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

POMRC
Perioperative Mortality Review Committee

Perioperative Mortality in New Zealand:

Seventh report of the Perioperative Mortality Review Committee

Report to the Health Quality & Safety Commission New Zealand

June 2018

POMRC. 2018. *Perioperative Mortality in New Zealand: Seventh report of the Perioperative Mortality Review Committee.* Wellington: Health Quality & Safety Commission.

Published in June 2018 by the Perioperative Mortality Review Committee, PO Box 25496, Wellington 6146, New Zealand

ISBN 978-0-908345-70-0 (Print)
ISBN 978-0-908345-71-7 (Online)

The document is available online on the Health Quality & Safety Commission's website:
www.hqsc.govt.nz

Acknowledgements

The Perioperative Mortality Review Committee (POMRC) would like to acknowledge:

- the committee members' ongoing commitment to families and whānau who have lost a loved one; to learn from their deaths and develop and share solutions
- the organisations and workplaces that have supported their staff to attend meetings and participate in the POMRC
- the work of the staff within the Health Quality & Safety Commission, particularly Owen Ashwell (POMRC Senior Specialist Advisor), Kiri Rikihana (Group Manager, Mortality Review Committees), Maree Meehan-Berge (Senior Project Manager), Alice McCallum (Report Writer/Policy Advisor) and Dez McCormack (Committees Coordinator)
- Dr Phil Hider for his epidemiological advice and analysis
- Dr Gabrielle McDonald for her support in developing the local review process
- the Ministry of Health for providing the baseline data for the analysis
- Kristie Saumure and the Ministry of Health Library for their support with the literature review
- the Māori Caucus convened by the Health Quality & Safety Commission, for reviewing the POMRC's findings and recommendations. Māori Caucus members include: Professor Denise Wilson (Chair), Dr Paula King (Deputy Chair), Ngaroma Grant, Associate Professor Sue Crengle, Dr Terryann Clark, Keri Parata-Pearse, Dr Fiona Cram, Lisa Paraku, Shayne Walker, Tania Papali'i, Witi Ashby, Dr Maria Baker and Dr Maxine Ronald
- the professional organisations, practitioners, government advisors and representatives from district health boards (DHBs) consulted with on the report recommendations, particularly Saira Dayal (Public Health Medicine Specialist/Clinical Leader, Quality Service Improvement and Innovation, Hutt Valley DHB), Jonathan Sharr (Deputy Clinical Director, Orthopaedics, Canterbury DHB), Celina Eves (Executive Director of Nursing and Midwifery, MidCentral DHB), Lynda Donaldson (Executive Officer, Australian & New Zealand Society for Geriatric Medicine), Rose Geden (Executive Director, New Zealand Private Surgical Hospitals Association), Virginia Mills (Senior Policy Adviser, Australian & New Zealand College of Anaesthetists), Nick Kendall (Manager, Treatment Injury, Accident Compensation Corporation), Richard Street (President, New Zealand Orthopaedic Association), Roger Harris (Clinical Lead, New Zealand Implementation Committee of the Australian & New Zealand Hip Fracture Registry), and Jacqueline Close (Co-Chair of the Australian & New Zealand Hip Fracture Registry).

Perioperative Mortality Review Committee Members

Dr Anthony (Tony) Williams (Chair)
Intensive Care Medicine Specialist, Counties Manukau Health

Prof Ian Civil
Professor of Surgery in the Department of Surgery, University of Auckland
Director of Trauma Services, Auckland City Hospital

Ms Stephanie Thomson
Nurse Practitioner, Adult Perioperative Care, Southern Cross Hospital, Rotorua

Mrs Keri Parata-Pearse, Ngāti Toarangatira, Ngāti Raukawa, Ngāti Awa
Registered Nurse, Mortality – Quality and Patient Safety Department, Waikato District Health Board

Mr Rob Vigor-Brown
Consumer Representative

Dr Maxine Ronald, Ngāti Wai, Ngāti Hine
General and Oncoplastic Breast Surgeon, Whangarei Hospital

Dr Dick Ongley
Specialist Anaesthetist, Canterbury District Health Board

Prof Andrew Hill
Colorectal Surgeon, Counties Manukau Health
Professor of Surgery, Faculty of Medical and Health Sciences, University of Auckland

Terms ended this year:

Dr Leona Wilson (Outgoing Chair)
Specialist Anaesthetist, Capital & Coast District Health Board

Advisors:

Dr Philip (Phil) Hider
Clinical Epidemiologist, University of Otago, Christchurch

Contents

List of Tables

List of Tables (continued)

List of Figures

Foreword

As the Chair of the Health Quality & Safety Commission, I am pleased to introduce the seventh annual report of the Perioperative Mortality Review Committee (POMRC). This report presents data and information on perioperative mortality in New Zealand, between 2011 and 2016. In particular, it focuses on mortality following hip fracture treatment.

Every year in New Zealand, more than 3,000 people are admitted to hospital with a hip fracture. The POMRC found that out of those admitted with a hip fracture, 8% died within 30 days. In reviewing these deaths, the POMRC found that:

- surgical repair was undertaken in 90.7% of patients admitted with hip fractures and had a 30-day mortality rate of 6.8%
- delays between admission and surgery increase the mortality rate. Delays also increase the period of discomfort and uncertainty for patients and their families/whānau, so it is important that every effort is made to operate on these patients as early as practicably possible
- sociodemographic factors (eg, gender and age) have an effect on outcomes, and, as one would expect, comorbidities, poor health status, and complications were associated with poorer outcomes
- mortality rates did not vary significantly across different district health boards in New Zealand, which is a reassuring finding that suggests New Zealanders are receiving essentially the same standard of care for these fractures wherever they live.

The POMRC's findings are consistent with international findings.

The POMRC's report also presents data for other selected procedures and for selected surgical quality measures. Overall, the rates for these procedures and measures are tracking downward, and New Zealand's measures are comparable, if not lower than, other OECD countries.

Importantly, the POMRC's report also includes the World Health Organization (WHO) surveillance metrics for surgical care. These metrics are of relevance to New Zealand but are even more important for efforts by the WHO and other organisations to drive improvement in surgery globally through the publication of comparative data. There are many countries in the world in which the outcomes of surgery, anaesthesia and obstetrics are orders of magnitude worse than in New Zealand, and it is important to play our role in these efforts to achieve greater global equity in this regard.

The take-home message of this report is that New Zealanders can be assured that surgical care in New Zealand is world class. In part this is because of a commitment by the system to continuous improvement: there is never room for complacency, and there is certainly more we can do to improve. This report reflects the POMRC's ongoing commitment to the efforts of all concerned to improve surgical services in New Zealand. Through its careful and thoughtful reviews of perioperative deaths, the POMRC provides useful insights and intelligence to inform clinical practice and direct national initiatives to improve the quality and safety of surgery. The present report showcases these insights, and will be of importance not only to those responsible for the funding and organisation of surgical services, but also to surgeons, anaesthetists and other clinicians who deliver these services, and to the patients and their families/whānau who depend upon them.

I would like to thank the Chair, Dr Tony Williams, and his team for their ongoing dedicated work on the POMRC.

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

Chair's Introduction

I am pleased to present the seventh 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.

First and foremost, I want to acknowledge the grief and loss that a family or whānau experiences when they lose a loved one after surgery. Every number in this report represents the loss of a life, and the loss of a loved one. The POMRC is committed to reviewing perioperative mortality in New Zealand so we can learn from these deaths, make recommendations and changes to continue to improve care for patients around the time of surgery, and reduce the number of avoidable deaths.

This year, the POMRC has focused on hip fracture – an injury that affects approximately 3,500 New Zealanders every year. Many New Zealanders will know someone who has sustained a hip fracture, and have seen first-hand the significant impact this injury can have.

In reviewing cases of hip fracture, we found there is an increasing number of hip fracture-related admissions, and more surgeries are being performed every year to repair them. In spite of this, the actual number of deaths is decreasing. That is, we are performing more surgeries, on sicker people, but the overall mortality rate is stable. The mortality rate for those admissions who are unable to have surgery is also tracking downward.

As we have found in previous reports, the mortality rate following hip fracture treatment increases with older age, more comorbidities and a higher American Society of Anesthesiologists (ASA) status (people who are very unwell). We also found that while a greater proportion of admissions were female, males admitted with a hip fracture had a higher mortality rate.

One encouraging finding was that there was no significant variation in mortality rates across the country, meaning that wherever a person lives and whichever district health board they are admitted to, they can expect to receive the same quality of care with the same outcomes.

However, there are changes that we can make to improve outcomes. The POMRC has developed the following recommendations to improve the care of those who are receiving treatment for a hip fracture.

- **Recommendation 1:** All patients presenting to hospital with a hip fracture, or sustaining a hip fracture in hospital, should be offered surgery within 48 hours, if surgery is the preferred or requested treatment and no clinical contraindication exists.
- **Recommendation 2:** People undergoing surgery should receive proactive perioperative care from a multidisciplinary team to enable the early detection and management of any comorbidities, or complications that arise.
- **Recommendation 3:** All patients presenting to hospital with a hip fracture, and their families and whānau, should be given the opportunity to discuss the risk of serious complications, including death, and to discuss the patient's goals of care and develop an advance care plan, if they are able to take part in such a conversation.

What is also clear is that the best way to avoid harm from a hip fracture is to avoid the fracture in the first place. This year the POMRC has included two recommendations specifically focused on the prevention of hip fractures:

- **Recommendation 4:** All people over the age of 65 who live in the community (including aged residential care facilities) and access primary and community health care should be routinely screened for osteoporosis risk factors and risk of falling, to enable the effective management of osteoporosis and implement strategies to mitigate the risks of falling.
- **Recommendation 5:** All health care facilities and aged residential care facilities should conduct a falls risk assessment for all patients over 65 years old, and should implement necessary preventative measures.

The Māori Caucus reviewed the data and has made a number of recommendations in this report. Broadly, these recommendations support the reduction of inequity in perioperative care and perioperative mortality.

Every year, the POMRC presents mortality rates for selected clinical procedures. Across the procedures we track, including hip replacement, New Zealand's rates of perioperative mortality are similar to other OECD countries. It is positive to see the rates are tracking down for a number of quality indicators, including same and next day mortality, inpatient mortality and 30-day mortality. However, we know there are still improvements to be made, in particular around the inequitable outcomes that exist in New Zealand.

Next year the POMRC will be focusing on perioperative mortality and Māori. We know that Māori often experience inequitable outcomes, including higher rates of perioperative harm and mortality. The 2019 report will be an opportunity for us to better understand the range of factors that contribute to these inequities, including barriers to care and clinical and systemic factors that impact care – both during and after surgery.

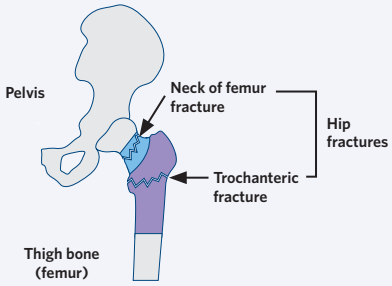
Focusing on perioperative mortality and Māori will also allow us to progress a number of recommendations from the fifth and sixth reports (POMRC 2016, 2017), including those from the Māori Caucus, so we can achieve positive health outcomes for Māori.

The POMRC is pleased to present its seventh report, outlining the outcomes for patients having surgery in New Zealand hospitals. We present the information here to help patients and the clinicians caring for them to make the best decisions, based on relevant New Zealand data.

Dr Tony Williams

Chair, Perioperative Mortality Review Committee

Hip fractures



Hip fractures are common

Falls are the leading cause of injury to older people, with over 3,000 people falling and fracturing their hip every year.

One in three older people has a fall each year, and the likelihood of falling increases as people get older and more frail.

POMRC
Perioperative Mortality Review Committee

Consequences of hip fracture are serious

- 8% of people who sustain a hip fracture will die within 30 days
- 10% don't return to their own home
- 50% will still experience a mobility-related disability 12 months after injury
- 25% will die within one year

Improvements to care

Having surgery within 48 hours of admission leads to better outcomes and a lower mortality rate. Operate within 48 hours, unless there is a good reason not to

Delays between admission and surgery increase the mortality rate

Comorbidities, health status and complications are associated with poorer outcomes

Postoperative complications have a significant impact on morbidity and mortality

People undergoing surgery should receive proactive perioperative care from a multidisciplinary team, to enable the early detection and management of comorbidities and complications

- All older people in the community should be routinely screened for osteoporosis and risk of falling.
- All health care facilities should conduct a falls risk assessment for patients over 70 years of age.

Take measures to reduce your risk of falling

- Keep active
- Have your medicines reviewed
- Have your eyes checked and update your glasses
- Remove trip hazards

Develop an advance care plan

Have a conversation about what to do if you fall. Making plans in case of an injury or illness gives people confidence that their thoughts and wishes are known and can be respected. Talk about and write an advance care plan.

Executive Summary

The Perioperative Mortality Review Committee (POMRC) is a statutory committee that reviews and reports on perioperative deaths in New Zealand. The aim of the POMRC is to reduce complications and death after surgery, and to continually improve surgical health care in New Zealand.

The POMRC defines 'perioperative death' as deaths that occur:

- during surgery
- within 30 days of surgery
- after 30 days of surgery, but before discharge from hospital
- while under the care of a surgeon in hospital, even if surgery was not undertaken.

For the purposes of the POMRC's definition of perioperative death, a surgery (or operative procedure) refers to any procedure requiring sedation or anaesthetic (either local, regional or general). This includes a wide range of procedures for the diagnosis and treatment of medical conditions. These procedures are usually carried out in operating theatres, but may also occur in endoscopy or radiology suites, or minor operations theatres. They include gastroscopy, colonoscopy, excision and biopsy of skin lesions, and cardiac and vascular angiographic procedures.

Perioperative mortality in New Zealand following hip fracture treatment

For this report, the POMRC examined perioperative mortality in New Zealand following treatment for hip fractures.

Hip fractures affect a large number of people, particularly those aged over 50, and have a significant impact on those who sustain the fracture, as well as those who love and care for them.

Every year in New Zealand, more than 3,000 people sustain a hip fracture, and with an ageing population and increasing life expectancy, this number is set to increase. It is predicted that by 2020, there will be more than 5,300 hip fractures in New Zealand every year (Brown et al 2007).

As well as affecting a large group of people, the consequences of hip fractures are serious. Approximately 5% of people who sustain a hip fracture die in hospital, 10% are newly discharged to an aged care facility, and more than 50% still experience a mobility-related disability 12 months after injury. Furthermore, 25% of people who sustain a hip fracture die in the year after discharge from hospital.

Key findings for hip fracture repair

Key findings from the POMRC's analysis are set out below.

- Between 2011 and 2016, there were 22,014 hip fracture-related admissions and 1,772 deaths. The overall 30-day mortality rate was 8%.

There are two main types of hip fracture diagnosis

- Neck of femur fractures were more common (58.5%) than trochanteric fractures (41.5%).
- The 30-day mortality rates following surgical repair were similar for both neck of femur and trochanteric fractures (6.9% and 6.6%, respectively).

Surgical repair of hip fracture is more common than non-surgical treatment

- Of the total admissions, 90.7% (19,959 admissions) were treated with surgical repair. The other 9.3% (2,055 admissions) were treated non-surgically.
- Fixation/Reduction procedures were more common (58.3%) than hip replacement procedures (42.2%). Fixation/Reduction procedures had a lower mortality rate (6.1%) compared with hip replacement (7.7%).

Surgical repair has a lower mortality rate than non-surgical treatment

- Surgical repair had an overall 30-day mortality rate of 6.8%. This rate decreased from 7.7% in 2011 to 5.9% in 2016.
- Non-surgical treatment had an overall 30-day mortality rate of 20.4%. This rate decreased from 23.5% in 2011 to 18.81% in 2016.

Delays between admission and surgery increase the mortality rate

- Mortality rates increased with longer delays between admissions and surgery.
- The mortality rate following surgery within one day of admission was 6.4%, and the mortality rate following surgery four days after admission was 8.2%.
- Twenty-one percent of admissions underwent surgical repair on the day of admission, 65.9% within two days, 85% within three days and 95% within five days.

Gender and age have an effect on outcomes

- More females were admitted with hip fracture (68.4%) than males.
- Males had a higher overall mortality rate than females, following both surgical repair (8.9% in males compared with 6.8% in females) and non-surgical treatment (22.4% in males compared with 19.2% in females).
- Mortality rates increased with age. Males over 80 years old had the highest mortality rate in both the surgical repair group (12.3%) and the non-surgical group (32.1%).
- The majority of admissions (92.7%) and deaths (93.4%) were for people who identified as New Zealand European. Māori represented a much smaller proportion of admissions (3%) and deaths (3.2%). The mortality rate for Māori (7.1%) was slightly higher than the mortality rate for New Zealand European (6.9%). This difference was not statistically significant.

Comorbidities, poor health status, and complications were associated with poorer outcomes

- Mortality rates increased with an increasing number of comorbidities in both the surgical repair group and the non-surgical treatment group. The mortality rate was higher for admissions with an American Society of Anesthesiologists (ASA) score of 4 or 5 (18.5% and 38.3%, respectively) than for those with an ASA score of 1–2 (1.52%).
- Mortality rates increased with an increasing number of complications. Among the eight complications the POMRC analysed, acute renal failure was the most common, occurring in 7% of admissions for surgical hip fracture repair.

Mortality rates do not vary across different DHBs in New Zealand

- There was no significant variation in mortality rates across DHBs, after adjusting for sociodemographic and clinical factors.

Seventh report recommendations

The following recommendations were informed by data presented in this report, and a review of the international literature.

Improvements to care

Recommendation 1: All patients presenting to hospital with a hip fracture, or sustaining a hip fracture in hospital, should be offered surgery within 48 hours, if surgery is the preferred or requested treatment and no clinical contraindication exists.

> *Rationale:* The POMRC found that patients who received hip fracture repair surgery within 48 hours of admission had lower 30-day mortality rates. This finding is consistent with international research and the clinical care standards set by the Australian Commission on Safety and Quality in Health Care (2016).

Recommendation 2: People undergoing surgery should receive proactive perioperative care from a multidisciplinary team to enable the early detection and management of any comorbidities, or complications that arise.

> *Rationale:* Comorbidities and postoperative complications have a significant impact on patient morbidity and mortality. Proactive screening and monitoring from a multidisciplinary team allows for the early detection and management of comorbidities and complications, which is critical to reduce the likelihood of death following surgery.

Recommendation 3: All patients presenting to hospital with a hip fracture, and their families and whānau, should be given the opportunity to discuss the risk of serious complications, including death, and to discuss the patient's goals of care and develop an advance care plan, if they are able to take part in such a conversation.

> *Rationale:* Hip fractures have a significant impact on a person, their functional status, independence and care status. Patients should be made aware of the likely impacts of their injury and the treatment, including surgery. Patients should also be given the opportunity to discuss their goals and wishes, and to make plans for their life after surgery.

Falls and fracture prevention

Recommendation 4: All people over the age of 65 who live in the community (including aged residential care facilities) and access primary and community health care should be routinely screened for osteoporosis risk factors and risk of falling, to enable the effective management of osteoporosis and implement strategies to mitigate the risks of falling.

> *Rationale:* The best way to prevent morbidity and mortality associated with hip fracture repair is to prevent hip fractures from occurring. Identification and effective management of osteoporosis can reduce the risk of a fracture from a fall. This recommendation is consistent with the guidance developed by the Health Quality & Safety Commission (2017). The POMRC endorses this recommendation as a strategy for preventing injury and harm from falls.

Recommendation 5: All health care facilities and aged residential care facilities should conduct a falls risk assessment for all patients over 65 years old, and should implement necessary preventative measures.

> *Rationale:* The best way to prevent morbidity and mortality associated with hip fracture repair is to prevent hip fractures from occurring. Conducting comprehensive falls risk assessments in health care facilities and acting on the findings reduces the likelihood of older patients falling and sustaining fractures.

Better documentation

Recommendation 6: All patients should have their American Society of Anesthesiologists (ASA) status recorded in their clinical anaesthetic record. Note: Recording of ASA status has improved on previous years. This recommendation is repeated from the sixth report of the POMRC (2017).

Rationale: The ASA score is a common standard measure that is often used before operations to identify high-risk patients. The ASA score takes into account patient comorbidities and the medical stability of those comorbidities. Accurate ASA scores allow anaesthetists and surgeons to assess the risk of perioperative mortality, depending on the patient's disease severity. Having a patient's ASA score available in the patient's record allows for improved anaesthetic optimisation, and can support audit processes.

Recommendation 7: All hospitals should actively contribute data to the Australian & New Zealand Hip Fracture Registry, and that data should be used for ongoing quality improvement activity.

Rationale: The Australian & New Zealand Hip Fracture Registry is a clinician-led audit of hip fracture care in Australia and New Zealand. The registry collects and stores extensive and specific data about hip fractures from participating hospitals, and generates real-time feedback on a wide range of measures and quality indicators.

The registry provides a mechanism for hospitals to use their data to prioritise quality improvement efforts and to ultimately improve outcomes for people who have fractured their hip.

Further research and research funding

Recommendation 8: Health research agencies should develop quality of life indicators and measures of postoperative outcomes other than mortality.

Rationale: Currently, the POMRC measures postoperative mortality; however, due to limitations with the available data it cannot measure other postoperative outcomes such as quality of life after surgery, postoperative disability and postoperative functional status. Measuring these outcomes would allow the POMRC to better understand surgical outcomes, and provide patients and their families and whānau with a more comprehensive picture of surgical risk.

Recommendations from the Māori Caucus

Recommendation 9: The Māori Caucus recommends clinicians should actively address reversible and preventable perioperative factors that may contribute to morbidity and mortality.

Recommendation 10: The Māori Caucus recommends the POMRC investigates the other factors contributing to the higher postoperative mortality rate in Māori compared with non-Māori (specifically the residual 14% difference in mortality following hip fracture repair, that is not explained by age, gender, deprivation, comorbidity and fitness for surgery).

Recommendation 11: The Māori Caucus recommends the POMRC and other relevant organisations in the health and disability sector consider how ethnicity data collection and management can be improved, following the Ethnicity Data Protocols for the Health and Disability Sector, to allow better measurement of Māori perioperative mortality.

Recommendation 12: The Māori Caucus recommends the POMRC investigates the rate at which Māori are offered non-surgical treatment and/or palliative treatment, compared with non-Māori.

The POMRC wishes to acknowledge the vast amount of research and work that has gone into understanding and preventing harm from falls. For this reason, it would like to endorse:

- the clinical care standards developed by the Australian Commission on Safety and Quality in Health Care (2016) and supported and adopted by the Health Quality & Safety Commission
- the Australia & New Zealand Hip Fracture Registry
- the 'Live stronger for longer' programme.

Endorsement

The POMRC endorses the clinical care standards set by the Australian Commission on Safety and Quality in Health Care (2016), and recommends that all hospitals providing care after a hip fracture implement these standards.

These standards are as follows:

1. A patient presenting to hospital with a suspected hip fracture receives care guided by timely assessment and management of medical conditions, including diagnostic imaging, pain assessment and cognitive assessment.
2. A patient with a hip fracture is assessed for pain at the time of presentation and regularly throughout their hospital stay, and receives pain management including the use of multimodal analgesia, if clinically appropriate.
3. A patient with a hip fracture is offered treatment based on an orthogeriatric model of care as defined in the *Australian and New Zealand Guideline for Hip Fracture Care* (Australian & New Zealand Hip Fracture Registry Steering Group 2014).
4. A patient presenting to hospital with a hip fracture, or sustaining a hip fracture while in hospital, receives surgery within 48 hours, if no clinical contraindication exists and the patient prefers surgery.
5. A patient with a hip fracture is offered mobilisation without restrictions on weight-bearing the day after surgery and at least once a day thereafter, depending on the patient's clinical condition and agreed goals of care.
6. Before a patient with a hip fracture leaves hospital, they are offered a falls and bone health assessment, and a management plan based on this assessment, to reduce the risk of another fracture.
7. Before a patient leaves hospital, the patient and their carer are involved in the development of an individualised care plan that describes the patient's ongoing care and goals of care after they leave hospital. The plan is developed collaboratively with the patient's general practitioner. The plan identifies any changes in medicines, any new medicines, and equipment and contact details for rehabilitation services they may require. It also describes mobilisation activities, wound care and function post-injury. This plan is provided to the patient before discharge and to their general practitioner and other ongoing clinical providers within 48 hours of discharge.

Mortality following Hip Fracture

Introduction from consumer representative

The special topic in this year's report is hip fracture. Hip fractures are common in older people and can lead to significant disability and death.

Hip fractures are common

Falls are the leading cause of injury to older people, with over 3,000 people falling and fracturing their hip every year.

Over the last six years, over 22,000 people were admitted to hospital with a fractured hip. Most of these people were over the age of 60.

Hip fractures have serious consequences, including disability, and sometimes death

A hip fracture can be a life-changing event. The initial effects on a person's mobility are obvious, but some consequences may be unforeseen and long-term. For example, many people who fracture their hip do not return home from the hospital, but are newly discharged to an aged care facility. Approximately 50% of people who fracture their hip still have a mobility-related disability one year later. Sadly, 8% of people with a hip fracture die within a month of their injury.

The care a person receives can impact their outcomes

There are two main treatment options for a hip fracture – either surgery, or non-surgical treatment. Non-surgical treatment usually involves bed rest for about six weeks. Most people who fracture their hip will choose to have surgery. Surgery usually leads to better outcomes, including better pain relief, and has a lower mortality rate than non-surgical treatment. Approximately 7% of people who undergo surgery die within a month, compared with 20% of people who opt for non-surgical treatment.

If you do decide that surgery is the best option, then having it quickly is important. The POMRC found that people who wait longer than 48 hours to have surgery fare worse than those who have it within 48 hours. Talk to your doctor about how soon you can have surgery.

The good news is that New Zealand has a high standard of care for hip fractures all over the country. For example, the POMRC found there were no differences in mortality rates following surgery at different DHBs. This means patients can be confident they will receive good surgical care in their own centre and do not need to be transferred.

Sometimes surgery is not possible or not the preferred option

There are some factors that can impact whether surgery is possible or advisable. For example:

- your age: the older you are, the higher your chance of dying after a hip fracture – regardless of whether you have surgery or not
- your health: if you are already sick and have other comorbidities or diseases, surgery may not be safe.

Ask your doctor about the risks of surgery and of not having surgery. It is important to talk to your doctor about whether surgery is safe for you and whether it is what you want.

Support and advocacy are important

It is important, if not crucial, for a patient to have a support person or advocate while they are in hospital. An advocate can help you understand the issues and challenges, provide advice and support while making decisions and ask questions on your behalf. This is critical in all the stages of your treatment and recovery.

Having a support person is helpful in the days after surgery, for example, to keep an eye on you and watch out for complications. Unfortunately, the risk of dying doesn't stop after surgery, but continues for days, weeks and sometimes even months. The POMRC found that among those who died within a month of surgery, most died on the first or the fourth day after surgery. They also found that between one month and one year, the mortality rate increased from approximately 8% to approximately 25%. This means that support and advocacy continue to be important after you are discharged from hospital.

When you leave the hospital, ask your health care team what services are available to support you. Talk to them about a discharge plan, and what steps you should take once you leave the hospital. Some hospitals may provide transitional care or wrap-around support services. These services can help with:

- follow-up advice and guidance
- disability support
- medicines review
- re-establishing a relationship with your general practitioner
- introducing you to other social and community support services.

Accessing services like this help improve your recovery and also reduce the likelihood of re-admission to hospital.

Prevention is better than cure

As you get older, there are measures you can take to lower your risk of falling and to reduce the risk of harm from a fall. For example:

- keep moving to improve your strength and balance. Keep as active as you can
- ask your health care professional to review your medicines
- have annual eye check-ups and be sure to update your glasses
- make your home safer by removing clutter and tripping hazards, putting railings on the stairs and grab bars in the bathroom and toilet, and making sure you have good lighting.

If you are in hospital, ask for a falls risk assessment. And if you do need to get up, do not be afraid to ask for help, especially at night time.

Make a plan for the future

As well as taking measures to reduce the risk of falling, it is also a good idea to have some conversations about what to do if you fall. Making plans in case of an injury or illness gives people confidence that their thoughts and wishes are known and can be respected. Talking about or writing an advance care plan is a good way to think about:

- what is important to you
- how you like to make decisions
- what care and treatment you would like in the future
- ultimately, what is important to you after you die.

In conclusion

There are measures you can take to reduce your risk of falling and injuring yourself – start making lifestyle changes now. Keep active, and have your medicines reviewed and eyes checked. Clear clutter from the floors.

If you do fall, make sure you have the right support and advocacy around you, especially during the conversations with your doctors about what treatment plan is best for you. Carefully weigh up the different options and explore the risks associated with surgery and non-surgical treatment.

When you are planning to leave hospital, make sure you talk about your discharge arrangements, and ask about what support is available for your transition out of hospital. Wrap-around and transitional care services provide great support to help with recovery and to prevent future falls and injury.

It has been my continuing privilege to be a member of the POMRC and to work with its members and advisors. The POMRC constantly strives to make our health system the best it can be. As a recent consumer of health care in New Zealand, I am grateful for the POMRC's work to improve surgical care in New Zealand.

Rob Vigor-Brown
POMRC consumer representative

This chapter uses information from the National Minimum Dataset (NMDS) and the National Mortality Collection (NMC) to review 30-day mortality following treatment for hip fracture. Detailed information about data sources and methods are presented in Appendix 3.

Hip fracture repair

Hip fractures are very common, with an average rate of 2.3 fractures per 1,000 people over 50 years old. Every year in New Zealand, approximately 3,500 people over the age of 50 fracture their hip (Health Quality & Safety Commission 2018). With the ageing population the number of hip fractures is expected to increase, with one study projecting an annual incidence of over 5,000 by 2020 in New Zealand (Brown et al 2007). The global incidence is projected to rise from 1.66 million in 1990 to 6.26 million by 2050 (Dhanwal et al 2011). While the crude number is set to increase with the ageing population, the rate of hip fractures appears to be stable or decreasing (Baker et al 2014). This is possibly due to better preventative measures.

As well as affecting a large group of people, the consequences of hip fractures are serious. Approximately 5% of people who sustain a hip fracture die in hospital, 10% are newly discharged to an aged care facility, and more than 50% still experience a mobility-related disability 12 months after injury. Furthermore, 25% of people die in the year after discharge from hospital.

In New Zealand, most people who experience a hip fracture present to hospital for treatment. The majority of those people undergo surgery to either:

- fix the fracture (internal fixation/reduction) – which involves the use of pins, screws, rods or plates to hold the bone in place while it heals
- replace part (the femoral head) or all (the femoral head and the socket) of the hip. This is called either a hip replacement, or hemiarthroplasty or total arthroplasty.[1]

A range of factors determine the type of surgery or treatment a patient will receive. These include the type of fracture; the patient's age, mobility before the fracture, and mental/cognitive capacity; and the condition of the patient's bones and joints (eg, whether they have arthritis).

Occasionally, surgery to repair or replace the hip may not be feasible or appropriate (due to comorbidities, for example), or a patient may choose not to have surgery. In this case, doctors take a non-surgical approach to treatment, which usually involves a long period of bed rest. Non-surgical approaches are avoided if possible because they can lead to poorer outcomes, a long length of stay in hospital and a slow recovery. Even in patients with significant comorbidities, surgery is often advised for pain relief and management.

The purpose of this chapter is to provide a comprehensive summary of perioperative mortality following hip fracture treatment in New Zealand, between 2011 and 2016. The POMRC selected hip fracture treatment as the special topic this year because hip fractures affect a large number of people and are associated with poor

1 This analysis has grouped both hemiarthroplasties and total hip replacements together. Future analyses will separate them out.

outcomes, including disability and mortality. There is also evidence that clinical and system factors related to hip fracture treatment may impact mortality rates and surgical outcomes. The POMRC wished to explore these factors and provide recommendations about modifications that may reduce the risk of complications and of dying postoperatively.

The POMRC's findings about hip fractures are presented in three sections. The first section includes the findings from the analysis of surgical treatment of hip fractures and the second focuses on the analysis of non-surgical treatment. The third section focuses on six-month and 12-month mortality following hip fracture.

A separate chapter focuses on hip fracture admissions and surgical outcomes for Māori. This chapter was prepared by the Māori Caucus, and provides a commentary on the POMRC's findings and gives recommendations to improve care and outcomes for Māori.

Recommendations

The POMRC recommends the following with regard to hip fractures:

Improvements to care

Recommendation 1: All patients presenting to hospital with a hip fracture, or sustaining a hip fracture in hospital, should be offered surgery within 48 hours, if surgery is the preferred or requested treatment and no clinical contraindication exists.

> *Rationale:* The POMRC found that patients who received hip fracture repair surgery within 48 hours of admission had lower 30-day mortality rates. This finding is consistent with international research and the clinical care standards set by the Australian Commission on Safety and Quality in Health Care (2016).

Recommendation 2: People undergoing surgery should receive proactive perioperative care from a multidisciplinary team to enable the early detection and management of any comorbidities, or complications that arise.

> *Rationale:* Comorbidities and postoperative complications have a significant impact on patient morbidity and mortality. Proactive screening and monitoring from a multidisciplinary team allows for the early detection and management of comorbidities and complications, which is critical to reduce the likelihood of death following surgery.

Recommendation 3: All patients presenting to hospital with a hip fracture, and their families and whānau, should be given the opportunity to discuss the risk of serious complications, including death, and to discuss the patient's goals of care and develop an advance care plan, if they are able to take part in such a conversation.

> *Rationale:* Hip fractures have a significant impact on a person, their functional status, independence and care status. Patients should be made aware of the likely impacts of their injury and the treatment, including surgery. Patients should also be given the opportunity to discuss their goals and wishes, and to make plans for their life after surgery.

Falls and fracture prevention

Recommendation 4: All people over the age of 65 who live in the community (including aged residential care facilities) and access primary and community health care should be routinely screened for osteoporosis risk factors and risk of falling, to enable the effective management of osteoporosis and implement strategies to mitigate the risks of falling.

Rationale: The best way to prevent morbidity and mortality associated with hip fracture repair is to prevent hip fractures from occurring. Identification and effective management of osteoporosis can reduce the risk of a fracture from a fall. This recommendation is consistent with the guidance developed by the Health Quality & Safety Commission (2017). The POMRC endorses this recommendation as a strategy for preventing injury and harm from falls.

Recommendation 5: All health care facilities and aged residential care facilities should conduct a falls risk assessment for all patients over 65 years old, and should implement necessary preventative measures.

Rationale: The best way to prevent morbidity and mortality associated with hip fracture repair is to prevent hip fractures from occurring. Conducting comprehensive falls risk assessments in health care facilities and acting on the findings reduces the likelihood of older patients falling and sustaining fractures.

Better documentation

Recommendation 7: All hospitals should actively contribute data to the Australian & New Zealand Hip Fracture Registry, and that data should be used for ongoing quality improvement activity.

Rationale: The Australian & New Zealand Hip Fracture Registry is a clinician-led audit of hip fracture care in Australia and New Zealand. The Registry collects and stores extensive and specific data about hip fractures from participating hospitals, and generates real-time feedback on a wide range of measures and quality indicators.

The Registry provides a mechanism for hospitals to use their data to prioritise quality improvement efforts and to ultimately improve outcomes for people who have fractured their hip.

Recommendation from the Māori Caucus

Recommendation 10: The Māori Caucus recommends the POMRC investigates the other factors contributing to the higher postoperative mortality rate in Māori compared with non-Māori (specifically the residual 14% difference that is not explained by age, gender, deprivation, comorbidity and fitness for surgery).

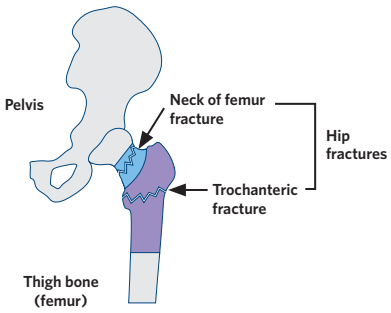
Key findings

Key findings from the POMRC's analysis are set out below. All findings relate to hip fracture treatment in New Zealand between 2011 and 2016.

- Between 2011 and 2016, there were 22,014 hip fracture-related admissions, and 1,772 deaths. The overall 30-day mortality rate was 8%.

There are two main hip fracture diagnoses

- Out of the 22,014 hip fracture-related admissions, 58.5% were for neck of femur fractures and 41.5% were for trochanteric fractures.
- Among the admissions who underwent surgical repair, 60% were for neck of femur fracture and 40% were for trochanteric fracture. The 30-day mortality rate was similar for both these diagnostic groups (6.9% and 6.6%, respectively). A small number of admissions (68) were diagnosed with both neck of femur and trochanteric fractures. The 30-day mortality rate for this group was higher (10.1%).



- Among the admissions who were treated non-surgically, 58% were for trochanteric fractures and 42% were for neck of femur fractures. There were four admissions with neck of femur fractures that also had trochanteric fractures.

The two treatment options are surgical repair and non-surgical treatment

- Of the total admissions, 90.7% were treated with surgical repair. The other 9.3% were treated non-surgically.
- Out of all neck of femur fracture admissions, 93.3% underwent surgical repair, compared with 87% of trochanteric fracture admissions.
- The overall 30-day mortality rate between 2011 and 2016 following surgical repair was 6.8%. This rate decreased from 7.7% in 2011 to 5.9% in 2016.
- The overall 30-day mortality rate between 2011 and 2016 following non-surgical treatment was 20.4%. This rate decreased from 23.5% in 2011 to 18.8% in 2016.
- Fixation/Reduction procedures were slightly more common (58.32%) than hip replacement procedures (42.2%). Fixation/Reduction procedures had a lower mortality rate (6.1%) compared with hip replacement (7.7%).
- In relation to fracture type and repair type, mortality was highest among those who had a neck of femur fracture and underwent a hip replacement (7.9%).

Delays between admission and surgery increase the mortality rate

- Mortality rates increased with longer delays between admissions and surgery. For example, the mortality rate following surgery within one day of admission was 6.4%, and the mortality rate following surgery four days after admission was 8.2%.
- Twenty-one percent of admissions underwent surgical repair on the day of admission, 65.9% within two days, 85% within three days and 95% within five days.

Gender and age have an effect on outcomes

- Overall, there were more females (68.4% of admissions) admitted with hip fracture than males (31.6% of admissions). However, males had a higher mortality rate in both the surgical repair group (8.9% for males compared with 6.8% in females) and the non-surgical treatment group (22.4% in males compared with 19.2% in females).
- Mortality rates increased with age. The highest mortality rate was in males over 80 years old in both the surgical repair group (12.3%) and the non-surgical treatment group (32.1%).
- The majority of admissions (92.7%) and deaths (93.4%) in the surgical repair group were people who identified as New Zealand European. Māori represented a much smaller proportion of admissions (3.04%) and deaths (3.18%) in this group. The mortality rate for Māori (7.08%) was slightly higher than the mortality rate for New Zealand European (6.88%) and the overall mortality rate (6.83%). The difference was not statistically significant.
- The 30-day mortality rate for Māori following non-surgical treatment was higher (26.6%) than the 30-day mortality rate for people of New Zealand European ethnicity (20.53%).[2]
- For those admissions who underwent surgical repair, people living in the most deprived areas (quintiles 4 and 5) had higher mortality rates (7.5% and 7.6%, respectively) than those living in the least deprived areas (quintile 1; 6.2%). In the non-surgical treatment group, mortality was highest in deprivation quintile 3 (22.5%).

Comorbidities, poor health status and complications are associated with poorer outcomes

- Mortality rates increased with an increasing number of comorbidities in both the surgical repair group and the non-surgical treatment group. The mortality rate was higher for admissions with an American Society of Anesthesiologists (ASA) score of 4 or 5 (18.5% and 38.3%, respectively) than for those with an ASA score of 1–2 (1.5%). ASA scores are not recorded for admissions who do not undergo surgical treatment.

2 Caution is advised when interpreting this analysis because the numbers of Māori admissions and Māori deaths in the non-surgical group are small.

- Mortality rates increased with an increasing number of complications. Among the eight complications the POMRC analysed, acute renal failure was the most common, occurring in 7% of admissions for surgical hip fracture repair.
- There was no significant variation in mortality rates across DHBs, after adjusting for sociodemographic and clinical factors.

Composite case 1: Fractured neck of femur following a fall at home

Mrs A, an 87-year-old woman with a history of controlled congestive heart failure and hypertension, was admitted to hospital with a suspected hip fracture.

Two weeks prior to her admission, Mrs A had a minor stroke and was experiencing some weakness on the left side of her body, which was affecting her balance. Two days prior to her admission Mrs A fell, and although she initially appeared and felt okay, her family noticed she showed discomfort on her left side. The stroke caused decreased sensation on her left side, which led to a delay in recognising and diagnosing the fractured hip.

Mrs A underwent surgical repair for her hip fracture. The night of her surgery, it was noted that Mrs A's urine output was low, and she showed signs that her heart failure was worsening. Mrs A's low urine output was initially treated with a diuretic, and she showed a slight improvement during the day; however, her symptoms worsened that night. On the second night after her surgery, Mrs A suffered another stroke, this time with a significant loss of function.

In accordance with her advance directive, which she had completed earlier that year, and after discussion with her family, the care team decided to provide palliative care. Mrs A died later that day.

Practice points:

- Patients may not be aware of changes in limb power with a stroke and expect to be more mobile than they are.
- The risk of dying postoperatively increases with an increasing number of complications; for example, heart failure and stroke (see Tables 10–12).
- An advance directive is very useful to guide decisions about care when the patient is no longer able to express their wishes.

International literature

With the increasing incidence in hip fractures globally, there is a significant amount of research into the individual patient factors and clinical factors that contribute to poor outcomes after surgery, including death. Overall, the POMRC's findings are consistent with international literature about hip fractures.

Sociodemographic factors

In line with the POMRC's key findings, research suggests that mortality rates after surgery increase with age. Studies have found that older age is associated with a greater risk of death in hospital, at 30 days and at one year (Bohm et al 2015). Bretherton and Parker (2015) found that each additional year in age increased the odds of 30-day mortality by 1.04 (95% CI 1.03–1.06, $p < 0.001$). Similarly, Nandra et al (2017) found a 5.7% increase in odds for every one-year increase in age.

As well as age, male gender is frequently identified in the literature as an independent risk factor for postoperative mortality. In an intervention study in Canada, analysis of over 6,000 patients found that male gender was associated with increased risk of death in hospital (adjusted hazard ratio (HR) 2.05, 95% CI 1.73–2.44), and one-year post surgery (adjusted HR 1.87, 95% CI 1.69–2.07) (Bohm et al 2015). These findings are supported by a number of other studies that found that male gender is a significant predictive factor for in-hospital (Major and North 2016; Manoli et al 2017), 30-day (Middleton et al 2016) and 90-day mortality (Nyholm et al 2015).

Clinical factors

As with most surgical procedures, the physical health of a person before surgery impacts their outcomes after surgery. Taking a person's physical health status into account when developing a treatment plan is critical.

The American Society of Anesthesiologists (ASA) physical status classification system (Dripps 1963) is a common standard measure used before surgery to identify high-risk patients. It takes into account patient comorbidities, and the stability of these comorbidities (Folbert et al 2017). A low ASA score represents a relatively well patient, whereas a higher score represents a person who is unwell, with severe systemic disease.

The ASA classification system is well recognised as a predictor of complications, adverse clinical outcomes and mortality following hip fracture repair (Folbert et al 2017). In a prospective observational study of over 6,000 patients, Bretherton and Parker (2015) found that a patient's ASA score was the strongest predictor of 30-day mortality, and that with every increase in the ASA score, the odds of mortality increased by 2.52 (95% CI 2.01–3.04, $p < 0.001$). Similarly, Dodd et al (2016) found that each increase in ASA score doubled the likelihood of death within 30 days. Other studies have found that an ASA score of 4 or 5 is significantly associated with in-hospital mortality (Major and North 2016).

Correlated with the ASA classification, the Charlson Comorbidity Index (CCI) (Charlson et al 1987) is a validated instrument that assigns weights and severities to different comorbidities (Folbert et al 2017). The CCI is frequently used to predict mortality (Graver et al 2015). Research has found that the presence of comorbidities (Bohm et al 2015) or acute medical conditions on admission (Major and North 2016) is associated with in-hospital and one-year mortality. For example, in a retrospective analysis of a large American surgical database, Dodd et al (2016) found that disseminated cancer, congestive heart failure and chronic obstructive pulmonary disease were preoperative risk factors for 30-day mortality. Similarly, Neuburger et al (2017) found that 30-day mortality was four times higher in people with two or more comorbidities than in those with none.

Composite case 2: Fractured neck of femur following a fall at home

Mr B, a 92-year-old man, was admitted to hospital with pneumonia, complicating his chronic lung disease. He was put on antibiotics, and was responding well to these.

Two days later, Mr B was found on the bathroom floor – he had fallen as he went to the toilet during the night. Mr B had severe pain and bruising on his left hip and was diagnosed with a fractured neck of femur.

On review by Mr B's anaesthetist, it was noted that Mr B was recovering from his pneumonia, so he and his family agreed to proceed with an operation to repair his fracture. The operation, performed under spinal anaesthesia was uneventful. However, over the next few days his pneumonia worsened and did not improve with antibiotics. Mr B died one week after surgery.

The hospital reviewed Mr B's fall and noted that he had been given a falls risk assessment. He was given a call button if he needed help, and a sensor mat was placed next to his bed to detect a fall. Mr B had rung the bell for help to go to the bathroom, but the ward was busy that night, and there was a delay in answering his call.

Practice points:

- Getting up at night to go to the toilet is a regular cause of falling and breaking a hip in the elderly.
- Proactively checking in with patients to see if they need to get out of bed and/or go to the bathroom is important.

Thirty-day mortality following hip fracture repair

There were 22,140 admissions for hip fracture between 2011 and 2016. The overall 30-day mortality rate was 8% (1,772 deaths).

Admissions and mortality by year

There were 19,959 surgical repairs for hip fracture between 2011 and 2016. Thirty-day mortality following hip fracture repair over the six-year period was 6.8% (1,352 deaths). There was a slight increase in the number of admissions, and a slight decrease in the number of deaths between 2011 and 2016. The 30-day mortality rate decreased from 7.7% in 2011 to 5.9% in 2016 (Table 1).

Table 1: Annual numbers of hospital admissions and 30-day mortality following hip fracture repair, New Zealand 2011–2016

DISCHARGE YEAR	Admissions	Deaths	Mortality rate (%)
2011	3,194	246	7.70
2012	3,228	214	6.63
2013	3,297	248	7.52
2014	3,417	222	6.50
2015	3,324	216	6.50
2016*	3,499	206	5.89
Total 2011–2016	19,959	1,352	6.77

Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.
* Provisional data.

Admissions and mortality by fracture type

Among the 19,959 admissions who underwent surgical hip fracture repair, 60% of admissions were diagnosed with a neck of femur fracture, and 40% were diagnosed with a trochanteric fracture. Thirty-day mortality rates following surgical repair were similar between neck of femur fractures (6.9%) and trochanteric fractures (6.6%). A small number of admissions were diagnosed with both neck of femur fracture and trochanteric fracture (68 admissions). The 30-day mortality rate for this group was higher (10.1%) (Table 2).

Table 2: Admissions and 30-day mortality following hip fracture repair, by fracture type, New Zealand 2011–2016

FRACTURE TYPE	Admissions	Deaths	Mortality rate (%)
Neck of femur fracture only	11,991	828	6.91
Neck of femur fracture	12,059	835	6.92
Trochanteric fracture only	7,900	517	6.54
Trochanteric fracture	7,968	524	6.58
Both neck of femur and trochanteric fracture	68	7	10.1
Total	19,959	1,352	6.77

Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any diagnosis field and any surgical repair listed in any procedure field.

Admissions and mortality by repair type

Approximately 58% of hip fractures were repaired with a fixation/reduction procedure, and approximately 42% were repaired with a hip replacement. Thirty-day mortality was slightly lower among admissions repaired with fixation/reduction (6.1%) compared with hip replacement (7.7%) (Table 3).

This analysis has grouped both hemiarthroplasties and total hip replacements together. Future analyses will separate them out. This will allow us to better understand the clinical and patient variables that contribute to the type of surgery a patient undergoes, and the risk associated with the different procedures.

Table 3: Admissions and 30-day mortality following hip fracture repair, by repair type, New Zealand 2011–2016

REPAIR TYPE	Admissions	Deaths	Mortality rate (%)
Hip replacement	8,417	645	7.66
Fixation/Reduction	11,640	707	6.07

Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.
Note: Ninety-eight admissions had both fixation/reduction and hip replacement procedures. Deaths were assigned to first procedure.

Admissions and mortality by fracture type and repair type

Thirty-day mortality was highest in admissions diagnosed with a neck of femur fracture and repaired with a hip replacement (7.9%). In contrast, 30-day mortality was lowest in admissions diagnosed with a trochanteric fracture and repaired with a hip replacement (3.1%) (Table 4).

Table 4: Admissions and 30-day mortality following hip fracture repair, by fracture type and repair type, New Zealand 2011–2016

FRACTURE TYPE AND REPAIR TYPE	Admissions	Deaths	Mortality rate (%)
Hip replacement			
Fractured neck of femur	7,997	632	7.90
Trochanteric fracture	420	13	3.10
Fixation/Reduction			
Fractured neck of femur	4,078	204	5.00
Trochanteric fracture	7,562	503	6.65

Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.
Note: Fixation/Reduction and hip replacement procedures occurred in 98 admissions. Deaths were assigned to first procedure.

Mortality by gender and age group

Among those admissions who underwent surgical repair after hip fracture, mortality increased with age and was higher among males than females, in each age group and overall (Table 5).

Table 5: Admissions and 30-day mortality following hip fracture repair, by age and gender, New Zealand 2011–2016

AGE GROUP (YEARS)	Admissions	Deaths	Mortality rate (%)
Male			
0–44	275	1	0.36
45–64	677	12	1.77
65–79	1,711	103	6.02
80+	3,485	428	12.28
Subtotal	6,148	544	8.85
Female			
0–44	107	0	0.00
45–64	794	9	1.13
65–79	3,296	111	3.37
80+	9,614	688	7.16
Subtotal	13,811	808	5.85
Total	19,959	1,352	6.77

Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.

Mortality by ethnicity

The majority of admissions and deaths following surgical repair were among people who identified as New Zealand European (92.7% and 93.4%, respectively). Māori represented a much smaller proportion of admissions (3%) and deaths (3.2%) (Table 6).

The mortality rate for Māori (7.1%) was slightly higher than the mortality rate for New Zealand European (6.9%) and the overall mortality rate (6.8%) (Table 6). The difference was not statistically significant. Further ethnicity analysis is included in the 'Commentary and recommendations from the Māori Caucus' section.

Table 6: Admissions and 30-day mortality following hip fracture repair, by ethnicity, New Zealand 2011–2016

ETHNICITY	Admissions	Deaths	Mortality rate (%)
New Zealand European	18,203	1,253	6.88
Māori	607	43	7.08
Other	597	34	5.70
Pacific	222	11	4.95
Total	19,629	1,341	6.83

Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.
Note: 'Other' ethnicity includes Asian, Middle Eastern, Latin American or African. Some admissions did not have ethnicity data recorded.

Admissions and mortality by socioeconomic deprivation

Previous POMRC reports have shown that people living in areas of high deprivation have higher mortality rates than people living in areas of low deprivation. The POMRC used the NZDep2013 measurement to analyse whether people's surgical outcomes were impacted by socioeconomic deprivation. The NZDep2013 measure uses a range of variables to calculate the relative deprivation of an area. Areas of New Zealand are then divided into quintiles: quintile 1 being the 20% least deprived areas (by population), quintile 5 being the 20% most deprived areas.

The numbers of both admissions and deaths were highest for people living in deprivation quintile 4. The 30-day mortality rate was highest for people living in the most deprived area, quintile 5 (7.6%) (Table 7).

Table 7: Admissions and 30-day mortality following hip fracture repair, by deprivation quintile, New Zealand 2011–2016

DEPRIVATION QUINTILE	Admissions	Deaths	Mortality rate (%)
1 (least deprived)	2,964	185	6.24
2	3,604	202	5.60
3	4,129	276	6.68
4	5,236	390	7.45
5 (most deprived)	3,796	290	7.64
Total	19,729	1,343	6.81

Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.
Note: Some admissions did not have deprivation data recorded.

Mortality by cause of death

In New Zealand during 2011–2016, 53% of people who died after hip fracture repair did not have cause of death recorded in the NMC. Out of those who did have the cause recorded, the two most common underlying causes of death were falls (272 deaths) and ischaemic heart disease (108 deaths) (Table 8).

Table 8: Underlying cause of death following hip fracture repair, New Zealand 2011–2016

PRIMARY CAUSE OF DEATH	Number of deaths
Fall	272
Ischaemic heart disease	108
Other cardiovascular	59
Respiratory	57
Other cause	45
Dementia/Alzheimer's disease/Central nervous system degeneration	38
Neoplasm	35
Gastrointestinal	14
Other injury	13
Missing	711
Total	1,352

Numerator: NMC: Cause of death as recorded in NMC.
Denominator: NMC: Deaths within 30 days of a hip fracture repair among admissions with a hip fracture.

Admissions and mortality by ASA classification

Among those admissions who underwent surgical repair, mortality was highest among those with an ASA score of 4 or 5 (highest disease severity) compared to those with an ASA score of 1–2 (lowest disease severity) (Table 9).

Table 9: Admissions and 30-day mortality following hip fracture repair, by ASA classification, New Zealand 2011–2016

ASA	Admissions	Deaths	Mortality rate (%)
ASA 1–2	5,064	77	1.52
3	8,903	551	6.19
4	2,645	490	18.53
5	60	23	38.33
Not stated	3,287	211	6.42
Total	19,959	1,352	6.77

Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.

Admissions with selected complications

The POMRC examined the frequency of eight common complications, and the relative mortality rate associated with each, following hip fracture repair. Acute renal failure was the most common complication, occurring in approximately 7% of all admissions for hip fracture repair. This was followed by bacterial pneumonia, which occurred in approximately 6% of all admissions for hip fracture repair (Table 10).

Table 10: Admissions with selected complications following hip fracture repair, New Zealand 2011–2016

COMPLICATION	Admissions with complication	Morbidity rate %
Acute renal failure	1,422	7.12
Bacterial pneumonia	1,281	6.42
Heart failure	1,004	5.03
Acute myocardial infarction	731	3.66
Cerebral infarction	236	1.18
Delirium	210	1.05
Pulmonary embolism	184	0.92
Urosepsis	158	0.79

Numerator: NMDS: Hospital admissions with a selected complication and a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.

Admissions and mortality with selected complications

Relative to the eight complications examined, mortality was highest among those admissions who had a cerebral infarction (30.9%), followed by those admissions who had an acute myocardial infarction (29.4%) (Table 11).

Table 11: Admissions with selected complications and 30-day mortality following hip fracture repair, New Zealand 2011–2016

COMPLICATION	Admissions with complication	Deaths	Mortality rate (%) with complication
Cerebral infarction	236	73	30.93
Acute myocardial infarction	731	215	29.41
Heart failure	1,004	275	27.39
Bacterial pneumonia	1,281	263	20.53
Delirium	210	43	20.48
Acute renal failure	1,422	285	20.04
Pulmonary embolism	184	34	18.48
Urosepsis	158	26	16.46

Numerator: NMC: Deaths within 30 days of a hip fracture surgical repair among those admissions with the complication.
Denominator: NMDS: Hospital admissions with a selected complication and a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.

The occurrence of one or more of the eight selected complications was associated with a higher mortality rate. Admissions with no complications had the lowest mortality rate (3.7%), while admissions with three complications had the highest mortality rate (39.3%) (Table 12).

Table 12: Admissions and 30-day mortality following hip fracture repair, by number of selected complications, New Zealand 2011–2016

NUMBER OF COMPLICATIONS	Admissions	Deaths	Mortality rate (%)
0	16,182	597	3.69
1	2,743	448	16.33
2	765	208	27.19
3	195	75	38.46
4	65	21	32.31
5	9	3	33.33
Total	19,959	1,352	6.77

Numerator: NMC: Deaths within 30 days of a hip fracture repair among those admissions with 0–5 complications.
Denominator: NMDS: Hospital admissions with 0–5 complications and a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.

Composite case 3: Fractured neck of femur following a fall at care facility

Mrs C, who was 89 years old, suffered from dementia. She had a fall at the dementia care unit where she lived and was admitted to hospital with a fractured hip. Her care team contacted her family, which took some time because the person with enduring power of attorney lived in Australia.

After a discussion with the family, it was agreed that Mrs C should undergo surgery to fix her hip. In keeping with her advance care plan, Mrs C's care team and family also decided that she should not receive any advanced resuscitative efforts. She had surgery two days after her initial admission to hospital.

After surgery, while in the post anaesthesia care unit, Mrs C was confused and disoriented. This was attributed to her preoperative cognitive impairment, dementia.

Mrs C was later transferred to the orthopaedic ward. She was noted to have a possible undiagnosed postural drop in her blood pressure, and was still exhibiting signs of postoperative agitation and confusion. This may have been due to the anaesthesia and pain medication, as well as her dementia. Mrs C was prescribed high doses of analgesia to help manage her pain, and as the dose of analgesia increased, Mrs C became increasingly sedated and consequently less mobile.

Two days later she was noted to be a bluer colour, and when assessed, her blood oxygen level was low. This was investigated and attributed to a pulmonary embolism, and she was started on anticoagulants. That night she collapsed and resuscitation was not undertaken in line with her advance care plan, and she died.

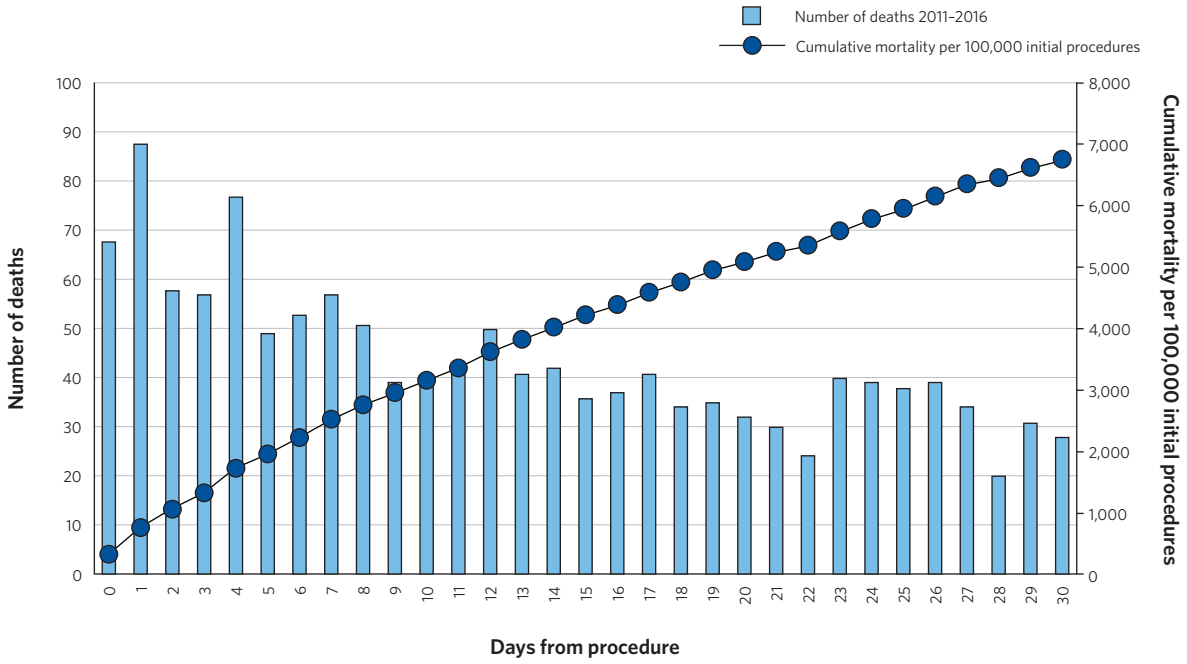
Practice points:

- Dementia and postoperative delirium are common in patients with hip fractures. These symptoms require monitoring and careful postoperative planning.
- Non-sedative drugs are preferable to sedation in the management of delirium. Sedation is undesirable, as it predisposes delirious patients to complications such as pulmonary emboli (blood clots going to the lung) or pneumonia.
- Decisions made with the family are crucial when caring for elderly patients, particularly in patients with cognitive impairment. Giving someone you trust the enduring power of attorney means that they can advocate for you, if/when you are unable to.
- Advance care plans are a good way to give thought to future health care plans and wishes.

Mortality by day from procedure

In New Zealand during 2011–2016 among those admissions who underwent hip fracture repair, the highest mortality occurred on the day after the procedure, followed by four days after the procedure (Figure 1).

Figure 1: Mortality following hip fracture repair, by day from procedure, New Zealand 2011–2016



Numerator: NMC: Deaths occurring within 30 days of a hip fracture repair, as recorded in the NMDS.
Denominator: NMDS: Admissions with a hip fracture diagnosis and hip fracture repair listed in any field.

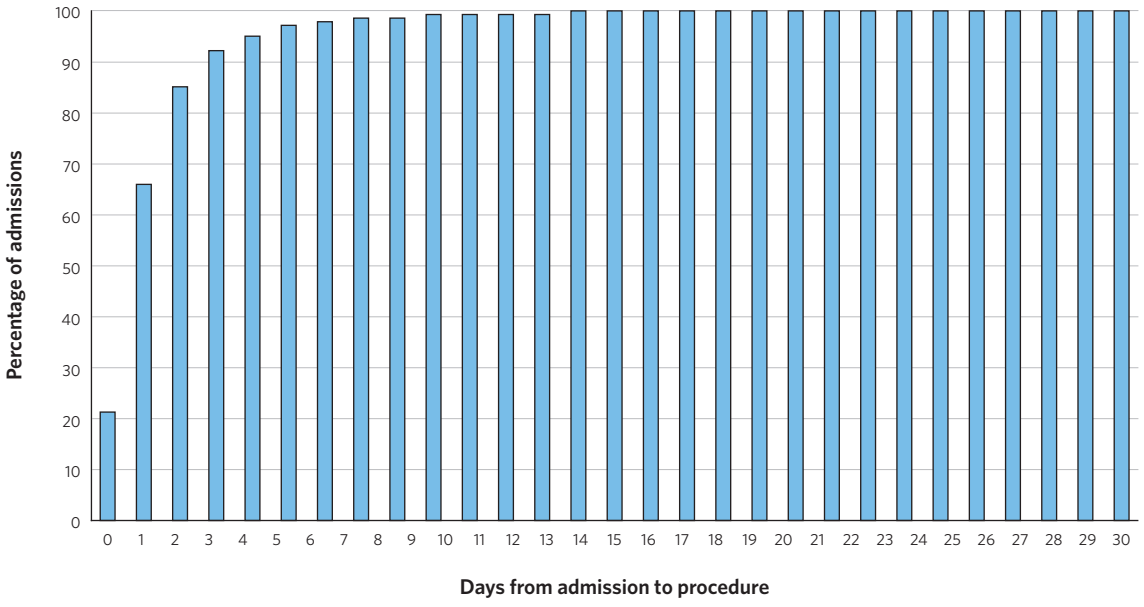
Between 2011 and 2016, 21.3% of admissions underwent surgical repair on the day of admission, 65.9% within two days, 85% within three days and 95% within five days (Table 13, Figure 2).

Table 13: Cumulative percentage of admissions undergoing hip fracture repair, by day from admission, New Zealand 2011–2016

DAYS FROM ADMISSION TO SURGERY	Cumulative percentage of admissions
0	21.28
1	65.90
2	84.95
3	92.21
4	95.14
5	96.89
6	97.91
7	98.50
8	98.88
9	99.15
10	99.33
11	99.47
12	99.59

Numerator: NMDS: Days from admission to repair procedure.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.

Figure 2: Cumulative percentage of admissions undergoing hip fracture repair, by day from admission, New Zealand 2011–2016



Numerator: NMDS: Procedures occurring within 30 days of a hip fracture admission as recorded in the NMDS.
Denominator: NMDS: Admissions with a hip fracture listed in any diagnosis field and a hip fracture repair listed in any of the procedure fields.

Mortality following delay between admission and surgical hip fracture repair

Following hip fracture repair, the mortality rate increased in relation to the number of days between admission and surgery (Table 14).

Table 14: Delay in days between admissions and hip fracture repair and cumulative mortality rate, New Zealand 2011–2016

DAYS FROM ADMISSION TO SURGERY	Admissions undergoing surgery by day	Deaths	Mortality rate (%)
0	4,247	227	5.34
1	8,905	571	6.41
2	3,804	282	7.41
3	1,449	111	7.66
4	584	48	8.22
5	350	29	8.29
6	202	23	11.39
7	119	20	16.81
8	76	9	11.84
9	54	7	12.96
10	36	2	5.56
11	28	4	14.29
12	23	6	26.09
Total	19,887	1,339	6.74

Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.

The POMRC recommends that all patients presenting to hospital with hip fracture should receive surgery within 48 hours, if surgery is the preferred or requested treatment and no clinical contraindication exists.

The POMRC found that the percentage of admissions undergoing fracture repair within 48 hours at different DHBs ranged between 55.6% and 73.8%.

The POMRC believes that increasing the percentage of admissions who undergo surgery within 48 hours could lead to improved outcomes, including lower mortality rates.

Admissions and mortality by number of comorbidities

Higher scores on the CCI were associated with higher mortality rates in those who underwent surgical repair (Table 15).

Table 15: Mortality following hip fracture repair, by Charlson Comorbidity Index score, New Zealand 2011–2016

CHARLSON COMORBIDITY INDEX SCORE	Admissions	Deaths	Mortality rate (%)
0	11,337	293	2.58
1	4,567	426	9.33
2	1,847	264	14.29
3	968	126	13.02
4	596	92	15.44
5	302	53	17.55
6	108	38	35.19
7	50	17	34.00
8	118	20	16.95
9	33	9	27.27
10	16	5	31.25
11+	17	9	52.94
Total	19,959	1,352	6.77

Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.

Admissions and mortality, by day of admission and day of procedure

There was very little variation in mortality in relation to the day of admission (Table 16) or day of repair procedure (Table 17).

Table 16: Admissions and 30-day mortality following hip fracture repair, by day of admission, New Zealand 2011–2016

DAY OF THE WEEK	Admissions	% of admissions	Deaths	Mortality rate (%)
Sunday	2,606	13.06	173	6.64
Monday	2,869	14.37	203	7.08
Tuesday	2,965	14.86	189	6.37
Wednesday	2,928	14.67	209	7.14
Thursday	2,924	14.65	183	6.26
Friday	2,951	14.79	200	6.78
Saturday	2,716	13.61	195	7.18
Total	19,959	100	1,352	6.77

Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.

Table 17: Admissions and 30-day mortality following hip fracture repair, by day of repair, New Zealand 2011–2016

DAY OF THE WEEK	Admissions	% of admissions	Deaths	Mortality rate (%)
Sunday	2,461	12.33	159	6.46
Monday	2,876	14.41	191	6.64
Tuesday	2,999	15.03	212	7.07
Wednesday	2,905	14.55	216	7.44
Thursday	3,012	15.09	201	6.67
Friday	3,104	15.55	194	6.25
Saturday	2,602	13.04	179	6.88
Total	19,959	100	1,352	6.77

Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.

Admissions and mortality following hip fracture repair by clinical and sociodemographic factors

Between 2011 and 2016, mortality rates in the 30 days following hip fracture repair (Table 18) were significantly higher for:

- people aged 80 years or older (compared with people aged 0–44 years)
- people with a CCI score of 1 or more (compared with a score of 0)
- people with an ASA score of 3, 4 or 5 (compared with an ASA score of 1–2).

Mortality was significantly reduced for:

- females (compared with males)
- people who identify as Pacific (compared with those who identify as New Zealand European).[3]

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

3 There was a small group of people who identified as Pacific ethnicity (222 admissions, 11 deaths).

Table 18: Mortality following hip fracture repair by age, gender, ethnicity, deprivation quintile, ASA score and Charlson Comorbidity Index score, New Zealand 2011–2016

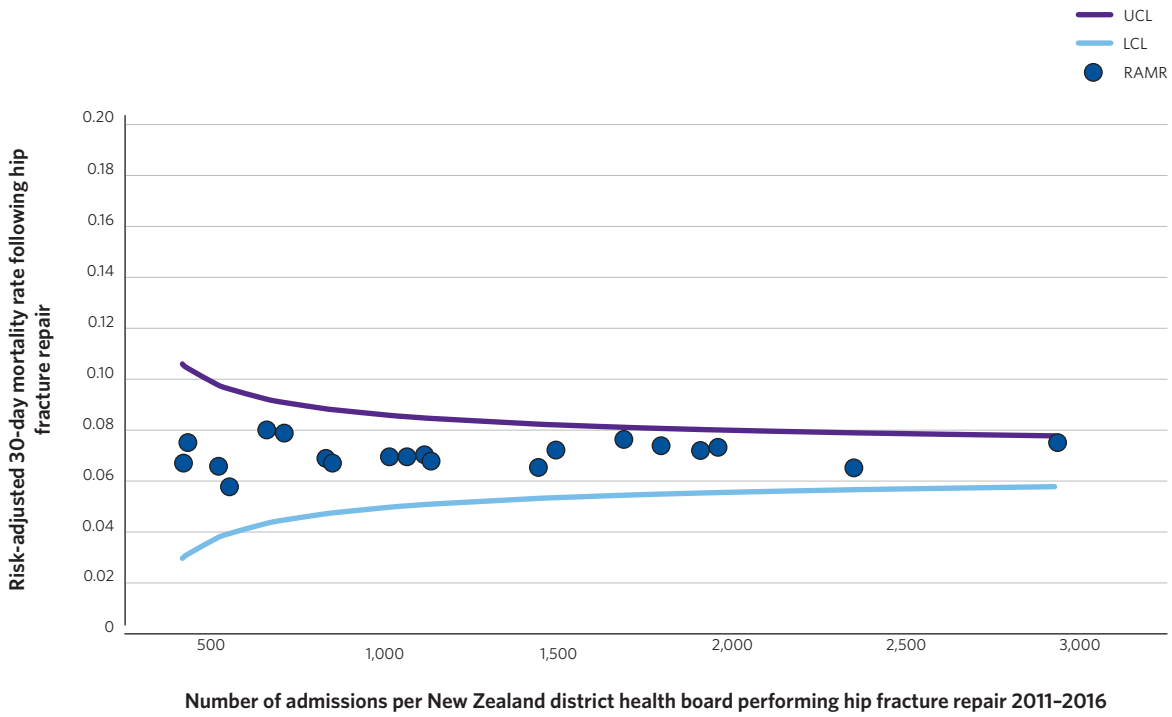
VARIABLE	CATEGORY	Deaths	Admissions	Raw % mortality	OR	95% CI		Multivariate OR	95% CI	
						Lower	Upper		Lower	Upper
Age	0–44	S	382	S	1			1		
	45–64	21	1,471	1.43	5.52	0.74	41.15	3.15	0.42	23.68
	65–79	214	5,007	4.27	17.01*	2.38	121.64	6.88	0.95	49.67
	80+	1,116	13,099	8.52	35.48*	4.98	252.76	12.87*	1.79	92.71
Gender	Male	544	6,148	8.85	1			1		
	Female	808	13,811	5.85	0.64*	0.57	0.72	0.67*	0.60	0.76
Ethnicity	European	1,253	18,203	6.88	1			1		
	Other	34	597	5.70	0.82	0.58	1.16	0.82	0.57	1.18
	Māori	43	607	7.08	1.03	0.75	1.41	1.11	0.79	1.56
	Pacific	11	222	4.95	0.71	0.38	1.30	0.50*	0.25	0.97
Deprivation quintile	1 (least deprived)	185	2,964	6.24	1			1		
	2	202	3,604	5.60	0.89	0.73	1.10	0.86	0.69	1.06
	3	276	4,129	6.68	1.08	0.89	1.30	1.01	0.83	1.24
	4	390	5,236	7.45	1.21*	1.01	1.45	1.12	0.92	1.35
	5 (most deprived)	290	3,796	7.64	1.24*	1.03	1.50	1.12	0.91	1.37
ASA score	1–2	77	5,064	1.52	1			1		
	3	551	8,903	6.19	4.27*	3.36	5.44	2.23*	1.74	2.86
	4	490	2,645	18.53	14.72*	11.52	18.82	5.95*	4.60	7.68
	5	23	60	38.33	H*	H	H	H*	H	H
	Not recorded	211	3,287	6.42	4.44*	3.41	5.79	2.51*	1.91	3.29
Charlson Comorbidity Index	0	293	11,337	2.58	1			1		
	1	426	4,567	9.33	3.88*	3.33	4.52	2.63*	2.24	3.08
	2	264	1,847	14.29	6.29*	5.28	7.48	4.48*	3.74	5.37
	3+	369	2,208	16.71	7.56*	6.44	8.89	4.70*	3.97	5.58

Numerator: NMC: Deaths occurring within 30 days of a hip fracture repair, as recorded in the NMDS.
Denominator: NMDS: Admissions with a hip fracture listed in any diagnosis field and a hip fracture repair listed in any procedure field.
* Significantly different from reference category. **ASA:** American Society of Anesthesiologists. **CI:** Confidence interval. **H:** Odds ratios supressed due to high mortality rates.
OR: Odds ratio. **S:** Rate suppressed due to small numbers.
Note: Caution should also be observed when interpreting ORs where mortality exceeds 10% (see Appendix 3 for details). 'Other' ethnicity includes Asian, Middle Eastern, Latin American or African. Some admissions did not have ethnicity data recorded.

Thirty-day mortality following surgical hip fracture repair, by DHB

A funnel plot of adjusted 30-day mortality rates shows that when mortality rates were adjusted for key sociodemographic (age, gender, ethnicity and deprivation) and clinical (ASA score and CCI score) characteristics of the patients, there is very little variation between DHBs (Figure 3).

Figure 3: Funnel plot risk-adjusted mortality after hip fracture repair by district health board, New Zealand 2011–2016



Numerator: NMC: Mortality occurring within 30 days of a hip repair procedure, as recorded in the NMDS.
Denominator: NMDS: Admissions with a hip fracture in any diagnosis field and a hip fracture repair listed in procedure field.
LCL: lower control limit. **RAMR:** risk-adjusted mortality rate. **UCL:** upper control limit.
Note: Control limits are 95% control limits. Rates adjusted for age, gender, ethnicity, deprivation, ASA score and CCI score.

Thirty-day mortality after hip fracture, with non-surgical treatment

The majority of people who fracture their hip will have surgery to repair it, but in some circumstances non-surgical treatment is a reasonable option; for example, in patients who are at high risk of perioperative mortality, or for patients with stable, undisplaced fractures who are able to mobilise (Australian and New Zealand Hip Fracture Registry 2017). This section of the report presents the findings for the group of people who fractured their hip, but did not undergo surgery.

To analyse the outcomes of this group, the POMRC looked at the data of people who were admitted to hospital with a hip fracture, but who did not have a surgical procedure recorded. Between 2011 and 2016 there were 2,055 admissions for hip fracture who were treated non-surgically.

Because there is limited information available about these admissions, it is impossible to know why surgery was not undertaken. Reasons could include that the patient was too sick to have surgery, or that surgery wasn't required. The POMRC therefore recommends that the findings in this section are interpreted with caution.

Admissions and mortality for non-surgical treatment by year

There were 2,055 admissions for hip fracture who were treated non-surgically. Out of those admissions, there were 420 deaths within 30 days of the admission. The cumulative mortality rate was 20.4%. There were significant fluctuations in the numbers of admissions and deaths over the six-year period and the annual mortality rate varied between 16.75% and 23.73% (Table 19).

Table 19: Annual numbers of hospital admissions and 30-day mortality following non-surgical treatment for hip fracture, New Zealand 2011–2016

YEAR	Admissions	Deaths	Mortality rate (%)
2011	323	76	23.53
2012	295	70	23.73
2013	270	54	20.00
2014	361	77	21.33
2015	418	70	16.75
2016*	388	73	18.81
Total	2,055	420	20.44

Numerator: NMC: Deaths within 30 days of admission for hip fracture and no surgical repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in the index diagnosis field but no surgical repair listed in any of the procedure fields. No transfers.
* Provisional data.

Admissions and mortality for non-surgical treatment, by fracture type

A greater proportion of fractures treated non-surgically were trochanteric (58%) rather than neck of femur (42%). Four admissions were diagnosed with both a neck of femur fracture and a trochanteric fracture (Table 20).

Table 20: Admissions and 30-day mortality following non-surgical treatment for hip fracture, by fracture type, New Zealand 2011–2016

FRACTURE TYPE	Admissions	Deaths	Mortality rate (%)
Fractured neck of femur	866	256	29.56
Trochanteric fracture	1,193	168	14.08

Numerator: NMC: Deaths within 30 days of admission for hip fracture and no surgical repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in the index diagnosis field but no surgical repair listed in any of the procedure fields. No transfers.
Note: Four admissions were diagnosed with both a neck of femur fracture and a trochanteric fracture.

Mortality following non-surgical treatment, by gender and age group

Mortality following non-surgical treatment increased with age and was higher among males compared with females for each age group (Table 21).

Table 21: Admissions and 30-day mortality following non-surgical treatment for hip fracture, by age and gender, New Zealand 2011–2016

AGE GROUP (YEARS)	Admissions	Deaths	Mortality rate (%)
Male			
0–44	68	0	0.00
45–64	69	2	2.90
65–79	176	20	11.36
80+	499	160	32.06
Subtotal	812	182	22.41
Female			
0–44	24	0	0.00
45–64	56	5	8.93
65–79	286	41	14.34
80+	877	192	21.89
Subtotal	1,243	238	19.15
Total	2,055	420	20.44

Numerator: NMC: Deaths within 30 days of admission for hip fracture and no surgical repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in the index diagnosis field but no surgical repair listed in any of the procedure fields. No transfers.

Mortality following non-surgical treatment, by ethnicity

The majority of admissions (91.1%) and deaths (91.8%) among those receiving non-surgical treatment were people who identified as New Zealand European ethnicity (91.4%). Māori represented a much smaller proportion of those who received non-surgical treatment (4.6%), and those who died following non-surgical treatment (6%) (Table 22).

The 30-day mortality rate for Māori following non-surgical treatment was higher (26.6%) than the 30-day mortality rate for people of New Zealand European ethnicity (20.53%). Caution is advised when comparing the mortality rates as the numbers of Māori admissions and Māori deaths in the non-surgical group are small (Table 22).

Table 22: Admissions and 30-day mortality following non-surgical treatment for hip fracture, by ethnicity, New Zealand 2011–2016

ETHNICITY	Admissions	Deaths	Mortality rate (%)
New Zealand European	1,851	380	20.53
Māori	94	25	26.60
Pacific	32	6	18.75
Other	54	4	7.41
Total	2,031	415	20.43

Numerator: NMC: Deaths within 30 days of admission for hip fracture and no surgical repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in the index diagnosis field but no surgical repair listed in any of the procedure fields. No transfers.
Note: 'Other' ethnicity includes Asian, Middle Eastern, Latin American or African. Some admissions did not have ethnicity data recorded.

Admissions and mortality following non-surgical treatment, by socioeconomic deprivation

The highest number of admissions for non-surgical treatment was associated with quintile 4. The highest 30-day mortality (22.5%) was associated with admissions in quintile 3 (Table 23).

Table 23: Admissions and 30-day mortality following non-surgical treatment, by deprivation quintile, New Zealand 2011–2016

DEPRIVATION QUINTILE	Admissions	Deaths	Mortality rate (%)
1 (least deprived)	286	54	18.88
2	320	70	21.88
3	445	100	22.47
4	548	105	19.16
5 (most deprived)	441	91	20.63
Total	2,040	420	20.59

Numerator: NMC: Deaths within 30 days of admission for hip fracture and no surgical repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in the index diagnosis field but no surgical repair listed in any of the procedure fields. No transfers. Some admissions did not have deprivation data recorded.

Admissions and mortality following non-surgical treatment, by number of comorbidities

Mortality was higher among those admissions with greater CCI scores (Table 24).

Table 24: Mortality following non-surgical treatment, by Charlson Comorbidity Index score, New Zealand 2011–2016

CHARLSON COMORBIDITY INDEX SCORE	Admissions	Deaths	Mortality rate (%)
0	1,267	122	9.63
1	391	133	34.02
2	177	59	33.33
3	74	35	47.30
4	66	25	37.88
5	22	10	45.45
6	15	9	60.00
7	6	2	33.33
8	24	15	62.50
9	7	5	71.43
10	3	3	100.00
11	1	1	100.00
12	2	1	50.00
Total	2,055	420	20.44

Numerator: NMC: Deaths within 30 days of admission for hip fracture and no surgical repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in the index diagnosis field but no surgical repair listed in any of the procedure fields. No transfers.

Admissions and mortality following non-surgical treatment for hip fracture, by clinical and sociodemographic factors

Between 2011 and 2016, 30-day mortality rates following non-surgical treatment (Table 25) were significantly higher for:

- people aged over 65 years (compared with people aged 0–64 years)
- people with a CCI score of 1 or more (compared with those with a score of 0).

Mortality was significantly reduced for females (compared with males).

These differences were still evident after adjusting for the effects of other sociodemographic factors (age, gender and socioeconomic deprivation) and clinical factors (CCI score).

Table 25: Mortality following non-surgical treatment by age, gender, ethnicity, deprivation quintile, Charlson Comorbidity Index score, New Zealand 2011–2016

VARIABLE	CATEGORY	Admissions	Deaths	Raw % mortality	OR	95% CI		Multivariate OR	95% CI	
						Lower	Upper		Lower	Upper
Age	0–64	217	7	3.23	1			1		
	65–79	462	61	13.20	4.56*	2.05	10.14	3.68*	1.60	8.47
	80+	1,376	352	25.58	H*	H	H	H*	H	H
Gender	Male	812	182	22.41	1			1		
	Female	1,243	238	19.15	0.82	0.66	1.02	0.82	0.65	1.04
Ethnicity	European	1,851	380	20.53	1			1		
	Other	54	4	7.41	0.31	0.11	0.86	0.31*	0.11	0.91
	Māori	94	25	26.60	H	H	H	H*	H	H
	Pacific	26	6	23.08	0.89	0.37	2.19	1.09	0.39	3.05
Charlson Comorbidity Index	0	1,267	122	9.63	1			1		
	1+	788	298	37.82	H*	H	H	H*	H	H
Deprivation quintile	1	286	54	18.88	1			1		
	2	320	70	21.88	1.20	0.81	1.79	1.31	0.85	2.02
	3	445	100	22.47	1.25	0.86	1.80	1.24	0.83	1.86
	4	548	105	19.16	1.02	0.71	1.47	1.06	0.71	1.58
	5	441	91	20.63	1.12	0.77	1.63	1.16	0.76	1.76

Numerator: NMC: Deaths within 30 days of admission for hip fracture and no surgical repair.
Denominator: NMDS: Hospital admissions with a hip fracture diagnosis in the index field but no surgical repair listed in any of the procedure fields. No transfers.
* Significantly different from reference category. **CI:** Confidence interval. **H:** Odds ratios supressed due to high mortality rates. **OR:** Odds ratio.
Note: Caution should also be observed when interpreting ORs where mortality exceeds 10% (see Appendix 3 for details). 'Other' ethnicity refers to Asian, Middle Eastern, Latin American or African. Some admissions did not have ethnicity data recorded.

Six-month and 12-month mortality following hip fracture

Mortality at six months and 12 months, by fracture type and treatment type including non-surgical treatment

The mortality rate following hip fractures continued to rise in the months following surgery, reaching 18.3% at six months, and 24.5% at 12 months (Table 26). Consistent with the 30-day mortality findings (Table 3), hip replacements had higher six-month and 12-month mortality rates (19.1% and 25.3%, respectively) than fixation/reduction procedures (17.7% and 23.8%, respectively).

In contrast to the 30-day mortality findings (Table 4), trochanteric fractures were associated with higher mortality rates than neck of femur fractures at both six months (19.7% versus 17.5%) (Table 26, Table 27) and 12 months (26.5% versus 23.2%) (Table 26, Table 28). Thirty-day, six-month and 12-month mortality rates were highest in the non-surgical repair group (20.4%, 31.9% and 37.2%, respectively) (Table 26).

Table 26: Thirty-day, six-month and 12-month mortality following hip fracture, by fracture type and repair type in the surgical repair group, and in the non-surgical treatment group, New Zealand 2011–2016

FRACTURE TYPE AND REPAIR TYPE	30-day mortality rate (%)	6-month mortality rate (%)	12-month mortality rate (%)
Surgical repair group			
Overall	6.77	18.33	24.48
By fracture type			
Neck of femur	6.92	17.48	23.17
Trochanteric	6.58	19.70	26.51
By repair type			
Hip replacement	7.66	19.13	25.31
Fixation/Reduction	6.07	17.70	23.78
Non-surgical treatment group			
Non-surgical treatment	20.44	30.85	37.18
Surgical repair group and non-surgical treatment group			
All	8.05	19.50	25.66

Hip repair:
Numerator: NMC: Deaths occurring after hip fracture repair date, as recorded in the NMDS.
Denominator: NMDS: Admissions with a hip fracture diagnosis and hip fracture repair listed in any field.
No repair:
Numerator: NMC: Deaths occurring after admission date, as recorded in the NMDS.
Denominator: NMDS: Admissions with a hip fracture diagnosis and no hip fracture repair listed in any field. No transfers.

Table 27: Mortality at six months, by fracture type and repair type in the surgical repair group, and in the non-surgical treatment group, New Zealand 2011–2016

FRACTURE TYPE AND REPAIR TYPE	Admissions	Deaths	Mortality rate (%)
Surgical repair group			
Six months post index operation	19,959	3,659	18.33
According to fracture type			
Neck of femur within six months	12,059	2,108	17.48
Trochanteric within six months	7,968	1,570	19.70
According to repair type			
Hip replacement six months	8,417	1,610	19.13
Fixation/Reduction six months	11,640	2,060	17.70
Non-surgical treatment group			
Six-month mortality in non-surgical admissions	2,055	634	30.85
Six-month mortality in non-surgical admissions with Charlson Comorbidity Index score of 1+	788	406	51.52

Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.

Table 28: Mortality at 12 months, by fracture type and repair type in the surgical repair group, and in the non-surgical treatment group, New Zealand 2011–2016

FRACTURE TYPE AND REPAIR TYPE	Admissions	Deaths	Cumulative mortality %
Surgical repair group			
12 months post index operation	19,959	4,885	24.48
According to fracture type			
Neck of femur within 12 months	12,059	2,794	23.17
Trochanteric within 12 months	7,968	2,112	26.51
According to repair type			
Hip replacement 12 months	8,417	2,130	25.31
Fixation/Reduction 12 months	11,640	2,768	23.78
Non-surgical treatment group			
12-month mortality in non-surgical admissions	2,055	764	37.18
12-month mortality in non-surgical admissions with Charlson Comorbidity Index score of 1+	788	465	59.01

Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.

Comparison between hip fracture treatment in 1999–2000 and hip fracture treatment in 2011–2016

In 2002, the Ministry of Health undertook an analysis of mortality following hip fractures in 1999 and 2000 (New Zealand Health Information Service 2002). The POMRC's 2011–2016 findings can be broadly compared with the 1999–2000 findings to give an indication of change over time. Caution is advised when interpreting these comparisons as the change between years may be due to differences in the hospitals and patients included in the studies and variation in the methods used for data collection and analysis.

Key observations:

- The proportion of hip fracture admissions undergoing surgical repair has remained constant: 91% in 1999–2000 and 90.7% between 2011 and 2016 (Table 29).
- The six-month and 12-month mortality rates decreased between 1999–2000 and 2011–2016 (Table 29).
- Twelve-month mortality decreased among those admissions treated with surgical repair (25.8% compared with 24.4%) and those that were treated non-surgically (39% and 37.2%).
- More patients underwent surgery on the day of admission (27%) or the following day (46%) in 1999–2000 than on the day of admission (21.3%) or the following day (44.6%) in 2011–2016 (Table 29).
- In both time periods, most patients underwent surgical repair by the fourth day after admission (96% between 1999 and 2000, and 95.1% between 2011 and 2016) (Table 29).

Table 29: Hip fracture treatment and mortality at 30 days, 6 months and 12 months in New Zealand, 1999–2000 compared with 2011–2016

QUALITY SURVEILLANCE MEASURES	1999–2000 (%)	2011–2016 (%)
30-day mortality	8.0	8.0
6-month mortality	20.0	19.5
12-month mortality	27.0	25.7
Proportion of hip fracture admissions who underwent surgical repair	91.0	90.7
12-month mortality among admissions who underwent surgical repair	25.8	24.4
12-month mortality among admissions treated non-surgically	39.0	37.2
Proportion of admissions in the surgical repair group who underwent surgery on the day of admission	27.0	21.3
Proportion of admissions in the surgical repair group who underwent surgery on the day after admission	46.0	44.6
Proportion of admissions in the surgical repair group who underwent surgery by the fourth day after admission	96.0	95.1

Data source 1999–2000: New Zealand Health Information Service (2002).
Data sources 2011–2016:
Numerator: NMC: Deaths within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any of the diagnosis fields and any surgical repair listed in any of the procedure fields.

Commentary and recommendations from the Māori Caucus

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

Age standardisation – admission rates

The crude rate ratio for admissions for Māori compared with non-Māori was 0.17. The age-standardised rate ratio of Māori to non-Māori was 0.72 (95% CI 0.69–0.74) (Table 30). This suggests Māori have fewer hip fractures than non-Māori, and this is not due to the differences in age distribution in the Māori versus non-Māori populations.

Table 30: Age-standardised admission rates for hip fracture, New Zealand 2011–2016

RATE TYPE	Māori	Non-Māori
Crude admission rate	14.49 per 100,000	84.48 per 100,000
Crude rate ratio Māori:non-Māori	0.17	
Age-standardised admission rate	11.04 per 100,000	15.33 per 100,000
Age-standardised rate ratio Māori:non-Māori	0.72 (95% CI: 0.69–0.74)	

Notes: Rates standardised to Indigenous Māori Standard (Māori Census population 2001) provided in Ministry of Health (2015).

Table 31: Standardised gender-specific population admission rates for hip fracture, New Zealand 2011–2016

RATE TYPE	Male	Female
Māori rate	14.69 per 100,000	19.04 per 100,000
Non-Māori rate	59.49 per 100,000	126.54 per 100,000
Crude rate ratios Māori:non-Māori	0.25	0.15
Age-standardised rate Māori	10.43 (95% CI: 9.3–11.6)	11.78 (95% CI: 10.6–12.9)
Age-standardised rate non-Māori	11.99 (95% CI: 11.7–12.3)	18.64 (95% CI: 18.3–18.9)
Age-standardised rate ratios Māori:non-Māori	0.87 (95% CI: 0.83–0.91)	0.63 (95% CI: 0.59–0.67)

Notes: Rates standardised to Indigenous Māori Standard (Māori Census population 2001) provided in Ministry of Health (2015).

Multivariate analysis – mortality rates

The 30-day mortality rate following surgical repair for Māori was 7.1%, which is slightly higher than that for the New Zealand European population (6.9%) and the non-Māori population (6.8%). There was no statistically significant difference between Māori and non-Māori mortality rates (odds ratio = 1.05, 95% CI 0.77–1.44; adjusted odds ratio = 1.14; 95% CI 0.81–1.60) (Table 32).

Table 32: Logistic regression modelling – mortality among Māori compared with non-Māori, following hip fracture repair by age, gender, Charlson Comorbidity Index score, deprivation quintile and ASA score, New Zealand 2011–2016

MODEL INCLUDING	Rate ratio (Māori:non-Māori)	95% CI	
		Lower	Upper
Crude estimate	1.05	0.77	1.44
Adjusted for age	1.65	1.19	2.27
Adjusted for age and gender	1.64	1.18	2.26
Adjusted for age, gender, Charlson Comorbidity Index	1.26	0.90	1.75
Adjusted for age, gender, Charlson Comorbidity Index, deprivation quintile	1.20	0.86	1.68
Adjusted for age, gender, Charlson Comorbidity Index, deprivation quintile, ASA	1.14	0.81	1.60

Numerator: NMC: Deaths occurring within 30 days of a hip fracture repair.
Denominator: NMDS: Hospital admissions with a hip fracture listed in any diagnosis field and any surgical repair listed in the procedure field.

The POMRC found that, following adjustment for:

- age, Māori had a 65% higher rate of mortality following hip fracture repair surgery than non-Māori
- age, gender and CCI, Māori had a 26% higher rate of mortality, though not statistically significant
- age, gender, CCI and deprivation quintile, Māori had a 20% higher rate of postoperative mortality, though not statistically significant
- sociodemographic and clinical factors (CCI and ASA scores), Māori had a 14% higher rate of mortality than non-Māori, though not statistically significant.

Insights from the POMRC's analysis and recommendations from the Māori Caucus

While the final adjusted mortality rate for Māori is not statistically significantly different from the non-Māori rate (adjusted rate ratio 1.14, 95% CI 0.81–1.60), it provides insights that clinicians can use to guide practice. For example, clinicians should be aware that Māori have higher rates of mortality following surgery, and that some of the increased rate is due to the presence of comorbidities and a patient's fitness for surgery (ie, ASA score).

Recognising the significant impact that comorbidities can have, the Māori Caucus endorses the POMRC's second recommendation: people undergoing surgery should receive proactive perioperative care from a multidisciplinary team to enable early detection and management of any comorbidities and/or complications that arise. The Māori Caucus emphasises the importance of this recommendation for Māori.

Recommendation 9: The Māori Caucus recommends clinicians should actively address reversible and preventable perioperative factors that may contribute to morbidity and mortality.

Recommendation 10: The Māori Caucus recommends the POMRC investigates the other factors contributing to the higher postoperative mortality rate in Māori compared with non-Māori (specifically the residual 14% difference in mortality following hip fracture repair, that is not explained by age, gender, deprivation, comorbidity and fitness for surgery).

Limitations of the data and recommendations for improvement

This POMRC report has analysed hip fracture data between 2011 and 2016. There are small numbers in some groups who were admitted for hip fracture treatment (eg, Māori). Analysing Māori mortality data from a longer time period (eg, 10 years) may provide a more accurate picture of perioperative mortality for Māori.

There are also limitations in the way ethnicity data is collected and coded, and there are variable levels of data completeness and quality of ethnicity data in the National Health Index. This impacts the POMRC's ability to analyse Māori mortality data effectively.

Recommendation 11: The Māori Caucus recommends the POMRC and other relevant organisations in the health and disability sector consider how ethnicity data collection and management can be improved, following the Ethnicity Data Protocols for the Health and Disability Sector, to allow better measurement of Māori perioperative mortality.

Even in patients who are very unwell and are not expected to survive for long, surgery is frequently offered as a palliative treatment to manage pain. The POMRC's analysis has not taken the intent or goal of surgery into account (ie, whether it is palliative). Further research should investigate the intent of surgery, and whether there is a difference in non-surgical treatment rates and palliative treatment rates between Māori and non-Māori.

Recommendation 12: The Māori Caucus recommends the POMRC investigates the rate at which Māori are offered non-surgical treatment and/or palliative treatment, compared with non-Māori.

The Māori Caucus welcomes the POMRC's intention to focus on perioperative mortality and Māori in its upcoming eighth report. This will give the POMRC the opportunity to progress the recommendations made by the Māori Caucus in both the fifth and sixth reports (POMRC 2016, 2017).

Perioperative Mortality for Special Topics in the Sixth Report

This section provides an update of the findings on the two special topics in the last POMRC report.

Perioperative mortality and socioeconomic deprivation

The POMRC chose socioeconomic deprivation as one of two special topics in 2017 (POMRC 2017), as previous reports had shown higher perioperative mortality rates for people living in more deprived areas than for those living in less deprived areas. The POMRC believes that a patient's socioeconomic status should not influence his or her outcome after surgery. 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 and twice as many acute admissions than people living in the least deprived (quintile 1) areas.

Updated findings 2011–2016

Areas of high deprivation had higher admission numbers and higher mortality rates (0.63%) than areas of low deprivation (0.39%) (Table 33).

Table 33: Number of admissions and 30-day mortality following general and/or neuraxial anaesthesia, by deprivation quintile, New Zealand 2011–2016

DEPRIVATION QUINTILE	Admissions	Deaths	Mortality rate (%)
1 (least deprived)	292,269	1,145	0.39
2	290,968	1,324	0.46
3	319,116	1,738	0.54
4	357,554	2,247	0.63
5 (most deprived)	378,957	2,381	0.63
Total	1,638,864	8,835	0.54

Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block.
Denominator: NMDS: Hospital admissions with at least one general anaesthetic or neuraxial block.

People living in areas of high deprivation had higher numbers of acute admissions than people in areas of low deprivation. Out of the acute admissions, 28% were for people living in areas of high deprivation, and 15% were for people living in areas of low deprivation. People living in areas of high deprivation had higher mortality rates following acute admission (1.67%) than people living in areas of low deprivation (1.53%) (Table 34, Figure 4).

Table 34: Number and percentage of admissions and deaths in acute admissions, by deprivation quintile, New Zealand 2011–2016

DEPRIVATION QUINTILE	Admissions	Deaths	Mortality rate (%)
1 (least deprived)	57,047 (15%)	871 (13%)	1.53
2	61,008 (16%)	992 (15%)	1.63
3	69,874 (19%)	1,284 (19%)	1.84
4	83,594 (22%)	1,701 (26%)	2.03
5 (most deprived)	105,214 (28%)	1,759 (27%)	1.67

Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block.
Denominator: NMDS: Acute hospital admissions with at least one general anaesthetic or neuraxial block.

For elective admissions, 21% were for people from areas of high deprivation and 19% were from areas of low deprivation. The mortality rate was higher in areas of high deprivation (0.16%) than areas of low deprivation (0.08%) (Table 35).

Table 35: Number and percentage of admissions and deaths in waiting list/elective admissions, by deprivation quintile, New Zealand 2011–2016

DEPRIVATION QUINTILE	Admissions	Deaths	Mortality rate (%)
1 (least deprived)	209,845 (19%)	176 (13%)	0.08
2	203,547 (18%)	231 (17%)	0.11
3	220,233 (20%)	284 (20%)	0.13
4	237,194 (22%)	338 (24%)	0.14
5 (most deprived)	229,900 (21%)	357 (26%)	0.16

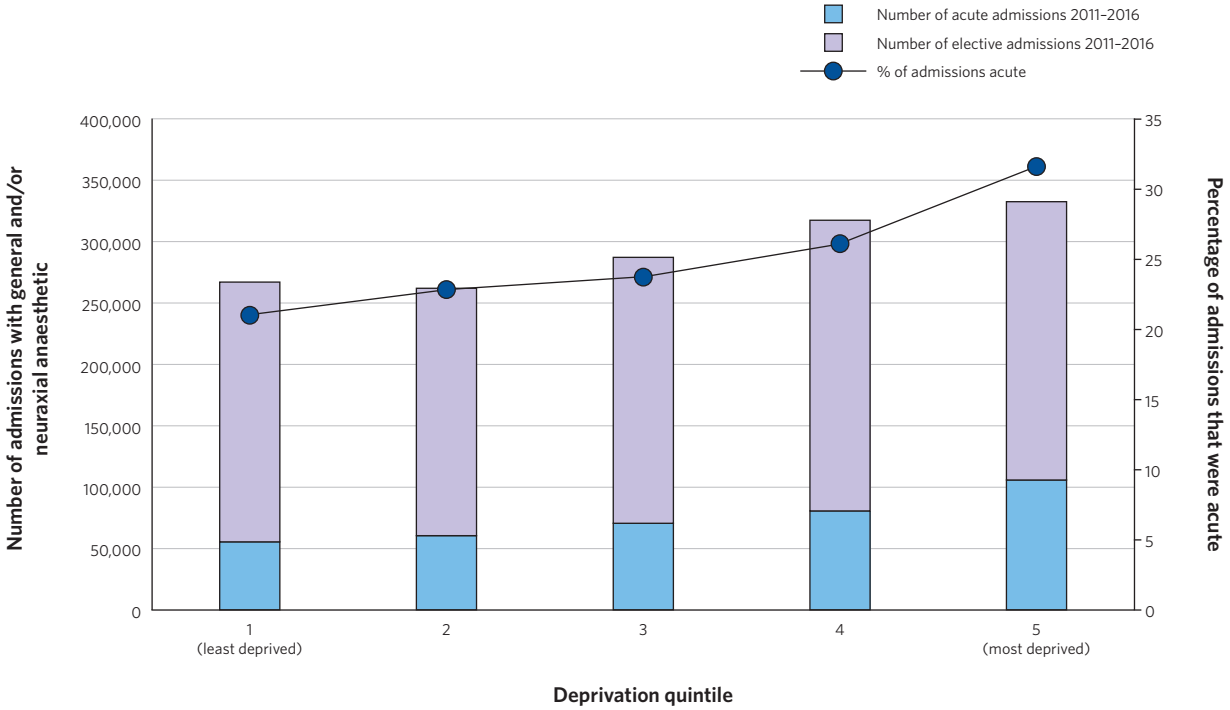
Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block.
Denominator: NMDS: Waiting list/Elective hospital admissions with at least one general anaesthetic or neuraxial block.

Table 36: Number of admissions with general and/or neuraxial anaesthesia and the percentage of those admissions that were acute, by deprivation quintile and admission type, New Zealand 2011–2016

DEPRIVATION QUINTILE	Acute admissions	Waiting list/Elective admissions	Acute: Waiting list/ Elective ratio
1 (least deprived)	57,047	209,845	0.27
2	61,008	203,547	0.30
3	69,874	220,233	0.32
4	83,594	237,194	0.35
5 (most deprived)	105,214	229,900	0.46
Total	376,737	1,100,719	0.34

Numerator: NMDS: Acute admissions with at least one general anaesthetic or neuraxial block.
Denominator: NMDS: All hospital admissions with at least one general anaesthetic or neuraxial block.

Figure 4: Number of admissions with general and/or neuraxial anaesthesia and the percentage of those admissions that were acute, by deprivation quintile and admission type, New Zealand 2011–2016



Numerator: NMDS: Number of admissions with general and/or neuraxial anaesthetic by deprivation quintile.
Denominator: NMDS: Hospital admissions with at least one general anaesthetic and/or neuraxial block.

The POMRC found that the crude 30-day mortality rate was higher in the most deprived areas than the least deprived areas for all six procedures that the POMRC tracks over time (Table 37). Note these are crude rates and are not adjusted for sociodemographic or clinical factors.

Table 37: Unadjusted 30-day mortality rate for the POMRC's tracking procedures, by deprivation quintile 1 and deprivation quintile 5, New Zealand 2011–2016

PROCEDURE	Mortality rate (%) quintile 1 (least deprived)	Mortality rate (%) quintile 5 (most deprived)	Rate ratios quintile 5: quintile 1
Cholecystectomy	0.23	0.34	1.46
Hip arthroplasty	1.04	1.76	1.69
Colorectal resection	2.23	4.44	1.99
Coronary artery bypass graft (CABG)	1.78	3.37	1.89
Percutaneous transluminal coronary angioplasty (PTCA)	1.56	1.99	1.28
Abdominal aortic aneurysm repair	5.06	9.59	1.90

Numerator: NMC: Deaths occurring within 30 days of a specified procedure.
Denominator: NMDS: Hospital admissions with at least one specified procedure recorded in any procedure field.

Thirty-day mortality following abdominal aortic aneurysm (AAA) repair

The POMRC chose abdominal aortic aneurysm (AAA) repair as the second special topic in 2017 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. The 2017 POMRC report found the following between 2010 and 2015:

- There were 2,226 admissions for AAA repair. Thirty-day mortality over this five-year period was 7.7% (171 deaths). The numbers of admissions and deaths each year were generally stable over the five-year period.
- Acute admissions made up 31% of all admissions for AAA repair and 79% of 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 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 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.

Updated findings 2011–2016

The 2011–2016 findings are consistent with the findings reported in the sixth report.

In New Zealand during 2011–2016 there were 3,483 admissions for AAA repair. Thirty-day mortality over the five-year period was 7.38% (257 deaths) (Table 38).

Table 38: Annual numbers of hospital admissions and 30-day mortality following AAA repair, New Zealand 2011–2016

DISCHARGE YEAR	Admissions	Deaths	Mortality rate (%)
2011	548	44	8.03
2012	598	45	7.53
2013	573	43	7.50
2014	564	50	8.87
2015	579	34	5.87
2016*	621	41	6.60
2011–2016	3,483	257	7.38

Numerator: NMC: Deaths occurring within 30 days of an AAA repair.
Denominator: NMDS: Hospital admissions with at least one AAA repair recorded in any procedure field.
* Provisional data. AAA: abdominal aortic aneurysm.

Acute admissions made up 31.84% of all admissions and 77.43% of deaths following AAA repair. The mortality rate was higher following acute admissions (17.94%) than elective/waiting list admissions (2.44%). Mortality was higher following an open repair (12.14%) than an endovascular repair (3.44%) (Table 39).

Table 39: Admissions and 30-day mortality rate for AAA repair, by admission type and by procedure type, New Zealand 2011–2016

ADMISSION TYPE AND PROCEDURE TYPE	Admissions	Deaths	Mortality rate (%)
Admission type			
Acute	1,109	199	17.94
Other	2,374	58	2.44
Procedure type			
Open	1,582	192	12.14
Endovascular	1,917	66	3.44

Numerator: NMC: Deaths occurring within 30 days of an AAA repair procedure.
Denominator: NMDS: Hospital admissions with at least one AAA repair procedure in any procedure field.
AAA: abdominal aortic aneurysm.

Table 40: Admissions and 30-day mortality rate for open repair vs endovascular AAA repair, by admission type, New Zealand 2011–2016

ADMISSION TYPE	Open repair			Endovascular repair		
	Admissions	Deaths	Mortality rate (%)	Admissions	Deaths	Mortality rate (%)
Acute	704	154	21.88	421	46	10.93
Elective/Waiting list	827	30	3.63	1,398	19	1.36

Numerator: NMC: Deaths occurring within 30 days of an AAA repair.
Denominator: NMDS: Hospital admissions with at least one AAA repair recorded in any procedure field.
AAA: abdominal aortic aneurysm.

Perioperative Mortality for Selected Clinical Areas and Procedures

This chapter presents the key findings from selected clinical areas and quality measures the POMRC monitors over time. This data is reported for the six-year period 2011–2016.

The clinical areas that POMRC tracks over time are:

- mortality following general and/or neuraxial 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
  - colorectal resection
  - coronary artery bypass graft (CABG) surgery
  - percutaneous transluminal coronary angioplasty (PTCA)
  - abdominal aortic aneurysm (AAA) repair.

International comparisons

This chapter also compares perioperative mortality rates in New Zealand with international perioperative mortality rates for the clinical areas the POMRC tracks over time. The countries included in the comparisons were chosen because data and mortality rates for the selected clinical areas were available.

Comparing perioperative mortality in New Zealand with other published studies is challenging because the timeframe within which mortality is measured varies widely. Medium- and long-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 (ie, mortality before discharge). However, for some procedures, a significant proportion of patients die within 30 days, but outside of hospital (ie, after discharge). These patients often die from complications related to infection and the quality of postoperative care outside of hospital. This is why in-hospital mortality 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 stage of postoperative care. Thirty-day mortality rates can provide an indicator of longer-term postoperative care, including care out of hospital and in the community.

Data notes and limitations

The rates presented in this section 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 health care institutions (district health boards (DHBs) and private hospitals) has increased over time, with the majority of them now reporting their rates. This may influence changes in the rates between years.

Note that for all of these graphs, the mortality rate in 2016 is provisional. This is due to delays in coded data being entered into the NMDS and the NMC. Statistical significance is therefore noted for the linear trend in mortality rates between 2011 and 2015, and is set at $p < 0.05$.

Perioperative mortality for selected clinical areas

Same or next day mortality following general and/or neuraxial anaesthesia

The same or next day mortality measure provides a general indicator of the quality of perioperative care close to the time of anaesthesia and surgery.

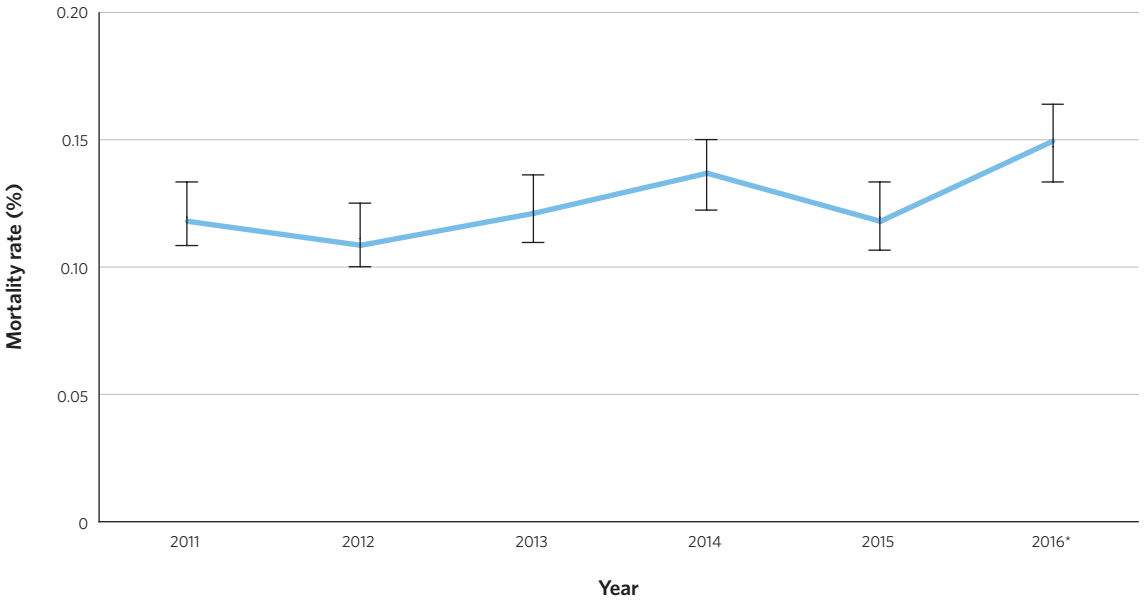
In New Zealand between 2011 and 2016, there were 1,905 deaths on the day of, or the day after surgery. Three-quarters (74%) of these deaths followed acute admission. There was no significant difference in mortality rates between 2011 and 2015 (Table 41, Figure 5).

Table 41: Same or next day mortality following hospital admission with one or more general and/or neuraxial anaesthetics by year, New Zealand 2011–2016

YEAR	Admissions	Deaths	Mortality rate (%)
2011	269,559	314	0.12
2012	270,925	287	0.11
2013	277,616	330	0.12
2014	285,130	370	0.13
2015	278,650	312	0.11
2016*	265,458	366	0.14
2011–2016			
Acute	381,558	1,475	0.39
Other	1,265,760	504	0.04
Overall	1,647,338	1,979	0.12

Numerator: NMC: Deaths occurring on the same or next day of a general anaesthetic or neuraxial block.
Denominator: NMDS: Hospital admissions with at least one general anaesthetic or neuraxial block.
* Provisional data.

Figure 5: Same or next day mortality following general and/or neuraxial anaesthesia, crude rate, New Zealand 2011–2016



* Provisional data.

International comparisons

The New Zealand same or next day mortality rate (0.12%) was similar to the rate obtained in a 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).

In-hospital mortality following general and/or neuraxial anaesthesia

The in-hospital mortality rate is one of the World Health Organization's (WHO) measures of surgical safety. It provides a general indicator of the quality of perioperative care in hospital in the 30 days following surgery.

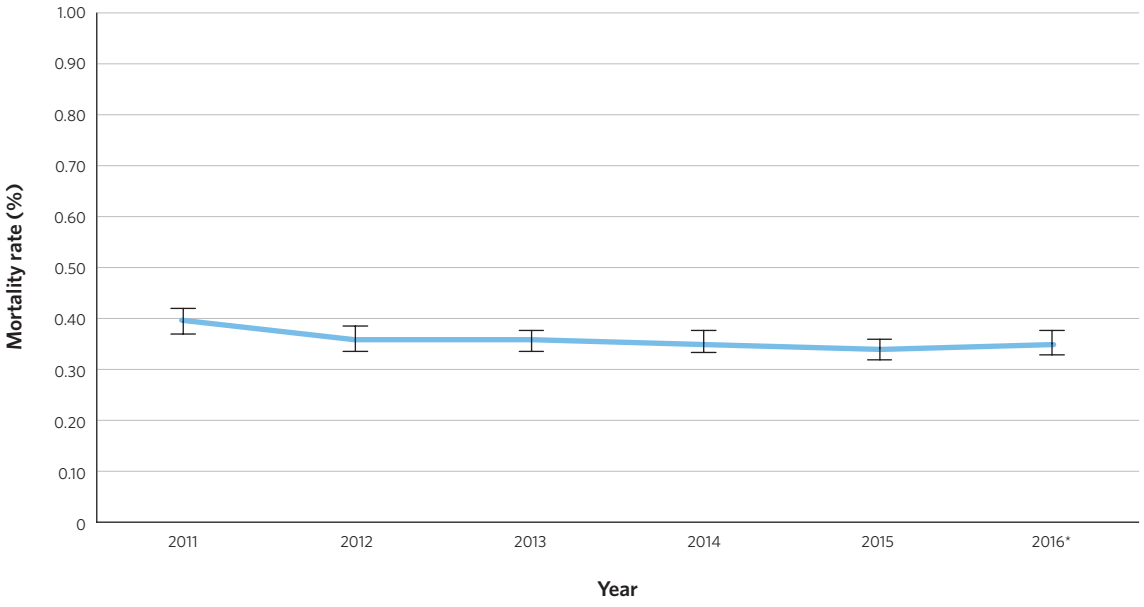
In New Zealand, between 2011 and 2016, the overall in-hospital mortality rate was 0.36%. There was a significant downward trend in the rate from 0.39% in 2011 to 0.34% in 2015 ($p < 0.005$) (Table 42, Figure 6).

Table 42: In-hospital mortality following hospital admission with general and/or neuraxial anaesthesia by year, New Zealand 2011–2016

YEAR	Admissions	Deaths	Mortality rate (%)
2011	269,559	1,052	0.39
2012	270,925	964	0.36
2013	277,616	987	0.36
2014	285,130	1,002	0.35
2015	278,650	944	0.34
2016*	265,458	927	0.35
Total	1,647,338	5,876	0.36

Numerator: NMC: Deaths occurring prior to discharge.
Denominator: NMDS: Hospital admissions with at least one general anaesthetic or neuraxial block.
* Provisional data.

Figure 6: In-hospital mortality following general and/or neuraxial anaesthesia, crude rate, New Zealand 2011–2016



* Provisional data.

International comparisons

The New Zealand in-hospital mortality rate (0.36%) was lower than the rates reported for:

- the Netherlands: 1.85%[4] (Noordzij et al 2010)
- Europe: in a cohort study across 28 European countries, the pooled in-hospital, seven-day mortality rate was 4%; there was significant variation across countries (eg, United Kingdom 3.6%, Ireland 6.4% and Netherlands 2.0%) (Pearse et al 2012).

Mortality in the 30 days following general and/or neuraxial anaesthesia

The 30-day mortality rate following general and/or neuraxial anaesthesia provides a general indicator of the quality of perioperative care in the 30 days following surgery. In New Zealand between 2011 and 2016, there were 8,933 deaths within 30 days of anaesthesia. Three-quarters (75%) of deaths followed acute admissions.

The overall mortality rate between 2011 and 2016 was 0.54%. There was a significant downward trend between 2011 and 2015 ($p < 0.05$) (Table 43, Figure 7).

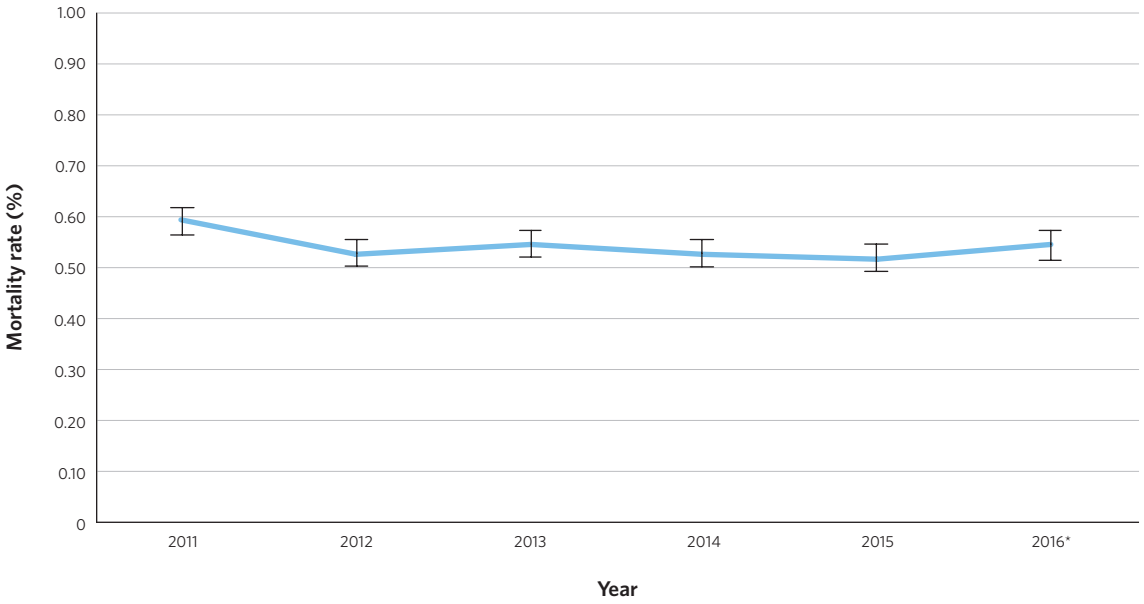
4 This study defined postoperative death as any death during the initial hospital stay after surgery or within 30 days after surgery, whichever came first.

Table 43: Thirty-day mortality following hospital admission with general and/or neuraxial anaesthesia by year, New Zealand 2011–2016

YEAR	Admissions	Deaths	Mortality rate (%)
2011	269,559	1,589	0.59
2012	270,925	1,437	0.53
2013	277,616	1,521	0.55
2014	285,130	1,499	0.53
2015	278,650	1,448	0.52
2016*	265,458	1,439	0.54
2011–2016			
Acute	381,558	6,695	1.75
Arranged in public facility	162,256	848	0.52
Elective/Arranged/Waiting list	1,103,504	1,390	0.13
Overall	1,647,338	8,933	0.54

Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block.
Denominator: NMDS: Hospital admissions with at least one general anaesthetic or neuraxial block.
* Provisional data.

Figure 7: Mortality in the 30 days following general and/or neuraxial anaesthesia, crude rate, New Zealand 2011–2016



* Provisional data.

International comparisons

The 30-day mortality rate in New Zealand (0.54%) between 2011 and 2016 was lower than the 30-day mortality rates in:

- the United States: 1.76% (Yu et al 2011); 1.34% for all non-cardiac surgery (Glance et al 2012)
- Sweden: 1.8% (this excludes day surgery, cardiac surgery, neurosurgery, radiological and obstetric procedures) (Jawad et al 2016)
- Canada: 0.84% (30-day mortality in 12 elective procedures) (Dubois et al 2017).

Thirty-day mortality following general and/or neuraxial anaesthesia in admissions with an ASA score of 4 or 5

A patient with an ASA score of 4 has a life-threatening condition, and a patient with an ASA score of 5 is defined as a 'moribund patient who is not expected to survive longer than 24 hours without surgical intervention'.

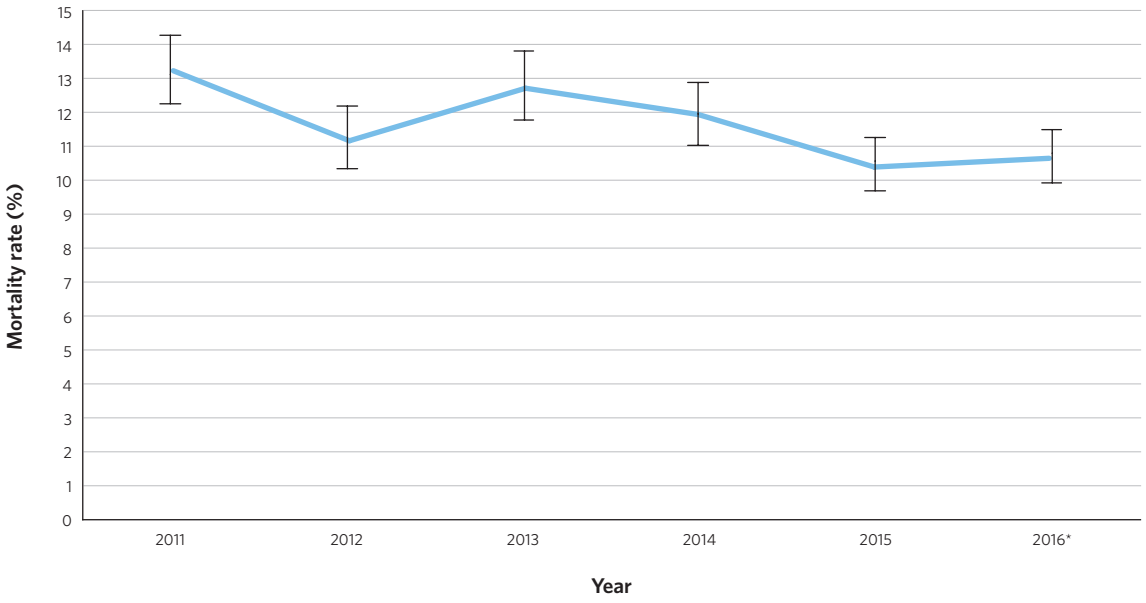
The overall mortality rate for patients with an ASA score of 4 or 5 was 11.65%. Mortality was higher for admissions with an ASA score of 5 (44.55%) than 4 (10.56%). There was a significant decreasing trend in mortality between 2011 and 2015 ($p < 0.05$) (Table 44, Figure 8).

Table 44: Thirty-day mortality following hospital admission with general and/or neuraxial anaesthesia and an ASA score of 4 or 5 by year, New Zealand 2011–2016

YEAR	Admissions	Deaths	Mortality rate (%)
2011	4,507	596	13.22
2012	4,485	505	11.26
2013	4,655	592	12.72
2014	4,917	586	11.92
2015	5,346	562	10.51
2016*	5,860	628	10.72
2011–2016			
Acute	17,315	2,941	16.99
Other	12,455	528	4.24
ASA 4	28,816	3,044	10.56
ASA 5	954	425	44.55
Overall	29,770	3,469	11.65

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

Figure 8: Mortality within 30 days of general and/or neuraxial anaesthesia for patients with an ASA score of 4 or 5, crude rate, New Zealand 2011–2016



* Provisional data.

International comparisons

The New Zealand rates for patients with an ASA score of 4 or 5 were slightly lower than the rate reported for the United States, where patients with an ASA score of 4 or 5 had a 30-day mortality rate of 11.14% and 50.87%, respectively (Hackett et al 2015).

Thirty-day mortality following general and/or neuraxial anaesthesia in elective admissions with an ASA score of 1 or 2, crude rate 2011–2016

Patients with an ASA score of 1 or 2 have a low risk of death and postoperative complications. A high mortality rate among patients with ASA scores of 1 or 2 may signal areas for review and improvement in perioperative care.

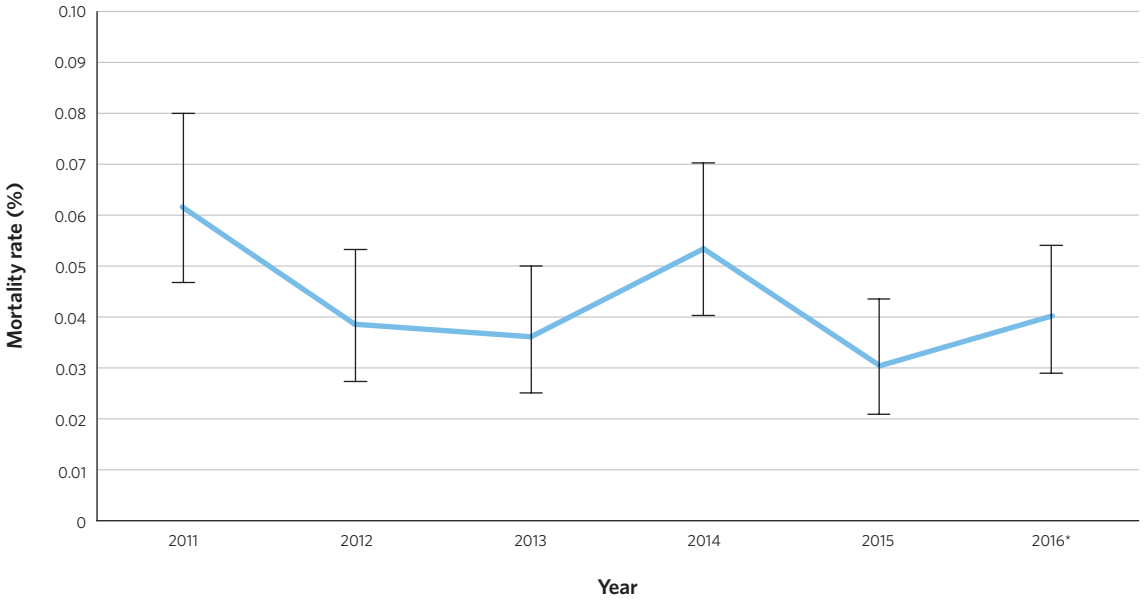
The mortality rate in ASA 1 or 2 patients was 0.04%. There was a significant downward trend in the rate between 2011 and 2015 ($p < 0.05$) (Table 45, Figure 9).

Table 45: Thirty-day mortality following elective admission with a first ASA score of 1 or 2 (elective admissions only) by year, New Zealand 2011–2016

YEAR	Admissions	Deaths	Mortality rate (%)
2011	86,519	53	0.06
2012	88,583	34	0.04
2013	88,578	32	0.04
2014	93,418	50	0.05
2015	94,441	29	0.03
2016*	95,075	38	0.04
Total	546,614	236	0.04

Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block.
Denominator: NMDS: Hospital admissions with at least one general anaesthetic or neuraxial block and an ASA score of 1 or 2 and an elective admission.
* Provisional data.

Figure 9: Mortality within 30 days of general and/or neuraxial anaesthesia for patients with an ASA score of 1 and 2, crude rate for elective admissions, New Zealand 2011–2016



* Provisional data.

International comparisons

The New Zealand rate of 30-day mortality following elective admission with an ASA score of 1 or 2 was lower than the rate in the United States (0.07%, Gabriel et al 2018; and 0.02% in non-cardiac patients, Hackett et al 2015).

Thirty-day mortality following general and/or neuraxial anaesthesia, by day of the week, crude rate 2011–2016

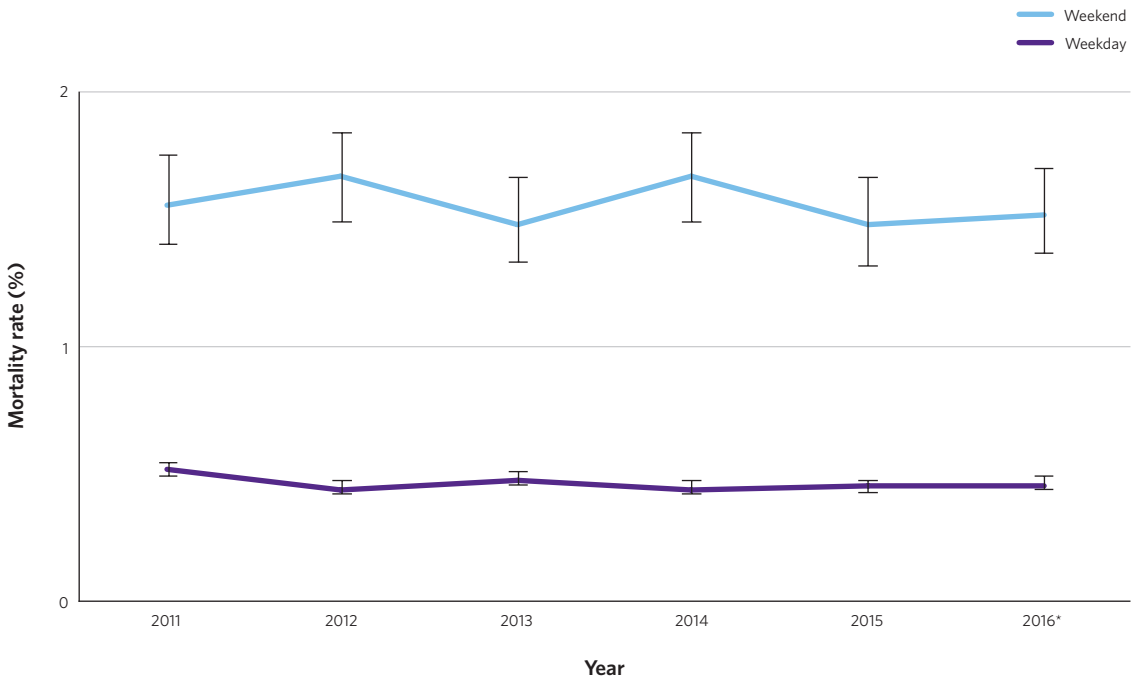
The 30-day mortality rate following general anaesthesia on weekends/holidays was approximately three times higher than on a weekday. There was no significant trend in the weekend and weekday rates between 2011 and 2015 (Table 46, Figure 10).

Table 46: Thirty-day mortality by day of the week, New Zealand 2011–2016

YEAR	Weekend and holiday			Weekday			Weekend/ holiday: weekday mortality ratio
	Admissions	Deaths	Mortality rate (%)	Admissions	Deaths	Mortality rate (%)	
Acute							
2011	14,934	272	1.82	48,021	941	1.96	0.93
2012	15,749	302	1.92	47,114	781	1.66	1.16
2013	15,566	271	1.74	47,494	873	1.84	0.95
2014	15,406	298	1.93	48,063	794	1.65	1.17
2015	15,107	251	1.66	48,759	832	1.71	0.97
2016*	15,799	274	1.73	49,546	806	1.63	1.06
2011–2016	**92,561**	**1,668**	**1.80**	**288,997**	**5,027**	**1.74**	**1.04**
All admissions							
2011	18,936	297	1.57	250,623	1,292	0.52	3.04
2012	19,730	328	1.66	251,195	1,109	0.44	3.77
2013	19,501	291	1.49	258,115	1,230	0.48	3.13
2014	19,720	327	1.66	265,410	1,172	0.44	3.76
2015	18,815	279	1.48	259,835	1,169	0.45	3.30
2016*	19,990	306	1.53	245,468	1,133	0.46	3.32
2011–2016	**116,692**	**1,828**	**1.57**	**1,530,646**	**7,105**	**0.46**	**3.37**

Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block.
Denominator: NMDS: Hospital admissions with at least one general anaesthetic or neuraxial block.
* Provisional data.

Figure 10: Mortality within 30 days of anaesthesia by day of the week, crude rate, New Zealand 2011–2016



* Provisional data.

International comparisons

Acute admissions

The mortality rates for weekend/holiday and weekday acute admissions in New Zealand between 2011 and 2016 were lower than those reported for:

- the United States: 2.9%–3% in the weekend compared with 2.5%–2.7% on weekdays (Ruiz et al 2015); in contrast, after adjusting for hospital and patient characteristics, Zapf et al (2015) found no significant weekend effect in an analysis of urgent general operative procedures
- the Netherlands: 4.6% during the weekend compared with 4.0%–4.2% during the week (Ruiz et al 2015)
- Australia: 3.6% during the weekend and 3.5%–3.6% during the week (ie, no weekend effect) (Ruiz et al 2015).

A retrospective observational study found higher odds of 30-day mortality following emergency surgery on Saturday and Sunday than on Monday in:

- England: adjusted odds ratio (AOR) 1.07 (95% CI 1.03–1.12) and AOR 1.08 (95% CI 1.04–1.13), respectively
- the United States: AOR 1.11 (95% CI 1.02–1.20) and AOR 1.13 (95% CI 1.04–1.24), respectively
- the Netherlands: AOR 1.20 (95% CI 1.09–1.33) and AOR 1.17 (95% CI 1.06–1.29), respectively (Ruiz et al 2015).

In a systematic review and meta-analysis, the pooled OR for mortality after urgent/emergent surgery for patients admitted on the weekend relative to weekdays was 1.27 (95% CI 1.08–1.49; *chi*-squared 96.9%) (Smith et al 2018).

All admissions

The mortality rates for all weekend/holiday admissions and all weekday admissions in New Zealand between 2011 and 2016 were lower than those reported for elective admissions in:

- the Netherlands: 1.35%–1.88% during the weekend compared with 0.49%–0.73% during the week (Ruiz et al 2015)
- Australia: 1.31%–1.32% during the weekend compared with 0.31%–0.34% on weekdays (Ruiz et al 2015)
- England: 1.03% on Sunday compared with 0.25%–0.37% on Monday through Saturday (Ruiz et al 2015)
- the United States: 1.31%–1.66% during the weekend compared with 0.33%–0.45% on weekdays (Ruiz et al 2015).

Ruiz et al (2015) found higher odds of 30-day mortality following elective surgery on:

- Sunday compared with Monday in England (AOR 2.78, 95% CI 1.93–4.03) and Australia (AOR 2.07, 95% CI 1.16–3.70)
- Saturday compared with Monday in the United States (AOR 2.48, 95% CI 1.17–5.23)
- Saturday and Sunday compared with Monday in the Netherlands (AOR 4.74, 95% CI 3.29–6.82; AOR 2.61, 95% CI 1.86–3.66).

Perioperative mortality for selected procedures

Thirty-day mortality following cholecystectomy, crude rate 2011–2016

Cholecystectomy is a surgical procedure to remove the gallbladder. It is a common procedure undertaken in many hospitals.

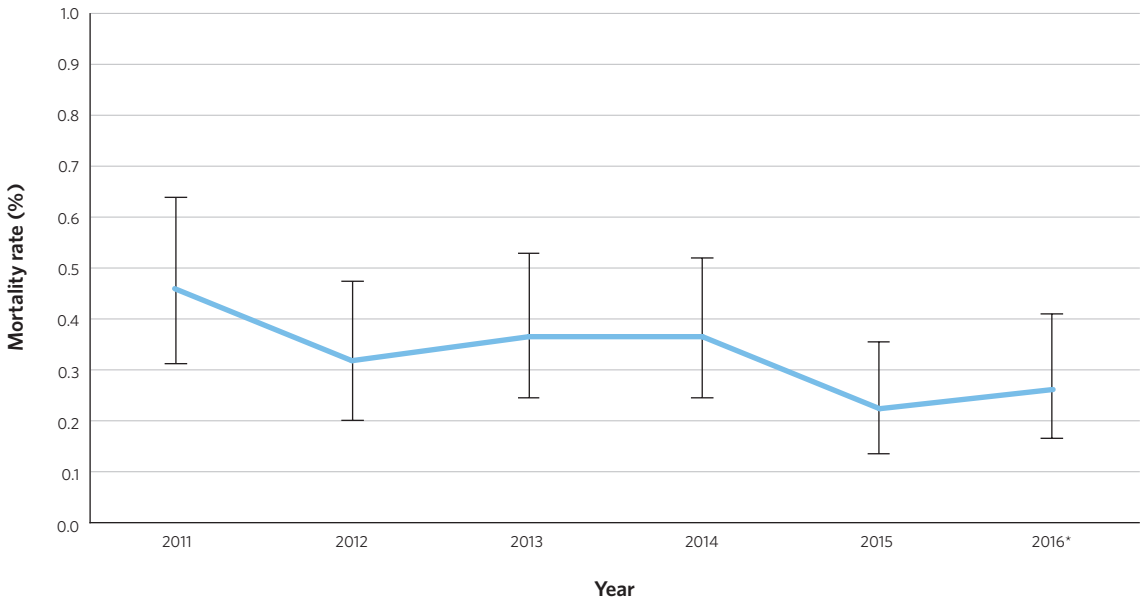
There were 137 deaths following cholecystectomy in New Zealand between 2011 and 2016. The mortality rate was 0.33% of admissions. Acute admissions had a higher mortality rate (0.58%) than elective admissions (0.21%). There was no significant difference in the rate between 2011 and 2015 (Table 47, Figure 11).

Table 47: Mortality following cholecystectomy by year, New Zealand 2011–2016

YEAR	Admissions	Deaths	Mortality rate (%)
2011	6,624	30	0.45
2012	6,654	21	0.32
2013	6,869	25	0.36
2014	7,187	26	0.36
2015	7,062	16	0.23
2016*	7,112	19	0.27
2011–2016			
Laparoscopic	37,943	44	0.12
Open	2,779	87	3.13
Laparoscopic to open	872	6	0.01
Acute	13,697	80	0.58
Elective/Waiting list	27,052	56	0.21
Overall	41,508	137	0.33

Numerator: NMC: Deaths occurring within 30 days of a cholecystectomy procedure.
Denominator: NMDS: Hospital admissions with at least one cholecystectomy procedure in any procedure field.
* Provisional data.
Note: The number of laparoscopic to open procedures in 2015 and 2016 was not available.

Figure 11: Mortality within 30 days of cholecystectomy, crude rate, New Zealand 2011–2016



* Provisional data.

International comparisons

The New Zealand mortality rate following cholecystectomy (0.33%) was lower than the rates reported for:

- Scotland: 0.49% (Harrison et al 2012)
- the United States: 0.53% (Ingraham et al 2010)
- Taiwan: 2.21% (Lu et al 2018).

Thirty-day mortality following hip arthroplasty, crude rate 2011–2016

The use of hip arthroplasty is increasing with the ageing population. Elective procedures are presumed to represent total hip replacements, and acute procedures are presumed to represent hip arthroplasty after a fracture.

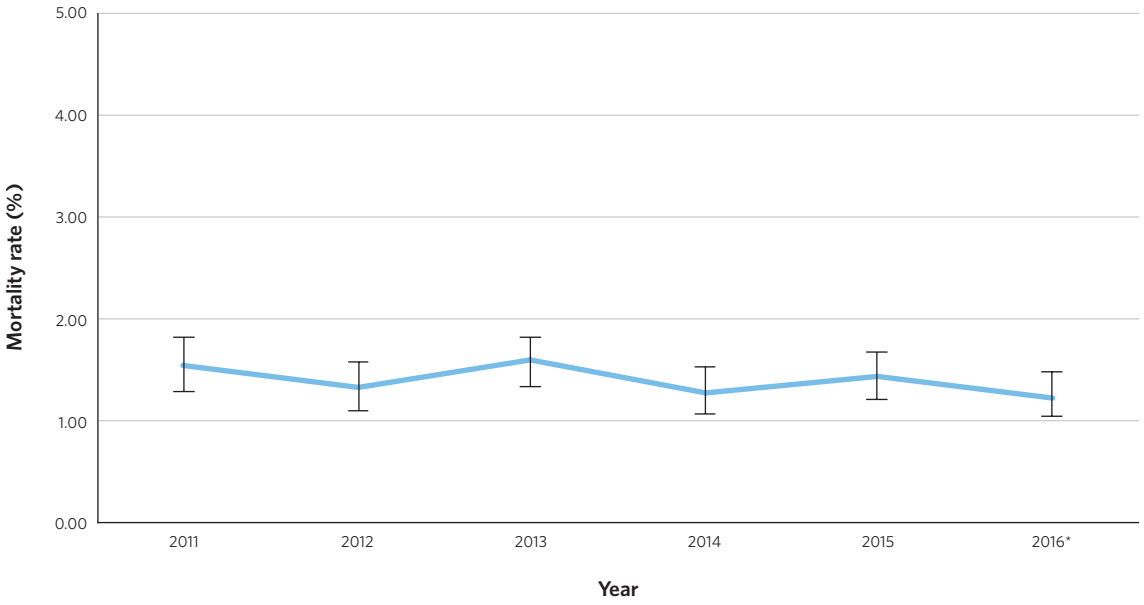
In New Zealand between 2011 and 2016 there were 780 deaths following hip arthroplasty. The mortality rate was 1.44% of admissions. Acute admissions had a higher 30-day mortality rate (7.01%) than elective/waiting list admissions (0.10%). There was no significant difference in the rate between 2011 and 2015 (Table 48, Figure 12).

Table 48: Mortality following hip arthroplasty by year, New Zealand 2011–2016

YEAR	Admissions	Deaths	Mortality rate (%)
2011	8,431	128	1.52
2012	8,762	116	1.32
2013	9,537	148	1.55
2014	10,124	129	1.27
2015	9,711	139	1.43
2016*	9,674	120	1.24
2011–2016			
Acute	10,195	715	7.01
Elective/Waiting list	45,407	46	0.10
Overall	56,239	780	1.39

Numerator: NMC: Deaths occurring within 30 days of a hip arthroplasty procedure.
Denominator: NMDS: Hospital admissions with at least one hip arthroplasty procedure in any procedure field.
* Provisional data.

Figure 12: Mortality within 30 days of hip arthroplasty, crude rate, New Zealand 2011–2016



* Provisional data.

International comparisons

The mortality rate in New Zealand following all hip arthroplasties (1.44%) was lower than the rate reported for Italy: 3% (Messina et al 2017).

The mortality rate in New Zealand following elective hip arthroplasty (0.10%) was lower than in:

- England and Wales: 0.20% (Hunt et al 2017)
- the United States: one-year mortality rate 1.1% (elective primary total hip arthroplasty) (Inacio et al 2017)
- a meta-analysis of mortality rates following total hip arthroplasty procedures, which found a pooled 30-day mortality rate of 0.30% (Berstock et al 2014)
- a meta-analysis of mortality rates following total and partial hip replacements, which found a pooled mortality rate of 0.63% (Singh et al 2011).

Thirty-day mortality following colorectal resection, crude rate 2011–2016

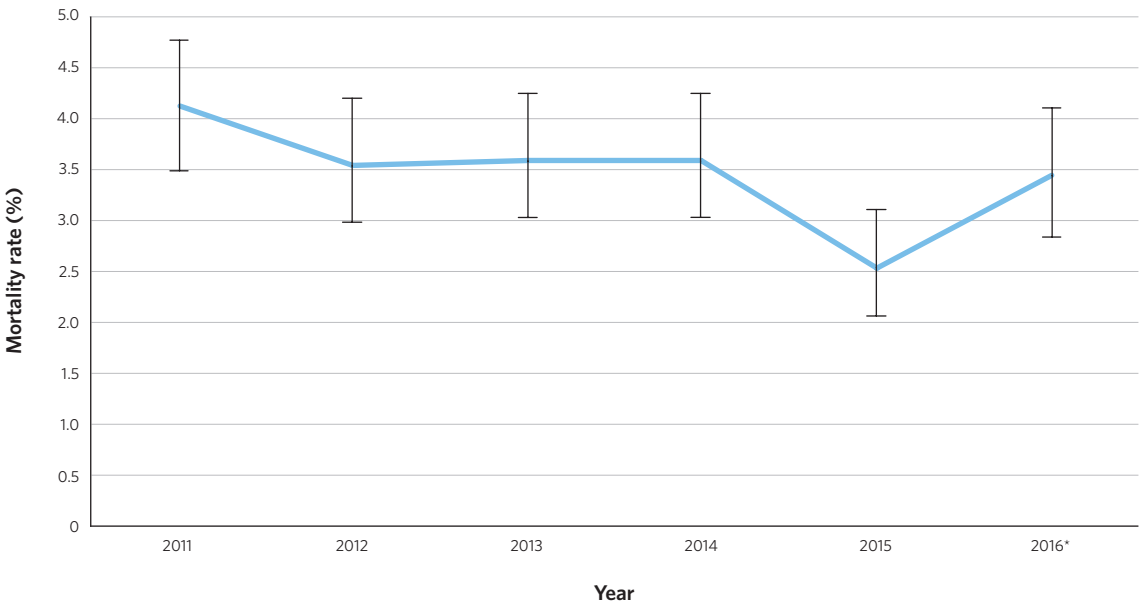
Between 2011 and 2016 in New Zealand, there were 729 deaths following colorectal resection. The mortality rate was 3.5%. Acute admissions had a higher mortality rate (7.63%) than elective/waiting list admissions (1.86%). There was a significant decrease in the rate between 2011 and 2015 ($p < 0.05$) (Table 49, Figure 13).

Table 49: Mortality following colorectal resection by year, New Zealand 2011–2016

YEAR	Admissions	Deaths	Mortality rate (%)
2011	3,505	144	4.11
2012	3,565	127	3.56
2013	3,601	130	3.61
2014	3,690	133	3.60
2015	3,403	87	2.56
2016*	3,139	108	3.44
2011–2016			
Acute	5,993	457	7.63
Other	14,910	272	1.82
Overall	20,903	729	3.49

Numerator: NMC: Deaths occurring within 30 days of a colorectal resection procedure.
Denominator: NMDS: Hospital admissions with at least one colorectal procedure in any procedure field.
* Provisional data.

Figure 13: Mortality within 30 days of colorectal resection, crude rate, New Zealand 2011–2016



* Provisional data.

International comparisons

The New Zealand mortality rate for acute colorectal resection (7.63%) was lower than the rate reported for the United States: 15.27% for emergency colorectal resection (Ingraham et al 2018).

The New Zealand mortality rate for elective/waiting list/arranged colorectal resection (1.86%) was similar to the rate reported for the United States (1.7% following elective colorectal resection; Gabre-Kidan et al 2014) and lower than the rate reported for Denmark (2.8% in 2011 for elective colorectal cancer procedures; Iversen et al 2014).

Thirty-day mortality rate following coronary artery bypass graft (CABG) surgery, crude rate 2011–2016

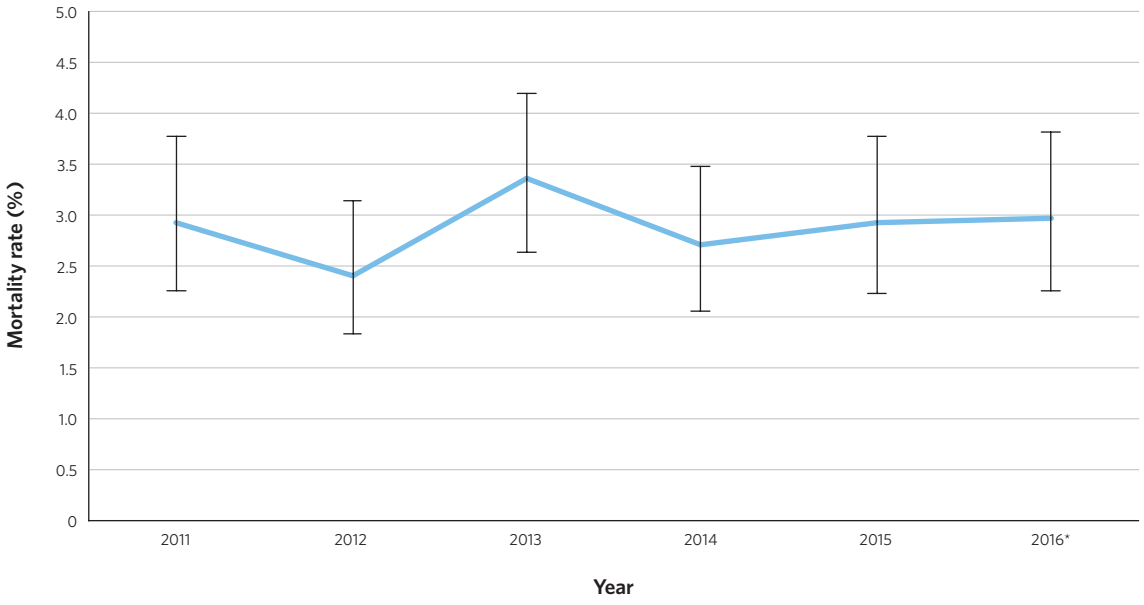
CABG surgery is used to treat ischaemic heart disease. The mortality rate was 2.87% of admissions. Acute admissions had a higher mortality rate (4.45%) than elective admissions (2.28%). There was no significant difference in the rate between 2011 and 2015 (Table 50, Figure 14).

Table 50: Mortality following CABG surgery by year, New Zealand 2011–2016

YEAR	Admissions	Deaths	Mortality rate (%)
2011	1,934	57	2.95
2012	2,058	50	2.43
2013	1,968	66	3.35
2014	1,953	53	2.71
2015	1,840	54	2.93
2016*	1,819	54	2.97
2011–2016			
Acute	3,195	145	4.54
Other	8,377	189	2.26
Overall	11,572	334	2.89

Numerator: NMC: Deaths occurring within 30 days of a CABG procedure.
Denominator: NMDS: Hospital admissions with at least one CABG procedure in any procedure field.
* Provisional data.

Figure 14: Mortality within 30 days of CABG surgery, crude rate, New Zealand 2011–2016



* Provisional data.

International comparisons

The New Zealand mortality rate for acute CABG surgery (4.54%) was lower than the rate reported for Japan: 8.79% (Sakata et al 2012); 20.7% for emergent/unexpected (Miyata et al 2011).

The New Zealand mortality rate for elective CABG surgery (2.28%) was higher than the rate reported for Japan: 1.12% (Sakata et al 2012).

The New Zealand overall mortality rate for all CABG procedures (2.87%) was lower than the rates reported for:

- Denmark: 3.2% (Adelborg et al 2017)
- five European countries (Denmark, England, Portugal, Slovenia and Spain): 3% (Gutacker et al 2017).

Thirty-day mortality following percutaneous transluminal coronary angioplasty (PTCA), crude rate 2011–2016

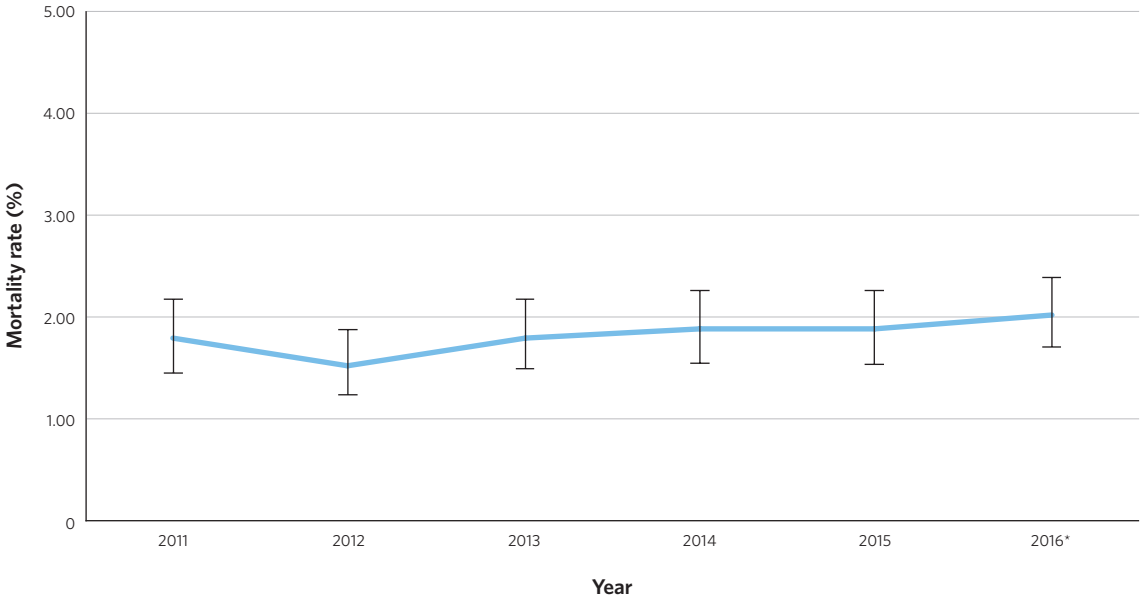
PTCA is used to treat ischaemic heart disease. The mortality rate was 1.82% of admissions. Acute admissions had a higher mortality rate (2.50%) than elective admissions (0.70%). There was no significant difference in the rate between 2011 and 2015 (Table 51, Figure 15).

Table 51: Mortality following PTCA by year, New Zealand 2011–2016

YEAR	Admissions	Deaths	Mortality rate (%)
2011	5,274	94	1.78
2012	5,458	84	1.54
2013	5,755	104	1.81
2014	5,392	102	1.89
2015	5,686	106	1.86
2016*	6,022	122	2.03
2011–2016			
Acute	21,036	525	2.50
Other	12,501	87	0.70
Overall	33,587	612	1.82

Numerator: NMC: Deaths occurring within 30 days of a PTCA procedure.
Denominator: NMDS: Hospital admissions with at least one PTCA procedure in any procedure field.
* Provisional data.

Figure 15: Mortality within 30 days of PTCA, crude rate, New Zealand 2011–2016



* Provisional data.

International comparisons

The New Zealand mortality rate following PTCA (1.82%) was similar to the rates observed for the United States: 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) (Brennan et al 2013).

Thirty-day mortality following abdominal aortic aneurysm (AAA) repair, crude rate 2011–2016

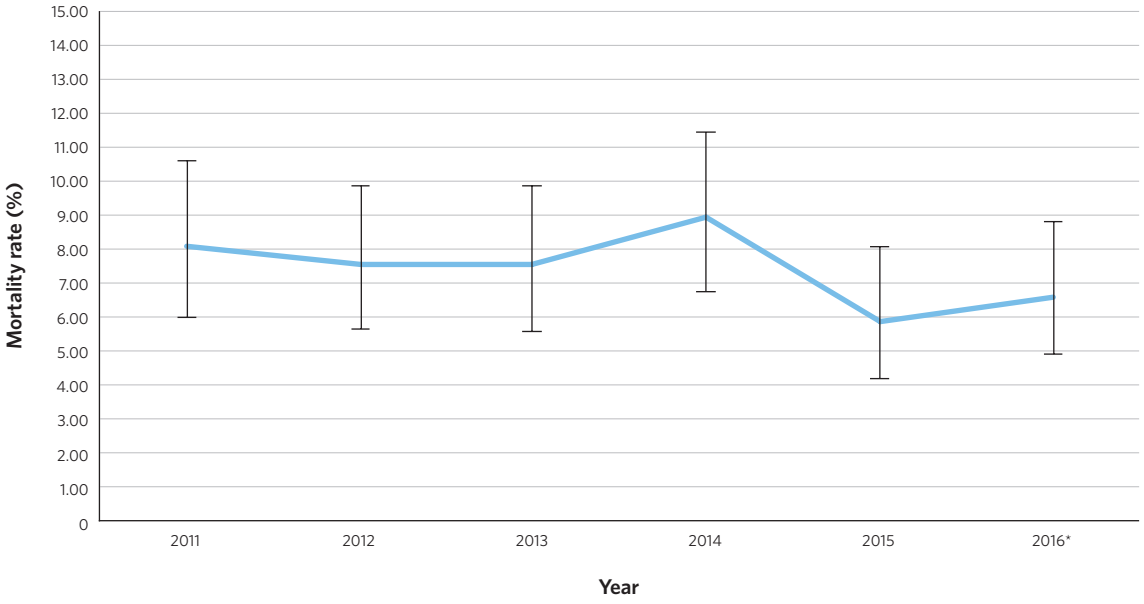
The mortality rate following AAA repair was 7.38% of admissions. Acute admissions had a higher mortality rate (17.95%) than other admissions (2.44%). Endovascular repair had a lower mortality rate (3.44%) than open repair (12.14%). There was no significant difference in the rate between 2011 and 2015 (Table 52, Figure 16).

Table 52: Annual numbers of hospital admissions and 30-day mortality following AAA repair, New Zealand 2011–2016

YEAR	Admissions	Deaths	Mortality rate (%)
2011	548	44	8.03
2012	598	45	7.53
2013	573	43	7.50
2014	564	50	8.87
2015	579	34	5.87
2016*	621	41	6.60
Overall	3,483	257	7.38

Numerator: NMC: Deaths occurring within 30 days of an AAA repair procedure.
Denominator: NMDS: Hospital admissions with at least one AAA repair procedure in any procedure field.
* Provisional data. AAA: abdominal aortic aneurysm.

Figure 16: Mortality within 30 days of AAA repair, crude rate, New Zealand 2011–2016



* Provisional data. AAA: abdominal aortic aneurysm.

International comparisons

Acute admissions/ruptured aneurysms

The New Zealand mortality rates for acute AAA open repairs (21.88%) and acute endovascular repairs (10.93%) were lower than those reported for:

- England: the 30-day mortality following endovascular repair for acute symptomatic or ruptured thoraco-abdominal aortic aneurysm was 26% (in admissions who were considered unsuitable for open repair; small sample: n=39) (Mascoli et al 2017)
- Germany: 40% for ruptured aneurysms (Kühnl et al 2017)
- the United States: 45.57% for open repair and 31.58% for endovascular repair (Karthikesalingam et al 2014); 41% for open, 27% for endovascular (Schermerhorn et al 2012)
- the United Kingdom and Canada: 40.6% for open repair and 36.4% for endovascular repair (IMPROVE trial investigators 2014)
- nine OECD countries: 32.6% for open, 19.7% for endovascular repair
- Australia: 30-day in-hospital mortality 33% for open, 22.6% for endovascular repair (Mani et al 2011).

Elective procedures/intact aneurysms

The New Zealand mortality rate for elective open repairs (3.63%) and elective endovascular repairs (1.36%) were similar to those reported in:

- nine OECD countries: 3.5% for open, 1.4% for endovascular repair (Mani et al 2011)
- Australia: 30-day in-hospital mortality 3.8% for open, 1.3% for endovascular repair (Mani et al 2011)
- the United States: 4% for open, 1% for endovascular repair (Schermerhorn et al 2012).

World Health Organization (WHO) Metrics in New Zealand

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

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 date 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 ratio (Table 53).

Table 53: The 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 inpatient 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 with the POMRC's day-of-surgery mortality rate. The POMRC also reports the same or next day mortality rate.
** This measure corresponds with the POMRC's inpatient mortality rate.
Note: The POMRC now includes deaths following both general and/or neuraxial anaesthesia in its measures of mortality. This may impact the ability to compare New Zealand's rates with other countries, and the rates presented in this report with the rates in previous POMRC reports.

These two metrics are reported for all surgical procedures during 2011–2016 (Table 54):

- day-of-surgery mortality rate: 0.04%
- inpatient mortality rate: 0.36%.

Table 54: WHO metrics and perioperative mortality by year, New Zealand 2011–2016

YEAR	Admissions with at least one general/neuraxial anaesthetic	Deaths on the same day as surgery	Day-of-surgery mortality rate per 100,000 (% of all admissions)	In-hospital deaths following general and/or neuraxial anaesthetic	In-hospital mortality rate per 100,000 (% of all admissions)
2011	269,559	93	34.50 (0.03%)	1,052	390.27 (0.39%)
2012	270,925	102	37.65 (0.04%)	964	355.82 (0.36%)
2013	277,616	112	40.34 (0.04%)	987	355.53 (0.36%)
2014	285,130	124	43.49 (0.04%)	1,002	351.42 (0.35%)
2015	278,650	99	35.53 (0.04%)	944	338.78 (0.34%)
2016*	265,458	124	46.71 (0.05%)	927	349.21 (0.35%)
2011–2016	1,647,338	654	39.70 (0.04%)	5,876	356.68 (0.33%)

Numerator: NMC: Deaths occurring after a general anaesthetic or neuraxial block.
Denominator: NMDS: Hospital admissions with at least one general anaesthetic or neuraxial block.
* Provisional data.

Perioperative Mortality Data

Supporting local systems for perioperative mortality review in New Zealand

This chapter gives an overview of and update on the POMRC Tier 1 project.

Many hospitals across New Zealand collect clinical and contextual information, including cause of death, to review the factors that may have contributed to perioperative deaths. In 2016, the POMRC began a project to enhance these local review processes, and to support hospitals to share their information and findings with the POMRC.

The aim is for the POMRC to use this contextual information, particularly around proximal cause of death, to enhance its analysis, improve its understanding of perioperative deaths in New Zealand, and to share these findings in its annual report.

The findings from local reviews will also be used to lead and support quality improvement initiatives, using New Zealand-specific data.

A working group comprising POMRC members, pilot site representatives and clinical leaders has been working with the Mortality Review Data Group at the University of Otago to develop a national, web-based system to collect the data. The Health Quality & Safety Commission is supporting five DHBs to pilot the web-based system, before rolling it out nationally. Work is also underway to ensure the system aligns with DHBs' and private hospitals' local review processes, and is fit-for-purpose.

Improving the quality of perioperative data

Improving ASA score records

The ASA physical status classification system score is well recognised as a predictor of complications, adverse clinical outcomes and mortality following hip fracture repair (Folbert et al 2017). This is supported by the POMRC's reports. Accurate ASA scores allow clinicians to adjust mortality estimates for a patient's comorbidities, and disease stability and severity, helping them to better understand the risk associated with different procedures.

Low recording rates continue to be an issue for New Zealand. For example, 16.5% of admissions who underwent surgical repair for a hip fracture did not have their ASA classification recorded. Overall, ASA classification status is recorded in 81.18% of public hospital patient notes, but only 15.89% of private hospital patient notes.

Better documentation

Recommendation 6: All patients should have their American Society of Anesthesiologists (ASA) status recorded in their clinical anaesthetic record. Note: Recording of ASA status has improved on previous years. This recommendation is repeated from the sixth report of the POMRC (2017).

> *Rationale:* The ASA score is a common standard measure that is often used before operations to identify high-risk patients. The ASA score takes into account patient comorbidities and the medical stability of those comorbidities. Accurate ASA scores allow anaesthetists and surgeons to assess the risk of perioperative mortality, depending on the patient's disease severity. Having a patient's ASA score available in the patient's record allows for improved anaesthetic optimisation, and can support audit processes.

Measuring morbidity and other outcomes after surgery

The primary outcome explored in this report is mortality; however, in future reports, the POMRC is also interested in assessing morbidity and quality of life after surgery.

Currently, there is no data available to measure quality of life outcomes; however, through the NMDS we can look at how long a person survives after they are discharged from hospital. This can be used as a proxy measure for independent functioning of the patient, outside of hospital.

The POMRC aims to include the 'days alive and out of hospital' measure and analysis in its 2019 report.

Further research and research funding

Recommendation 8: Health research agencies should develop quality of life indicators and measures of postoperative outcomes other than mortality.

> *Rationale:* Currently, the POMRC measures postoperative mortality; however, due to limitations with the available data it cannot measure other postoperative outcomes such as quality of life after surgery, postoperative disability, and postoperative functional status. Measuring these outcomes would allow the POMRC to better understand surgical outcomes, and provide patients and their families and whānau with a more comprehensive picture of surgical risk.

Appendices

Appendix 1: Current and previously reported mortality rates for POMRC tracking procedures and clinical areas

This appendix summarises key findings from 2011 to 2016 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 55, along with the rates from previously reported time periods since 2006–2010.

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 may appear to differ slightly from year to year.

Table 55: Current and previously reported mortality rates for POMRC tracking procedures and clinical areas, New Zealand 2006–2016

TOPICS ANALYSED OVER TIME	2006–2010	2007–2011	2008–2012	2009–2014	2010–2015	2011–2016
Cumulative one-day mortality rate per 100,000 (%)						
General anaesthesia	-	125.5 (0.13%)	121.5 (0.12%)	124.6 (0.12%)	121 (0.12%)	-
General and/or neuraxial anaesthesia	-	-	-	-	-	125.4 (0.13%)
Cumulative 30-day mortality rate per 100,000 (%)						
General anaesthesia	-	-	-	-	554 (0.55%)	-
General and/ or neuraxial anaesthesia	-	-	-	-	-	542 (0.54%)
Cholecystectomy: acute	1,040.9 (1.04%)	975 (0.98%)	821.7 (0.82%)	695 (0.69%)	575 (0.58%)	584 (0.58%)
Cholecystectomy: elective/waiting list	164.6 (0.16%)	151 (0.15%)	181.8 (0.18%)	214 (0.21%)	220 (0.22%)	207 (0.21%)
Hip arthroplasty: acute	-	6,608.9 (6.61%)	7,098 (7.10%)	7,113.8 (7.11%)	7,311 (7.31%)	7,185 (7.19%)
Hip arthroplasty: elective/waiting list	-	180.5 (0.18)	171 (0.17%)	124.3 (0.12%)	181 (0.18%)	100 (0.10%)
Knee arthroplasty: elective/waiting list	-		142.8 (0.14%)	168.3 (0.17%)	129 (0.13%)	-
Colorectal resection: acute	-	8,456 (8.46%)	-	8,449.8 (8.45%)	8,093 (8.09%)	7,631 (7.6%)
Colorectal resection: elective	-	1,700.6 (1.70%)	-	2,031.5 (2.03%)	1,875 (1.87%)	1,855 (1.86%)
Coronary artery bypass graft (CABG)	-	-	2,645 (2.65%)	2,918.8 (2.92%)	2,874 (2.87%)	2,886 (2.89%)
Percutaneous transluminal coronary angioplasty (PTCA)	-	-	1,661.3 (1.66%)	1,768.5 (1.77%)	1,761 (1.76%)	1,822 (1.82%)
ASA 4 & 5 (high-risk anaesthesia)	-	-	13,701.9 (13.7%)	12,237 (12.24%)	12,578 (12.58%)	11,652 (11.65%)

Appendix 2: Thirty-day mortality rates in New Zealand's resident population

Table 56: Estimated all-cause mortality rates in 30 days in New Zealand's resident population, by age group, 2012–2014

AGE GROUP (YEARS)	Male 30-day mortality per 100,000 population	Female 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.
Denominator: Average (mean) population in New Zealand during 2012–2014.
Source: Statistics New Zealand Life Tables 2012–14 (50th percentile).

Appendix 3: Methods and limitations

Data sources

Hospital admission data was obtained from the National Minimum Dataset (NMDS), supplied by the Ministry of Health in September 2017 and January 2018. Mortality rates were sourced from National Mortality Collection (NMC) data and compared with NMDS admission counts.

Special topic: Hip fracture treatment

The following data was obtained for the special topic in this report. Data from both public and private hospitals that submit data to the NMDS was included. Acute admissions for hip fracture to private hospitals were very uncommon.

Hip fracture

Fractures were defined as neck of femur or trochanteric fractures. A small number of admissions were diagnosed with both trochanteric and neck of femur fractures (n=69 among the surgical repair group and n=4 among those admissions who received non-surgical treatment).

NMDS data was coded according to the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM) v6. The following codes were used to define hip fracture: S7200, S7201, S7202, S7203, S7204, S7205, S7208, S7210 and S7211. Mortality information was sourced from the NMC and as recorded in the NMDS.

Hip fracture surgical repair

For those admissions who underwent surgical repair, hip fracture was defined in relation to the occurrence of any hip fracture diagnostic code in any diagnostic field and the presence of any surgical repair code in any procedure field.

Admissions related to either fixation or reduction procedures have been grouped together. All hip replacement procedures including both partial and total hip arthroplasty procedures and either primary or revision procedures have been included in one group. A small number of admissions were treated with a hip replacement procedure as well as a fixation/reduction procedure (n=98).

The following codes were used to define hip replacement procedures: 4752200, 4931200, 4931500, 4931800, 4931900, 4932400, 4932700, 4933000, 4933300, 4933900, 4934200, 4934500, 4934600. The following codes identified fixation or reduction procedures: 4751900, 4751601, 4753100, 4752800, 4752801. Mortality information was sourced from the NMC and as recorded in the NMDS.

Tables are presented according to the numbers of new procedures. That is, any procedure occurring within 30 days of another procedure has been considered to be a revision arising as a complication of the prior procedure, and in such cases the outcomes arising from the second procedure have been attributed to the first. These re-admissions were also not included in the denominator. Thirty-day mortality has been presented in relation to the index procedure. When more than one procedure occurred during an admission, mortality has been ascribed to the procedure that occurred first.

Non-surgical treatment

In relation to those admissions who received non-surgical treatment, hip fracture was defined by the occurrence of any hip fracture diagnosis code in the index diagnosis field and the absence of any surgical repair code in any procedure field code. Procedure codes for either a general and/or neuraxial anaesthetic were also used to eliminate some admissions. Those admissions who were either transferred from or to another facility where a hip repair procedure occurred were also excluded.

In relation to those admissions who did not undergo surgical repair, mortality has been calculated according to the date of admission rather than the date of procedure.

Complications

Complications were analysed among those admissions that included a procedure where the condition onset flag indicated that the relevant diagnoses were not present on admission. However, the exact timing of the complication – that is, whether it was diagnosed before or after the procedure – cannot be further defined by the available NMDS data.

ICD10 codes for complications

COMPLICATION	ICD10 codes
Myocardial infarction	I21X
Pneumonia	J13X–J16X, J18X
Cerebral infarction	I61X, I63X–I64X
Pulmonary embolism	I26X
Acute renal failure	N17X
Congestive heart failure	I50X
Delerium	F05X
Urosepsis	N08X, N10X–N13X, N16X, N30X, N39X

Risk-adjusted mortality

Risk adjustment was undertaken using a logistic regression model that controlled for age, gender, ASA score, NZDep and Charlson Comorbidity Index score. Risk-adjusted mortality was presented in a funnel plot with 95% control limits.

Commentary from the Māori Caucus: age standardisation – admission rates

To calculate gender-specific, age-standardised admission rates, the population was standardised to the Māori population in the 2001 Census, using data provided in *Tatau Kahukura Māori Health Chart Book 2015* (Ministry of Health 2015). The results were stratified by gender.

Commentary from the Māori Caucus: multivariate analysis – mortality rates

Logistic regression modelling was conducted on mortality among Māori compared with non-Māori sequentially adjusted for demographic and clinical factors.

Data limitations

Data in this report was sourced from the NMDS and the 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 variations 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.

Previously reported measures

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

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

  All hospital admissions with a general and/or neuraxial anaesthetic (ICD-10-AM Australian Classification of Health Interventions (ACHI) Version 6: 92514XX, 92508XX) listed in the first 90 procedure codes as recorded in the NMDS were included. Mortality rates of those who died (on the same day or the day following a general and/or neuraxial anaesthetic) were sourced from NMC data and compared with NMDS admissions counts in which a general and/or neuraxial anaesthetic was administered.

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

  All hospital admissions with a general and/or neuraxial anaesthetic (ICD-10-AM ACHI Version 6: 92514XX, 92508XX) listed in the first 90 procedure codes as recorded in the NMDS were included. In-hospital mortality was calculated from the number of people who were deceased upon discharge (within 30 days following a general and/or neuraxial anaesthetic), as recorded in the NMDS.

- **General and/or neuraxial anaesthesia (within 30 days)**

  All hospital admissions with a general and/or neuraxial anaesthetic (ICD-10-AM ACHI Version 6: 92514XX, 92508XX) listed in the first 90 procedure codes as recorded in the NMDS were included. Mortality rates of those who died (within 30 days following a general and/or neuraxial anaesthetic) were sourced from NMC data and compared with NMDS admissions in which a general and/or neuraxial anaesthetic was administered.

- **Cholecystectomy**

  All 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) as recorded in the NMDS were included. 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 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 were included. 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 who had a first ASA score of 1 or 2 and had 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) were included. 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.

- **Coronary artery bypass graft (CABG)**

  All hospital admissions 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 were included. Mortality information was sourced from the NMC and as recorded in the NMDS.

- **Percutaneous transluminal coronary angioplasty (PTCA)**

  All hospital admissions with a PTCA 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 were included. Mortality information was sourced from the NMC and as recorded in the NMDS.

- **ASA score 4 or 5**

  All hospital admissions who had an ASA score of 4 or 5 and had a general anaesthetic (ICD-10-AM ACHI Procedure Codes, Version 6: Block 1910, 92514-XX) or neuraxial block (ICD-10-AM ACHI Procedure Codes, Version 6: Block 1909, 92508-XX) were included. 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 with a general anaesthetic (ICD-10-AM ACHI Version 6: 92514XX) listed in the first 90 procedure codes as recorded in the NMDS were included. 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, 2013). The methods applied to the 'Mortality following Hip Fracture' 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.

Hospital admission types and hospital re-admissions

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 2015). 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, however, 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).

Re-admissions

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 re-admissions were not included in the denominator used to calculate mortality rates by procedure. If a re-admission occurred more than 30 days from the original procedure, however, this was considered to be a new procedure in the calculation of mortality rates.

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 CCI 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 CCI has been validated in a variety of clinical settings and has been recently updated to enable it to be used with ICD-10 administrative data in New Zealand (Quan et al 2011).

New Zealand Deprivation Index (NZDep)

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.

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 overestimate 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 ratios (and the magnitude of effect).

Appendix 4: Sixth report recommendations – progress summary

The following table presents the POMRC's progress on recommendations made in the previous report.

RECOMMENDATIONS OF SIXTH REPORT	PROGRESS TO DATE
Recommendations by the POMRC	
All patients should have their ASA status recorded in their clinical anaesthetic record.	ASA classification status is recorded in approximately 15.89% of private hospital patient files and approximately 81.18% of public hospital patient notes.
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.	The POMRC has selected Māori and perioperative mortality for the topic of focus for its 2019 report. The POMRC's analysis will attempt to further understand the impact of ethnicity and socioeconomic status on surgical outcomes. The POMRC has also recommended that the Health Research Council considers investigating the impact of ethnicity and socioeconomic status on surgical outcomes, including mortality.
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.	Barriers to accessing health care, specifically rurality, will be part of the wider special topic for the 2019 POMRC report. Equitable access to health care has been brought to the attention of DHBs via conference presentations and the Ministry of Health's mortality forum.
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 as the risks and benefits of no operation (if appropriate), should be discussed with the patient.	This recommendation was a focus at the 2017 POMRC conference, as well as other forums. Infographics outlining this recommendation have been circulated widely to perioperative groups.
The risk of dying preoperatively (and of serious complications) should be discussed with all patients contemplating an operation with a significant risk (eg, ruptured AAA repair).	This recommendation has been raised via conference presentations. It also aligns with the Health Quality & Safety Commission 'Let's talk' promotion designed to get patients engaging and asking questions with medical staff.
Recommendations by the Māori Caucus for future research	
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.	Further investigation is planned in the 2019 POMRC report special topic looking at outcomes for Māori.
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.	
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.	
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 outcome for Māori, compared with non-Māori non-Pacific as the comparator group, at 30 days and at 90 days.	

List of Abbreviations

AAA	abdominal aortic aneurysm
ACHI	Australian Classification of Health Interventions
AOR	adjusted odds ratio
ASA	American Society of Anesthesiologists
CABG	coronary artery bypass graft
CCI	Charlson Comorbidity Index
CI	confidence interval
DHB	district health board
HR	hazard ratio
ICD	International Classification of Diseases
ICD-10-AM	International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification
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

References

Adelborg K, Horváth-Puhó E, Schmidt M, et al. 2017. Thirty-year mortality after coronary artery bypass graft surgery – a Danish nationwide population-based cohort study. *Circulation: Cardiovascular Quality and Outcomes* 10(5): e002708.

Ariyaratnam R, Palmqvist CL, Hider P, et al. 2015. Toward a standard approach to measurement and reporting of perioperative mortality rate as a global indicator for surgery. *Surgery* 158(1): 17–26.

Atkinson J, Salmond C, Crampton P. 2014. *NZDep2013 Index of Deprivation.* Wellington: Department of Public Health, University of Otago. URL: www.otago.ac.nz/wellington/otago069936.pdf (accessed April 2018).

Australian Commission on Safety and Quality in Health Care. 2016. *Hip Fracture Care Clinical Care Standard.* URL: www.safetyandquality.gov.au/wp-content/uploads/2016/09/Hip-Fracture-Care-Clinical-Care-Standard_tagged.pdf (accessed April 2018).

Australian & New Zealand Hip Fracture Registry. 2017. *Australian & New Zealand Hip Fracture Registry Bi-National Annual report for Hip Fracture Care 2017.* Sydney: Australian & New Zealand Hip Fracture Registry.

Australian & New Zealand Hip Fracture Registry Steering Group. 2014. *Australian and New Zealand Guideline for Hip Fracture Care: Improving Outcomes in Hip Fracture Management of Adults.* Sydney: Australian & New Zealand Hip Fracture Registry Steering Group.

Aylin P, Alexandrescu R, Jen H, et al. 2013. Day of week procedure and 30 day mortality for elective surgery: retrospective analysis of hospital episode statistics. *BMJ* 346: f2424.

Aylin P, Yunus A, Bottle A, et al. 2010. Weekend mortality for emergency admissions: A large, multicentre study. *BMJ Quality and Safety* 19: 213–7.

Bainbridge D, Martin J, Arango M, et al. 2012. Perioperative and anaesthetic-related mortality in developed and developing countries: a systematic review and meta-analysis. *The Lancet* 380: 1075–81.

Baker PN, Salar O, Ollivere BJ, et al. 2014. Evolution of the hip fracture population: time to consider the future? A retrospective observational analysis. *BMJ Open* 4(4): e004405.

Berstock JR, Beswick AD, Lenguerrand E, et al. 2014. Mortality after total hip replacement surgery: A systematic review. *Bone & Joint Research* 3: 175–82.

Bohm E, Loucks L, Wittmeier K, et al. 2015. Reduced time to surgery improves mortality and length of stay following hip fracture: results from an intervention study in a Canadian health authority. *Canadian Journal of Surgery* 58: 257–63.

Brennan JM, Curtis JP, Dai D, et al. 2013. Enhanced mortality risk prediction with a focus on high-risk percutaneous coronary intervention: results from 1,208,137 procedures in the NCDR (National Cardiovascular Data Registry). *JACC: Cardiovascular Interventions* 6: 790–9.

Bretherton CP, Parker MJ. 2015. Early surgery for patients with a fracture of the hip decreases 30-day mortality. *The Bone & Joint Journal* 97-B: 104–8.

Brown P, McNeill R, Radwan E, et al. 2007. *The burden of osteoporosis in New Zealand: 2007–2020.* Auckland: University of Auckland/UniServices.

Charlson ME, Pompei P, Ales KL, et al. 1987. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *Journal of Chronic Diseases* 40: 373–83.

Dhanwal DK, Dennison EM, Harvey NC, et al. 2011. Epidemiology of hip fracture: Worldwide geographic variation. *Indian Journal of Orthopaedics* 45: 15–22.

Dodd AC, Bulka C, Jahangir A, et al. 2016. Predictors of 30-day mortality following hip/pelvis fractures. *Orthopaedics & Traumatology: Surgery & Research* 102: 707–10.

Dripps RD. 1963. New classification of physical status. *Anesthesiology* 24: 111.

Dubois L, Vogt K, Vinden C, et al. 2017. Association between day of the week of elective surgery and postoperative mortality. *Canadian Medical Association Journal* 189: E303.

Folbert EC, Hegeman JH, Gierveld R, et al. 2017. Complications during hospitalization and risk factors in elderly patients with hip fracture following integrated orthogeriatric treatment. *Archives of Orthopaedic and Trauma Surgery* 137: 507–15.

Gabre-Kidan A, Esemuede I, Lee-Kong SA, et al. 2014. Analysis of 30-day mortality after elective colorectal surgery. *Journal of the American College of Surgeons* 219: e82–3.

Gabriel RA, Sztain JF, A'Court AM, et al. 2018. Postoperative mortality and morbidity following non-cardiac surgery in a healthy patient population. *Journal of Anesthesia* 32: 112–9.

Glance L, Lustik SJ, Hannan E, et al. 2012. The surgical mortality probability model: derivation and validation of a simple risk prediction rule for noncardiac surgery. *Annals of Surgery* 255(4): 696–702.

Graver A, Merwin S, Collins L, et al. 2015. Comorbid profile rather than age determines hip fracture mortality in a nonagenarian population. *HSS Journal* 11: 223–35.

Gutacker N, Bloor K, Cookson R, et al. 2017. Hospital surgical volumes and mortality after coronary artery bypass grafting: using international comparisons to determine a safe threshold. *Health Services Research* 52: 863–78.

Hackett NJ, De Oliveira GS, Jain UK, et al. 2015. ASA class is a reliable independent predictor of medical complications and mortality following surgery. *International Journal of Surgery* 18: 184–90.

Harrison EM, O'Neill S, Meurs TS, et al. 2012. Hospital volume and patient outcomes after cholecystectomy in Scotland: retrospective, national population based study. *BMJ* 344: e3330.

Health Quality & Safety Commission. 2017. *Topic 2: Which older person is at risk of falling? Ask, assess and act*. Wellington: Health Quality & Safety Commission. URL: www.hqsc.govt.nz/assets/Falls/10-Topics/2017_Topic_2_-_Which_older_person_is_at_risk_of_falling_-_Ask_assess_and_act.pdf (accessed April 2018).

Health Quality & Safety Commission. 2018. *Falls Atlas domain: falls in people aged 50 and over.* URL: www.hqsc.govt.nz/our-programmes/health-quality-evaluation/projects/atlas-of-healthcare-variation/falls/ (accessed April 2018).

Hunt LP, Blom A, Wilkinson JM. 2017. An analysis of 30-day mortality after weekend versus weekday elective joint arthroplasty in England and Wales: a cohort study using the National Joint Registry Dataset. *Bone & Joint Journal* 99-B(12): 1618–28.

IMPROVE trial investigators. 2014. Endovascular or open repair strategy for ruptured abdominal aortic aneurysm: 30 day outcomes from IMPROVE randomised trial. *BMJ* 348: f7661.

Inacio MCS, Dillon MT, Miric A, et al. 2017. Mortality after total knee and total hip arthroplasty in a large integrated health care system. *Permanente Journal* 21: 16–171.

Ingraham AM, Cohen ME, Bilimoria KY, et al. 2018. Comparison of 30-day outcomes after emergency general surgery procedures: Potential for targeted improvement. *Surgery* 148: 217–38.

Ingraham AM, Cohen ME, Ko CY, et al. 2010. A current profile and assessment of North American cholecystectomy: results from the American College of Surgeons National Surgical Quality Improvement Program. *Journal of the American College of Surgeons* 211: 176–86.

Iversen LH, Ingeholm P, Gögenur I, et al. 2014. Major reduction in 30-day mortality after elective colorectal cancer surgery: a nationwide population-based study in Denmark 2001–2011. *Annals of Surgical Oncology* 21: 2267–73.

Jawad M, Baigi A, Oldner A. 2016. Swedish Surgical Outcomes Study (SweSOS): An observational study on 30-day and 1-year mortality after surgery. 2016. *European Journal of Anaesthesiology* 33: 317–25.

Karthikesalingam A, Holt PJ, Vidal-Diez A, et al. 2014. Mortality from ruptured abdominal aortic aneurysms: clinical lessons from a comparison of outcomes in England and the USA. *The Lancet* 383: 963–9.

Kühnl A, Erk A, Trenner M, et al. 2017. Incidence, treatment and mortality in patients with abdominal aortic aneurysms: an analysis of hospital discharge data from 2005–2014. *Deutsches Ärzteblatt International* 114: 391–8.

Lichtman JH, Wang Y, Jones SB, et al. 2014. Age and sex differences in inhospital complication rates and mortality after percutaneous coronary intervention procedures: Evidence from the NCDR. *American Heart Journal* 167: 376–83.

Lu P, Yang N-P, Chang N-T, et al. 2018. Effect of socioeconomic inequalities on cholecystectomy outcomes: a 10-year population-based analysis. *International Journal for Equity in Health* 17: 22.

Major LJ, North JB. 2016. Predictors of mortality in patients with femoral neck fracture. *Journal of Orthopaedic Surgery* 24: 150–2.

Mani K, Lees T, Beiles B, et al. 2011. Treatment of abdominal aortic aneurysm in nine countries 2005–2009: a Vascunet report. *European Journal of Vascular and Endovascular Surgery* 42: 598–607.

Manoli A 3rd, Driesman A, Marwin RA, et al. 2017. Short-term outcomes following hip fractures in patients at least 100 years old. *The Journal of Bone and Joint Surgery* 99: e68.

Mascoli C, Vezzosi M, Koutsoumpelis A, et al. 2017. Endovascular repair of acute thoraco-abdominal aortic aneurysms. *European Journal of Vascular and Endovascular Surgery* 55: 92–100.

Messina G, Forni S, Rosadini D, et al. 2017. Risk adjusted mortality after hip replacement surgery: a retrospective study. *Annali dell'Istituto Superiore di Sanità* 53: 40–5.

Middleton M, Wan B, Da Assuncao R. 2016. Improving hip fracture outcomes with integrated orthogeriatric care: a comparison between two accepted orthogeriatric models. *Age Ageing* 46: 465–70.

Ministry of Health. 2015. *Tatau Kahukura: Māori Health Chart Book 2015 (3rd edition).* Wellington: Ministry of Health. URL: www.health.govt.nz/system/files/documents/publications/tatau-kahukura-maori-health-chart-book-3rd-edition-oct15.pdf (accessed April 2018).

Miyata H, Motomura N, Tsukihara H, et al. 2011. Risk models including high-risk cardiovascular procedures: clinical predictors of mortality and morbidity. *European Journal of Cardio-Thoracic Surgery* 39: 667–74.

Nandra R, Pullan J, Bishop J, et al. 2017. Comparing mortality risk of patients with acute hip fractures admitted to a major trauma centre on a weekday or weekend. *Scientific Reports* 7: 1233.

National Health Board. 2015. National Minimum Dataset (Hospital Events) Data Dictionary. Wellington: Ministry of Health. URL: www.health.govt.nz/system/files/documents/publications/nmds_data_dictionary_v7.8.pdf (accessed May 2018).

Neuburger J, Currie C, Wakeman R, et al. 2017. Increased orthogeriatrician involvement in hip fracture care and its impact on mortality in England. *Age Ageing* 46: 187–92.

New Zealand Health Information Service. 2002. *Fracture of neck of femur services in New Zealand hospitals 1999/2000.* Wellington: Ministry of Health. URL: www.moh.govt.nz/notebook/nbbooks.nsf/0/34AAE6E97FD30F07CC2578320068FA7E/$file/fnf2002.pdf (accessed April 2018).

Noordzij PG, Poldermans D, Schouten O, et al. 2010. Postoperative mortality in the Netherlands: A population-based analysis of surgery-specific risk in adults. *Anesthesiology* 112: 1105–15.

Nyholm AM, Gromov K, Palm H, et al. 2015. Time to surgery is associated with thirty-day and ninety-day mortality after proximal femoral fracture: a retrospective observational study on prospectively collected data from the Danish Fracture Database Collaborators. *Journal of Bone & Joint Surgery* 97: 1333–9.

Pearse RM, Moreno RP, Bauer P, et al. 2012. Mortality after surgery in Europe: a 7 day cohort study. *The Lancet* 380: 1059–65.

Peterson ED, Dai D, Delong ER, et al. 2010. Contemporary mortality risk prediction for percutaneous coronary intervention: results from 588,398 procedures in the National Cardiovascular Data Registry. *Journal of the American College of Cardiology* 55: 1923–32.

POMRC. 2016. *Perioperative Mortality in New Zealand: Fifth report of the Perioperative Mortality Review Committee.* Wellington: Health Quality & Safety Commission.

POMRC. 2017. *Perioperative Mortality in New Zealand: Sixth report of the Perioperative Mortality Review Committee.* Wellington: Health Quality & Safety Commission.

Quan H, Li B, Courus C, et al. 2011. Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. *American Journal of Epidemiology* 173: 676–82.

Ruiz M, Bottle A, Aylin PP. 2015. The Global Comparators project: international comparison of 30-day in-hospital mortality by day of the week. *BMJ Quality & Safety* 24(8): 492–504.

Sakata R, Kuwano H, Yokomise H. 2012. Hospital volume and outcomes of cardiothoracic surgery in Japan: 2005–2009 national survey. *General Thoracic and Cardiovascular Surgery* 60: 625–38.

Schermerhorn ML, Bensley RP, Giles KA, et al. 2012. Changes in abdominal aortic aneurysm rupture and short-term mortality, 1995–2008: a retrospective observational study. *Annals of Surgery* 256: 651–8.

Singh JA, Kundukulam J, Riddle DL, et al. 2011. Early postoperative mortality following joint arthroplasty: a systematic review. *Journal of Rheumatology* 38: 1507–13.

Smith SA, Yamamoto JM, Roberts DJ, et al. 2018. Weekend surgical care and postoperative mortality: a systematic review and meta-analysis of cohort studies. *Medical Care* 56: 121–9.

Statistics New Zealand. (nd). *Māori Population Estimates – information releases.* URL: http://archive.stats.govt.nz/browse_for_stats/population/estimates_and_projections/maori-population-estimates-info-releases.aspx (accessed April 2018).

Steuer J, Lachat M, Veith FH, et al. 2016. Endovascular grafts for abdominal aortic aneurysm. *European Heart Journal* 37(2): 145–51. URL: https://doi.org/10.1093/eurheartj/ehv593 (accessed April 2018).

World Health Organization. 2009. *WHO Guidelines for Safe Surgery, 2009: Safe surgery saves lives.* Geneva: World Health Organization.

Yu P, Chang DC, Osen HB, et al. 2011. NSQIP reveals significant incidence of death following discharge. *Journal of Surgical Research* 170: e217–24.

Zapf MA, Kothari AN, Markossian T, et al. 2015. The "weekend effect" in urgent general operative procedures. *Surgery* 158: 508–14.