 | 94,407 | 0.05 |
| *2015** | *36* | *96,042* | *0.04* |
| 2010–2015 | 265 | 539,912 | 0.05 |

**Numerator:** NMC: Deaths within 30 days of a general anaesthetic or neuraxial block among patients admitted electively with an ASA score of 1 or 2, as recorded in the NMDS.
**Denominator:** NMDS: Elective admissions with an ASA score of 1 or 2 and at least one general anaesthetic or a neuraxial block.
* Provisional data.

Table 31: Thirty-day mortality by day of the week, New Zealand 2010–2015

| YEAR | Weekend | | | Weekday | | | Weekend: Weekday mortality ratio |
|---|---|---|---|---|---|---|---|
| | Admissions | Deaths | Mortality rate (%) | Admissions | Deaths | Mortality rate (%) | |
| **Acute** | | | | | | | |
| 2010 | 12,861 | 232 | 1.80 | 45,652 | 728 | 1.59 | 1.13 |
| 2011 | 12,995 | 229 | 1.76 | 46,332 | 840 | 1.81 | 0.97 |
| 2012 | 13,373 | 240 | 1.79 | 45,932 | 736 | 1.60 | 1.12 |
| 2013 | 13,288 | 215 | 1.62 | 46,541 | 807 | 1.73 | 0.94 |
| 2014 | 13,140 | 249 | 1.89 | 46,925 | 729 | 1.55 | 1.22 |
| *2015** | *12,950* | *198* | *1.53* | *47,626* | *772* | *1.62* | *0.94* |
| **2010–2015** | **78,607** | **1,363** | **1.73** | **279,008** | **4,612** | **1.65** | **1.05** |
| **Acute/elective/waiting list admissions** | | | | | | | |
| 2010 | 15,051 | 257 | 1.71 | 228,503 | 1,093 | 0.48 | 3.56 |
| 2011 | 15,363 | 247 | 1.61 | 233,506 | 1,179 | 0.50 | 3.22 |
| 2012 | 15,483 | 261 | 1.69 | 234,153 | 1,056 | 0.45 | 3.76 |
| 2013 | 15,289 | 228 | 1.49 | 240,166 | 1,157 | 0.48 | 3.10 |
| 2014 | 15,672 | 273 | 1.74 | 247,787 | 1,092 | 0.44 | 3.95 |
| *2015** | *14,847* | *219* | *1.48* | *198,456* | *1,091* | *0.55* | *2.69* |
| **2010–2015** | **91,705** | **1,485** | **1.62** | **1,382,571** | **6,668** | **0.48** | **3.38** |

**Numerator:** NMC: Weekday or weekend deaths occurring within 30 days of a general anaesthetic or neuraxial block.
**Denominator:** NMDS: Admissions with at least one general anaesthetic or neuraxial block.
**Note:** Mortality following elective admissions is not shown, as the number of deaths following elective admissions on the weekend is too low to be reliable. The number of deaths and admissions in 2015 appears lower than previous years due to delays in coded data being entered into NMDS and NMC.
* Provisional data.

Table 32: Mortality following cholecystectomy by year, New Zealand 2010–2015

| YEAR | Deaths | Admissions | Mortality per 100 admissions (%) |
|---|---|---|---|
| 2010 | 16 | 6,301 | 0.25 |
| 2011 | 30 | 6,624 | 0.45 |
| 2012 | 21 | 6,654 | 0.32 |
| 2013 | 25 | 6,869 | 0.36 |
| 2014 | 26 | 7,187 | 0.36 |
| *2015** | *15* | *6,244* | *0.24* |
| **2010–2015** | | | |
| Laparoscopic | 34 | 35,931 | 0.09 |
| Open | 89 | 2,726 | 3.26 |
| Laparoscopic to open | 10 | 1,153 | 0.87 |
| Acute | 75 | 13,036 | 0.58 |
| Elective/waiting list | 57 | 25,899 | 0.22 |
| **Overall** | **133** | **39,879** | **0.33** |

**Numerator:** NMC: Deaths occurring within 30 days of a cholecystectomy, as recorded in the NMDS.
**Denominator:** NMDS: Admissions with a cholecystectomy listed in any of the first 90 procedures.
* Provisional data.

Table 33: Mortality following hip arthroplasty by year, New Zealand 2010–2015

| YEAR | Deaths | Admissions | Mortality per 100 admissions (%) |
|---|---|---|---|
| 2010 | 142 | 8,524 | 1.67 |
| 2011 | 129 | 8,430 | 1.53 |
| 2012 | 117 | 8,762 | 1.34 |
| 2013 | 148 | 9,088 | 1.63 |
| 2014 | 129 | 10,124 | 1.27 |
| *2015** | *138* | *8,233* | *1.68* |
| **2010–2015** | | | |
| Acute | 726 | 9,930 | 7.31 |
| Elective/waiting list | 76 | 42,013 | 0.18 |
| **Overall** | **803** | **53,161** | **1.51** |

**Numerator:** NMC: Deaths occurring within 30 days of a hip arthroplasty, as recorded in the NMDS.
**Denominator:** NMDS: Hospital discharges with a hip arthroplasty listed in any of the first 90 procedures.
* Provisional data.

Table 34: Mortality following knee arthroplasty by year, New Zealand 2010–2015

| YEAR | Deaths | Admissions | Mortality per 100 admissions (%) |
|---|---|---|---|
| 2010 | 14 | 5,686 | 0.25 |
| 2011 | 12 | 5,935 | 0.20 |
| 2012 | 4 | 6,224 | 0.06 |
| 2013 | 8 | 6,492 | 0.12 |
| 2014 | 15 | 7,932 | 0.19 |
| *2015** | *8* | *6,049* | *0.13* |
| **2010–2015** | | | |
| Acute | 14 | 505 | 2.77 |
| Elective/waiting list | 47 | 36,522 | 0.13 |
| **Overall** | **62** | **38,318** | **0.16** |

**Numerator:** NMC: Deaths occurring within 30 days of a knee arthroplasty, as recorded in the NMDS.
**Denominator:** NMDS: Hospital discharges with a knee arthroplasty listed in any of the first 90 procedures.
* Provisional data.

Table 35: Mortality following colorectal resection by year, New Zealand 2010–2015

| YEAR | Deaths | Admissions | Mortality per 100 admissions (%) |
|---|---|---|---|
| 2010 | 150 | 3,580 | 4.19 |
| 2011 | 143 | 3,504 | 4.08 |
| 2012 | 127 | 3,565 | 3.56 |
| 2013 | 130 | 3,562 | 3.65 |
| 2014 | 133 | 3,690 | 3.60 |
| *2015** | *85* | *3,198* | *2.70* |
| **2010–2015** | | | |
| Acute | 493 | 6,092 | 8.09 |
| Elective/waiting list | 275 | 14,670 | 1.87 |
| **Overall** | **782** | **21,196** | **3.69** |

**Numerator:** NMC: Deaths occurring within 30 days of a colorectal resection, as recorded in the NMDS.
**Denominator:** NMDS: Hospital discharges with a colorectal resection listed in any of the first 90 procedures.
* Provisional data.

Table 36: Mortality following CABG surgery by year, New Zealand 2010–2015

| YEAR | Deaths | Admissions | Mortality per 100 admissions (%) |
|---|---|---|---|
| 2010 | 56 | 1,949 | 2.87 |
| 2011 | 57 | 1,934 | 2.95 |
| 2012 | 50 | 2,058 | 2.43 |
| 2013 | 66 | 1,968 | 3.35 |
| 2014 | 53 | 1,953 | 2.71 |
| *2015** | *54* | *1,828* | *2.95* |
| **2010–2015** | | | |
| Acute | 142 | 3,242 | 4.38 |
| Elective/waiting list | 189 | 8,253 | 2.29 |
| **Overall** | **336** | **11,690** | **2.87** |

**Numerator:** NMC: Deaths occurring within 30 days of a CABG, as recorded in the NMDS.
**Denominator:** NMDS: Hospital discharges with a CABG listed in any of the first 90 procedures.
* Provisional data.

Table 37: Mortality following PTCA by year, New Zealand 2010–2015

| YEAR | Deaths | Admissions | Mortality per 100 admissions (%) |
|---|---|---|---|
| 2010 | 94 | 5,338 | 1.76 |
| 2011 | 94 | 5,357 | 1.75 |
| 2012 | 84 | 5,542 | 1.52 |
| 2013 | 104 | 5,862 | 1.77 |
| 2014 | 102 | 5,480 | 1.86 |
| *2015** | *107* | *5,747* | *1.86* |
| **2010–2015** | | | |
| Acute | 498 | 20,232 | 2.46 |
| Elective/waiting list | 79 | 11,890 | 0.66 |
| **Overall** | **577** | **32,770** | **1.76** |

**Numerator:** NMC: Deaths occurring within 30 days of a PTCA, as recorded in the NMDS.
**Denominator:** NMDS: Hospital discharges with a PTCA listed in any of the first 90 procedures.
* Provisional data.

## Appendix 2: Additional data

*Thirty-day mortality rates in New Zealand's resident population*

Table 38: Estimated 30-day mortality rates (all cause) in New Zealand's resident population, by age group

| AGE GROUP (YEARS) | Male<br>30-day mortality per 100,000 population | Female<br>30-day mortality per 100,000 population |
|---|---|---|
| 0 | 40.84 | 33.94 |
| 1–4 | 1.97 | 1.73 |
| 5–9 | 1.15 | 0.89 |
| 10–14 | 1.51 | 1.10 |
| 15–19 | 5.31 | 2.53 |
| 20–24 | 6.71 | 2.56 |
| 25–29 | 6.53 | 2.53 |
| 30–34 | 6.89 | 3.80 |
| 35–39 | 9.17 | 5.28 |
| 40–44 | 12.51 | 8.47 |
| 45–49 | 19.10 | 13.23 |
| 50–54 | 29.18 | 20.66 |
| 55–59 | 43.71 | 29.70 |
| 60–64 | 67.56 | 47.01 |
| 65–69 | 111.09 | 72.57 |
| 70–74 | 188.37 | 121.76 |
| 75–79 | 318.49 | 222.02 |
| 80–84 | 581.90 | 407.16 |
| 85–89 | 1,090.31 | 814.60 |
| 90+ | 2,432.84 | 2,234.33 |

**Numerator:** Average (mean) number of deaths (all cause) in 30 days in New Zealand during 2012–2014.
**Denominator:** Average (mean) population in New Zealand during 2012–2014.
**Source:** Statistics New Zealand Life Tables 2012–14 (50th percentile).

*Current and previously reported mortality rates for POMRC tracking procedures and clinical areas*

This appendix summarises key findings from 2010–2015 for the tracking procedures and clinical areas that were included in previous POMRC reports. Thirty-day mortality rates for these procedures and clinical areas are summarised in Table 37, along with the rates from previously reported time periods since 2005–2009.

Changes in mortality rates over time should be interpreted with caution as a range of factors related to coding and small variations in data sets across years (due to time lapses in receiving and entering data) could influence apparent changes in rates. These factors also explain why some of the rates presented in each report differ slightly from year to year.

Table 39: Current and previously reported mortality rates for POMRC tracking procedures and clinical areas, New Zealand 2005–2015

| TOPICS ANALYSED OVER TIME | 2005–2009 | 2006–2010 | 2007–2011 | 2008–2012 | 2009–2014 | 2010–2015 |
|---|---|---|---|---|---|---|
| **Cumulative one-day mortality rate per 100,000** | | | | | | |
| General anaesthesia | 119.08 (0.12%) | | 125.47 (0.13%) | 121.5 (0.12%) | 124.6 (0.12%) | 121 (0.12%) |
| **Cumulative 30-day mortality rate per 100,000** | | | | | | |
| General anaesthesia | | | | | | 554 (0.55%) |
| Cholecystectomy: acute | | 1040.9 (1.04%) | 975 (0.98%) | 821.7 (0.82%) | 695 (0.69%) | 575 (0.58%) |
| Cholecystectomy: elective/ waiting list | | 164.6 (0.16%) | 151 (0.15%) | 181.8 (0.18%) | 214 (0.21%) | 220 (0.22%) |
| Hip arthroplasty: acute | 7268.6 (7.27%) | | 6608.9 (6.61%) | 7098.0 (7.10%) | 7113.8 (7.11%) | 7311 (7.31%) |
| Hip arthroplasty: elective/waiting list | 235.3 (0.24%) | | 180.5 (0.18%) | 171.0 (0.17%) | 124.3 (0.12%) | 181 (0.18%) |
| Knee arthroplasty: elective/waiting list | 206.9 (0.21%) | | | 142.8 (0.14%) | 168.3 (0.17%) | 129 (0.13%) |
| Colorectal resection: acute | 9818.3 (9.82%) | | 8456.0 (8.46%) | | 8449.8 (8.45%) | 8093 (8.09%) |
| Colorectal resection: elective/waiting list | 2057.7 (2.06%) | | 1700.6 (1.70%) | | 2031.5 (2.03%) | 1875 (1.87%) |
| Coronary artery bypass graft (CABG) | | | | 2645.0 (2.47%) | 2918.8 (2.92%) | 2874 (2.87%) |
| Percutaneous transluminal coronary angioplasty (PTCA) | | | | 1661.3 (1.66%) | 1768.5 (1.77%) | 1761 (1.76%) |
| ASA 4 & 5 (high-risk anaesthesia) | | | | 13,701.9 (13.70%) | 12,237.4 (12.24%) | 12578 (12.58%) |
| ASA 1 & 2, elective/waiting list (low-risk anaesthesia) | | 68.8 (0.07%) | 62.9 (0.06%) | 54.5 (0.05%) | 50.64 (0.05%) | 49 (0.05%) |
| Weekend vs weekday mortality | | | | | | 1.62% vs 0.48% |

## Appendix 3: Methods

For all measures in this report that have been used in previous reports, the data sources and methods are consistent with those used for previous reports. Methods related to the two special topics are outlined below.

### *Data sources*

Hospital admission data was obtained from the NMDS and compared with Estimated Resident Population counts from Statistics New Zealand (projected from 2009). Mortality rates were sourced from NMC data and compared with NMDS admissions counts.

#### *Special topics*

The following data was obtained for the two new clinical areas included in this report:

- **Thirty-day mortality following AAA repair**

  All hospital admissions were included with an AAA repair listed in the first 90 procedure codes (ICD-10-AM ACHI Procedure Codes, Version 6, 3308000, 3310900, 3318100, 3314800, 3311200, 3315100, 3311500, 3315400, 3311800, 3315700, 3312100, 3316000, 3311600) and with AAA listed in any of the diagnosis fields. Mortality information was sourced from the NMC and as recorded in the NMDS. This definition is consistent with previous New Zealand studies of AAA repair that have used NMDS data (Khashram et al 2015).

- **Perioperative mortality and socioeconomic deprivation**

  Analysis was limited to people living in deciles 9 and 10 according to NZDep2013 (Atkinson et al 2014). All hospital admissions were included with a general anaesthetic (ICD-10-AM ACHI Version 6: 92514XX) listed in the first 90 procedure codes as recorded in the NMDS. Mortality rates of those who died (within 30 days following a general anaesthetic) were sourced from NMC data and compared with NMDS admissions counts in which a general anaesthetic was administered.

#### *Previously reported measures*

In relation to the specific tracking procedures and clinical areas included in this report, the following data was obtained:

- **General anaesthesia (same or next day)/WHO's day-of-surgery death ratio**

  All hospital admissions were included with a general anaesthetic (ICD-10-AM ACHI Version 6: 92514XX) listed in the first 90 procedure codes as recorded in the NMDS. Mortality rates of those who died (on the same day or the day following a general anaesthetic) were sourced from NMC data and compared with NMDS admissions counts in which a general anaesthetic was administered.

- **General anaesthesia (in hospital, within 30 days)/WHO's postoperative in-hospital death ratio**

  All hospital admissions were included with a general anaesthetic (ICD-10-AM ACHI Version 6: 92514XX) listed in the first 90 procedure codes as recorded in the NMDS. In-hospital mortality was calculated from the number of people who were deceased upon discharge (within 30 days following a general anaesthetic), as recorded in the NMDS.

- **General anaesthesia (within 30 days)**

  All hospital admissions were included with a general anaesthetic (ICD-10-AM ACHI Version 6: 92514XX) listed in the first 90 procedure codes as recorded in the NMDS. Mortality rates of those who died (within 30 days following a general anaesthetic) were sourced from NMC data and compared with NMDS admissions in which a general anaesthetic was administered.

- **Cholecystectomy**

  Hospital admissions with a cholecystectomy listed in the first 90 procedure codes (ICD-10-AM ACHI Procedure Codes, Version 6: 3044300, 3044500, 3044600, 3044800, 3044900, 3045401, 3045500). In a small proportion of cases (n=485), other more complex procedures

were undertaken at the same time as the cholecystectomy (eg, liver resections). When a cholecystectomy was performed as part of a more complex procedure, the risk of mortality is likely to have been significantly higher than if a cholecystectomy was either the main or the only procedure undertaken at the time of the operation. These admissions were not included in the analyses. Mortality rates of those who died following a cholecystectomy were sourced from NMC data (with cases being selected from the cohort of those undergoing cholecystectomy, as identified in the NMDS) and compared with NMDS admissions in which a cholecystectomy was listed in any of the first 90 procedure codes.

- **Hip arthroplasty**

  All hospital admissions were included with a hip arthroplasty listed in the first 90 procedure codes (ICD-10-AM ACHI Procedure Codes, Version 6, Blocks: 1489 and 1492) as recorded in the NMDS. Mortality information was sourced from the NMC and as recorded in the NMDS.

- **Knee arthroplasty**

  All hospital admissions were included with a knee arthroplasty listed in the first 90 procedure codes (ICD-10-AM ACHI Procedure Codes, Version 6, Blocks: 1518, 1519, 1523 and 1524) as recorded in the NMDS. Mortality information was sourced from the NMC and as recorded in the NMDS.

- **Mortality in elective admissions with an ASA score of 1 or 2**

  All elective or waiting list hospital admissions were included in those with a first ASA score of 1 or 2 that included a general anaesthetic (ICD-10-AM ACHI Procedure Code Version 3: 92514-XX) or neuraxial block (ICD-10-AM ACHI Procedure Code Version 6: 92508-XX). Deaths related to elective/waiting list admissions with an ASA score of 1 or 2 were included when mortality occurred within 30 days of the first general anaesthetic or neuraxial block.

- **Colorectal resection**

  Hospital admissions with a colorectal resection listed in the first 90 procedure codes (ICD-10-AM ACHI Blocks, Version 6: 913, 934, 935, 936) were obtained from the NMDS. Mortality information was sourced from the NMC and as recorded in the NMDS.

- **CABG**

  All hospital admissions were included with a CABG procedure listed in the first 90 procedure codes (ICD-10-AM ACHI Procedure Codes, Version 6, 3849700, 3849701, 3849702, 3849703, 3849704, 3849705, 3849706, 3849707, 3850000, 3850300, 3850001, 3850301, 3850002, 3850302, 3850003, 3850303, 3850004, 3850304, 9020100, 9020101, 9020102, 9020103, 3863700) as recorded in the NMDS. Mortality information was sourced from the NMC and as recorded in the NMDS.

- **PTCA**

  All hospital admissions were included with an angioplasty procedure listed in the first 90 procedure codes (ICD-10-AM ACHI Procedure Codes, Version 6, 3530400, 3530500, 3531000, 3531001, 3531002) as recorded in the NMDS. Mortality information was sourced from the NMC and as recorded in the NMDS.

- **ASA score 4 or 5**

  All hospital admissions were included for those with an ASA score of 4 or 5 that included a general anaesthetic (ICD-10-AM ACHI Procedure Code Version 6: Block 1910, 92514-XX) or neuraxial block (ICD-10-AM ACHI Procedure Code Version 6: Block 1909, 92508-XX). Deaths related to the admissions with an ASA score of 4 or 5 were included in which mortality occurred within 30 days of the general anaesthetic or neuraxial block.

- **Day-of-the-week mortality**

  All hospital admissions were included with a general anaesthetic (ICD-10-AM ACHI Version 6: 92514XX) listed in the first 90 procedure codes as recorded in the NMDS. Mortality rates of those

who died (within 30 days following a general anaesthetic) were sourced from NMC data and compared with NMDS admissions counts in which a general anaesthetic was administered. Day of the week information was sourced from the NMDS.

The first procedure that involved a general anaesthetic during a hospital admission was used as the index procedure, and the date of this procedure was obtained from information included in the NMDS. The day of the week for the occurrence of the index procedure was assigned on the basis of the date for the procedure. Deaths within 30 days were assessed in relation to the day of the week of the index procedure. The analyses followed the methodology employed by Aylin et al (2010 and 2013). The methods applied to the 30-day mortality chapter were also followed with these analyses. In some analyses, information related to procedures on Saturday and Sunday were combined and assessed as weekend procedures.

## Notes on interpretation

The following notes describe the data definitions used for analyses included in this report.

*1) Hospital admission types and hospital readmissions*

The following occurrences, unless otherwise stated, have been dealt with in the same way as in previous reports.

### *Acute, arranged (semi-acute) and elective/waiting list admissions*

The analyses included in this report used the hospital admissions typology specified in the NMDS Data Dictionary (National Health Board 2014). An acute admission is defined as an unplanned admission occurring on the day of presentation, while an arranged admission is a non-acute admission with an admission date less than seven days after the date the decision was made by the specialist that the admission was necessary. Similarly, waiting list admissions arise when the planned admission date is seven or more days after the date the decision was made that admission was necessary.

These definitions, however, are inconsistently used by private hospitals, with a significant proportion of private hospital admissions in the NMDS coded as arranged when in reality they meet the criteria for an elective admission as outlined above. As a result, in this report all arranged private hospital cases have been included in the elective/waiting list category, while arranged admissions occurring in public hospitals have been included in the public hospital semi-acute admission category. Thus, unless otherwise specified, acute and elective/waiting list admissions include both public and private cases, while semi-acute admissions are confined to public hospitals only.

### *Private and public hospital admissions*

The NMDS contains near complete information on all publicly funded inpatient events occurring in public hospitals. In contrast, private hospital events include a mix of publicly funded and privately funded cases. DHB-funded events occurring in private hospitals are usually reported to the NMDS by the DHB contracting the treatment, and thus are mostly complete in the data set. As NMDS reporting is not legally mandated for New Zealand health care providers, many private surgical or procedural day-stay or outpatient hospitals, facilities or in-rooms do not report any events to the NMDS.

The Ministry of Health is unable to provide any estimate of the extent to which the NMDS undercounts events from private surgical or procedural day-stay or outpatient hospitals, facilities or in-rooms, although it notes that the data most likely to be missing is privately funded or Accident Compensation Corporation (ACC) funded events, or publicly funded long-stay geriatric cases. Thus, in this report it must be remembered that the data presented is likely to undercount some private hospital events, with the magnitude of this undercount being difficult to quantify (although it is assumed to be significant).

### *Readmissions*

Both first-time procedures and revisions of previous procedures were included in the analyses, with a small number of individuals appearing more than once in the data. In such cases, if a second procedure occurred within 30 days of the initial procedure, it was considered to be a revision, arising as a complication of

the first procedure, and, in such cases, the outcomes arising from the second procedure were attributed to the first. These readmissions were not included in the denominator used to calculate mortality rates by procedure. If a readmission occurred more than 30 days from the original procedure, however, this was considered to be a new procedure in the calculation of mortality rates.

*2) Sociodemographic and clinical covariates*

Sociodemographic and clinical factors have been dealt with in the same way as in previous reports, unless otherwise stated.

### *Charlson Comorbidity Index (CCI) score*

The Charlson Comorbidity Index is a method of categorising comorbidities of patients based on the International Classification of Diseases (ICD) diagnosis codes found in administrative data, such as hospital admission data. Each comorbidity category has an associated weight, based on the adjusted risk of mortality, and the sum of all the weights results in a single comorbidity score for an admission. The index has been validated in a variety of clinical settings and has been recently updated to enable it to be used with ICD10 administrative data in New Zealand (Quan et al 2011).

### *New Zealand Deprivation Index (NZDep) decile*

Analysis of NZDep information in this report is based on NZDep2013 (Atkinson et al 2014).

### *ASA and emergency suffixes*

All ICD–10-AM ACHI anaesthesia codes require a two-character extension, with the first digit indicating the ASA's Physical Status Classification and the second digit indicating whether the procedure was routine or carried out as an emergency, as follows:

ASA and emergency suffixes

| ASA SCORE | Description |
|---|---|
| 1 | A normal healthy patient |
| 2 | A patient with mild systemic disease |
| 3 | Patient with severe systemic disease that limits activity |
| 4 | Patient with severe systemic disease that is a constant threat to life |
| 5 | A moribund patient who is not expected to survive longer than 24 hours without surgical intervention |
| 6 | A declared brain-dead patient whose organs are being removed for donor purposes |
| 9 | No documented ASA score |

| EMERGENCY | Modifier description |
|---|---|
| 0 | Procedure being performed as an emergency |
| 9 | Non-emergency or not known |

The ASA status referred to throughout this report is the ASA status derived from the first anaesthesia code for each admission event (with the order of procedure codes being determined by the diagnosis sequence variable within the NMDS). In the case of multiple anaesthetics, it is likely that this first ASA status reflects most closely the ASA status of the patient at the time of admission.

*3) Interpreting multivariate analyses: odds ratios and rate ratios*

This report used logistic regression for multivariate analysis. A limitation of logistic regression is that the results generated are expressed as odds ratios (the odds of an event occurring in an exposed group versus the odds of it occurring in an unexposed group) as opposed to rate ratios such as relative risk (the risk of an event occurring in an exposed group relative to the risk of it occurring in the unexposed group). An odds ratio is used to estimate a rate ratio when there is not enough information to calculate risk directly.

Odds ratios provide a close estimate of relative risk for rare outcomes. However, for more common outcomes, odds ratios become biased away from the null, resulting in a tendency to over-estimate the magnitude of any effect.

In this report, consistent with previous reports, all odds ratios derived from figures in which the mortality rate exceeds 20% have been suppressed (as indicated by an H). Interpreting any odds ratios in which the associated mortality is in the 10–19% range should also be interpreted with caution because of the tendency for odds ratios to slightly overestimate rate ratio (and the magnitude of effect).

## Appendix 4: Fifth report recommendations – progress summary

The following tables present the POMRC's progress on recommendations made in the previous fifth report.

Table 40: Progress summary of fifth report recommendations

| RECOMMENDATIONS OF FIFTH REPORT (MARCH 2016) | PROGRESS TO DATE (MARCH 2016) |
|---|---|
| Non-operative treatment for patients who are assessed as having an ASA status of 5 must be considered. | The 'Choosing Wisely' campaign[20] in New Zealand was launched in December 2016, and is run by the Council of Medical Colleges, with support from the Health Quality & Safety Commission and Consumer NZ. Choosing Wisely is centred on helping patients make good choices and focuses on areas where evidence shows that a test, treatment or procedure provides little or no benefit to a patient and could even cause harm. These are not grey areas where evidence is debatable. Health professionals will be encouraged to discuss the risks and benefits of these tests with patients, so patients can make an informed choice. |
| The risk of dying perioperatively should be discussed with all patients contemplating an operation with a significant risk. | The POMRC's Chair presented at the 'Surgery 2016' conference for the Royal Australasian College of Surgeons on perioperative mortality. She emphasised the importance of understanding both the risk of the procedure, and the risk for that specific patient (increased risk for age and comorbidities).<br>This recommendation is repeated again in the sixth report. |
| Death following elective surgery performed on the weekend should be investigated in depth by the health care institution.<br>The resources available for the care of electively admitted patients operated on in the weekend compared with those operated on in the weekdays should be reviewed.<br>The difference in mortality between patients having procedures in the weekend compared with weekdays, in particular those admitted electively, should be investigated. | *For all day-of-the-week recommendations:*<br>The POMRC has made this recommendation to DHBs. It will take some time to see changes in mortality after procedures on weekdays compared with weekends. The POMRC will continue to monitor perioperative mortality by day of the week.<br>The 'weekend effect' was brought to the attention of the DHBs and the POMRC will continue to monitor it and provide relevant information in subsequent reports to help DHBs track progress. |
| All patients should have their ASA status recorded in their clinical anaesthetic record. | This recommendation was first made in 2015. Since then, recording of ASA status has increased. The Health Quality & Safety Commission surgical teamwork and communication programme rolled out in 2015 made ASA status a requirement on the 'time out' component of the surgical safety checklist.<br>This recommendation is repeated again in the sixth report. |
| The reasons for increased perioperative mortality of Māori should be further investigated. | The high mortality rate of Māori patients following general anaesthesia (highlighted in the fifth report) was brought to the attention of the Health Research Council to consider how future research in this area could be supported. |
| The impact that the Māori population age structure has on analyses of perioperative mortality should be investigated. | The POMRC has investigated the effect of different methods of adjusting for age, and found that logistic regression (which the POMRC currently uses) produces similar results to other methods. The POMRC will continue to use logistic regression and will review this decision every two years as the age structure of the population changes. |
| The Charlson Comorbidity Index should be considered to strengthen future analyses and better understand how severity of illness impacts Māori perioperative mortality. | The Charlson Comorbidity Index is now included as a factor in the POMRC's multivariate analyses. |

20 For more information visit the Choosing Wisely website, http://choosingwisely.org.nz/patients-consumers/.

# List of Abbreviations

| | |
|---|---|
| **AAA** | Abdominal aortic aneurysm |
| **ACC** | Accident Compensation Corporation |
| **ACHI** | Australian Classification of Health Interventions |
| **ASA** | American Society of Anesthesiologists |
| **CABG** | Coronary artery bypass graft |
| **CCI** | Charlson Comorbidity Index |
| **CI** | Confidence interval |
| **DHB** | District health board |
| **ICD** | International Classification of Diseases |
| **MELAA** | Middle Eastern/Latin American/African |
| **NMC** | National Mortality Collection |
| **NMDS** | National Minimum Dataset |
| **NZDep** | New Zealand Deprivation Index |
| **OR** | Odds ratio |
| **POMRC** | Perioperative Mortality Review Committee |
| **PTCA** | Percutaneous transluminal coronary angioplasty |
| **WHO** | World Health Organization |

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