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

POMRC
Perioperative Mortality Review Committee

Perioperative Mortality in New Zealand:

Fourth report of the Perioperative Mortality Review Committee

Report to the Health Quality & Safety Commission New Zealand

June 2015

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Foreword

As Chair of the Health Quality & Safety Commission, I am pleased to welcome the fourth report from the Perioperative Mortality Review Committee (the POMRC).

This report presents data on perioperative mortality in New Zealand for five new areas of clinical importance analysed over the years 2008–2012: coronary artery bypass graft (CABG), percutaneous transluminal coronary angioplasty (PTCA), bariatric surgery, admissions with an ASA score of 4 or 5 and severe postoperative sepsis. As part of the POMRC's approach to continuing long-term surveillance of perioperative mortality, rates for the clinical areas included in previous reports are also presented for the same time period.

The POMRC has continued its involvement with developing the World Health Organization (WHO) metrics for use in New Zealand. Adopting this set of standardised metrics is central to the POMRC's ability to make international comparisons in access to surgery and surgical quality. This report presents the two previously reported WHO metrics (same day surgical mortality and postoperative inpatient mortality) alongside two more metrics reported for the 10 most frequent surgical procedures performed in New Zealand.

Internationally, the POMRC is working with the Lancet Commission on Global Surgery to refine the measurement of perioperative mortality across countries with varied levels of economic development. The POMRC has also made important contributions to developing methods for measuring the need for essential surgery in different countries with varying hospital information systems and data on disease prevalence.

In New Zealand, the POMRC has continued to develop a system for reviewing local perioperative deaths within health service providers and district health boards. The aim is to understand the nuanced factors that contribute to these deaths and identify ways to improve the quality and safety of surgery and thereby save lives.

This report reflects the commitment of the POMRC to improved patient care through national and international perioperative mortality measurement and surveillance. Dr Wilson and the many other individuals who have worked on this report are to be congratulated.

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

Chair's Introduction

I am pleased to present the fourth report of the Perioperative Mortality Review Committee (the POMRC).

The POMRC is a statutory committee that reviews and reports on perioperative deaths with the aim of reducing these deaths and supporting continuous quality improvement throughout the sector. The POMRC achieves this by advising the Health Quality & Safety Commission on all matters related to perioperative mortality and morbidity, and making sector-wide recommendations to assist with improving the quality and safety of perioperative care.

This report presents the findings on the epidemiology of perioperative mortality for 2008–2012 in five new clinically important areas:

1. Coronary artery bypass graft (CABG)
2. Percutaneous transluminal coronary angioplasty (PTCA)
3. Bariatric surgery
4. Admissions with an American Society of Anesthesiologists (ASA) score of 4 or 5
5. Severe postoperative sepsis.

CABG and PTCA were included among the five clinical areas because they were both frequent, and had a significant number of deaths associated with them; bariatric surgery as this is occurring in increasing numbers, both nationally and internationally; and ASA 4 and 5, and severe postoperative sepsis, because these are patients who were thought to have an increased risk of perioperative death.

In addition to presenting perioperative mortality in these five clinical areas, this report extends analyses from clinical areas included in previous reports to cover the time period for 2008–2012. Clinical areas included in the extended analyses are cholecystectomy, general anaesthesia, hip and knee arthroplasty, mortality in elective admissions for those classified as ASA 1 or 2 and pulmonary embolus-associated mortality. These analyses are part of the POMRC's approach to maintaining ongoing surveillance of perioperative mortality in New Zealand.

Findings from the analysis on PTCA revealed the majority of patients receive this procedure through acute hospital admissions. The POMRC suspects that data on many elective/waiting list admissions for PTCA, entering through private hospitals, are not being routinely submitted to the National Minimum Dataset (NMDS). The results from the sections on hip and knee joint replacements reveal some insight into the percentage of private patients missing from the NMDS.

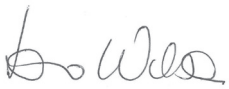
The POMRC is continuing its work on developing the World Health Organization (WHO) metrics for surgical care in New Zealand. Standardised public health metrics from previous reports – day of surgery mortality rate and inpatient mortality rate – are included in this report. Two additional metrics recommended for countries with more advanced data capability have also been introduced in this report; these include:

- number of surgical procedures performed in operating rooms for the 10 most frequent procedures in the country
- proportion of deaths after surgery by procedure for the 10 most frequent procedures in the country.

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

The POMRC is also continuing its work on developing principles and examples of local multidisciplinary review systems for collecting in-depth information to enhance our understanding of perioperative deaths. Since the previous report, the POMRC has conducted a survey of the local perioperative review processes currently used by district health boards (DHBs) and surgical service providers in New Zealand. From these survey results, the POMRC chose three exemplars (Waikato DHB, Southern Cross Main Office and Whanganui DHB) suitable for site visits to gather further details on their review processes. Based on site visits, and acknowledging the variety of institutions involved in perioperative care, work has continued in developing the principles for such systems and potential practical examples.

The 2015 workshop will focus on local perioperative mortality review, and be an opportunity to consult on the progress achieved and future development. This will enable the POMRC to start looking at why patients died, while continuing to monitor who died.



Dr Leona Wilson, ONZM
Chair, Perioperative Mortality Review Committee

Executive Summary

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

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

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

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

Perioperative mortality in New Zealand 2008–2012

The following section summarises the key findings from 2008–2012 for the five clinical areas analysed in this report and for Māori perioperative mortality. Further background data on hospital admissions for the five clinical areas are available in the companion document *Background Information for the Fourth Report of the Perioperative Mortality Review Committee*, which will be available on the Health Quality & Safety Commission's website by July 2015.

For these clinical areas the American Society of Anesthesiologists (ASA) Physical Status Classification System score is a strong predictor of perioperative mortality – evident in both this report and previous reports from the POMRC.

Higher perioperative mortality is associated with a number of risk factors, including:

- increasing age
- comorbidities and poorer overall health status (higher ASA score)
- emergency (not elective/waiting list) admissions into hospital.

Among the five new clinical areas reviewed for this report, the most frequently listed causes of death were myocardial infarction, ischaemic heart disease and other cardiovascular causes, and neoplasms and gastrointestinal causes. However, these were also likely the reasons for many of the procedures being undertaken in the first instance.

In New Zealand during 2008–2012, the following key findings were observed for each new clinical area.

Coronary artery bypass graft (CABG)

- There were 134 deaths and cumulative mortality in the first 30 days following the procedure was 2.47% of admissions.
- Mortality was higher for acute admissions, older people, Māori and those with a higher ASA score. These differences were present after adjusting for clinical and demographic factors.
- Deaths most often occurred within three days of surgery.

Percutaneous transluminal coronary angioplasty (PTCA)

- There were 369 deaths and the 30-day cumulative mortality rate was 1.66% of admissions.
- Mortality was higher with acute admissions (2.28% of admissions) and when no stent was undertaken (5.52% of admissions).
- Mortality increased with increasing age and ASA score, and was higher for Pacific peoples. These differences were present after adjusting for clinical and demographic factors.
- Cumulative mortality among admissions with an ASA score of 5 was very high (62.5%).

Bariatric surgery

- Mortality following bariatric surgery was uncommon – 30-day cumulative mortality was 0.07% of admissions.
- Deaths were due to gastrointestinal causes and injury.
- Admission rates were higher for women, those aged 40–54 years and Māori aged 45–54 years.

Mortality in admissions with an ASA score of 4 or 5

- There were 2099 deaths and cumulative mortality in the first 30 days following the procedure was 13.7% of admissions.
- Cumulative mortality for admissions with an ASA score of 5 was 51.95% of admissions and mortality was highest among emergency admissions with multiple procedures and an ASA score of 5 (58.62%).
- Deaths were most common one day after the anaesthetic procedure.

Severe postoperative sepsis

Among admissions with severe sepsis[1] following general/neuraxial anaesthetic:

- There were 305 deaths and cumulative mortality was high – 21.69% of admissions.
- Most deaths (80%) occurred among acute admissions where cumulative mortality was 22.85%.

Māori perioperative mortality

- Māori mortality was 8.5% following acute CABG and 3.5% following CABG delivered through elective/waiting list admissions. Mortality rates were significantly higher for Māori compared to Europeans after adjusting for sociodemographic and clinical variables.
- Mortality following cholecystectomy delivered through elective/waiting list admission routes was significantly higher for Māori (0.24%) compared to Europeans (0.14%) after adjusting for socio-demographic and clinical variables.
- Same or next day mortality following elective/waiting list admissions with a general anaesthetic was significantly higher for Māori compared to Europeans after adjusting for socio-demographic and clinical variables.
- Across all other clinical areas included in this report, Māori perioperative mortality rates were similar to European rates. This is consistent with findings from previous POMRC reports.

1 Patients with a primary diagnosis of severe sepsis, those with cancer, immunocompromise or pregnancy-related admissions were excluded from analyses.

Perioperative mortality: clinical areas from previous reports

The following section summarises findings from 2008–2012 for the clinical areas that were included in previous POMRC reports. Perioperative mortality rates from previous reports are summarised in Table 1.

It is important to note that changes in mortality 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.

Further data on mortality and hospital admissions for these clinical areas is available in the companion document, which will be available on the Commission's website by July 2015.

In New Zealand during 2008–2012, the following key findings were observed for each of the previously reported clinical areas.

Cholecystectomy

- There were 113 deaths. The overall cumulative mortality was 0.37% of admissions.
- Mortality was higher when an open procedure was undertaken (4.23% of admissions) or when a laparoscopic procedure was converted to an open procedure (1.09% of admissions).
- Cumulative mortality rates were higher among acute admissions (0.82% of admissions) than elective/waiting list admissions (0.18% of admissions).
- Findings were generally consistent with the 2006–2010 and 2007–2011 previously reported time periods.

General anaesthesia

- There were 1436 deaths (0.12% of admissions), most of which occurred among acute admissions and at public hospitals.
- Mortality was between 0.11% and 0.13% of admissions each year.
- Mortality was higher among those admissions that were acute or emergency, those with more than one anaesthetic and those with increasing age and ASA score regardless of other clinical or demographic factors.
- These findings were consistent with those observed in 2007–2011.

Hip arthroplasty

- There were 645 deaths and five-year cumulative mortality was 1.58% of admissions.
- When clinical and demographic factors were considered, rates were significantly higher, and associated with increasing age and poorer health (higher ASA score) among both elective/waiting list and acute admissions.
- The most common cause of death was falls for acute admissions and cardiovascular causes for elective/waiting list admissions.
- Findings were generally consistent with previous reports and data from 2005–2009.

Knee arthroplasty

- There were 46 deaths and the cumulative mortality rate was low (0.17% of admissions).
- Mortality rates increased with increasing age and ASA score, when clinical and demographic factors were considered. Most of the mortality occurred following elective/waiting list procedures, which comprised 98.5% of all knee arthroplasty admissions.
- Cardiovascular causes were the main cause of death.
- The findings are consistent with data from 2005–2009.

Mortality in elective/waiting list admissions with an ASA score of 1 or 2 and who received a general anaesthetic or neuraxial block

- There were between 35 and 60 deaths per annum and the cumulative mortality rate was 0.05%.
- Malignant/Other neoplasms were the most frequently listed cause of death for those over 25 years of age.
- Mortality was significantly higher for males, those over 25 years of age, those receiving two or more anaesthetics during their admission, those given an ASA score of 3 or 4 for the last of their subsequent anaesthetics, and those undergoing subsequent emergency procedures, when clinical and demographics factors were considered.
- Cumulative mortality declined slightly from previous years (down from 0.07% during 2006–2010).

Pulmonary embolus-associated and attributed mortality

For pulmonary embolus-associated admissions:

- There were 307 deaths and the cumulative mortality was 0.024% of initial anaesthetics.

For pulmonary embolus-attributed admissions:

- There were 199 deaths and the overall cumulative mortality for the 30-day period was 0.016% of initial anaesthetics.

In relation to both pulmonary embolus-associated mortality and attributed mortality:

- Malignant/Other neoplasms was the most frequently listed main underlying cause of death regardless of the admission type.
- Mortality rose with age, was higher for acute admissions and was more common in those admissions that had an ASA score of 4.
- In comparison with the 2007–2011 period, cumulative mortality rates were higher in 2008–2012 for both pulmonary embolus-associated and attributed admissions.

Table 1: Cumulative Mortality (per 100,000), New Zealand 2005–2012

TOPICS ANALYSED OVER TIME	2005–2009	2006–2010	2007–2011	2008–2012
		Cumulative 30-Day Mortality Rate per 100,000		
Cholecystectomy: Acute		1040.9 (1.04%)	975.0 (0.98%)	821.7 (0.82%)
Cholecystectomy: Elective/Waiting List		164.6 (0.16%)	151.0 (0.15%)	181.8 (0.18%)
Hip Arthroplasty 45 Yrs +: Acute	7268.6 (7.27%)		6608.9 (6.61%)	7098.0 (7.10%)
Hip Arthroplasty 45 Yrs +: Elective/Waiting List	235.3 (0.24%)		180.5 (0.18%)	171.0 (0.17%)
Knee Arthroplasty 45 Yrs +: Elective/Waiting List	206.9 (0.21%)			142.8 (0.14%)
ASA 1 & 2, Elective/Waiting List (Low-Risk Anaesthetic)		68.8 (0.07%)	62.9 (0.06%)	54.5 (0.05%)
Pulmonary Embolism (Cause of Death): Acute		54.5 (0.055%)	61.7 (0.062%)	67.5 (0.068%)
Pulmonary Embolism (Cause of Death): Elective/Waiting List		7.6 (0.008%)	8.7 (0.009%)	9.0 (0.009%)
		Cumulative One-Day Mortality Rate per 100,000		
General Anaesthetic	119.08 (0.12%)		125.47 (0.13%)	121.5 (0.12%)

Data limitations

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

Many privately funded surgical and procedural day-stay or outpatient hospitals, facilities and in-rooms do not report any events to the NMDS. The Ministry of Health is unable to estimate the extent to which the NMDS undercounts events from private surgical, procedural day-stay or outpatient hospital, and facility or in-room hospitalisations. For this report the data presented is likely to undercount some private hospital events, with the magnitude of this undercount being difficult to quantify. Findings from the sections on hip and knee joint arthroplasty, being derived from the New Zealand Joint Registry, do not have the same issues with underreporting of privately delivered procedures and, as such, they reveal some insight into the percentage of private patients missing from the NMDS.

Small variation in the data sets across time can also result in slight variations in the mortality and hospitalisation rates included in each annual report. This variation can be caused by lapses in the time it takes for the data from each year to be entered into the NMDS and NMC databases, and also through changes in coding over the years. Such variation limits the ability to compare findings between time periods of interest.

Additional information on data limitations is provided in Appendix 2 of this report.

Developing local systems for perioperative mortality review in New Zealand

The POMRC is continuing its work on developing local multidisciplinary perioperative review systems in New Zealand. Since the previous report, the POMRC has conducted a survey of the local perioperative review processes currently used by district health boards (DHBs) and surgical service providers in New Zealand. From these survey results, the POMRC selected three exemplars, with relatively robust review systems already in place, for site visits: Waikato DHB, Southern Cross Main Office and Whanganui DHB. The purpose of these site visits was to gather further details on each organisation's local review processes, policies and best practices.

As a result of these site visits the POMRC agreed to actively recommend that all providers have a designated local mortality review group, and that attendance at dedicated mortality and morbidity meetings occur in protected time. The organisations visited also identified the importance of having a means (eg, forums) to share learnings from local reviews and enable dissemination of key best practice throughout the sector.

Further investigation into how larger hospitals carry out their local mortality reviews is currently under way. Ultimately, local review systems will enhance the POMRC's collection of in-depth information which will, in turn, result in a deeper understanding of the complexities underlying perioperative mortality.

World Health Organization surgical care metrics: developing standardised measures of surgical care in New Zealand

This report presented the two World Health Organization (WHO) public health metrics for surgical care included in the POMRC's previous reports (day of surgery mortality rate and inpatient mortality rate) for the 2008–2012 time period. Two different analytical methods were used to calculate the New Zealand metrics; consistent with previous reports, general anaesthesia/neuraxial admissions were used for one method and the second approach was based on surgical specialty admissions.

An additional two WHO metrics, recommended for countries with more advanced data capability, were introduced for this report:

- number of surgical procedures performed in operating rooms for the 10 most frequent procedures in the country
- proportion of deaths after surgery by procedure for the 10 most frequent procedures in the country.

Key findings included:

- The two different analytical methods yielded slightly varying day of surgery mortality rates (0.07%, and 0.12%) and very similar perioperative (inpatient) mortality rates (0.37% and 0.36% of admissions).
- The 10 most common procedures and 10 procedure blocks associated with the most deaths can be used to guide selection of procedures for in-depth analysis.
- The 10 most common procedures are internally consistent, but there is considerable variation within some of the 10 procedure blocks associated with the most deaths.

Future work will continue to explore and expand the use of WHO metrics as standardised indicators for surgical care in New Zealand. This is part of the POMRC's long-term approach for comparing New Zealand data with other international jurisdictions. The POMRC will also continue working with other bodies (Lancet Commission on Global Surgery, New Zealand Joint Registry) to better understand perioperative mortality and provide information on the safety of surgery and anaesthesia in New Zealand.

Fourth report recommendations

The following recommendations have been developed by the POMRC and are informed by the data presented in this report from the NMDS and NMC.

The POMRC recommends that:

1. Further work should be undertaken to reduce the risk of thromboembolic disease. Consideration should be given to continuing prophylaxis after discharge from hospital including engaging patients in the ways they can reduce their risk.
2. The POMRC continues to participate in the development and evaluation of WHO metrics for monitoring and strengthening global surgery and anaesthesia.
3. All providers (public and private) should contribute data on health care to the NMDS.
4. The ASA status should be recorded for all patients for all procedures (including all procedures that do not involve an anaesthetist).
5. Given the high mortality associated with severe postoperative sepsis, further investigation into prophylaxis, early detection, diagnosis and management should be undertaken.
6. A targeted evaluation of the mortality rate of Māori patients undergoing CABG should be undertaken.
7. Local multidisciplinary mortality review committees should be developed. Review should not be limited to patients viewed as low risk, as investigation of higher risk patients (older, high ASA status, acute) who died may help prevent future deaths by identifying common factors and determining preventable strategies or more appropriate treatment pathways.

The Māori Caucus recommends that:

1. Further research be undertaken to identify ways to improve Māori access to cardiac treatments, including screening, early detection and addressing barriers to service uptake.

Perioperative Mortality 2008–2012

Since the Perioperative Mortality Review Committee's (the POMRC's) first report, initiatives and programmes for improving surgical safety and reducing surgical mortality have continued to expand internationally.

Many of the recent gains in patient safety have stemmed from initiatives that emphasise process improvements, such as the use of the World Health Organization (WHO) surgical safety checklist (Avidan and Kheterpal 2012). A number of international studies and reviews have demonstrated that surgical safety checklist use is associated with reduced perioperative mortality, morbidity and length of in-hospital stays (eg, de Vries et al 2010; Fudickar et al 2012; Haugen et al 2015; van Klei et al 2012).

Having standardised indicators is a crucial aspect of tracking population-level improvements in surgical quality and safety. The perioperative mortality rate (POMR) is an internationally recognised indicator of access to, and the safety of, surgery (Makasa 2012). The POMR is often defined as deaths following anaesthesia within two time periods: day-of-surgery and before discharge from hospital or within 30 days of surgery. Adjustments for socio-demographic and clinical risk factors allow for comparisons in POMRs across jurisdictions (Watters et al 2014). A systematic review and meta-analysis of POMRs across developed and developing countries provides evidence that perioperative mortality has declined over the past 50 years, despite increasing pre-operative risk among patients (Bainbridge et al 2012).

The following chapters present the perioperative mortality findings for the five new clinical areas examined in this report: coronary artery bypass grafts (CABG), percutaneous transluminal coronary angioplasty (PTCA), bariatric surgery, American Society of Anesthesiologists (ASA) scores of 4 and 5, and severe postoperative sepsis. Among these clinical areas, CABG and PTCA were both included because the procedures are used relatively frequently and had a significant number of deaths associated with them. Bariatric surgery was included due to its increasing frequency of use, both nationally and internationally. Severe postoperative sepsis and ASA scores of 4 and 5 were both included as these patients are likely to have increased risk of perioperative death.

In addition to these clinical areas, a summary of key findings for Māori and a brief discussion are presented for all clinical areas reviewed for this report. Where health systems are not addressing a population's need for both surgical access and safety, the POMRs will be higher and there will be fewer procedures per head of population (Watters et al 2014). Thus, this chapter also presents relevant background information on Māori hospital admissions.

Further background information on hospital admissions for each clinical area is provided in the companion document, which will be available on the Commission's website by July 2015.

Mortality following Coronary Artery Bypass Graft (CABG)

Information from the National Minimum Dataset (NMDS) and the National Mortality Collection (NMC) were used to review mortality in the first 30 days following a CABG or as an inpatient.

Key findings

In New Zealand during 2008–2012, following CABG:

- There were 134 deaths and cumulative mortality was 2.47% of admissions.
- The most common causes of death were myocardial infarction, ischaemic heart disease and other cardiovascular causes.
- Deaths most often occurred within three days of surgery.
- Mortality was higher for acute admissions, older people, Māori, and those with a higher ASA score, when clinical and socio-demographic factors were accounted for.
- The mortality rate for acute admissions with an ASA score of 5 was very high (33.3%).

Data sources, methods and limitations

Details on the CABG data sources are presented in Appendix 2.

The NMDS and NMC data sets have limitations associated with coding accuracy and data completeness. For example, some privately funded procedures undertaken at private hospitals are not recorded in the NMDS. Both data sets are dependent on the quality of clinical records and classification systems.

Information on methods and interpretation notes are presented in Appendix 2.

Mortality following CABG

Mortality following CABG by year

In New Zealand during 2008–2012, there were between 21 and 29 deaths each year following CABG and the proportion of deaths per 100 admissions varied between 1.86% and 2.75% (Table 2). Cumulative mortality over the five-year period was 2.47% of admissions.

Table 2: Mortality following CABG by Year, New Zealand 2008–2012

YEAR	Deaths	Admissions	Mortality per 100 Admissions (%)
2008	28	1,107	2.53
2009	29	1,075	2.70
2010	21	1,131	1.86
2011	28	1,017	2.75
2012	28	1,106	2.53
Total	134	5,436	2.47

Data source: NMC: Deaths occurring within 30 days of a CABG or as an inpatient as recorded in the NMDS. NMDS: Hospital admissions with a CABG listed in any of the first 90 procedures.

Mortality following CABG by number of initial procedures

In New Zealand during 2008–2012, 134 deaths occurred within 30 days following CABG (Table 3) or as an inpatient. Most deaths related to a single procedure; however, in 27% of admissions more than one type of bypass procedure occurred on the same day. Cumulative mortality related to a single procedure was 2.61% of admissions compared with 2.08% among those with more than one bypass procedure. Overall cumulative mortality for all admissions during 2008–2012 was 2.47% of admissions.

Table 3: Mortality following CABG by Number of Initial Procedures, New Zealand 2008–2012

PROCEDURES	Deaths	Admissions	Annual Average	Deaths in Category (%)
One Initial Procedure	104	3,991	20.8	77.6
Two Initial Procedures	25	1,160	5.0	18.7
Three or More	5	285	1.0	3.7
Total	134	5,436	26.8	100.0

Data source: NMC: Deaths occurring within 30 days of a CABG or as an inpatient, as recorded in the NMDS. NMDS: Hospital admissions with a CABG listed in any of the first 90 procedures.

Mortality following CABG procedures by type of initial procedure

In New Zealand during 2008–2012, most deaths following CABG (62%) occurred following procedures that involved grafting the left internal mammary artery (LIMA) (Table 4). Most CABG admissions (66%) used the LIMA for the bypass procedure.

Table 4: Mortality following CABG by Main Type of Initial Procedure, New Zealand 2008–2012

PROCEDURES	Deaths	Admissions	Annual Average	Deaths in Category (%)
Saphenous Vein Only	18	285	3.6	13.4
LIMA Only	83	3,597	16.6	61.9
RIMA Only	0	16	0.0	0.0
Radial Artery Only	1	34	0.2	0.7
One Other Only	2	59	0.4	1.5
Two Initial Procedures	25	1,160	5.0	18.7
Three or More	5	285	1.0	3.7
Total	134	5,436	26.8	100.0

Data source: NMC: Deaths occurring within 30 days of a CABG or as an inpatient, as recorded in the NMDS. NMDS: Hospital admissions with a CABG listed in any of the first 90 procedures.
LIMA: left internal mammary artery.
RIMA: right internal mammary artery.

Mortality following CABG by cause of death

In New Zealand during 2008–2012, myocardial infarction was the most common single underlying cause of death following CABG. Cardiovascular causes were the predominant underlying causes of death (Table 5).

Table 5: Main Underlying Cause of Death following CABG, New Zealand 2008–2012

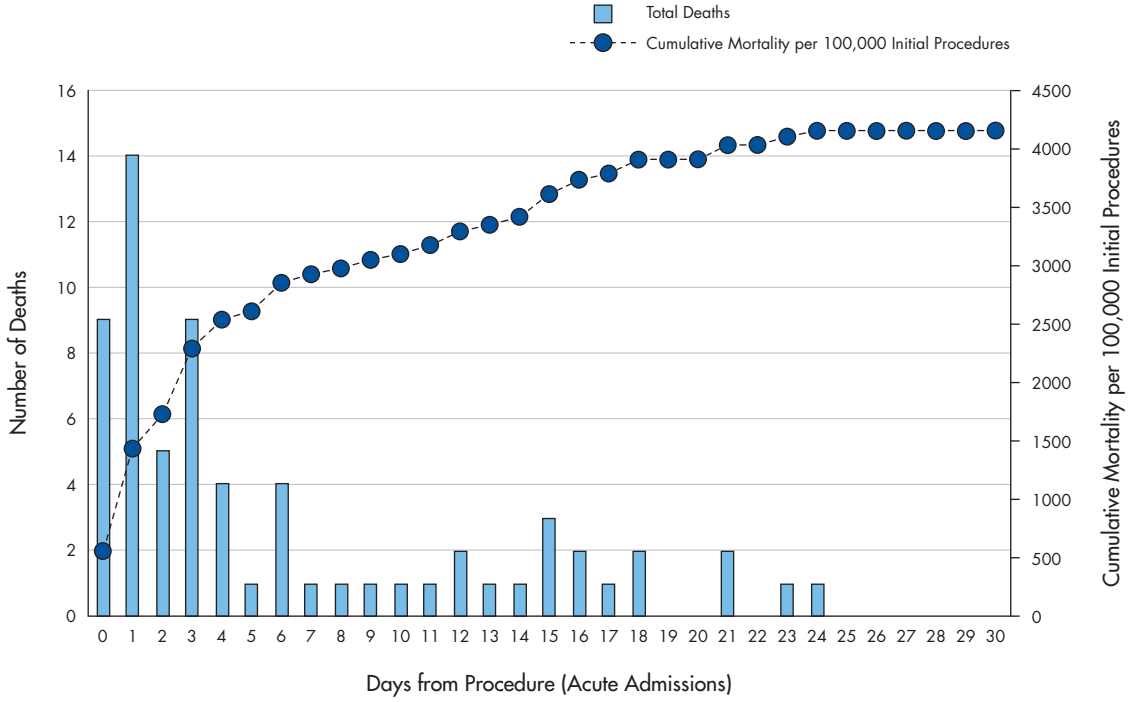
MAIN UNDERLYING CAUSE OF DEATH FOLLOWING CABG	Deaths	Annual Average	Deaths in Category (%)
Myocardial Infarction	35	7.0	26.1
Other Cardiovascular Causes	27	5.4	20.1
Other Ischaemic Heart Disease	37	7.4	27.6
Non-Insulin Dependent Diabetes	3	0.6	2.2
Other	4	0.8	3.0
Not Stated	28	5.6	20.9
Total	134	26.8	100.0

Data source: NMC: Deaths occurring within 30 days of a CABG or as an inpatient, as recorded in the NMDS.

Mortality following CABG by day from procedure

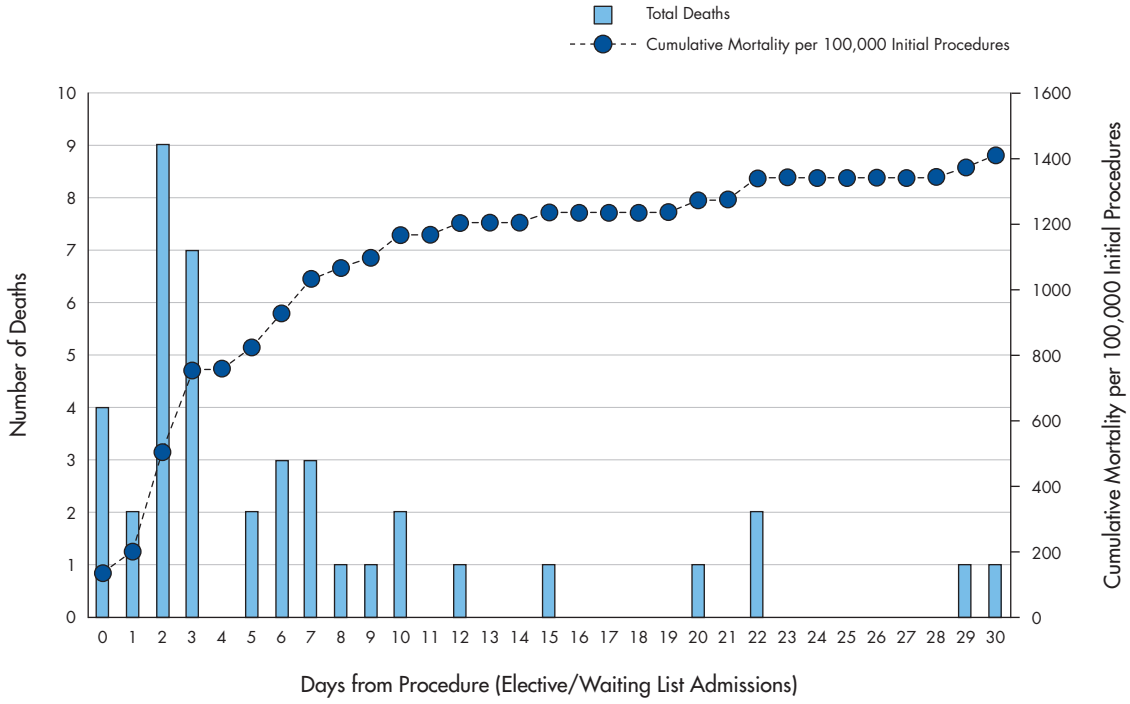
Mortality following acute CABG during 2008–2012 was highest on the first day after surgery (Figure 1), whilst for elective/waiting list admissions, the highest number of deaths occurred two days after surgery (Figure 2). Cumulative 30-day mortality was higher for acute admissions (4.16% of admissions) than elective/waiting list admissions (1.41% of admissions).

Figure 1: Mortality following Acute Admission for CABG by Days from Procedure, New Zealand 2008–2012



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

Figure 2: Mortality following Elective/Waiting List Admission for CABG by Days from Procedure, New Zealand 2008–2012

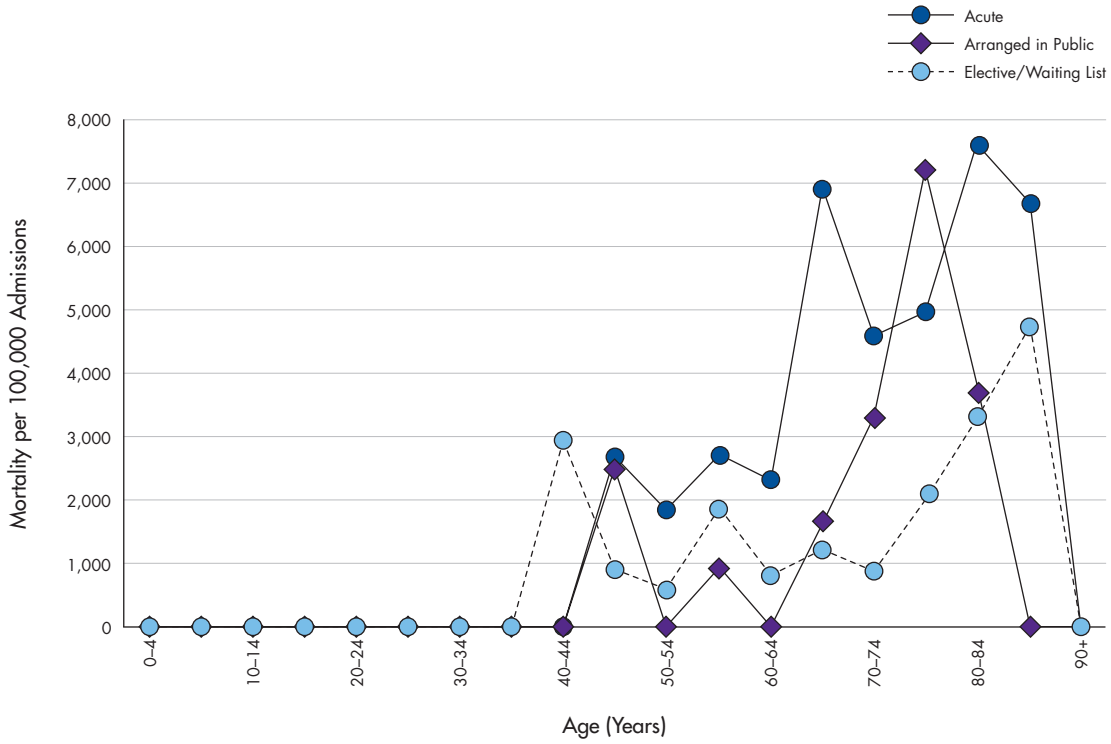


Numerator: NMC: Deaths occurring within 30 days of a CABG, as recorded in the NMDS.
Denominator: NMDS: Elective/Waiting list hospital admissions with a CABG listed in any of the first 90 procedures.

Mortality following CABG by age and admission type

In New Zealand from 2008 to 2012, mortality in adults following a CABG increased with age, reaching the highest rates at 80–84 years for acute admissions and 85–89 years for elective/waiting list admissions. The peak was slightly younger for semi-acute (arranged in public) admissions, at 75–79 years (Figure 3). Acute admissions had a higher rate of mortality than elective/waiting list admissions in every age group except 40–44-year-olds, although those numbers were small.

Figure 3: Mortality following CABG by Admission Type and Age, New Zealand 2008–2012

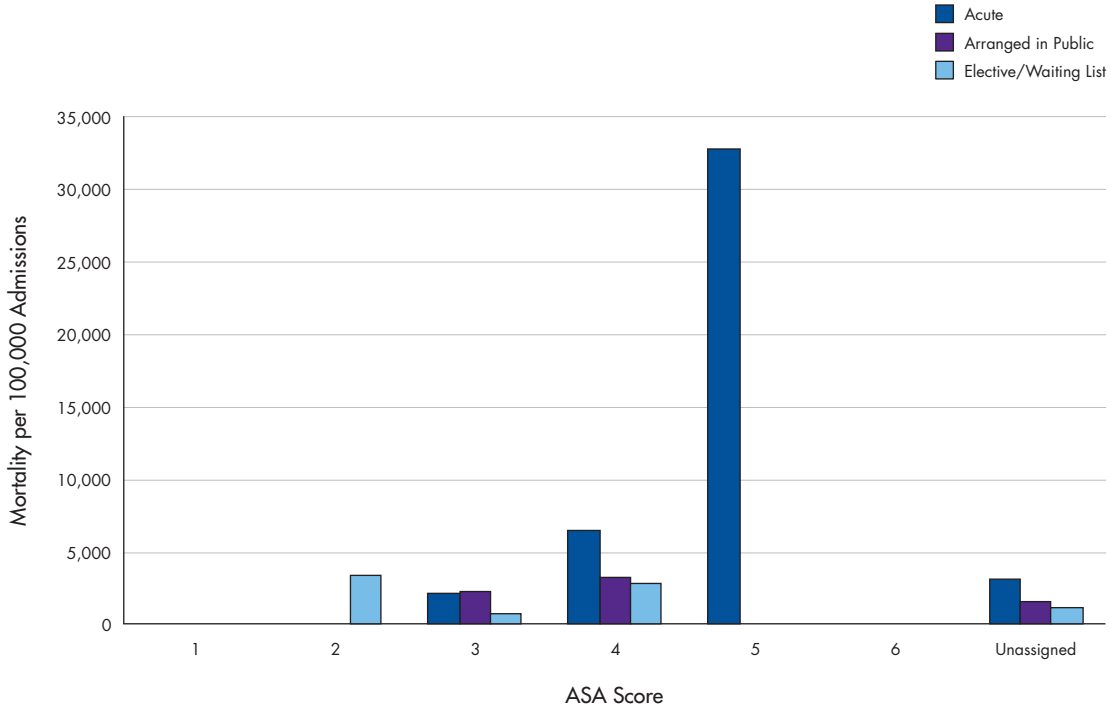


Numerator: NMC: Deaths occurring within 30 days of a CABG or as an inpatient, as recorded in the NMDS.
Denominator: NMDS: Hospital admissions with a CABG listed in any of the first 90 procedures.

Mortality by ASA score

Mortality rates following CABG during 2008–2012 generally increased with increasing ASA score for all admission types (Figure 4). Higher rates of mortality were observed for those admitted acutely in ASA score categories 4 to 5. The mortality rate for acute admissions with an ASA score of 5 was notably high (33.3%).

Figure 4: Mortality following CABG by Admission Type and ASA Score, New Zealand 2008–2012



Numerator: NMC: Deaths occurring within 30 days of a CABG or as an inpatient, as recorded in the NMDS.
Denominator: NMDS Hospital admissions with a CABG listed in any of the first 90 procedures.

Mortality by socio-demographic factors and ASA score

Acute admissions

Mortality rates following acute admissions for CABG in New Zealand during 2008–2012 were significantly higher for those groups aged over 64 years (compared to 45–64 years), females (vs males), Māori (vs European), and for those with a first ASA score of 4 or more (compared with an ASA score of 1, 2 or 3) (Table 6). These differences were evident when the model was adjusted for other socio-demographic risk factors (age, gender, ethnicity and New Zealand Deprivation Index (NZDep) decile) and ASA score.

Elective/Waiting list admissions

During 2008–2012, mortality following elective/waiting list admissions for CABG was significantly higher for those groups aged 80 years and over (vs. 45–64 years), those with an ASA score of 4 or more (vs. ASA score of 1, 2 or 3) and for those of Māori ethnicity (vs. European) (Table 7). These results were evident when other socio-demographic and clinical risk factors (age, gender, ethnicity, NZDep decile and ASA score) were accounted for.

Table 6: Mortality following Acute Admission for CABG by Age, Gender, ASA Score, Ethnicity and NZDep Decile, New Zealand 2008–2012

VARIABLE	CATEGORY	Number of Deaths	Number of Admissions	Mortality per 100,000 Admissions	Mortality per 100 Admissions (%)	Univariate OR	95% CI	Multivariate OR	95% CI
Age Group	45–64 years	15	656	2,287	2.3	1		1	
	65–79 years	43	751	5,726	5.7	2.60*	(1.46–4.87)	2.56*	(1.40–4.92)
	80+ years	7	100	7,000	7.0	3.22*	(1.20–7.84)	3.48*	(1.24–9.01)
Gender	Male	40	1,188	3,367	3.4	1		1	
	Female	25	319	7,837	7.8	2.44*	(1.44–4.06)	2.06*	(1.20–3.48)
ASA Score	1,2,3	12	529	2,268	2.3	1		1	
	4,5,6	39	571	6,830	6.8	3.16*	(1.69–6.36)	3.09*	(1.63–6.29)
	Not stated	14	407	3,440	3.4	1.53	(0.70–3.41)	1.47	(0.66–3.30)
Ethnicity	European	47	1,167	4,027	4.0	1		1	
	Māori	9	106	8,491	8.5	2.21	(0.99–4.44)	2.73*	(1.15–5.97)
	Pacific	4	110	3,636	3.6	0.90	(0.27–2.26)	0.82	(0.24–2.21)
	Asian/ MELAA/ Other	5	124	4,032	4.0	1.00	(0.34–2.34)	1.10	(0.37–2.65)
NZDep Decile	Decile 1–2	11	255	4,314	4.3	1		1	
	Decile 3–4	5	266	1,880	1.9	0.42	(0.13–1.19)	0.46	(0.14–1.29)
	Decile 5–6	18	342	5,263	5.3	1.23	(0.58–2.74)	1.28	(0.59–2.89)
	Decile 7–8	17	362	4,696	4.7	1.09	(0.51–2.44)	1.06	(0.48–2.42)
	Decile 9–10	14	282	4,965	5.0	1.16	(0.52–2.66)	1.02	(0.43–2.45)

Data source: NMC: Deaths occurring within 30 days of a CABG or as an inpatient as recorded in the NMDS. NMDS: Acute hospital admissions with a CABG listed in any of the first 90 procedures.
CI: Confidence interval, OR: Odds ratio, *: Significantly different from reference category, MELAA: Middle Eastern/Latin American/African.

Table 7: Mortality following Elective/Waiting List Admission for CABG by Age, Gender, ASA Score, Ethnicity and NZDep Decile, New Zealand 2008–2012

VARIABLE	CATEGORY	Number of Deaths	Number of Admissions	Mortality per 100,000 Admissions	Mortality per 100 Admissions (%)	Univariate OR	95% CI	Multivariate OR	95% CI
Age Group	45–64 years	12	1,033	1,162	1.2	1		1	
	65–79 years	20	1,514	1,321	1.3	1.14	(0.56–2.41)	1.41	(0.67–3.10)
	80+ years	6	201	2,985	3.0	2.62	(0.90–6.83)	3.12*	(1.00–8.98)
Gender	Male	30	2,236	1,342	1.3	1		1	
	Female	8	512	1,563	1.6	1.17	(0.50–2.44)	0.98	(0.41–2.07)
ASA Score	1,2,3	10	1,257	796	0.8	1		1	
	4,5,6	18	628	2,866	2.9	3.68*	(1.72–8.33)	2.98*	(1.37–6.84)
	Not stated	10	863	1,159	1.2	1.46	(0.60–3.58)	1.37	(0.56–3.36)
Ethnicity	European	24	2,232	1,075	1.1	1		1	
	Māori	8	227	3,524	3.5	3.36*	(1.40–7.26)	3.74*	(1.45–8.88)
	Pacific	<3	120	833	0.8	s	s	s	s
	Asian/ MELAA/ Other	5	169	2,959	3.0	2.80	(0.93–6.88)	2.96	(0.96–7.54)
NZDep Decile	Decile 1–2	4	442	905	0.9	1		1	
	Decile 3–4	4	492	813	0.8	0.90	(0.21–3.82)	0.83	(0.19–3.57)
	Decile 5–6	12	588	2,041	2.0	2.28	(0.79–8.20)	1.93	(0.66–6.99)
	Decile 7–8	10	646	1,548	1.5	1.72	(0.57–6.31)	1.42	(0.46–5.27)
	Decile 9–10	8	580	1,379	1.4	1.53	(0.48–5.77)	1.10	(0.33–4.30)

Data source: NMC: Deaths occurring within 30 days of a CABG or as an inpatient as recorded in the NMDS. NMDS: Elective/Waiting list hospital admissions with a CABG listed in any of the first 90 procedures.
CI: Confidence interval, OR: Odds ratio, *: Significantly different from reference category, s: Results suppressed due to small numbers, MELAA: Middle Eastern/Latin American/African.

Mortality following Percutaneous Transluminal Coronary Angioplasty (PTCA)

The following section uses information from the NMDS and the NMC to review mortality either in the first 30 days following PTCA or as an inpatient.

Key findings

In New Zealand during 2008–2012 following PTCA:

- There were 369 deaths and the cumulative mortality rate was 1.66% of admissions.
- Most deaths were due to myocardial infarction.
- Mortality was higher with acute admissions (2.28% of admissions) and when no stent was undertaken (5.52% of admissions).
- Mortality increased with increasing age and ASA score, and was higher for Pacific peoples, when clinical and socio-demographic factors were accounted for.
- Mortality more than 20 days after a procedure was uncommon.
- Cumulative mortality among admissions with an ASA score of 5 was very high (62.5%).

Data sources, methods and limitations

Details on the PTCA data sources are presented in Appendix 2.

The NMDS and NMC data sets have limitations associated with coding accuracy and data completeness. For example, some privately funded procedures undertaken at private hospitals are not recorded in the NMDS. Both data sets are dependent on the quality of clinical records and classification systems.

An ASA score was not available for 86% of admissions. For analyses by admission type, semi-acute (arranged in public) admissions are presented with elective/waiting list admissions as most deaths following PTCA occurred during acute admissions.

Information on methods and interpretation notes are presented in Appendix 2.

Mortality following PTCA

Mortality following PTCA by year

In New Zealand during 2008–2012, there were between 58 and 86 deaths each year following PTCA and the proportion of deaths per 100 admissions varied between 1.34% and 1.88% (Table 8). Cumulative mortality over the five-year period was 1.66% of admissions.

Table 8: Mortality following PTCA by Year, New Zealand 2008–2012

YEAR	Deaths	Admissions	Mortality per 100 Admissions (%)
2008	68	4,296	1.58
2009	58	4,331	1.34
2010	74	4,437	1.67
2011	83	4,405	1.88
2012	86	4,742	1.81
Total	369	22,211	1.66

Data source: NMC: Deaths occurring within 30 days of a PTCA or as an inpatient as recorded in the NMDS. NMDS: Hospital admissions with a PTCA listed in any of the first 90 procedures.

Mortality following PTCA by initial procedure

In New Zealand during 2008–2012, 369 deaths occurred within 30 days following a PTCA (Table 9). Overall cumulative mortality was 1.66% of admissions. Most deaths and most admissions related to a single stent inserted into one artery.

Table 9: Mortality following PTCA by Initial Procedure Types, New Zealand 2008–2012

PROCEDURES	Deaths	Admissions	Cumulative Mortality (%)	Deaths in Category (%)
PTCA 1 Stent into 1 Artery	180	13,015	1.38	48.8
PTCA > 1 Stent into 1 Artery	76	3,929	1.93	20.6
PTCA > 1 Stent into > 1 Artery	60	4,121	1.46	16.3
PTCA No Stent	48	869	5.52	13.0
Multiple Procedures	5	277	1.81	1.3
Total	369	22,211	1.66	100.0

Data source: NMC: Deaths occurring within 30 days of a PTCA or as an inpatient as recorded in the NMDS. NMDS: Hospital admissions with a PTCA listed in any of the first 90 procedures.

Mortality following PTCA by cause of death

In New Zealand during 2008–2012, myocardial infarction was the most common underlying cause of death among admissions for PTCA. Cardiovascular causes were the predominant underlying cause of death (Table 10).

Table 10: Main Underlying Cause of Death following PTCA, New Zealand 2008–2012

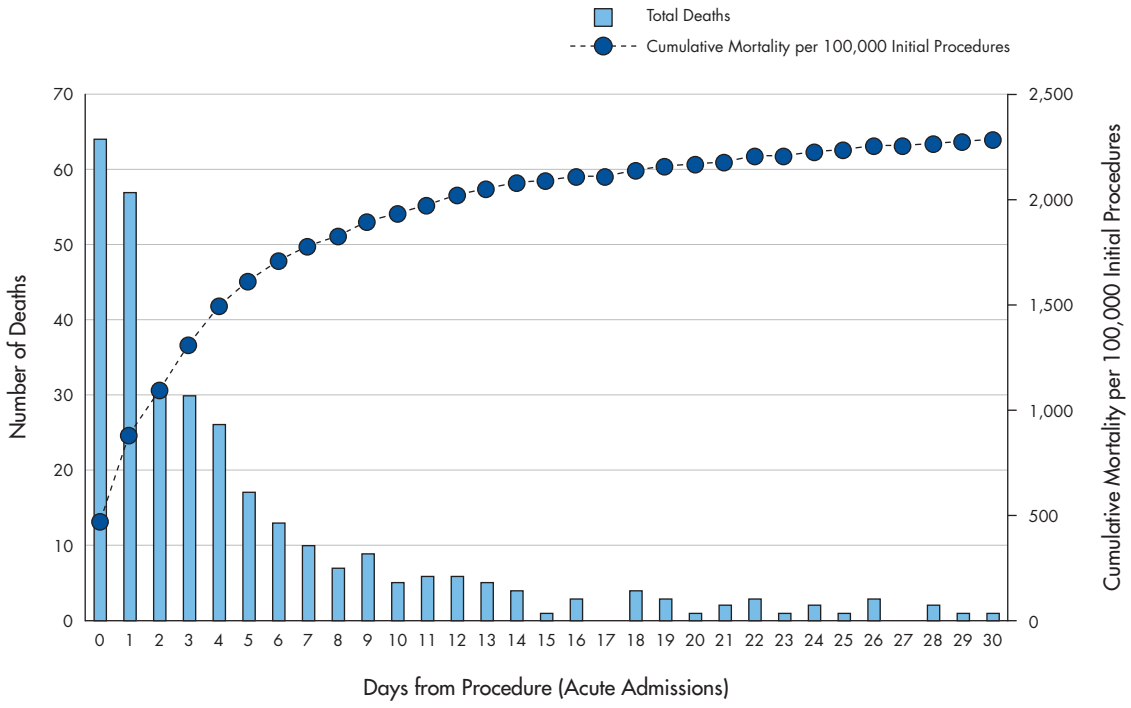
	Deaths	Annual Average	Deaths in Category (%)
Other Causes	16	3.2	4.3
Myocardial Infarction	206	41.2	55.8
Other Cardiovascular Causes	9	1.8	2.4
Other Ischaemic Heart Disease	32	6.4	8.7
Non-Insulin Dependent Diabetes	11	2.2	3
Neoplasms	3	0.6	0.8
Respiratory	4	0.8	1.1
Not Stated	88	17.6	23.8
Total	369	73.8	100

Data source: NMC: Deaths occurring within 30 days of a PTCA or as an inpatient, as recorded in the NMDS.

Mortality following PTCA by day from procedure

Mortality following PTCA for acute admissions in New Zealand during 2008–2012 was highest on the same day as surgery and the following day (Figure 5). The number of deaths declined over the following three weeks. Cumulative 30-day mortality for acute admissions was 2.28% of admissions. Deaths related to arranged in public/elective/waiting list procedures were uncommon (Figure not shown) and mostly occurred on the same day as the procedure.

Figure 5: Mortality following Acute Admission for PTCA by Days from Procedure, New Zealand 2008–2012

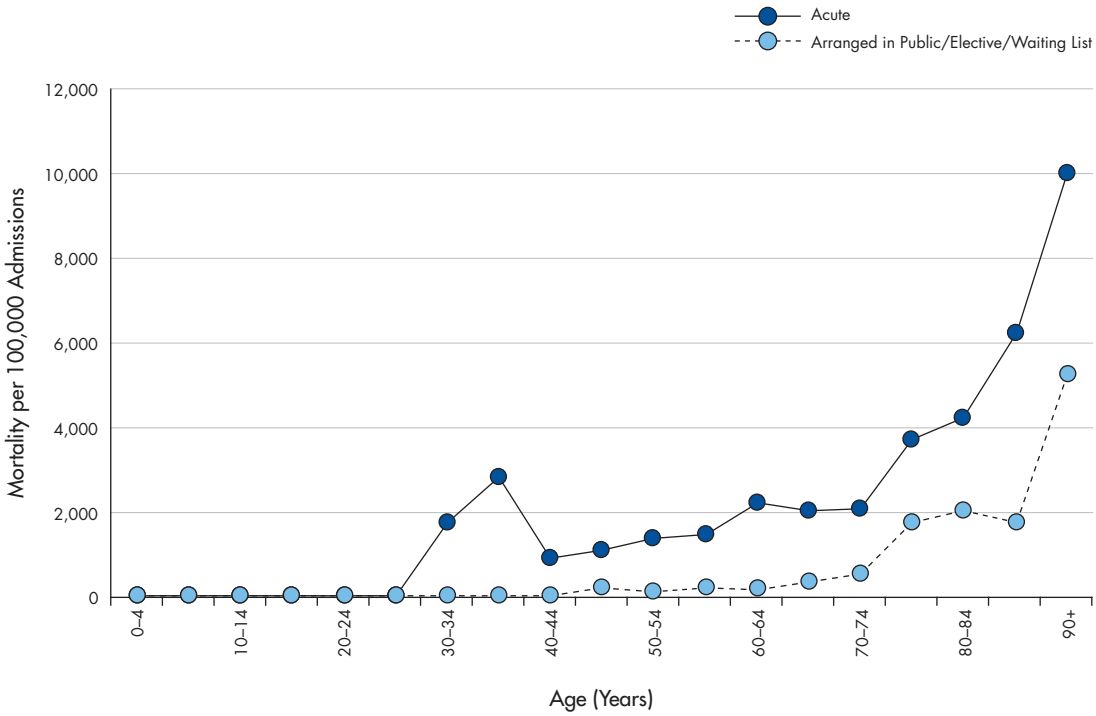


Numerator: NMC: Deaths occurring within 30 days of a PTCA, as recorded in the NMDS.
Denominator: NMDS: Acute hospital admissions with a PTCA listed in any of the first 90 procedures.

Mortality following PTCA by age and admission type

In New Zealand from 2008 to 2012, mortality following a PTCA increased with age, reaching the highest rates at 90+ years for acute and arranged in public/elective/waiting list admissions (Figure 6). Acute admissions had a higher rate of mortality than arranged in public/elective/waiting list admissions in every age group. Deaths before age 25, regardless of admission type, were rare.

Figure 6: Mortality following PTCA by Admission Type and Age, New Zealand 2008–2012

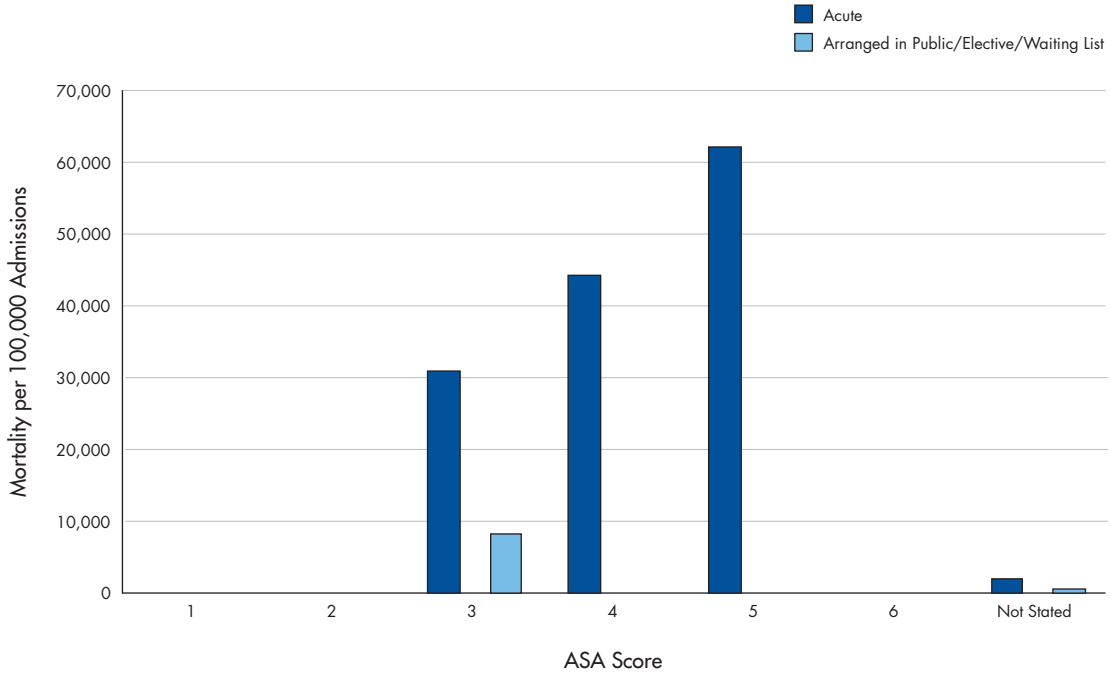


Numerator: NMC: Deaths occurring within 30 days of a PTCA or as an inpatient, as recorded in the NMDS.
Denominator: NMDS: Hospital admissions with a PTCA listed in any of the first 90 procedures.

Mortality by ASA score

Mortality rates following PTCA during 2008–2012 in New Zealand increased with increasing ASA score for acute admission types (Figure 7). Higher rates of mortality were observed for those admitted acutely in ASA score 4 and 5 categories (62.5% for ASA 5).

Figure 7: Mortality following PTCA by Admission Type and ASA Score, New Zealand 2008–2012



Numerator: NMC: Deaths occurring within 30 days of a PTCA or as an inpatient, as recorded in the NMDS.
Denominator: NMDS: Hospital admissions with a PTCA listed in any of the first 90 procedures.

Mortality by socio-demographic factors and ASA score

Acute admissions

Mortality rates following acute admissions for PTCA in New Zealand during 2008–2012 were significantly higher for those groups aged over 64 years (compared to 45–64 years), ASA 4, 5 and 6 (compared with ASA 1, 2 and 3) Pacific (vs European) and among those with NZDep deciles 7–10 (vs deciles 1–2) (Table 11). These differences were evident when the model was adjusted for other socio-demographic risk factors (age, gender, ethnicity and NZDep decile) and ASA score. An ASA score was not available for 86% of admissions.

Table 11: Mortality following Acute Admission for PTCA by Age, Gender, ASA Score, Ethnicity and NZDep Decile, New Zealand 2008–2012

VARIABLE	CATEGORY	Number of Deaths	Number of Admissions	Mortality per 100,000 Admissions	Mortality per 100 Admissions (%)	Univariate OR	95% CI	Multivariate OR	95% CI
PTCA									
Acute admissions									
Age Group	0–44 years	12	791	1,517	1.50	0.93	(0.48–1.63)	0.81	(0.42–1.43)
	45–64 years	102	6,247	1,633	1.60	1		1	
	65–79 years	120	5,018	2,391	2.40	1.48*	(1.13–1.93)	1.61*	(1.23–2.12)
	80+ years	64	1,293	4,950	4.90	3.14*	(2.27–4.30)	3.65*	(2.60–5.08)
Gender	Male	209	9,754	2,143	2.10	1		1	
	Female	89	3,595	2,476	2.50	1.16	(0.90–1.48)	0.96	(0.74–1.24)
ASA Score	1,2,3	4	16	25,000	25	1		1	
	4,5,6	38	76	50,000	50	3	(0.95–11.49)	4.56*	(3.02–5.96)
	Not stated	256	13,257	1,931	1.90	0.06*	(0.02–0.21)	1	
Ethnicity	European	224	10,660	2,101	2.10	1		1	
	Māori	24	918	2,614	2.60	1.25	(0.80–1.88)	1.47	(0.92–2.25)
	Pacific	22	613	3,589	3.60	1.73*	(1.08–2.65)	2.08*	(1.26–3.27)
	Asian/ MELAA/ Other	28	1,158	2,418	2.40	1.15	(0.76–1.69)	1.34	(0.87–1.97)
NZDep Decile	Decile 1–2	41	2,471	1,659	1.70	1		1	
	Decile 3–4	53	2,415	2,195	2.20	1.33	(0.88–2.02)	1.33	(0.88–2.02)
	Decile 5–6	58	2,829	2,050	2.10	1.24	(0.83–1.87)	1.21	(0.81–1.83)
	Decile 7–8	74	3,029	2,443	2.40	1.48*	(1.02–2.20)	1.46*	(1.00–2.17)
	Decile 9–10	72	2,605	2,764	2.80	1.68*	(1.15–2.50)	1.62*	(1.09–2.44)

Data source: NMC: Deaths occurring within 30 days of a PTCA or as an inpatient, as recorded in the NMDS. NMDS: Acute hospital admissions with a PTCA listed in any of the first 90 procedures.
CI: Confidence interval, OR: Odds ratio, *: Significantly different from reference category, MELAA: Middle Eastern/Latin American/African.

Mortality following Bariatric Surgery

The following section uses information from the NMDS and the NMC to review mortality either in the first 30 days following bariatric surgery or as an inpatient.

Key findings

In New Zealand during 2008–2012:

- Mortality following bariatric surgery was uncommon; cumulative mortality was 0.07% of admissions.
- Deaths were due to gastrointestinal causes and injury.
- Admission rates were higher for women, those aged 40–54 years and Māori aged 45–54 years.

Data sources, methods and limitations

Details on the bariatric surgery data sources are presented in Appendix 2.

The NMDS and NMC data sets have limitations associated with coding accuracy and data completeness. For example, some privately funded procedures undertaken at private hospitals are not recorded in the NMDS. Both data sets are dependent on the quality of clinical records and classification systems.

Information on methods and interpretation notes are presented in Appendix 2.

Mortality following bariatric surgery

Mortality following bariatric surgery

In New Zealand during 2008–2012, there were three deaths within 30 days following 4067 bariatric admissions. The overall cumulative mortality was 0.07% of admissions.

Mortality following bariatric surgery by type of initial procedure

In New Zealand during 2008–2012, two out of the three deaths following bariatric surgery occurred after a gastric bypass procedure (Table 12). Gastric reduction was the most common procedure performed on those admitted for bariatric surgery during 2008–2012. The proportion of admissions where more than one procedure was undertaken during the operation was small (1%).

Table 12: Mortality following Bariatric Surgery by Main Type of Initial Procedure, New Zealand 2008–2012

PROCEDURES	Deaths	Admissions	Cumulative Mortality % Admissions
Gastric Reduction (Sleeve Gastrectomy)	1	2,403	0.04
Gastric Bypass	2	1,373	0.15
Reversal of Procedure for Morbid Obesity	0	89	0
Revision of Gastric Band	0	148	0
Two Initial Procedures	0	54	0
Total	3	4,067	0.07

Data source: NMC: Deaths occurring within 30 days of bariatric surgery or as an inpatient, as recorded in the NMDS. NMDS: Hospital admissions with bariatric surgery listed in any of the first 90 procedures.

Mortality following bariatric surgery by admission type, cause of death, day from procedure and age

In New Zealand during 2008–2012, injury and gastrointestinal causes were the main underlying cause for the three deaths related to bariatric surgery. Deaths occurred between 9 and 19 days following surgery and admission ages were 40–49 years.

Mortality in Admissions with an ASA Score of 4 or 5

The following section uses information from the NMDS and the NMC to review mortality in the first 30 days following any operative procedure that included a general anaesthetic or neuraxial block on those admitted to hospital with an initial ASA score of 4 or 5. General anaesthetics or neuraxial blocks for maternity procedures were not included in the data set reviewed for this chapter.

Additional background information on ASA scores is provided in Appendix 2.

Key findings

In New Zealand during 2008–2012, for those admissions that were given an ASA score of 4 or 5 and who received a general anaesthetic or neuraxial block during their admission:

- There were 2099 deaths and the cumulative mortality rate was 13.7% of admissions.
- The cumulative mortality for admissions with an ASA score of 5 was 51.95% of admissions, and mortality was highest among emergency admissions with multiple procedures and an ASA score of 5 (58.62%).
- Cardiovascular diseases and neoplasms were the most common underlying cause of death.
- Mortality was higher among acute admissions, those older than 45 years, those with an ASA score of 5, and emergency procedures.
- Deaths were most common one day after the anaesthetic procedure.

Data sources, methods and limitations

Appendix 2 describes the data sources for mortality in admissions with an ASA score of 4 or 5 that included a general anaesthetic or neuraxial block.

It is important to note that, among the elective/waiting list admissions, some were admitted for procedures and initially assigned an ASA score of 4, but then subsequently became unwell and required another procedure for which they were assigned an ASA score of 5. Some of the elective/waiting list admissions may have had acute deterioration after admission, but before their first procedure. Some may have been miscoded.

The NMDS and NMC data sets have limitations associated with coding accuracy and data completeness. For example, some privately funded procedures undertaken at private hospitals are not recorded in the NMDS. Both data sets are dependent on the quality of clinical records and classification systems.

Information on methods and interpretation notes are presented in Appendix 2.

Mortality in admissions with an ASA score of 4 or 5

Mortality by year

In New Zealand during 2008–2012, annual mortality was between 395 and 447 deaths and cumulative mortality was between 12.75% and 14.86% for those admissions that were given an ASA score of 4 or 5, and who received a general anaesthetic or neuraxial block during their admission (Table 13). The overall five-year cumulative mortality for 2008–2012 was 13.7% of admissions.

Table 13: Thirty-Day Mortality following Admission with an ASA Score of 4 or 5 by Year, New Zealand 2008–2012

YEAR	Deaths	Admissions	Cumulative Mortality per 100 Admissions (%)
2008	425	3,244	13.10
2009	404	3,002	13.46
2010	428	2,967	14.43
2011	447	3,008	14.86
2012	395	3,098	12.75
Total	2,099	15,319	13.70

Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block or as an inpatient in those admitted with an ASA score of 4 or 5.
Denominator: NMDS: Admissions with an ASA score of 4 or 5 and either a general anaesthetic or a neuraxial block.

Mortality by ASA score, procedure number and emergency status

In New Zealand during 2008–2012, among people given an ASA score of 4 or 5 and who received a general anaesthetic or neuraxial block during their admission, there was a total of 2099 deaths within 30 days (Table 14). Most deaths (88%) occurred after an emergency procedure. The overall cumulative mortality for admissions with an ASA score of 4 or 5 was 13.7% of admissions. The cumulative mortality for admissions with an ASA score of 5 was 51.95% of admissions and among them the rate was highest for emergency admissions with multiple anaesthetic procedures (58.62%).

Table 14: Mortality following Admission with an ASA Score of 4 or 5 by Score, Procedure Number and Emergency Status, New Zealand 2008–2012

PROCEDURES	Deaths	Admissions	Cumulative Mortality % Admissions	Deaths in Category (%)
Single Emergency ASA 4	1,056	5,533	19.09	50.3
Single ASA 4	598	8,343	7.17	28.5
Single Emergency ASA 5	233	415	56.14	11.1
Single ASA 5	43	120	35.83	2.0
Max ASA=4 in Multiple	152	879	17.29	7.2
Max ASA=5 in Multiple	17	29	58.62	0.8
Total	2,099	15,319	13.70	100.0

Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block or as an inpatient in those admitted with an ASA score of 4 or 5.
Denominator: NMDS: Admissions with an ASA score of 4 or 5 and either a general anaesthetic or a neuraxial block.

Mortality by cause of death

In New Zealand during 2008–2012, cardiovascular diseases and neoplasms were the most frequently "listed causes of death for all admission types who were given an ASA score of 4 or 5, and who received a general anaesthetic or neuraxial block during their admission (Table 15).

Table 15: Main Underlying Cause of Death following Admission with an ASA Score 4 or 5 by Admission Type, New Zealand 2008–2012

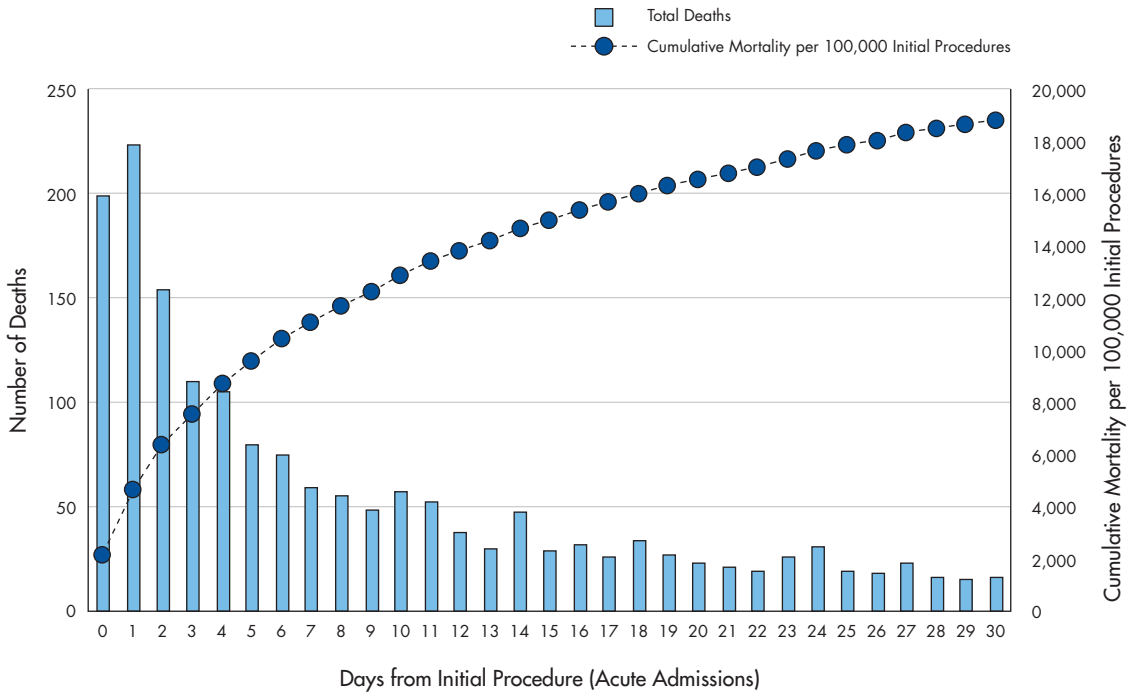
MAIN UNDERLYING CAUSE OF DEATH BY ADMISSION TYPE		Deaths	Annual Average	Deaths in Category (%)
Acute	Other Causes	147	29.5	10.4
	Cerebral Infarction	9	1.8	0.6
	Myocardial Infarction	110	22	7.8
	Other Cardiovascular Causes	283	56.6	19.9
	Other Ischaemic Heart Disease	99	19.8	7.0
	Non-Insulin Dependent Diabetes	43	8.6	3.0
	Chronic Renal Failure	13	2.6	0.9
	Neoplasms	197	39.4	13.9
	Emphysema and COPD	56	11.2	3.9
	Other Respiratory Diseases	8	1.6	0.6
	Pneumonia	5	1.0	0.4
	Dementia/Alzheimer's/CNS Degeneration	12	2.4	0.8
	Diverticular Disease	23	4.6	1.6
	Other Gastrointestinal Diseases	121	24.2	8.5
	Paralytic Ileus/Intestinal Obstruction	44	8.8	3.1
	Vascular Disorders Intestine	35	7.0	2.5
	Fall	129	25.8	9.1
	Other Injuries/External Causes	85	17.0	6.0
	Cause Not Stated	356	-	-
	Subtotal	1775	355	100.0
Arranged in Public	Other Causes	16	2.6	18.1
	Myocardial Infarction	5	1	6.6
	Other Cardiovascular Causes	19	3.8	25.0
	Other Ischaemic Heart Disease	7	1.4	9.7
	Non-Insulin Dependent Diabetes	3	0.6	3.9
	Neoplasms	18	3.6	23.6
	Other Gastrointestinal Diseases	5	1.0	6.5
	Other Injuries/External Causes	3	0.6	3.9
	Cause Not Stated	17	-	-
	Subtotal	93	18.6	100.0
Elective/Waiting List	Other Causes	19	3.8	10.1
	Myocardial Infarction	12	2.4	6.2
	Other Cardiovascular Causes	51	10.2	26.4
	Other Ischaemic Heart Disease	24	4.8	12.4
	Neoplasms	60	12.0	31.0
	Respiratory	12	2.4	6.2
	Gastrointestinal Diseases	15	3.0	7.8
	Cause Not Stated	38	-	-
	Subtotal	231	46.2	100.0
Total		2,099	419.8	100.0

Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block or as an inpatient in those admitted with an ASA score of 4 or 5.
Denominator: NMDS: Admissions with an ASA score of 4 or 5 and either a general anaesthetic or a neuraxial block.
CNS: central nervous system.
COPD: chronic obstructive pulmonary disease.

Mortality by day from first anaesthetic

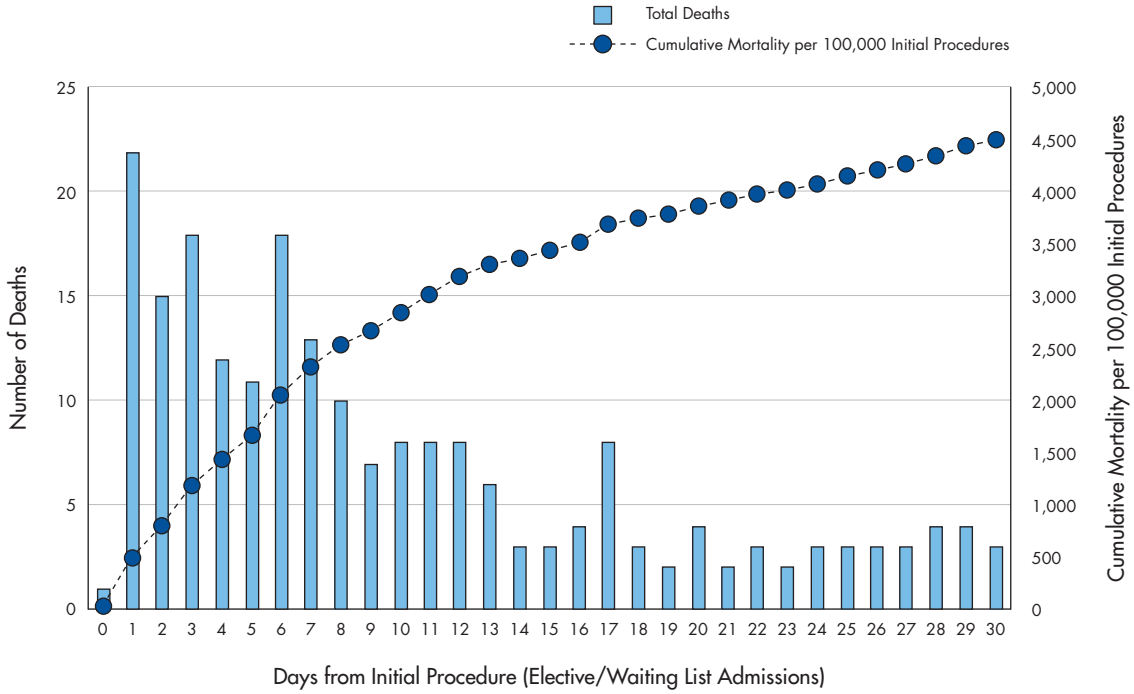
In New Zealand during 2008–2012, over the first 30 days following an initial general anaesthetic or neuraxial block in those admitted acutely with an ASA score of 4 or 5, mortality was highest on the day after surgery, although deaths occurred with varying numbers right up until day 30 following the initial anaesthetic (Figure 8). Cumulative mortality at day 30 reached 18.79% of initial anaesthetics. Among those admitted electively or from the waiting list, mortality was also highest on day one, although it stayed relatively high over the first week (Figure 9). Cumulative mortality at day 30 reached 4.52% of initial anaesthetics.

Figure 8: Thirty-Day Mortality following Acute Admissions with an ASA Score of 4 or 5 by Day from Initial Procedure, New Zealand 2008–2012



Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block in those admitted with an ASA score of 4 or 5.
Denominator: NMDS: Acute admissions with an ASA score of 4 or 5 and either a general anaesthetic or a neuraxial block.

Figure 9: Mortality following Elective/Waiting List Admissions with an ASA Score of 4 or 5 by Day from Initial Procedure, New Zealand 2008–2012

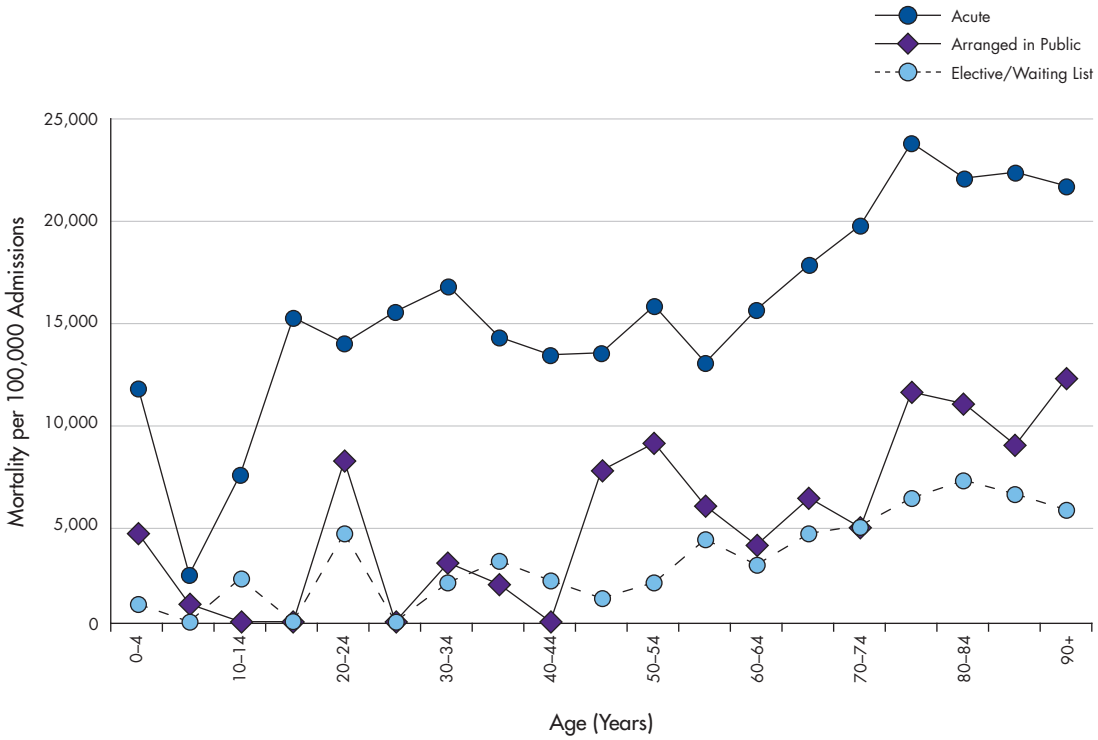


Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block in those admitted with an ASA score of 4 or 5.
Denominator: NMDS: Elective/Waiting list admissions with an ASA score of 4 or 5 and either a general anaesthetic or a neuraxial block.

Mortality by age and admission type

In New Zealand during 2008–2012, mortality in the first 30 days following an initial general anaesthetic or neuraxial block with an ASA score of 4 or 5 was relatively high for all acute admissions and the rate generally increased with age before declining slightly after age 79 years (Figure 10). The mortality rate among those aged 75–79 years was 23.8%. Among elective/waiting list admissions, mortality rates also generally climbed with age but remained lower in all age groups than acute admissions. Mortality rates were more variable among publicly arranged (semi-acute) admissions, but they did increase overall, reaching their highest point among those aged 90+ years.

Figure 10: Mortality following Admission with ASA 4 or 5 by Admission Type and Age, New Zealand 2008–2012

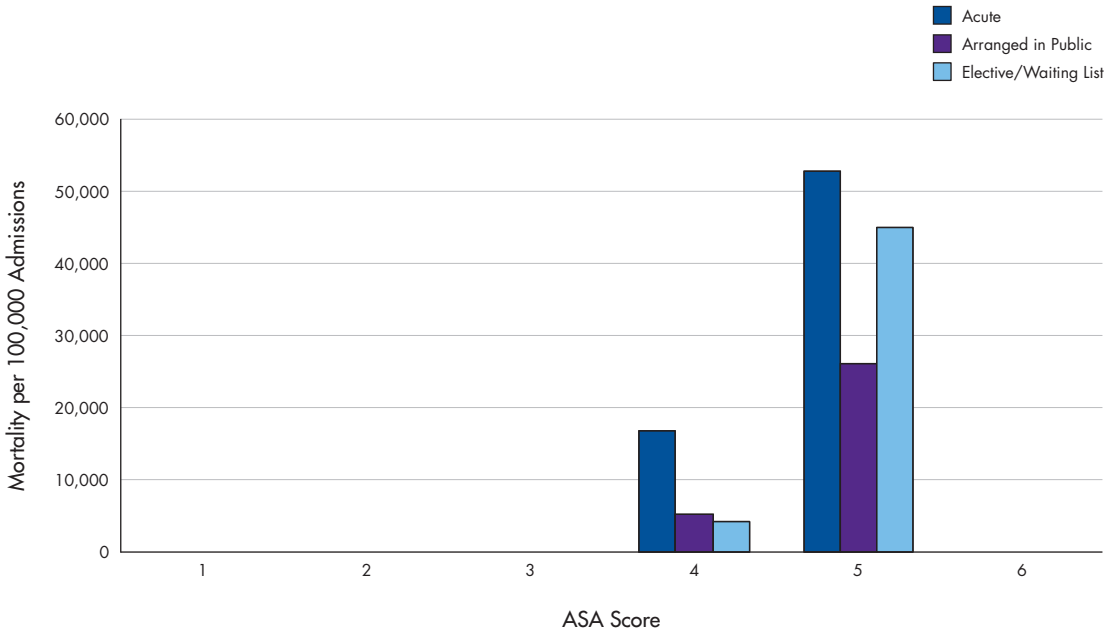


Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block or as an inpatient in those admitted with an ASA score of 4 or 5.
Denominator: NMDS: Admissions with an ASA score of 4 or 5 and either a general anaesthetic or a neuraxial block.

Mortality by ASA score

In New Zealand during 2008–2012, mortality was highest among acute admissions with an ASA score of 5 (52.8%) (Figure 11).

Figure 11: Mortality following Admission with ASA 4 or 5 by ASA Score and Admission Type, New Zealand 2008–2012



Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block or as an inpatient in those admitted with an ASA score of 4 or 5.
Denominator: NMDS: Admissions of those with an ASA score of 4 or 5 and either a general anaesthetic or a neuraxial block.

Mortality by socio-demographic and clinical factors

In New Zealand during 2008–2012, mortality in the first 30 days following a general anaesthetic or neuraxial block in those with a first ASA score of 4 or 5 was significantly higher for both acute and elective/waiting list admissions among those aged over 65 years (compared to 45–64 years) and those with an ASA score of 5 (vs ASA 4) (Tables 16, 17). For acute admissions, being aged under 45 years (compared with ages 45–65 years), female gender (compared with male) and Pacific ethnicity (compared with European) were protective. These differences were evident when the risk was adjusted for other socio-demographic factors and clinical factors.

Table 16: Mortality following Acute Admission for ASA Score 4 or 5 by Age, Gender, ASA Score, Ethnicity and NZDep Decile, New Zealand 2008–2012

VARIABLE	CATEGORY	Number of Deaths	Number of Admissions	Mortality per 100,000 Admissions	Mortality per 100 Admissions (%)	Univariate OR	95% CI	Multivariate OR	95% CI
ASA 4 and 5									
Acute Admissions									
Age Group	0–44 years	151	1,158	13,040	13.04	0.88	(0.71–1.09)	0.78*	(0.62–0.97)
	45–64 years	276	1,899	14,534	14.53	1		1	
	65–79 years	545	2,645	20,605	20.60	1.53*	(1.30–1.79)	1.52*	(1.29–1.80)
	80+ years	687	3,126	21,977	21.98	1.66*	(1.42–1.93)	1.81*	(1.53–2.14)
Gender	Male	913	4,699	19,430	19.43				
	Female	746	4,129	18,067	18.07	0.91	(0.82–1.02)	0.88*	(0.79–0.98)
ASA Score	4	1,412	8,360	16,890	16.89	1		1	
	5	247	468	52,778	52.78	H*	H	H*	H
Ethnicity	European	1,287	6,622	19,435	19.44	1		1	
	Māori	208	1,131	18,391	18.39	0.93	(0.79–1.10)	1.14	(0.94–1.36)
	Pacific	81	640	12,656	12.66	0.60*	(0.47–0.76)	0.75*	(0.57–0.96)
	Asian/ MELAA/ Other	83	435	19,080	19.08	0.98	(0.76–1.24)	1.17	(0.90–1.51)
NZDep Decile	Decile 1–2	194	1,053	18,424	18.42	1		1	
	Decile 3–4	181	1,094	16,545	16.54	0.88	(0.70–1.10)	0.88	(0.70–1.10)
	Decile 5–6	325	1,621	20,049	20.05	1.11	(0.91–1.35)	1.13	(0.93–1.39)
	Decile 7–8	389	1,935	20,103	20.10	1.11	(0.92–1.35)	1.12	(0.92–1.37)
	Decile 9–10	384	2,003	19,171	19.17	1.05	(0.87–1.27)	1.14	(0.93–1.40)

Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block or as an inpatient in those admitted with a first ASA score of 4 or 5.
Denominator: NMDS: Acute admissions of those with an ASA score of 4 or 5 and either a general anaesthetic or a neuraxial block.
CI: Confidence interval, OR: Odds ratio with confidence interval,*: Significantly different from reference category, MELAA: Middle Eastern/Latin American/African, H: Odds ratios suppressed due to high mortality rates.
Caution should be used in interpreting ORs where mortality exceeds 10% (see Appendix 2 for details).

Table 17: Mortality following Elective/Waiting List Admission for ASA Score 4 or 5 by Age, Gender, ASA Score, Ethnicity and NZDep Decile, New Zealand 2008–2012

VARIABLE	CATEGORY	Number of Deaths	Number of Admissions	Mortality per 100,000 Admissions	Mortality per 100 Admissions (%)	Univariate OR	95% CI	Multivariate OR	95% CI
ASA 4 and 5									
Elective/Waiting List Admissions									
Age Group	0–44 years	8	508	1,575	1.57	0.54	(0.23–1.12)	0.49	(0.20–1.03)
	45–64 years	33	1,142	2,890	2.89	1		1	
	65–79 years	102	1,928	5,290	5.29	1.88*	(1.27–2.84)	1.72*	(1.14–2.64)
	80+ years	70	1,067	6,560	6.56	2.36*	(1.56–3.64)	2.20*	(1.42–3.49)
Gender	Male	121	2,775	4,360	4.36	1.00		1.00	
	Female	92	1,870	4,920	4.92	1.13	(0.86–1.50)	1.12	(0.84–1.49)
ASA Score	4	191	4,596	4,156	4.16	1		1	
	5	22	49	44,898	44.90	H*	H	H*	H
Ethnicity	European	179	3,576	5,006	5.01	1		1	
	Māori	21	628	3,344	3.34	0.66	(0.40–1.02)	0.9	(0.53–1.47)
	Pacific	5	267	1,873	1.87	0.36*	(0.13–0.80)	0.52	(0.18–1.21)
	Asian/ MELAA/ Other	8	174	4,598	4.60	0.91	(0.41–1.77)	0.86	(0.36–1.77)
NZDep Decile	Decile 1–2	28	588	4,762	4.76	1		1	
	Decile 3–4	31	711	4,360	4.36	0.91	(0.54–1.55)	0.9	(0.52–1.54)
	Decile 5–6	53	934	5,675	5.67	1.2	(0.76–1.95)	1.18	(0.73–1.93)
	Decile 7–8	53	1,197	4,428	4.43	0.93	(0.58–1.50)	0.93	(0.58–1.53)
	Decile 9–10	48	1,215	3,951	3.95	0.82	(0.51–1.34)	0.95	(0.58–1.58)

Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block or as an inpatient in those admitted with an ASA score of 4 or 5.

Denominator: NMDS: Elective/Waiting list admissions with an ASA score of 4 or 5 and either a general anaesthetic or a neuraxial block.

Elective ASA 5: Among the 49 admissions, it should be noted that 26 admissions were admitted electively, had a procedure and were assigned an ASA score of 4, but then subsequently became unwell and required another procedure, for which they were given an ASA score of 5. Among the other 23 elective admissions with a first ASA score of 5, some may have had acute deterioration after admission but before their first procedure. Some may have been miscoded.

CI: Confidence interval, OR: Odds ratio with confidence interval,*: Significantly different from reference category, MELAA: Middle Eastern/Latin American/African, H: Odds ratios suppressed due to high mortality rates.

Mortality Related to Severe Postoperative Sepsis

The following section uses information from the NMDS and the NMC to review hospital deaths related to severe sepsis within 30 days of one or more general or neuraxial anaesthetics. Patients with a primary diagnosis of severe sepsis, those with cancer, immunocompromise, or pregnancy-related admissions, were excluded from analyses.

Key findings

In New Zealand during 2008–2012, among admissions with severe sepsis following general/neuraxial anaesthesia:

- There were 305 deaths and cumulative mortality was high – 21.69% of admissions.
- Most deaths (80%) occurred among acute admissions where cumulative mortality was 22.85%.
- Mortality increased with increasing age and ASA score.
- Cardiovascular and gastrointestinal causes were the most commonly listed underlying causes of death.

Data sources, methods and limitations

Severe postoperative sepsis admissions included any hospital event with at least one operation and any secondary diagnosis for severe sepsis or severe infection (eg, septicaemia, infection with shock). The following exclusions were applied: any admissions with a primary diagnosis of sepsis or infection, any admission with cancer, those with immunocompromise and those related to pregnancy. Further details on severe postoperative sepsis data sources are presented in Appendix 2.

The NMDS and NMC data sets have limitations associated with coding accuracy and data completeness. For example, some privately funded procedures undertaken at private hospitals are not recorded in the NMDS. Both data sets are dependent on the quality of clinical records and classification systems.

Information on methods and interpretation notes are presented in Appendix 2.

Mortality related to severe sepsis following one or more general/neuraxial anaesthetics

Mortality related to severe sepsis following one or more general/neuraxial anaesthetics by year

In New Zealand during 2008–2012, there were 305 deaths related to severe sepsis within 30 days after a general or neuraxial anaesthetic (Table 18). The overall mortality rate for the five-year period was 21.69% of admissions. The annual mortality rate varied between 17.76% and 26.09% of admissions. Exclusions related to this measure, including the deletion of all cancer-related cases, suggest that both the number of admissions and the number of deaths may be conservative estimates.

Table 18: Mortality Related to Severe Sepsis following One or More General/Neuraxial Anaesthetics by Year, New Zealand 2008–2012

YEAR	Deaths	Admissions	Mortality per 100 Admissions (%)
2008	38	214	17.76
2009	66	253	26.09
2010	57	312	18.27
2011	78	315	24.76
2012	66	312	21.15
Total	305	1,406	21.69

Data source: NMC: Deaths related to severe sepsis following a general anaesthetic (as recorded in the NMDS).

Mortality related to severe sepsis following one or more general/neuraxial anaesthetics and hospital type

In New Zealand during 2008–2012, most deaths related to severe sepsis within 30 days after a general or neuraxial anaesthetic occurred during an acute admission (80%). Cumulative mortality among publicly arranged (semi-acute) admissions was high at 61.70% of admissions. Cumulative mortality among acute admissions was higher than that for elective/waiting list admissions – 22.85% compared with 11%.

Mortality related to severe sepsis following one or more general/neuraxial anaesthetics and cause of death

In New Zealand during 2008–2012, across admission types, cardiovascular and gastrointestinal causes were the most commonly listed underlying reason for mortality among admissions with severe sepsis following a general or neuraxial anaesthetic (Table 19).

Table 19: Mortality Related to Severe Sepsis following Hospital Admissions with One or More General/ Neuraxial Anaesthetics by Admission Type and Main Underlying Cause of Death, New Zealand 2008–2012

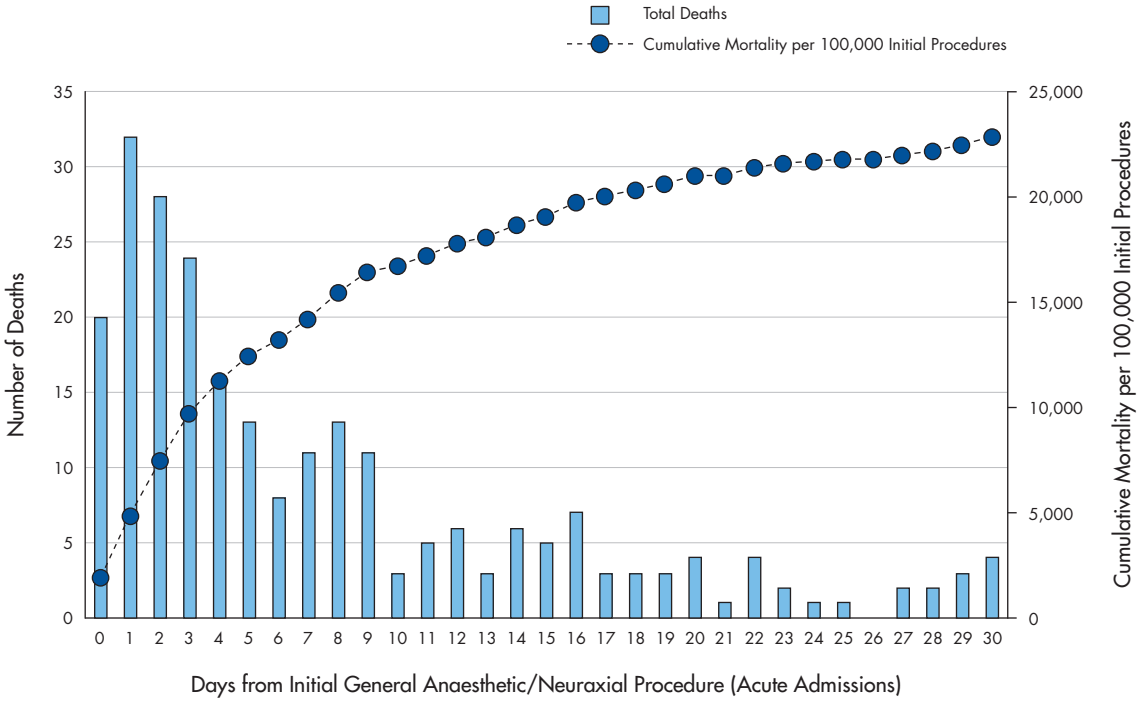
MAIN UNDERLYING CAUSE OF DEATH BY ADMISSION TYPE		Deaths	Annual Average	Deaths in Category (%)
Acute	Other Causes	28	5.6	13.7
	Myocardial Infarction	8	1.6	3.9
	Other Cardiovascular Causes	33	6.6	16.2
	Other Ischaemic Heart Disease	14	2.8	6.9
	Non-Insulin Dependent Diabetes	4	0.8	2.0
	Neoplasms	10	2.0	5.0
	Respiratory Diseases	10	2.0	4.9
	Diverticular Disease	4	0.8	2.0
	Other Gastrointestinal Diseases	39	7.8	19.1
	Paralytic Ileus/Intestinal Obstruction	16	3.2	7.8
	Vascular Disorders Intestine	11	2.2	5.4
	Fall	15	3.0	7.4
	Other Injuries/External Causes	12	2.4	5.9
	Subtotal	204	40.8	100.0
Arranged in Public	Other Causes	3	0.6	33.3
	Cardiovascular Causes	6	1.2	66.6
	Subtotal	9	1.8	100.0
Elective/Waiting List	Other Causes	10	2.0	45.3
	Cardiovascular Causes	9	1.8	40.9
	Gastrointestinal Diseases	3	0.6	13.6
	Subtotal	22	4.4	100.0
	Missing Cause of Death Information	70		
Total		305	61.0	100.0

Data source: NMC: Deaths related to severe sepsis following a general/neuraxial anaesthetic (as recorded in the NMDS).

Mortality related to severe sepsis following one or more general/neuraxial anaesthetics by day from procedure

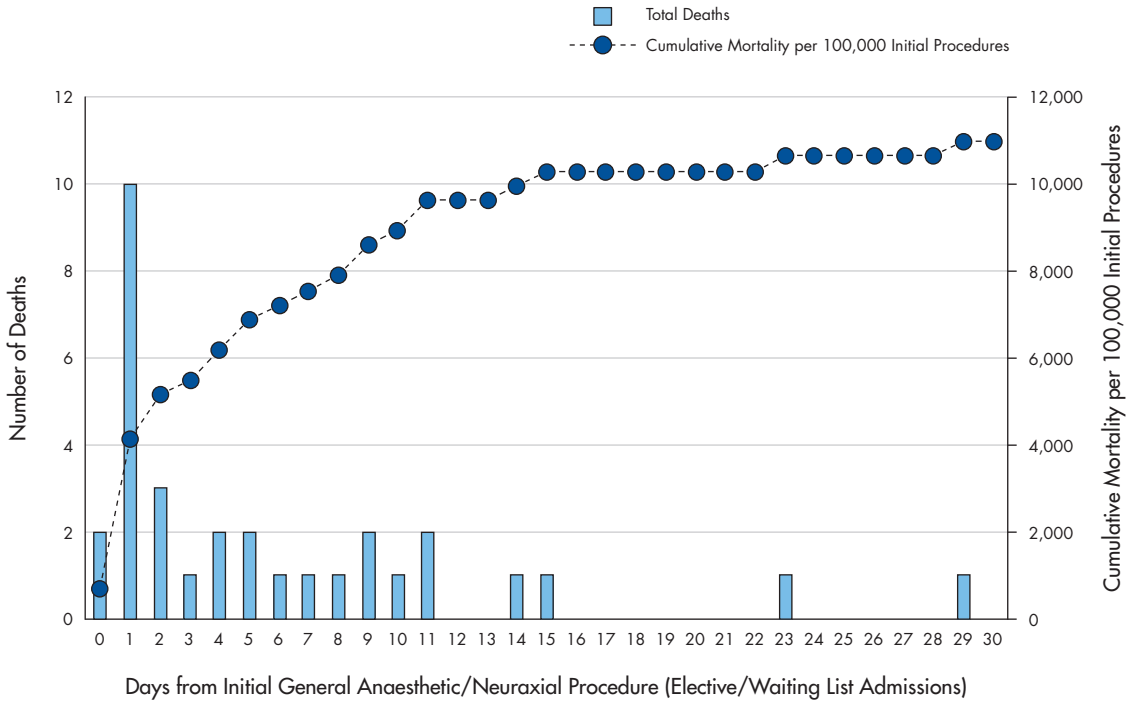
Mortality following an acute or elective/waiting list admission associated with severe sepsis after a general or neuraxial anaesthetic during 2008–2012 was highest on the first day after surgery (Figures 12,13). The number of deaths was more sporadic over the following three weeks for elective/waiting list admissions. Cumulative 30-day mortality was higher for acute admissions (22.85% initial anaesthetics) than elective/ waiting list admissions (11% initial anaesthetics).

Figure 12: Mortality Related to Severe Sepsis for Acute Admissions with One or More General/Neuraxial Anaesthetics by Days from Anaesthetic Procedure, New Zealand 2008–2012



Numerator: NMC: Deaths occurring within 30 days of an anaesthetic for acute admissions with severe sepsis, as recorded in the NMDS.
Denominator: NMDS: Acute hospital admissions with severe sepsis listed in any secondary diagnosis.

Figure 13: Mortality Related to Severe Sepsis for Elective/Waiting List Admissions with One or More General/Neuraxial Anaesthetics by Days from Anaesthetic Procedure, New Zealand 2008–2012

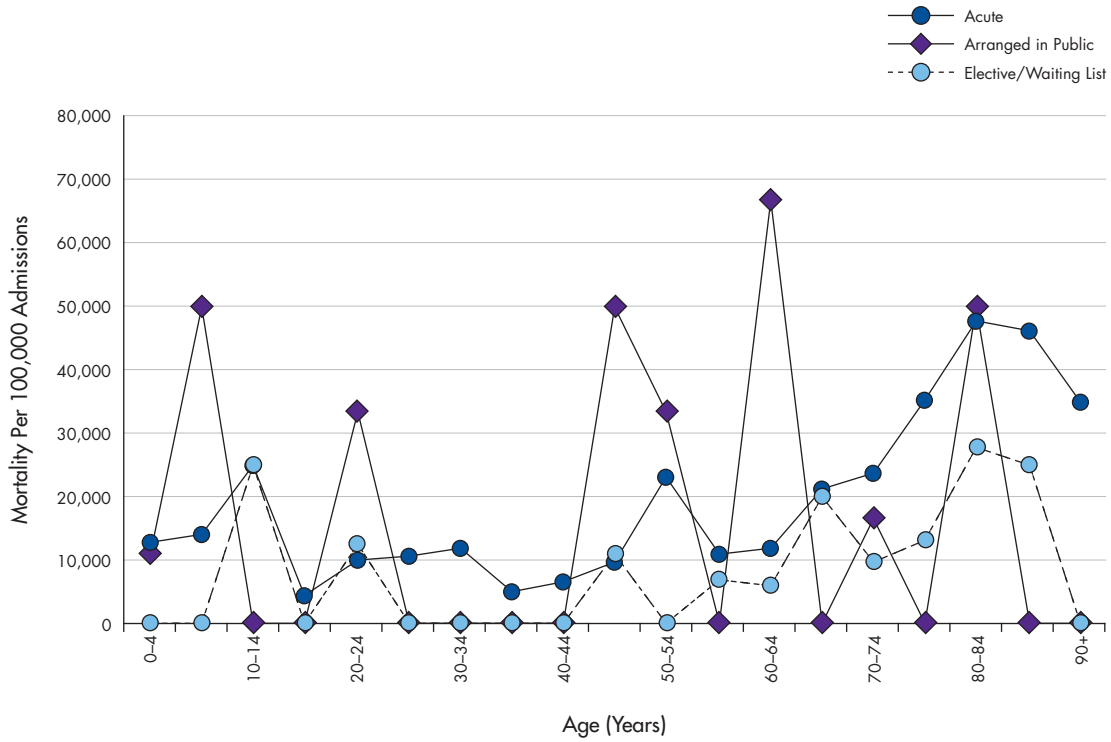


Numerator: NMC: Deaths occurring within 30 days of an anaesthetic for elective/waiting list admissions with severe sepsis, as recorded in the NMDS.
Denominator: NMDS: Elective/Waiting list hospital admissions with severe sepsis listed in any secondary diagnosis.

Mortality related to severe sepsis following one or more general/neuraxial anaesthetics by age

In New Zealand during 2008–2012, mortality related to severe sepsis following general or neuraxial anaesthesia increased with increasing age for acute and elective/waiting list admission types, after an initial small peak for ages 10–14 years (Figure 14). Acute admissions had higher mortality rates among groups aged 70 years and over compared with those admitted electively or from the waiting list. Mortality rates among publicly arranged (semi-acute) admissions were variable across the age groups at least, in part, due to small numbers.

Figure 14: Mortality Related to Severe Sepsis following One or More General/Neuraxial Anaesthetics by Age and Admission Type, New Zealand 2008–2012

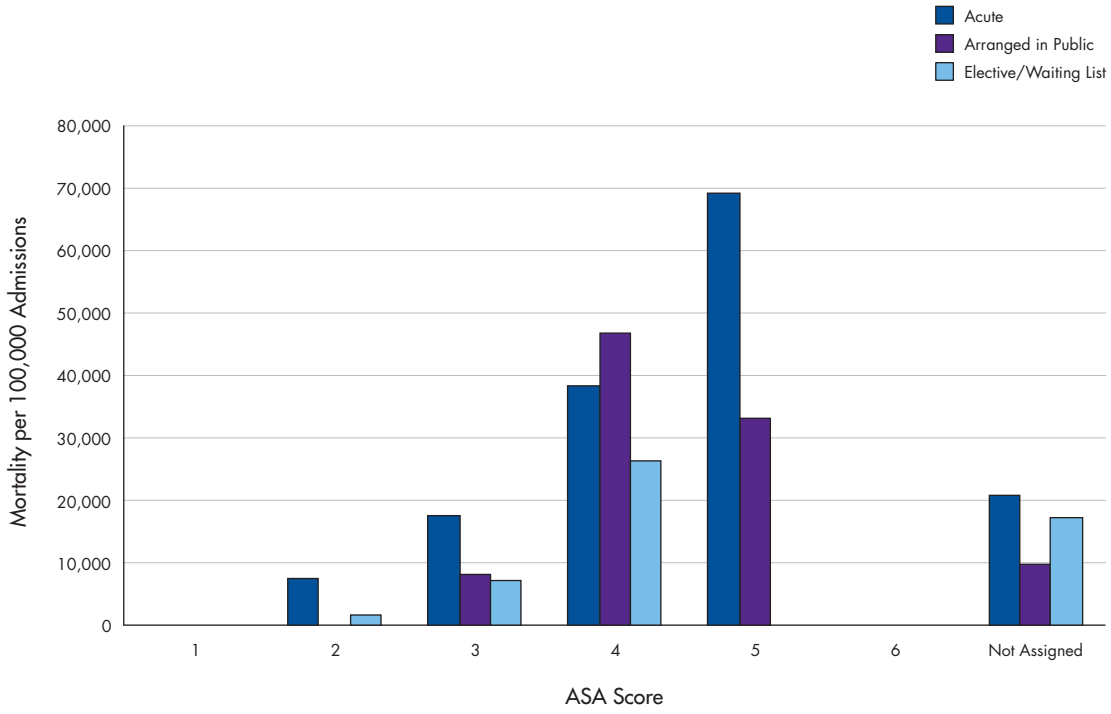


Numerator: NMC: Deaths related to severe sepsis following a general or neuraxial anaesthetic.
Denominator: NMDS: Hospital admissions with severe sepsis listed in any secondary diagnosis.

Mortality related to severe sepsis following one or more general/neuraxial anaesthetics by ASA score and admission type

In New Zealand during 2008–2012, mortality related to severe sepsis following general or neuraxial anaesthesia increased with increasing ASA score for acute and elective/waiting list admissions (Figure 15). Among semi-acute admissions mortality was lower for ASA 5 compared with ASA 4. Within ASA categories 1–4, and most evident for those admissions with an ASA score of 3 or 4, there was a higher rate of mortality for those admitted acutely than for those admitted electively or from the waiting list, or semi-acutely. Among those patients admitted with an ASA score of 5 there were high mortality rates for acute and publicly arranged (semi-acute) admissions.

Figure 15: Mortality Related to Severe Sepsis following One or More General/Neuraxial Anaesthetics by ASA Score and Admission Type, New Zealand 2008–2012



Numerator: NMC: Deaths related to severe sepsis following a general or neuraxial anaesthetic.
Denominator: NMDS: Hospital admissions with severe sepsis listed in any secondary diagnosis.

Mortality related to elective/waiting list admissions with severe sepsis following one or more general anaesthetics by socio-demographic factors, number of anaesthetics and ASA score

Acute admissions

During 2008–2012, mortality after an acute hospital admission associated with severe sepsis following one or more general anaesthetics was significantly higher for those age groups over 65 years (vs. 45–64 years), and those with a first ASA score of 3 or more (Table 20). The differences for each of these variables were statistically significant after the other socio-demographic and clinical factors were included in the multivariate model (age, gender, ethnicity, NZDep decile and ASA score).

Elective/Waiting list admissions

Mortality after an elective/waiting list hospital admission associated with severe sepsis following a general/neuraxial anaesthetic during 2008–2012 was significantly higher for those groups aged over 80 years (vs. 45–64 years), and those with a first ASA score of 4 or 5 (vs. ASA score 1 or 2) (Table 21). These differences were evident when socio-demographic and clinical factors (age, gender, ethnicity, NZDep decile and ASA score) were adjusted for in the multivariate model.

Table 20: Mortality Related to Severe Sepsis Among Acute Admissions with One or More General/ Neuraxial Anaesthetics by Age, Gender, Number of Anaesthetics, ASA Score, Ethnicity and NZDep Decile, New Zealand 2008–2012

VARIABLE	CATEGORY	Number of Deaths	Number of Admissions	Mortality per 100,000 Admissions	Mortality per 100 Admissions (%)	Univariate OR	95% CI	Multivariate OR	95% CI
Age Group	0–44 years	22	254	8,661	8.7	0.55*	(0.31–0.94)	0.71	(0.40–1.26)
	45–64 years	40	271	14,760	15	1		1	
	65–79 years	78	292	26,712	27	H*	H	H*	H
	80+ years	94	212	44,340	44	H*	H	H*	H
ASA Score	1,2	11	174	6,322	6.3	1		1	
	3	59	337	17,507	18	3.14*	(1.67–6.47)	2.21*	(1.14–4.65)
	4, 5	112	274	40,876	41	H*	H	H*	H
	Not Stated	52	244	21,311	21	H	H	H	H
Ethnicity	European	187	738	25,339	25	1		1	
	Māori	29	156	18,590	19	0.67	(0.43–1.03)	1.04	(0.62–1.74)
	Pacific	9	80	11,250	11	0.37*	(0.17–0.72)	0.73	(0.32–1.55)
	Asian/ MELAA/ Other	9	55	16,364	16	0.58	(0.26–1.15)	0.84	(0.35–1.82)
Gender	Male	131	588	22,279	22	1		1	
	Female	103	441	23,356	23	1.06	(0.79–1.43)	1.02	(0.73–1.42)
NZDep Decile	Decile 1–2	32	135	23,704	24	1		1	
	Decile 3–4	32	169	18,935	19	0.75	(0.43–1.31)	0.79	(0.43–1.44)
	Decile 5–6	55	199	27,638	28	1.23	(0.75–2.05)	1.28	(0.73–2.24)
	Decile 7–8	52	233	22,318	22	0.92	(0.56–1.54)	0.96	(0.56–1.68)
	Decile 9–10	63	293	21,502	22	0.88	(0.55–1.44)	1.29	(0.74–2.26)

Numerator: NMC: Deaths among acute admissions with severe sepsis following a general/neuraxial anaesthetic.
Denominator: NMDS: Acute hospital admissions with severe sepsis following one or more general anaesthetics listed in any of the first 90 procedures.
ASA score is first listed ASA score per admission.
CI: Confidence interval, *: Significantly different from reference category, MELAA: Middle Eastern/Latin American/African, OR: Odds ratio, H: Odds ratios suppressed due to high mortality rates. Caution should be used in interpreting ORs where mortality exceeds 10% (see Appendix 2 for details).

Table 21: Mortality Related to Severe Sepsis Among Elective/Waiting List Admissions with One or More General/Neuraxial Anaesthetics by Age, Gender, Number of Anaesthetics, ASA Score, Ethnicity and NZDep Decile, New Zealand 2008–2012

VARIABLE	CATEGORY	Number of Deaths	Number of Admissions	Mortality per 100,000 Admissions	Mortality per 100 Admissions (%)	Univariate OR	95% CI	Multivariate OR	95% CI
Age Group	0–44 years	<3	58	3,448	3.4	s	s	s	s
	45–64 years	6	96	6,250	6.3	1		1	
	65–79 years	14	98	14,286	14	2.50	(0.96–7.33)	1.63	(0.54–5.35)
	80+ years	9	33	27,273	27	H*	H	H*	H
ASA Score	1,2	<3	74	1,351	1.4	1		1	
	3	8	109	7,339	7.3	5.78	(1.03–108.44)	4.36	(0.74–83.19)
	4,5	15	57	26,316	26	H*	H	H*	H
	Not Stated	7	45	15,556	16	13.45*	(2.28–256.14)	12.72*	(2.03–248.37)
Ethnicity	European	27	217	12,442	12	1		1	
	Māori	<3	35	2,857	2.9	s	s	s	s
	Pacific	<3	20	10,000	10	s	s	s	s
	Asian/ MELAA/ Other	<3	13	7,692	7.7	s	s	s	s
Gender	Male	18	174	10,345	10	1		1	
	Female	13	111	11,712	12	1.15	(0.53–2.44)	1.18	(0.50–2.74)
NZDep Decile	Decile 1–2	4	32	12,500	13	1		1	
	Decile 3–4	4	46	8,696	8.7	0.67	(0.15–3.03)	0.77	(0.14–4.16)
	Decile 5–6	7	62	11,290	11	0.89	(0.25–3.64)	1.06	(0.25–5.10)
	Decile 7–8	9	63	14,286	14	1.17	(0.35–4.61)	1.81	(0.45–8.55)
	Decile 9–10	7	82	8,537	8.5	0.65	(0.18–2.65)	0.84	(0.19–4.14)

Numerator: NMC: Deaths among elective/waiting list admissions with severe sepsis following a general/neuraxial anaesthetic.
Denominator: NMDS: Elective/Waiting list hospital admissions with one or more general anaesthetics listed in any of the first 90 procedures. ASA score is first listed ASA score per admission.
CI: Confidence interval, *: Significantly different from reference category, MELAA: Middle Eastern/Latin American/African, OR: Odds ratio, s: Suppressed due to small numbers. H: Odds ratios suppressed due to high mortality rates. Caution should be used in interpreting ORs where mortality exceeds 10% (see Appendix 2 for details).

Māori Perioperative Mortality

The following section summarises and discusses key findings for Māori perioperative mortality revealed in analyses for this report, with a focus on the CABG results. Mortality rates during 2008–2012 are presented alongside hospital admissions for all clinical areas reviewed in this report where results were statistically significant for Māori. The findings for CABG procedures are discussed with reference to literature, focusing on the implications for Māori access to care.

Data sources and methods are described in the relevant report chapters on each clinical area and in Appendix 2. Further background data on hospital admissions for the clinical areas, including mortality data for previously reported clinical areas, are available in the companion document, which will be available on the Health Quality & Safety Commission's website by July 2015.

Key findings

In New Zealand during 2008–2012, for individual operative procedures, the numbers of deaths among Māori were low; however, the following key findings were noted.

- Māori perioperative mortality was 8491 per 100,000 (8.5%) following acute CABG and 3524 per 100,000 (3.5%) following CABG delivered through elective/waiting list admissions. These rates were significantly higher for Māori compared with Europeans after adjusting for socio-demographic variables (age, gender and NZDep decile) and ASA score (Tables 6, 7).
- Compared with other ethnic groups, Māori had fewer admissions for acute CABG (Figure 16).
- Māori: European differences in perioperative mortality were not evident for PTCA (Table 11). However, PTCA admission rates for Māori adults aged 60–80 years peaked at a lower rate compared with European and Asian/MELAA/Other adults of the same ages.[1]
- Mortality following cholecystectomy delivered through elective/waiting list admission routes was significantly higher for Māori (0.24%) compared with Europeans (0.14%) after adjusting for socio-demographic variables and ASA score. There was no significant difference in mortality for these populations following acute cholecystectomy.[2]
- Acute admissions for cholecystectomy were higher for Māori and Pacific peoples aged 10–54 years than for those of European ethnicity between the same ages.[3]
- Same or next day mortality following elective/waiting list admissions with a general anaesthetic was significantly higher for Māori (0.03%) compared with Europeans (0.02%) after adjusting for socio-demographic variables and ASA score.[4]
- Acute admission rates, where one or more general anaesthetics were administered, were higher for Māori and Pacific peoples than for Europeans up until 75 years of age. Elective/Waiting list admission rates with general anaesthesia were higher for Europeans for every age group.[5]
- Across all other clinical areas included in this report, Māori POMRs were similar to European rates. This is consistent with findings from previous POMRC reports.
- Multivariate analyses show the influences of age, health status (ASA status) and admission status (acute versus elective/waiting list) appear to have a greater effect on perioperative mortality outcomes than Māori ethnicity.

1 Refer to Figure 8 of the companion document.
2 Refer to Tables 11 and 12 in the companion document.
3 Refer to Figure 27 of the companion document.
4 Refer to Table 17 in the companion document.
5 Refer to Figure 32 of the companion document.

Recommendations to improve outcomes for Māori:

1. The POMRC recommends that:

A targeted evaluation of the mortality rate of Māori patients undergoing CABG should be undertaken.

2. The Māori Caucus recommends that:

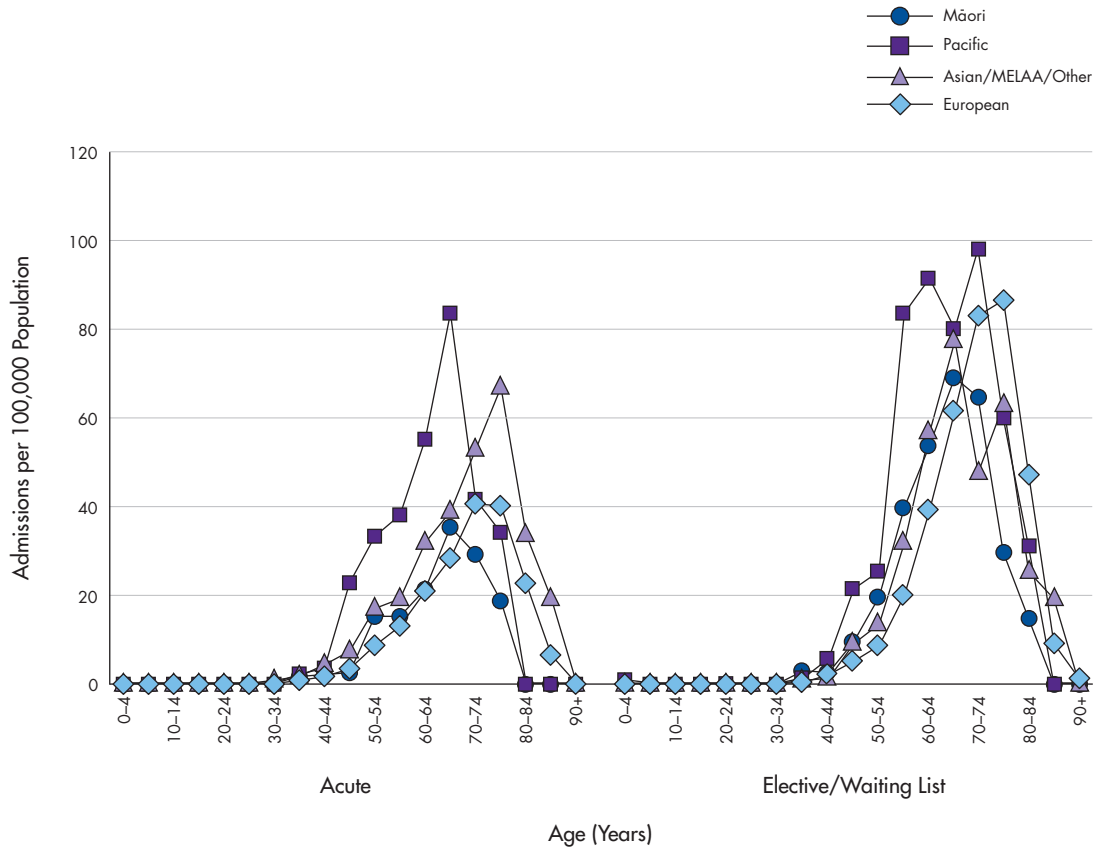
Further research be undertaken to identify ways to improve Māori access to cardiac treatments, including screening, early detection and addressing barriers to service uptake.

Māori perioperative mortality following CABG

Hospital admissions and mortality following CABG

Figure 16 shows the hospital admissions for CABG by age, admission type and ethnicity in New Zealand during 2008–2012. For Māori, admission rates for CABG increased from ages 40–44 years and peaked at ages 65–70 years. Acute admissions for Māori were lower compared to Pacific peoples and Asian populations and similar to European admission rates for younger age groups. Some of the lower Māori CABG admissions in older age groups will be due to the younger age structure of the Māori population.

Figure 16: Hospital Admissions for CABG by Age, Admission Type and Ethnicity, New Zealand 2008–2012



Numerator: NMDS: Hospital admissions with one or more CABG listed in any of the first 90 procedures.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2008) procedures.
MELAA: Middle Eastern/Latin American/African.

Tables 6 and 7 show that, after adjusting for socio-demographic and clinical factors, Māori mortality following CABG procedures remains significantly higher than in Europeans. For Māori, as for other ethnic groups, mortality was higher following acute admissions for CABG procedures (8.5%). A higher adjusted 30-day mortality rate following CABG for Māori compared with Europeans has also been observed in one cohort study in Auckland City Hospital (Wang et al 2013).

There are multiple possible explanations that, together, may account for the higher POMRs observed for Māori following CABG. Firstly, Māori tend to have a high prevalence of comorbidities, such as diabetes and hypertension, and have increased exposure to risk behaviours, such as smoking – all of which increase the risk of developing postoperative complications (Curtis et al 2007; Curtis et al 2010; White et al 2013). It should be noted that the Māori mortality disparity following CABG persists after controlling for some comorbidities, suggesting there are additional factors explaining the higher post-CABG mortality rate among Māori (Wang et al 2013).

Secondly, and related to the high prevalence of cardiovascular risk factors, the type of vascular disease among Māori may differ from other ethnic groups. Cohort studies from New Zealand lend some support for this, with Māori CABG patients having a higher prevalence of diabetes (Kerr et al 2014; Wang et al 2013). Coronary artery disease in diabetics is generally more diffuse and involves smaller vessels, rendering it more difficult to treat with revascularisation procedures.[6] Diffuse multi-vessel patterns of disease also require more complex operations, as evidenced by longer surgical cross-clamp and bypass times in Māori CABG patients (see Wang et al 2013).

Thirdly, Māori could be presenting for revascularisation at later stages of disease and, therefore, present with more severe disease pathology that is not amenable to CABG intervention. This hypothesis is supported by a recent retrospective cohort study of patients who underwent a CABG at Auckland City Hospital from July 2010 to June 2012. Results showed Māori had a higher prevalence of many clinical indicators for severe heart disease (eg, lower ejection fraction and higher rates of congestive heart failure) suggesting delayed presentation for surgical treatment (Wang et al 2013; Wang et al 2014).

Recommendation:

For these reasons, the POMRC has recommended that targeted research evaluating the main underlying causes of higher Māori mortality following CABG should be undertaken.

Māori access to health care for ischaemic heart disease

Given the higher prevalence and mortality from ischaemic heart disease among Māori compared with non-Māori (Ministry of Health 2014; Ministry of Health 2010b), we would expect Māori hospitalisation rates for both CABG and PTCA procedures to be higher among Māori compared with other ethnic groups. However, the higher 30-day mortality rate following CABG observed in this report, together with the lower than expected hospitalisations for CABG, suggest an unmet need for Māori accessing CABG revascularisation treatment in New Zealand. As noted by Curtis et al (2010), the inverse care law is evident in New Zealand, whereby those who need services the most are the least likely to receive them.

Some of the lower than expected CABG hospitalisations could be due to Māori having a pattern of vessel disease that is not amenable to CABG intervention, or the presence of severe comorbidities that make them inoperable. In a recent study, a cohort of patients presenting with ST elevation myocardial infarction (STEMI) who received

6 Coronary artery disease associated with diabetes is generally more amenable to percutaneous coronary intervention than bypass grafting. This is consistent with the analyses from this report where acute PTCA admissions and perioperative mortality for Pacific peoples were high compared to other ethnic groups. The prevalence of diabetes in Pacific peoples is high compared to other population groups in New Zealand (Ministry of Health 2014).

an angiogram were analysed and actual referrals made for CABG and percutaneous coronary intervention (PCI) were compared with blinded angiogram reviews of the same cohort (ie, cardiologists reassessed the angiograms without knowing any patient details other than age and sex). Blinded assessments revealed that Māori STEMI patients were more likely to be undertreated for CABG compared with Europeans; however, review of the undertreated patient's clinical notes revealed the patients were not referred for CABG treatment due to the presence of severe comorbidities (Sandiford et al, in press).

For Māori, the findings of this report point to a multitude of factors which collectively influence their ability to access care. In addition to access issues associated with lower socio-economic status, Māori experience a number of barriers to accessing health care in New Zealand. Some of these barriers are complex, with roots in the history of colonisation, and the relationships between Māori and others that were gradually cultivated over successive generations. These include Māori–non-Māori patient–clinician trust issues, previous experiences of racism and wider structural aspects of society that impact access equity for Māori (Ellison-Loschmann and Pearce 2006; Harris et al 2012; Reid and Robson 2007; Robson et al 2011).

Geographical barriers also affect the Māori population as a larger proportion of Māori live in isolated rural locations (Ministry of Health 2012a). Living in rural communities can result in some delays accessing cardiac angiography and invasive revascularisation procedures, particularly where patients are admitted to hospitals without cardiac intervention facilities (Ellis et al 2004; Ellis et al 2010).

Another barrier to accessing care is poor 'health literacy'. Health literacy is a broad term referring to one's ability to obtain and understand basic health information and services needed to make appropriate health decisions. It is seen as an essential life skill that helps one navigate through health and health care (Kickbusch et al 2005; Nutbeam 2000). On average, New Zealanders have poor health literacy; however, for Māori living in both urban and rural locations, health literacy scores are significantly lower than for non-Māori (Ministry of Health 2010a).

Those who are less health literate have less knowledge of their illness, treatment and medicines, and are more likely to visit physicians in later stages of disease; more likely to use emergency and hospital services; less likely to adhere to medication regimes; and less likely to use preventive screening services (Kickbusch 2008). To adequately address these issues, it is important that interventions aimed at improving health literacy are developed in partnership with Māori and their whānau, and that resources are produced in accessible and culturally relevant and appropriate formats (Comrie et al 2010; Ministry of Health 2012b).

The CABG and PTCA analyses from this report, and also the higher rates of Māori acute surgical admissions where one or more general anaesthetics were administered, highlight the differential admission rates for Māori and non-Māori. These findings point to wider issues than preventable mortality, but are nevertheless significant. Further investigation is needed to identify the key barriers to accessing care where the most significant gains can be achieved for Māori. Such knowledge could be used to drive interventions and assist with improving the timely access to surgical treatment for ischemic heart disease among Māori.

Recommendation:

For these reasons, the Māori Caucus has recommended that further research be undertaken to identify ways to improve Māori access to cardiac treatments, including screening, early detection and addressing barriers to service uptake.

Perioperative Mortality for Previously Reported Clinical Areas

The following series of chapters present the key findings from clinical areas included in previous POMRC reports, extending analyses for the 2008–2012 time period. This is part of the POMRC's approach to tracking perioperative mortality over time. These clinical areas include:

1. Cholecystectomy
2. General anaesthesia
3. Hip arthroplasty
4. Knee arthroplasty
5. Mortality in elective admissions with an ASA score of 1 or 2
6. Pulmonary embolus-associated and attributed mortality.

Among these clinical areas, cholecystectomy is of continuing interest as it is a common procedure undertaken at a wide range of hospitals and is associated with a relatively high number of deaths. Deaths occurring on the same and following days of general anaesthesia are included as a general indicator of perioperative care close to the time of anaesthesia and surgery. Both hip and knee arthroplasty, presented in the POMRC's second report, are included again as the use of these procedures is increasing with the ageing population. Mortality in elective admissions with an ASA score of 1 or 2 continues to be of interest as these patients have a low risk of death and postoperative complications. Analyses for pulmonary embolus-associated and attributed mortality are re-visited, in keeping with the Health Quality & Safety Commission's programme on reducing perioperative harm and also the associated use of the WHO surgical safety checklist.

Further information on mortality for each clinical area, and background information on hospital admissions, is available from the companion document which will be available on the Commission's website by July 2015.

Mortality following Cholecystectomy

The following section uses information from the NMDS and the NMC to review mortality in the first 30 days following cholecystectomy. Consistent with the 2014 report, those procedures in which a cholecystectomy was conducted as a minor component of a more extensive operation have been removed from these analyses (approximately 420 cases).

Key findings

In New Zealand from 2008–2012 following cholecystectomy:

- There were 113 deaths; the overall cumulative mortality was 0.37% of admissions.
- Mortality was higher when an open procedure was undertaken (4.23% of admissions) or when a laparoscopic procedure was converted to an open procedure (1.09% of admissions).
- Cumulative mortality rates were higher among acute admissions (0.82% of admissions) than elective/waiting list admissions (0.18% of admissions).
- Gastrointestinal diseases and malignant neoplasms were the main underlying causes of death.
- Mortality rates increased with increasing age and higher ASA scores.
- Findings were generally consistent with the 2006–2010 and 2007–2011 periods.

Mortality following cholecystectomy

Mortality following cholecystectomy per year

In New Zealand during 2008–2012, the annual number of deaths following a cholecystectomy procedure varied between 14 and 28 deaths and annual mortality was 0.23%–0.44% of admissions (Table 22). The cumulative mortality for any cholecystectomy procedure during 2008–2012 was 0.37% of admissions.

Table 22: Mortality following Cholecystectomy by Year, New Zealand 2008–2012

	Deaths	Admissions	Mortality per 100 Admissions (%)
2008	24	5,778	0.42
2009	27	6,217	0.43
2010	14	6,074	0.23
2011	28	6,406	0.44
2012	20	6,426	0.31
Total	113	30,901	0.37

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

Mortality following General Anaesthesia

The following section uses information from the NMDS and the NMC to review hospital admissions where one or more general anaesthetics were performed, as well as same and next day mortality following a general anaesthetic.

Key findings

In New Zealand during 2008–2012, following general anaesthesia on the same or next day:

- There were 1436 deaths (0.12% of admissions); most of these deaths occurred among acute admissions and at public hospitals.
- Mortality was between 0.11% and 0.13% of admissions each year.
- Cardiovascular causes were the most commonly listed underlying reason for mortality.
- Mortality was higher among those admissions that were acute or emergency, those with more than one anaesthetic and those with increasing age and ASA score regardless of other clinical or demographic factors. Mortality was lower among those admissions aged under 45 years.
- These findings were consistent with those observed in 2007–2011.
- An ASA score was included with 64.8% of admissions, compared with 63.4% in 2007–2011.

Same or next day mortality following one or more general anaesthetics

Mortality following one or more general anaesthetics and year

In New Zealand during 2008–2012, there were 1436 deaths on the same or next day. The overall mortality rate for the five-year period was 0.12% of admissions. The annual rate varied between 0.11% and 0.13% of admissions (Table 23).

Table 23: Same or Next Day Mortality following Hospital Admissions with One or More General Anaesthetics by Year, New Zealand 2008–2012

YEAR	Deaths	Admissions	Mortality per 100 Admissions (%)
2008	290	228,550	0.13
2009	311	234,496	0.13
2010	261	235,519	0.11
2011	299	241,108	0.12
2012	275	241,997	0.11
Total	1,436	1,181,670	0.12

Data source: NMC: Same day (day 0) or next day (day 1) deaths following a general anaesthetic (as recorded in the NMDS).

Mortality following Hip Arthroplasty

Information from the NMDS and the NMC were used to review mortality in the first 30 days following a hip arthroplasty.

Key findings

In New Zealand during 2008–2012, following hip arthroplasty:

- There were 645 deaths and five-year cumulative mortality was 1.58% of admissions.
- Most deaths (568) occurred among acute admissions.
- When clinical and demographic factors were considered, rates were significantly higher among older age groups and those with poorer health (higher ASA score) among both elective/waiting list and acute admissions.
- Deaths occurred most frequently on the same day as an acute hip athroplasty and either two or six days following an elective/waiting list operation.
- Cumulative 30-day mortality was higher for acute admissions (7.10% of initial procedures) than elective/waiting list admissions (0.17% of initial procedures).
- The most common cause of death was falls for acute admissions and cardiovascular causes for elective/waiting list admissions.
- Findings were generally consistent with a previous report and data from 2005–2009.

Mortality following hip arthroplasty

Mortality following hip arthroplasty by year

In New Zealand during 2008–2012, mortality rates following hip arthroplasty varied between 1.42% and 1.73% of admissions (Table 24).

Table 24: Mortality following Hip Arthroplasty by Year, New Zealand 2008–2012

YEAR	Deaths	Admissions	Mortality per 100 Admissions (%)
2008	130	7,952	1.63
2009	123	8,093	1.52
2010	142	8,231	1.73
2011	131	8,120	1.61
2012	119	8,387	1.42
Total Acute	568	8,106	7.00
Total Elective/Waiting List	55	32,208	0.17
Total*	645	40,783	1.58

Numerator: NMC: Deaths occurring within 30 days of a hip arthroplasty, as recorded in the NMDS.
Denominator: NMDS: Hospital discharges with a hip arthroplasty listed in any of the first 90 procedures.
* Total Acute and Total Elective/Waiting List are not equal to the Total as a small number of arranged in public (semi-acute) cases also occurred.

Mortality following Knee Arthroplasty

Information from the NMDS and the NMC were used to review mortality in the first 30 days following knee arthroplasty.

Key findings

In New Zealand during 2008–2012, following knee arthroplasty:

- Mortality was low; there were 46 deaths and the cumulative mortality rate was 0.17% of admissions.
- When clinical and socio-demographic factors were considered, mortality rates increased with increasing age and ASA score. Most of the mortality observed represents elective/waiting list procedures, which comprised 98.5% of all knee arthroplasty admissions.
- Cardiovascular causes were the main cause of death.
- The findings are consistent with a previous report and data from 2005–2009.

Mortality following knee arthroplasty

Mortality following knee arthroplasty by year

In New Zealand during 2008–2012, there was a small and variable number of deaths each year. Annual mortality rates following knee arthroplasty varied between 0.07% and 0.22% of admissions (Table 25). The overall cumulative mortality was 0.17% of admissions.

Table 25: Mortality following Knee Arthroplasty by Year, New Zealand 2008–2012

YEAR	Deaths	Admissions	Mortality per 100 Admissions (%)
2008	8	5,298	0.15
2009	10	5,474	0.18
2010	12	5,405	0.22
2011	12	5,617	0.21
2012	4	5,920	0.07
Total	46	27,714	0.17

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

Mortality in Elective Admissions with an ASA Score of 1 or 2

The following section uses information from the NMDS and the NMC to review mortality in the first 30 days following a general anaesthetic or a neuraxial block in those admitted electively or from the waiting list with a first ASA score of 1 or 2.

Key findings

In New Zealand during 2008–2012, for those admissions that were given an initial ASA score of 1 or 2, were admitted electively or from the waiting list, and who received a general anaesthetic or neuraxial block during their admission:

- There were between 35 and 60 deaths per annum and the cumulative mortality rate was 0.05%.
- Mortality was highest on the second day after the initial general anaesthetic or neuraxial block, although deaths occurred right up to the cut-off point for this analysis (day 30 after the initial anaesthetic).
- Malignant/other neoplasms were the most frequently listed cause of death for those over 25 years of age.
- Mortality was significantly higher for males, those over 25 years of age, those receiving two or more anaesthetics during their admission, those given an ASA score of 3 or 4 for the last of their subsequent anaesthetics, and those undergoing subsequent emergency procedures, when clinical and socio-demographic factors were considered.
- Cumulative mortality has slightly reduced from previous years (down from 0.07% during 2006–2010).

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

Mortality in elective admissions with an ASA score of 1 or 2 by year

In New Zealand during 2008–2012, annual mortality was between 35 and 60 deaths and between 0.04% and 0.07% of admissions for those admissions that were given an initial ASA score of 1 or 2, were admitted electively or from the waiting list, and who received a general anaesthetic or neuraxial block during their admission (Table 26). Cumulative mortality over the five-year period was 0.05% of admissions.

Table 26: Thirty-Day Mortality following Elective Admissions with a First ASA Score of 1 or 2 by Year, New Zealand 2008–2012

YEAR	Deaths	Admissions	Mortality per 100 Admissions (%)
2008	37	73,610	0.05
2009	60	80,977	0.07
2010	45	83,377	0.05
2011	48	86,519	0.06
2012	35	88,583	0.04
Total	225	413,066	0.05

Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block in those admitted electively or from the waiting list with a first ASA score of 1 or 2.
Denominator: NMDS: Elective/Waiting list admissions of those with a first ASA score of 1 or 2 and either a general anaesthetic or a neuraxial block.

Pulmonary Embolus-Associated and Attributed Mortality

This chapter uses information from the NMDS and the NMC to review hospital admissions in those receiving a general anaesthetic or neuraxial block that were associated with a pulmonary embolus, as well as mortality in the first 30 days following anaesthetic that was either associated with, or attributed to, a pulmonary embolus.

Key findings

In New Zealand during 2008–2012, in relation to hospital admissions in which death occurred within the first 30 days following a general anaesthetic or neuraxial block, the following were key findings.

For pulmonary embolus-associated admissions:

- There were 307 deaths and the cumulative mortality was 0.024% of initial anaesthetics.
- Mortality for acute admissions was most common on the same or next day following anaesthesia and remained increased over the entire 30-day period, while for elective/waiting list admissions it was more common over the first week after the anaesthetic.

For pulmonary embolus-attributed admissions:

- There were 199 deaths and the overall cumulative mortality for the 30-day period was 0.016% of initial anaesthetics.

In relation to both pulmonary embolus-associated mortality and attributed mortality:

- Malignant/other neoplasms was the most frequently listed main underlying cause of death regardless of the admission type.
- Mortality rose with age, was higher for acute admissions and was more common in those admissions that had an ASA score of 4. In general, there was a stepwise increase in mortality with rising ASA score.
- In comparison with the 2007–2011 period, cumulative mortality rates were higher in the 2008–2012 period for both pulmonary embolus-associated and attributed admissions.

Pulmonary embolus-associated and attributed mortality

Pulmonary embolus-associated and attributed mortality by admission type and hospital type

In New Zealand during 2008–2012, there were 307 admissions with pulmonary embolus-associated mortality. Most (68%) involved an acute hospital admission to a public hospital. Among the 76 deaths related to an elective/waiting list admission, 12 involved an admission to a private hospital.

Pulmonary embolus-associated mortality by year

In New Zealand during 2008–2012, there were between 44 and 80 pulmonary embolus-associated deaths per annum (Table 27). Annual cumulative mortality rates varied between 0.017% and 0.031% and the overall cumulative mortality rate was 0.024% of admissions.

Table 27: Pulmonary Embolus-Associated Mortality by Year, New Zealand 2008–2012

YEAR	Deaths	Admissions	Mortality per 100 Admissions (%)
2008	50	247,991	0.02
2009	44	254,740	0.02
2010	73	256,277	0.03
2011	80	261,797	0.03
2012	60	263,281	0.02
Total	307	1,284,086	0.02

Numerator: NMC: Pulmonary embolus-associated deaths within 30 days of first anaesthetic of an acute index admission.
Denominator: NMDS: All acute admissions with a general anaesthetic or neuraxial block.

Developing World Health Organization (WHO) Metrics in New Zealand

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

Reporting using the WHO metrics is increasingly being adopted by other countries throughout the world. The following chapter describes the POMRC's work to date in applying the WHO metrics for routine surveillance of surgical safety in New Zealand. In the future, this will enable the POMRC to make international comparisons in perioperative mortality.

Key findings

- The data presented reflects the difficulties in identifying 'all procedures'; however, two different methodologies have identified very similar POMRs (0.37% and 0.36% of admissions).
- The 10 most common procedures and 10 procedure blocks associated with the most deaths are used to guide selection of procedures for in-depth analysis.
- The 10 most common procedures are internally consistent, but there is considerable variation within some of the 10 procedure blocks associated with the most deaths.
- The POMRC is working with other bodies (Lancet Commission on Global Surgery, New Zealand Joint Registry) to better understand perioperative mortality and provide information to the public on the safety of surgery and anaesthesia in New Zealand.

New Zealand perioperative mortality and international comparisons

The POMRC continues to work with international colleagues to meet the challenges involved with benchmarking or comparing New Zealand's perioperative mortality data internationally.

There are few international reports that consider perioperative mortality across a whole health system, especially relating to surgical procedures. Comparisons between countries, regions or hospitals require adjustment for varying mortality risks that occur with different mixes of population demographics, illnesses and other characteristics. Similarly, there are major differences in how hospitals and health care systems are organised and how data is collected across these systems.

WHO metrics

In an effort to overcome these challenges there are increasing efforts to improve the standardisation of data collection and reporting and, therefore, enable international comparisons with other jurisdictions. The WHO (2009) has proposed some standardised public health surveillance metrics for surgical care (Table 28). The POMRC has focused on two of these metrics: day of surgery and postoperative inpatient deaths.

Table 28: WHO's Proposed Standardised Public Health Metrics for Surgical Care Analysed by the POMRC (WHO 2009)

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

The day of surgery death ratio can be equated with the analysis of general anaesthesia deaths as presented in the POMRC's previous reports and also presented here with adjustment for same-day death among the surgical specialty admissions (as surgical specialty admissions includes procedures performed without general anaesthesia).

Table 29 presents draft results to describe the total number of inpatient surgical procedures provided in New Zealand (2008–2012), the proportion of same-day fatalities and the proportion of inpatient deaths related to the admissions.

Table 29: Inpatient Deaths for All Surgical Procedures, New Zealand 2008–2012

	Deaths on Same Day as Operation *(Deaths within one day of general anaesthetic)*	Deaths as Inpatient	Admissions	Day of Surgery Mortality Rate per 100,000 (% all admissions) *(Deaths within one day of general anaesthetic)*	Inpatient Mortality Rate per 100,000 (% all admissions)
All surgical specialty patients	1,554	7,693	2,078,430	74.77 (0.07%)	370.14 (0.37%)
Deaths related to patients who undergo a general anaesthetic	1,436	5,103	1,181,670	121.52 (0.12%)	359.9 (0.36%)

In addition, the WHO guidelines also recommend the following measures for countries with more advanced data capability:

- number of surgical procedures performed in operating rooms for the 10 most frequent procedures in the country
- proportion of deaths after surgery by procedure for the 10 most frequent procedures in the country.

Procedures in the NMDS are coded according to the Australian Classification of Health Interventions (ACHI). The classification system includes over 5000 procedures organised into blocks. The most common surgical procedure blocks associated with the first general or neuraxial anaesthetic among inpatients in New Zealand 2008–2012 are reported in Table 30. Tonsillectomy and adenoidectomy procedures are the most frequent with 38,494 procedures occurring during the first anaesthetic of the admission.

Table 30: The 10 Most Frequent Surgical Inpatient Procedures by ACHI Block and First Procedure, New Zealand 2008–2012

BLOCK	NUMBER OF INDEX PROCEDURES 2008–2012	Description of Procedures in Block
412	38,494	Tonsillectomy with adenoidectomy, Adenoidectomy without tonsillectomy
1265	38,440	Dilation & curettage of uterus (D&C), Curettage of uterus without dilation
309	37,632	Myringotomy unilateral, Myringotomy bilateral, Myringotomy with insertion of unilateral or bilateral tube
412	29,648	Cholecystectomy and laparoscopic cholecystectomy
990	28,874	Inguinal hernia repair unilateral or bilateral including laparoscopic repairs
926	27,626	Appendicectomy including laparoscopic
457	26,248	Tooth removal
1489	22,001	Hip arthroplasty
1606	21,411	Abscess, Haematoma skin lesion incision/removal
1554	20,553	Removal of metal

The 10 blocks associated with the most deaths within 30 days following the occurrence of the procedure at the first anaesthetic during the inpatient stay are presented in Table 31.

Table 31: The 10 Procedure Blocks Associated with the Most Deaths, New Zealand 2008–2012

BLOCK	NUMBER OF DEATHS 2008–2012 WITHIN 30 DAYS OF FIRST PROCEDURE	Description of Procedures in Block
1479	426	External fixation of fracture of pelvis, Internal fixation of fracture of acetabulum, Internal fixation of disruption of sacro-iliac joint, Internal fixation of fracture of trochanteric or subcapital femur
913	380	Limited excision of large intestine with formation of stoma, Right hemicolectomy with formation of stoma, Limited excision of large intestine with anastomosis, Right hemicolectomy with anastomosis, Sub-total colectomy with formation of stoma, Extended right hemicolectomy with formation of stoma, Subtotal colectomy with anastomosis, Extended right hemicolectomy with anastomosis, Left hemicolectomy with anastomosis, Left hemicolectomy with formation of stoma, Total colectomy with ileostomy, Total colectomy with ileorectal anastomosis
1489	368	Hemiarthroplasty of femur, Excision arthroplasty of hip, Partial arthroplasty of hip, Total arthroplasty of hip, unilateral, Total arthroplasty of hip, bilateral
715	188	Replacement of popliteal aneurysm using vein, Replacement of popliteal aneurysm using synthetic graft, Replacement of carotid artery aneurysm with graft, Replacement of thoraco-aortic aneurysm with graft, Replacement of thoraco-abdominal aneurysm with graft, Replacement of suprarenal abdominal aorta aneurysm with graft, Replacement of infrarenal abdominal aortic aneurysm with tube graft, Replacement of infrarenal abdominal aortic aneurysm with bifurcation graft to iliac arteries, Replacement of infrarenal abdominal aortic aneurysm with bifurcation graft to femoral arteries, Replacement of iliac artery aneurysm with graft, unilateral, Replacement of iliac artery aneurysm with graft, bilateral, Replacement of visceral artery aneurysm with graft, Replacement of ruptured thoraco-aortic aneurysm with graft, Replacement of ruptured thoraco-abdominal aneurysm with graft, Replacement of ruptured suprarenal abdominal aortic aneurysm with graft, Replacement of ruptured infrarenal abdominal aortic aneurysm with tube graft, Replacement of ruptured infrarenal aortic aneurysm with bifurcation graft to iliac arteries, Replacement of ruptured infrarenal abdominal aortic aneurysm with bifurcation graft to femoral arteries, Replacement of ruptured iliac artery aneurysm with graft, Replacement of ruptured visceral artery aneurysm with graft, Replacement of other major artery aneurysm with graft
985	184	Exploratory laparotomy, Staging laparotomy for lymphoma, Postoperative reopening of laparotomy site, Staging laparotomy
895	179	Resection of small intestine with formation of stoma, Resection of small intestine with anastomosis
986	143	Division of abdominal adhesions, Laparoscopic division of abdominal adhesions
8	123	Drainage of intracranial haemorrhage, Drainage of intracranial tumour or cyst, Drainage of intracranial infection
623	120	Replacement of aortic valve with mechanical prosthesis, Replacement of aortic valve with bioprosthesis, Replacement of aortic valve with homograft, Replacement of aortic valve with unstented heterograft
934	111	Coronary artery bypass, using 1 LIMA graft, Coronary artery bypass, using ≥ 2 LIMA grafts

LIMA: left internal mammary artery.

Lancet Commission on Global Surgery

The POMRC is also working to assist the Lancet Commission on Global Surgery (http://www.thelancet.com/commissions/global-surgery) as it seeks to define solutions for the provision of quality surgical and anaesthesia care for all. The POMRC has contributed to key methodological efforts to explore perioperative mortality measurement across high, middle and low-income countries. This work has assessed the effect of using admission episodes or procedures as the denominator, and the difference between in-hospital perioperative mortality and 30-day mortality incorporating post-discharge deaths. The need for risk adjustment has also been considered in relation to its effects on relative POMRs across the sites. Standardised approaches to reporting and analysis will strengthen the validity of the POMR as the principal indicator of the safety of surgery and anaesthesia care for national and international comparisons (Palmqvist et al 2015).

The POMRC has supported efforts to estimate the minimum need for surgical procedures worldwide based on regional estimates of the prevalence of major diseases. As part of this work the POMRC has provided an important contribution by developing a methodology for defining the role of surgical care within health systems that is based on hospital service epidemiological information and disease prevalent data (Hider et al 2015; Rose et al 2015). It is expected that this work will provide useful information for international and national public health planning of surgical services.

Comparison of data included in the national database and clinical registry

The POMRC is working with the New Zealand Joint Registry to compare the occurrence of data about hip and knee arthroplasty procedures in a national administrative database with those in a well-established clinical registry. In previous reports the POMRC has identified that, although the NMDS is largely complete for all publicly funded events, it does not include information about all privately funded hospital admissions. This work aims to assess the nature and extent of what data may be missing from the NMDS and the importance of these omissions for any estimates of perioperative mortality. By combining data from both the NMDS and the New Zealand Joint Registry, the POMRC may obtain more in-depth information on all hip and knee arthroplasty procedures in New Zealand, and may be able to fully describe all the patients who undergo these treatments and their outcome.

Appendices

Appendix 1: Thirty-Day Mortality Rates in New Zealand Resident Population

Table 32: Thirty-Day Mortality Rates for New Zealand Resident Population

Age Groups (Five-Year Blocks)*	Male 30-Day Mortality/100,000	Female 30-Day Mortality/100,000
0	44.88	36.00
1	2.38	1.89
5	0.58	0.66
10	1.40	1.15
15	6.25	2.71
20	7.40	3.04
25	6.00	3.53
30	8.14	4.27
35	9.53	5.92
40	13.81	9.29
45	19.48	13.97
50	29.75	21.04
55	46.60	30.16
60	70.60	49.07
65	117.29	81.12
70	191.34	129.04
75	332.14	215.10
80	581.51	415.73
85	1011.37	801.21
90	1841.84	1722.66

* The age interval relates to a five-year period except for age 0 (which relates to a one-year period), age 1 (which relates to a four-year period), and age 90, which relates to remaining life span.

Based on Statistics New Zealand Life Tables 2009–11.

Appendix 2: Methods

The data sources and methods employed in this report for chapters that have been published before are consistent with those used for previous reports unless otherwise stated. Methods related to new chapters are outlined below.

Data sources

Hospital admission data was obtained from the NMDS and compared with Estimated Resident Population counts from Statistics New Zealand (projected from 2008). Mortality rates were sourced from NMC data and compared to NMDS admissions counts.

In relation to specific chapters included in this report the following data was obtained:

- **Cholecystectomy**

  All hospital admissions were included with a cholecystectomy listed in the first 90 procedure codes (ICD-10-AM ACHI Procedure Codes, Version 3: 3044300, 3044500, 3044600, 3044800, 3044900, 3045401, 3045500). In a small proportion of cases (n=420), other more complex procedures were undertaken at the same time as the cholecystectomy (eg, liver resections). In such cases where 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 to NMDS admissions where a cholecystectomy was listed in any of the first 90 procedure codes.

- **General anaesthesia**

  All hospital admissions were included with a general anaesthetic (ICD-10-AM ACHI Version 3: 92514XX) listed in the first 90 procedure codes were sourced from the NMDS. Mortality rates of those who died (on the same day or the day following a general anaesthetic) are sourced from NMC data and compared to NMDS admissions counts where a general anaesthetic was administered.

- **Hip arthroplasty**

  All hospital admissions were included with a hip arthroplasty listed in the first 90 procedure codes (ICD-10-AM ACHI Procedure Codes, Version 3, Blocks: 1489 and 1492) as recorded in the NMDS. Mortality information was sourced from the NMC and as recorded in the NMDS.

- **Knee arthroplasty**

  All hospital admissions were included with a knee arthroplasty listed in the first 90 procedure codes (ICD-10-AM ACHI Procedure Codes, Version 3, Blocks: 1518, 1519, 1523 and 1524) as recorded in the NMDS. Mortality information was sourced from the NMC and as recorded in the NMDS.

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

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

- **Bariatric surgery**

  Hospital admissions were initially reviewed if any bariatric procedure was listed in the first 90 procedure codes (ICD-10-AM ACHI Procedure Codes, Version 3, Blocks: 889, 875 and 1666) as listed in the NMDS. Admissions for the chapter were included only if a bariatric procedure for morbid obesity was listed in the first 90 procedure codes (ICD-10-AM ACHI Procedure Codes, Version 3, Block: 889) as recorded in the NMDS. Mortality information was sourced from the NMC and as recorded in the NMDS.

- **ASA 4 and 5**

  All hospital admissions were included in those with an ASA score of 4 or 5 that included a general anaesthetic (ICD-10-AM ACHI Procedure Code Version 3: Block 1910, 92514-XX) or neuraxial block (ICD-10-AM ACHI Procedure Code Version 3: Block 1909, 92508-XX). Deaths related to the admissions with an ASA score of 4 or 5 were included where mortality occurred within 30 days of the general anaesthetic or neuraxial block.

- **PTCA**

  All hospital admissions were included with an angioplasty procedure listed in the first 90 procedure codes (ICD-10-AM ACHI Procedure Codes, Version 3, 3530400, 3530500, 3531000, 3531001, 3531002) as recorded in the NMDS. Mortality information was sourced from the NMC and as recorded in the NMDS.

- **CABG**

  All hospital admissions were included with a CABG procedure listed in the first 90 procedure codes (ICD-10-AM ACHI Procedure Codes, Version 3, 3849700, 3849710, 3849720, 3849730, 3849740, 3849750 3849760, 3849770, 3850000, 3850300, 3850001, 3850301, 3850002, 3850302, 3850003, 3850303, 3850004, 3850304, 9020100, 9020101, 9020102, 9020103, 3863700) as recorded in the NMDS. Mortality information was sourced from the NMC and as recorded in the NMDS.

- **Sepsis**

  All hospital admissions were included with any secondary diagnosis of sepsis. The ICD-10-AM Edition 3 diagnosis codes used to define sepsis were A400, A401, A402, A403, A408, A409, A410, A411, A412, A413, A414, A4150, A4151, A4152, A4158, A418, A419, R571, R578, R579 and T811. An admission was included if any of these codes were identified in the 2nd to 90th diagnostic fields. Mortality information was sourced from the NMC and as recorded in the NMDS.

- **Pulmonary embolus-associated and attributed mortality**

  — *Pulmonary embolus admissions*

  All hospital admissions were included where a general anaesthetic (ICD-10-AM ACHI Procedure Code 92514-XX) or neuraxial block (ICD-10-AM ACHI Procedure Code Version 3: 92508-XX) was administered, and where 1) a pulmonary embolus (ICD-10-AM Version 3: 126.0, 126.8, 126.9) was identified in any of the diagnostic codes associated with the admission or 2) the patient was readmitted within 30 days of the first anaesthetic date of the index admission with a pulmonary embolus identified in any of the diagnostic codes or 3) where the patient died within 30 days of the first anaesthetic date of the index admission and a pulmonary embolus was identified as the main underlying cause of death or as a contributory cause in the NMC. The denominator used the NMDS: All hospital admissions where the patient received a general anaesthetic or neuraxial block. Note: In ICD-10-AM, pulmonary emboli associated with pregnancy and childbirth are coded separately, and these obstetric-related pulmonary emboli have been excluded from this analysis.

  — *Pulmonary embolus-associated mortality*

  Numerator: NMDS and NMC: All deaths occurring within 30 days of the first anaesthetic date of the index admission where the hospital admission met the criteria for a pulmonary embolus-associated admission outlined above.

  a) Denominator: NMDS: All hospital admissions where the patient received a general anaesthetic or neuraxial block.

  b) Denominator: NMDS: All pulmonary embolus-associated hospital admissions in those receiving a general anaesthetic or neuraxial block.

— *Pulmonary embolus-attributed mortality*

Numerator: NMDS and NMC: All deaths occurring within 30 days of the first anaesthetic date of the index admission where a pulmonary embolus was listed as either the main underlying cause of death or as a contributory cause of death in the NMC.

Denominator: NMDS: All hospital admissions where the patient received a general anaesthetic or neuraxial block.

Notes on interpretation

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

1) Hospital admission types and hospital readmissions

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

Acute, arranged in public (semi-acute) and elective/waiting list admissions

The analyses included in this report used the hospital admissions typology specified in the NMDS Data Dictionary (National Health Board 2014). An acute admission is defined as an unplanned admission occurring on the day of presentation, while an arranged in public (semi-acute) 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, elective/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 uploading their data to the NMDS, with a significant proportion of private hospital admissions being coded as semi-acute when in reality they meet the criteria for an elective/waiting list admission as outlined above. As a result, in the report all semi-acute private hospital cases have been included in the elective/waiting list category, while semi-acute admissions occurring in public hospitals have been included in the arranged in public (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 private surgical or procedural day-stay or outpatient hospitals, facilities or in-room events, although it notes that the data most likely to be missing is privately funded or Accident Compensation Corporation (ACC) funded events, or publicly funded long-stay geriatric cases. Thus, in this report it must be remembered that the data presented is likely to undercount some private hospital events, with the magnitude of this undercount being difficult to quantify (although it is assumed to be significant).

Readmissions

Both first-time procedures and revisions of previous procedures were included in the analyses, with a small number of individuals appearing more than once in the data. In such cases, if a second procedure occurred within 30 days of the initial procedure, it was considered to be a revision, arising as a complication of the first procedure, and, in such cases, the outcomes arising from the second procedure were attributed to the first. These readmissions were not included in the denominator used to calculate mortality rates by procedure. If a readmission occurred more than 30 days from the original procedure, however, this was considered to be a new procedure in the calculation of mortality rates.

2) Chapter-specific notes

The following information relates to chapters on clinical areas that have not been presented in previous reports.

Mortality related to CABG, PTCA and bariatric surgery

Consistent with other reports, mortality is presented as deaths occurring within 30 days of any procedure that meets the definition criteria for that chapter. In addition, for the new chapters presented in this report for the first time (CABG, PTCA, sepsis, ASA 4 and 5, and bariatric surgery) deaths as inpatients are also included where they have occurred after a relevant procedure but before discharge home or to a rehabilitation facility. The inclusion of deaths prior to discharge is consistent with the POMRC's terms of reference A2 (Deaths occurring after an operative procedure after 30 days but before discharge from hospital or to a rehabilitation facility).

Multiple anaesthetics and readmissions for ASA 4 and 5

Admissions were included if the ASA score of any anaesthetic (either a general anaesthetic or a neuraxial block) during that admission was either 4 or 5. Most admissions (91.5%) included only one anaesthetic with an ASA score of 4 or 5 as the first anaesthetic. In a number of admissions (1302) multiple anaesthetics were administered and the ASA score for one of these later anaesthetic events was 4 or 5. The anaesthetic with an ASA score of 4 or 5 was taken to be the index event for both the calculation of 30-day mortality and for assigning the ASA score.

In this analysis, all admissions with any anaesthetic procedure with an ASA of 4 or 5 have been included even if the ASA score of an earlier or later anaesthesia during that admission was not 4 or 5. Similarly only, deaths within 30 days of the index anaesthetic have been included, even if earlier or later anaesthetics occurred during the same admission (ie, 30-day mortality has been calculated with respect to the index rather than the first or last anaesthetic within an admission). In a small number of cases, two admissions occurred within 30 days of death. In such cases, the first elective/waiting list admission in the 30-day period has been taken to be the index event.

Admissions and mortality related to sepsis

An admission was included if any of the listed codes for sepsis were identified in the 2nd to 90th diagnostic fields. Admissions included any hospital event with a surgical diagnosis related group (DRG) that listed at least one operating room procedure. The list of operating room procedures and all other clinical codes were obtained by the Health Quality & Safety Commission and were based on the Victorian State Government document: Patient Safety Indicators: Translated Technical Specifications (http://www.health.vic.gov.au/__data/assets/pdf_file/0009/270855/Translated-Technical-Specifications.pdf). Operating room procedures and diagnoses were translated into ICD–10-AM Edition 3 and DRG codes were translated into Edition 3 and Edition 6. As from 1 July 2011 NMDS data contains DRGs in ICD–10-AM Edition 6. The following exclusions were applied to the admissions:

- any admissions with a primary diagnosis of sepsis
- those with a primary diagnosis of infection
- those with any code for an immunocompromised state
- those with any code for cancer
- those with a major diagnostic category 14 (pregnancy, childbirth and puerperium)
- those with a length of stay of less than 2 days.

The first operation date was used as the index date for mortality.

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

Multiple anaesthetics and readmissions for the 'Mortality following General Anaesthesia' chapter

While in the majority of cases only one general anaesthetic was performed per hospital admission, in 2.5% of admissions, two or more general anaesthetics were performed, with the maximum number of general anaesthetics performed during any one admission being 75. Further, in a number of cases, two or more anaesthetics were performed within a day of the death, resulting in both anaesthetic events being eligible for inclusion in the numerator. Finally, in a number of cases, two separate hospital admission events occurred within a day of each other, with both admission events including a general anaesthetic which occurred within a day of the death. As a result of these complexities, mortality rates have been calculated per 100,000 admission events where one or more anaesthetics were performed, rather than per 100,000 anaesthetics (ie, the denominator is the number of admission events rather than the number of anaesthetics). Where two eligible admissions occurred within a day of the death, both admission events have been counted in the denominator (number of hospital admissions) but the death has only been counted once, in the most recent admission event prior to the death.

Multiple anaesthetics and readmissions for the 'Mortality in Elective Admissions with an ASA Score of 1 or 2' chapter

Elective/waiting list admissions were included if the ASA score of the first anaesthetic (either a general anaesthetic or a neuraxial block) during that admission was either 1 or 2. In a small number of admissions, multiple anaesthetics were administered, and in some cases the ASA score for these later anaesthetic events was 3 or more. Because the first anaesthetic was taken to be the index event for both the calculation of 30-day mortality and for assigning the ASA score, in this analysis all admissions have been included, even if the ASA score of later anaesthesia was 3 or more. Similarly, only deaths within 30 days of the index anaesthetic have been included, even if later anaesthesia occurred during the same admission (ie, 30-day mortality has been calculated with respect to the first rather than the last anaesthetic within an admission). In a small number of cases, two elective/waiting list admissions occurred within 30 days of death. In such cases, the first elective/waiting list admission in the 30-day period has been taken to be the index event.

Multiple anaesthetics and readmissions for the 'Pulmonary Embolus-Associated and Attributed Mortality' chapter

In a small number of cases, two or more hospital admissions occurred within 30 days of a pulmonary embolus-associated or attributed death, and in such cases, the first admission was considered to be the index admission, with the second admission being removed from both the numerator and denominator of the mortality rate calculations (although both admissions were included in the calculation of pulmonary embolus-associated admission rates). Similarly, only deaths occurring within 30 days of the first anaesthetic date of the index admission were included, even if later anaesthesia occurred during the same admission (ie, 30-day mortality was calculated with respect to the first rather than the last anaesthetic for each index admission).

3) Socio-demographic and clinical covariates

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

NZDep decile

Analysis of NZDep information is not separately included in this report as only 2006 NZDep data could be obtained. It is likely that the 2006 data would have limited relevance to the admissions and mortality information from the later years analysed in this report. Thus, separate analyses of data were not presented in relation to NZDep. However, this data was used in the logistic regression analyses in order to give some indication of the effect of deprivation on the results.

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 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

Unless otherwise specified, 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. However, in Table 18 of the companion report (available on the Commission's website by July 2015) the ASA status and emergency status of the last listed anaesthesia code has been used, in order to better reflect the factors associated with the last anaesthetic prior to death (with the order of procedure codes again being determined by the diagnosis sequence in the NMDS).

4) 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).

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

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

Appendix 3: Previous report recommendations – progress summary

The following tables present the Committee's progress on recommendations made in the previous three reports.

Table 33: Progress Summary of Third Report Recommendations

RECOMMENDATIONS OF THIRD REPORT (MARCH 2014)	PROGRESS TO DATE (MARCH 2015)
Recommendations for *improving perioperative care:* The ASA Physical Status Classification for each patient is collected and communicated to all theatre staff. The POMRC considers this is best done in the time-out part of the WHO Surgical Safety Checklist.	The Perioperative Harm Advisory Group has highlighted the need for ASA recording, as part of the surgical safety checklist. The proportion of ASA recording is improving but is far from complete. This recommendation will be repeated.
A continuing focus on promotion of formal and timely assessment of the risk of venous thromboembolism (VTE) is warranted, including with acutely admitted patients, given the apparent minor increase in pulmonary embolism mortality.	The Commission is partnering with the International Society on Thrombosis and Haemostasis, highlighting a systematic approach to assessment and prophylaxis of VTE. Help for introducing hospital VTE prevention programmes was included in a 2012 Commission-sponsored project to establish a national policy framework for VTE. As the most recent year reported on is 2012, no effect would yet be seen.
Recommendations for *system development:* The POMRC works with health care providers to develop recommendations for standardised perioperative mortality reporting and reviewing.	All DHB and private providers have been surveyed as to how they undertake local perioperative mortality review. Areas that are doing it well have been identified and the Lead Coordinator for the POMRC has undertaken site visits collecting information as to what best practice looks like. Recommendations will then be drawn up as to how best to undertake a standardised local perioperative mortality review.
Recommendations for *further analysis:* The proposed WHO measures of surgical care are incorporated into perioperative mortality analysis and reporting.	The 2015 report has focused on two of the WHO proposed standardised public health surveillance metrics: day of surgery and postoperative inpatient deaths.
A standard out-of-hospital death notification process be explored as a mechanism to identify deaths that occurred within 30 days of an operative procedure but after discharge.	This process is under development.
The Commission considers developing a resource on hospital standardised mortality ratios.	Under investigation.

Table 34: Progress Summary of Second Report Recommendations

RECOMMENDATIONS OF SECOND REPORT (MARCH 2013)	PROGRESS TO DATE (MARCH 2015)
All patients should be formally assessed preoperatively for risk of venous thromboembolism and appropriate thromboprophylaxis implemented, taking into account the individual risk/benefit profile.	Raising the profile of venous thromboembolism risk is part of the Health Quality & Safety Commission's *Open for better care* campaign and promoted by the Reducing Perioperative Harm programme.
All health care professionals should participate actively in the WHO Surgical Safety Checklist, including the question on thromboprophylaxis.	The Perioperative Harm Advisory Group of the Commission is actively promoting the use of the checklist to improve teamwork and communication.
To assist informed consent, information should be available for patients concerning the risk of dying within 30 days of any procedure that has significant risk of mortality.	Reports of the POMRC (reporting mortality on a five-year rolling basis starting from 2006) will shape the development of informed consent resources for patients. This will be developed in conjunction with the Consumer Engagement team of the Commission. Data from the reports has been used in clinical teaching.
Non-operative care pathways should be developed and used when surgical procedures are deemed inappropriate because of excessive risk.	This has been raised with the Royal Australasian College of Surgeons and the Australian and New Zealand College of Anaesthetists and is supported.
Case studies are developed to highlight current good practice or recommend practice change.	Case studies are used in the annual POMRC workshops.
Psychosocial issues contributing to mortality following procedures require further investigation.	Close communications maintained with the Suicide Mortality Review Committee.
Given the relative mortality of acute (1.0%) and elective (0.16%) cholecystectomy, further research is conducted into the management of acute cholecystitis.	Analysis included in the 2015 report.
Mortality following acute surgery for those aged over 80 years needs further assessment and discussion with health care professionals so that optimal health care can be planned.	Analysis included in the 2015 report.
There is a continuing focus on ASA 1 and 2 elective surgery mortality (as, for these patients, a positive outcome was anticipated).	Further analysis included in the 2015 report.

Table 35: Progress Summary of Inaugral Report Recommendations

RECOMMENDATIONS OF INAUGURAL REPORT (FEBRUARY 2012)	PROGRESS TO DATE (MARCH 2015)
A whole-of-system perioperative mortality review process is developed which builds on the NMDS and the NMC. This would include the accurate and systematic recording of patient and procedure details from all health care facilities and practitioners.	An integrated data entry process is being developed to collect data across all health care facilities.
Key components The enhancement and standardisation of existing data collections and current mortality review processes to ensure a uniform, efficient and meaningful national methodology.	An integrated data entry process is being developed to collect data across all health care facilities. Identification of 'all perioperative processes' in the NMDS remains problematic and will be addressed by the data entry process being developed. Private hospital coverage is still incomplete, particularly private day-stay providers.
A coding mechanism that recognises both procedures and deaths within the remit of the POMRC. This will require investigation to determine optimal methodology.	See above. Comments from previous reports remain.
The development of a national standardised perioperative mortality review form that will be common to all health care facilities and practitioners. This form will enable and facilitate additional data collection and peer review processes.	This will be an electronic data only process, which is under development.
Secure national data storage hosted by, and under the guardianship of, the Health Quality & Safety Commission.	Completed.
The ability to carry out whole-of-system and focused (sub-group) analysis of both qualitative and quantitative data.	Under development.
The ability to report at a number of levels (national, regional, within health care facility) and to a variety of audiences, including consumers and the wider community.	Data entry processes are being developed to enable national, regional and local reporting.
The ability to generate evidence-based, peer-reviewed recommendations for reinforcing current 'good practice' or system improvements leading to practice change.	In progress.
Formalised Memorandum of Understanding between the POMRC and Coronial Services to enable enhanced and standardised data access.	A change in Chief Coroner has slowed the process but progress is being achieved. The Memorandum of Understanding is in development and is expected to cover all the mortality review committees.
Work with the National Health Board to ensure that the NMDS and NMC collections are enhanced and standardised by: • ensuring that the ASA score is recorded for all procedures • separately identifying existing conditions from those acquired during that admission • ensuring that the immediate cause of death can be identified from the data collections.	The National Health Board and mortality review committees have worked together to improve data capture. This remains an iterative process as data collection and reporting systems are further developed.
Submission of data to the NMDS is mandatory for all health care facilities.	Following sector consultation, this recommendation has been well received by both the public and private sectors. Despite this, there are some private facilities still not submitting data to the NMDS.

Appendix 4: POMRC Progress 2010–2015

Table 36: POMRC Progress 2010–2015

ESTABLISHMENT PHASE		IMPLEMENTATION PHASE		
Year 1 July 2010–June 2011	**Year 2 July 2011–June 2012**	**Year 3 July 2012–June 2013**	**Year 4 July 2013–June 2014**	**Year 5 July 2014–June 2015**
POMRC establishment	Inaugural report published (February 2012)	POMRC at full membership	Publication of progress report (March 2014)	Publication of progress report (June 2015)
Sector engagement/ consultation	Sector engagement/ consultation	Sector engagement/ consultation	Publication of further national perioperative mortality data (June 2014)	Publication of fourth report (June 2015)
Data scoping	Developing data analysis methodology	Publication of second report	Second workshop (June 2014)	Third workshop (June 2015)
Determine reporting focus	Reviewing additional data modalities	Endoscopy Working Group established	Endoscopy case review	
Transition from Ministry of Health to Health Quality & Safety Commission		Inaugural workshop (June 2013)	Integrated review form piloted internally and externally	Review of existing local mortality review processes
		Development of integrated perioperative mortality review form	National perioperative mortality data collection infrastructure developed	

List of Abbreviations

ACC	Accident Compensation Corporation
ACHI	Australian Classification of Health Interventions
ASA	American Society of Anesthesiologists
CABG	Coronary artery bypass graft
CI	Confidence interval
DHB	District health board
DRG	Diagnosis related group
LIMA	Left internal mammary artery
MELAA	Middle Eastern/Latin American/African
NMC	National Mortality Collection
NMDS	National Minimum Dataset
NZDep	New Zealand Deprivation Index
OR	Odds ratio
POMR	Perioperative mortality rate
POMRC	Perioperative Mortality Review Committee
PTCA	Percutaneous transluminal coronary angioplasty
RIMA	Right internal mammary artery
VTE	Venous thromboembolism
WHO	World Health Organization

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