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

POMRC
Perioperative Mortality Review Committee

Perioperative Mortality in New Zealand:

Second report of the Perioperative Mortality Review Committee

Report to the Health Quality & Safety Commission New Zealand

March 2013

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Contents

List of Tables and Figures

Foreword

The Perioperative Mortality Review Committee (the Committee) is a statutory committee established under the New Zealand Public Health and Disability Act 2000 that reports to the Health Quality & Safety Commission (the Commission). The Commission welcomes the Committee's second report.

Although there has been an increase in patient baseline risk over the past 50 years, we know from the published literature that perioperative mortality rates have steadily declined. There is a range of factors that have contributed to this, including routine use of surgical safety checklists (Haynes et al 2009), clinical pathways (Muller et al 2009), enhanced recovery strategy (Rawlinson et al 2011), volume of cases (Birkmeyer et al 2002) and ability to recognise and manage complications (Ghaferi and Dimick 2012; Vonlanthen and Clavien 2012).

These improvements to the quality and safety of the patient journey can be further enhanced by the publication of reports such as this. Understanding the risks associated with surgery is essential for assisting patients in making appropriate choices between health care options, for improving the safety of surgery and for ensuring that the best value is obtained from the resources invested in health care. For example, this report illustrates the tragedy and waste of valuable resource that occurs when a patient dies from a pulmonary embolism that could potentially have been prevented. This report is the next step in developing a whole-of-system national perioperative mortality review process. The Committee has selected four clinically important areas and analysed mortality against these categories for the period 2006–2010.

The Committee has further sought to understand the role of coronial files in the development of contextual information to understand the causative factors and systemic issues leading to perioperative mortality and morbidity and, more importantly, to inform future recommendations that focus on preventable mortality.

I am encouraged by this report's contribution to data that are both locally relevant and internationally significant. 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 second report of the Perioperative Mortality Review Committee. The aim of the Committee is to review and report on perioperative deaths, with a view to reducing these deaths and continuously improving health quality and safety through the promotion of ongoing quality assurance programmes. The Committee advises on other matters related to mortality and develops strategic plans and methodologies designed to reduce perioperative mortality and morbidity.*

In this second report, we have continued to investigate the epidemiology of perioperative mortality. We have chosen four clinically important areas and analysed mortality for 2006–2010:

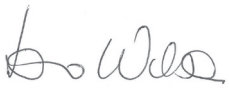
- Cholecystectomy
- Pulmonary embolus
- Patients aged 80 years and older (following general anaesthetic or neuraxial block)
- Elective admissions for those classified as ASA 1 or 2.

By choosing an operation, a potential cause of death and a high-risk and low-risk group of patients, the Committee aimed to further its understanding of the strengths and weaknesses of using the nationally collected data in the National Minimum Dataset (NMDS) and National Mortality Collection (NMC). The Committee hopes that these data will assist patients and their doctors and nurses make appropriate decisions about their care.

The Committee is developing a system that will allow the reporting of contextual information to enable peer review and better understanding of the causes of perioperative mortality. The data collection system will take account of existing processes for the collection of morbidity and mortality data locally, with an emphasis on collecting whole-of-system information. We recognise that data collection can impose burdens on individual clinicians, and it is our intention to minimise that by using data already collected as a basis for clinician reports.

Information from coronial files on deaths of interest to the Committee was investigated to understand how it could add to the review process. This work will form a basis for our discussions with the coroners on developing a memorandum of understanding about further enabling enhanced and standardised data access. As we develop our work programme this year, the Committee will be holding its inaugural workshop on 13 June 2013 in Wellington to present the findings of this report. Experts will be invited to critique this report, and further recommendations will be made about preventable perioperative mortality.

This report contains the progress on recommendations made in the first report and the responses to our consultation on the future direction of the Committee. We have been very grateful for the support shown and advice given by the sector and the thoughtful responses to our consultation. We look forward to continuing to work with you in the coming year as, together, we develop the national whole-of-system perioperative mortality review process.



Dr Leona Wilson, ONZM
Chair, Perioperative Mortality Review Committee

* Refer to POMRC Terms of Reference, http://www.hqsc.govt.nz/our-programmes/mrc/pomrc/about-us/terms-of-reference/.

Executive Summary

It has been estimated that more than 230 million major surgical procedures are undertaken worldwide each year (Weiser et al 2008), but the risk of death related to surgery and anaesthesia is not well known and remains rarely measured at the national level. In this report, the epidemiology of perioperative mortality in four clinically important areas has been analysed for New Zealand for the period 2006–2010. International comparisons are drawn when appropriate. In addition, a review of a sample of coronial files has been investigated to determine how these data may provide useful context to complement the epidemiology of perioperative mortality.

Results

Perioperative mortality 2006–2010: cholecystectomy

*Cholecystectomy was chosen in order to analyse a **procedure** undertaken in many health facilities.*

1. Malignant neoplasms were the most frequently listed main underlying cause of death in those dying within 30 days of a cholecystectomy. However, 30-day mortality following a cholecystectomy was relatively infrequent (120 deaths following 29,473 cholecystectomy admissions during 2006–2010).

2. Mortality following an acute cholecystectomy was highest in the first five days following surgery, while for elective admissions, mortality was highest on day two post-surgery.

3. Mortality following cholecystectomy was relatively infrequent amongst those with an ASA score of 1 or 2, irrespective of whether the admission was acute or elective. For those with an ASA score of 3 or more, mortality rates increased with increasing ASA score, with the highest rates within each ASA category being seen for acute admissions.

4. Reports describing national experiences of postoperative mortality following cholecystectomy are rare. The overall mortality rate in New Zealand associated with cholecystectomy, at 0.4%, is similar to that in the United States (0.53%). Mortality rates in both countries are higher among those undergoing emergency surgery or an open procedure (Ingraham et al 2011a).

5. In a small number cases, cholecystectomy was part of a more complx operation that would be expected to have a higher mortality rate (such as lobectomy of liver). Dues to NMDS coding, however, separation of these data is problematic.

Perioperative mortality 2006–2010: elective admissions for ASA 1 or 2

This group was chosen as these patients were less likely to die, being classified as healthy, or with mild disease and were admitted for elective surgery.

6. Injuries/External causes and malignant/other neoplasms were the most frequent causes of mortality in the first 30 days following an initial general anaesthetic or neuraxial block in children and young people aged 0–24 years admitted electively with a first ASA score of 1 or 2, while malignant/other neoplasms were the most frequent causes of mortality in those aged 25–44 years. Malignant/Other neoplasms, myocardial infarctions/other ischaemic heart disease and other cardiovascular causes were also the most frequent causes of mortality in the first 30 days following an anaesthetic in those aged 45–64 and 65–79 years, as well as those aged 80+ years, who were admitted electively with an ASA score of 1 or 2.

7. Thirty-day mortality in those admitted electively with an ASA score of 1 or 2 was relatively infrequent (259 deaths per 376,454 initial anaesthetics), with mortality being highest on the second postoperative day, although a number of deaths occurred each day right up until 30 days following the initial anaesthetic. Cumulative 30-day mortality was 68.8 per 100,000 initial anaesthetics (or 0.07%).

8. Thirty-day mortality in those admitted electively with an ASA score of 1 or 2 was relatively infrequent in those aged under 50 years, but rose progressively thereafter, with the highest rates being seen in those aged 90+ years. The largest number of actual deaths, however, occurred in those aged 80–84 years.

9. Thirty-day mortality was *significantly* higher in those who subsequently received two or more anaesthetics (vs. one anaesthetic), those whose last anaesthetic was undertaken as an emergency (vs. non-emergency or not stated) and those whose last anaesthetic for the index admission had risen to an ASA score of 3 or 4 (vs. ASA score 1–2).

10. Few studies have specifically focused on the mortality associated with admissions with an ASA score of 1 or 2. In a meta-analysis of studies that included where ASA 1 and 2 status had been reported, the finding of a mortality rate of 688 per million for patients is broadly consistent with the New Zealand data, although it should be noted that the Committee's data were restricted to elective patients and excluded urgent or acute cases for whom the risk of death may be higher. Despite overseas concerns about the inter-rater reliability of the ASA scoring by different anaesthetists (Aronson et al 2003), the score has been shown to be an important predictor of mortality for surgical patients in New Zealand (Hooper et al 2012).

Perioperative mortality 2006–2010: aged 80+ years following general anaesthetic or neuraxial block

This was chosen as the previous report identified this group as having a higher risk of perioperative mortality.

11. Falls, followed by myocardial infarction/other ischaemic heart disease were the most frequently listed main underlying causes of death in those aged 80+ years dying within 30 days of a general anaesthetic or neuraxial block who were admitted acutely, while malignant/other neoplasms and myocardial infarction/other ischaemic heart disease were the most frequent cause of mortality for public hospital semi-acute and elective admissions.

12. Mortality in the first 30 days following a general anaesthetic or neuraxial block in those aged 80+ years was relatively frequent (2799 deaths following 62,230 initial anaesthetics during 2006–2010). Cumulative 30-day mortality, however, was higher for acute admissions (9008.6 per 100,000 initial anaesthetics, or 9.0%) than for elective admissions (1210.9 per 100,000 initial anaesthetics, or 1.2%).

13. Mortality following a general anaesthetic or neuraxial block in those admitted acutely was highest on day one and two, with the number of deaths then tapering off over the first week. For elective admissions, mortality was highest on the second day following the anaesthetic. However, deaths still occurred right up until 30 days for both admission types.

14. Mortality was similar for those with ASA scores of 1 or 2 but increased with increasing ASA score thereafter, with the highest rates being seen in those with an ASA score of 5. As expected, no elective admissions occurred in those with an ASA score of 5. Thus, for those admitted acutely with an ASA score of 5, mortality was 49.7%.

15. In those aged 80+ years, 13.4% of acute admissions had two or more anaesthetics, with mortality in those undergoing two or more anaesthetics being *significantly* higher than for those only undergoing one anaesthetic. Mortality rates for those acute admissions where the last anaesthetic was undertaken as an emergency were also *significantly* higher than for those where the last anaesthetic's emergency status was either non-emergency or not stated — mortality rate 11.2 per 100 admissions.

16. Similarly, 9.4% of elective admissions in those aged 80+ years had two or more anaesthetics, with mortality in this group again being *significantly* higher than for those undergoing only one anaesthetic — mortality rate 4.3 per 100 admissions, univariate OR 4.98 (95% CI 4.04–6.13), multivariate OR 3.72 (95% CI 2.94–4.71). Mortality rates for those elective admissions where the last anaesthetic was undertaken as an emergency were also *significantly* higher than for those where the status was either non-emergency or not stated — mortality rate 10.4 per 100 admissions, univariate OR 10.7 (95% CI 7.86–14.55), multivariate OR 3.38 (95% CI 2.34–4.89).

17. International comparisons for mortality risk borne by the elderly across a variety of procedures are difficult because of the paucity of relevant national audits.

Perioperative mortality 2006–2010: pulmonary embolism

*Pulmonary embolism was chosen in order to analyse a **cause of death**.*

18. Pulmonary embolus-associated hospital admissions were infrequent in children and young people 0–24 years but increased thereafter, with the highest rates being seen in those aged 80+ years. In each age group, pulmonary embolus-associated admission rates were higher for acute admissions than for elective admissions.

19. Repairs of fractures of the femur were the most frequently undertaken procedures to occur during acute admissions associated with pulmonary emboli, followed by hemi-arthroplasties of the femur and hip arthroplasty. Similarly, knee and hip arthroplasties were the procedures most frequently undertaken during elective admissions associated with pulmonary emboli.

20. Falls, malignant/other neoplasms and myocardial infarction/other ischaemic heart disease were the most frequently listed main underlying causes of death in those meeting the criteria for a pulmonary embolus-associated death (ie, death within 30 days of the first anaesthetic of a pulmonary embolus-associated admission) who were admitted acutely. Similarly, malignant/other neoplasms were the most frequently listed main underlying causes of death in those admitted electively/from the waiting list who met the criteria for a pulmonary embolus-associated death.

21. Pulmonary embolus-associated mortality in those admitted acutely was highest on the same day or the day immediately after a general anaesthetic or neuraxial block. Mortality following elective admissions associated with a pulmonary embolus was highest during the first two weeks. Cumulative 30-day mortality was higher for acute admissions (54.5 per 100,000 initial anaesthetics, or 0.05%) than for elective admissions (7.6 per 100,000 initial anaesthetics, or 0.008%).

22. Pulmonary embolus-associated and attributed mortality was infrequent in those aged less than 45 years, with the vast majority of deaths occurring in those who were admitted acutely and who had an ASA score of 4. Amongst older age groups, while mortality was again higher for those with an ASA score of 4, differences between those with ASA scores of 1, 2 and 3 were less consistent. Within each ASA score category, mortality rates were generally (although not always) higher for acute than for elective surgical admissions.

23. The mortality rate associated with pulmonary embolism in New Zealand for either acute or elective admissions (0.05% or 0.008%) is broadly similar to that reported for the Japanese surgical population (0.08%) (Sakon et al 2004) and markedly lower than an estimate for general Western surgical populations (0.9%) (Geerts et al 2001). The New Zealand figure also includes fatalities occurring among inpatients and up to 30 days postoperatively, which is consistent with evidence that thromboembolism may often occur days after surgery when the patient may have been discharged (Bjornara et al 2006).

Coronial review and perioperative mortality

24. A review of a sample of coronial files highlighted that the majority of relevant information for the purposes of perioperative mortality review is obtainable from hospital records. There is a number of instances, however, where coronial files add important contextual information to further understand the circumstances surrounding perioperative deaths. These circumstances include:
    - when the cause of death is uncertain, post-mortem results are helpful
    - when an inquest has taken place, expert opinion may provide useful additional information
    - when the death occurred out of hospital and there was subsequent coronial review.

Consultation and next steps

25. Following release of the Committee's inaugural report, feedback was sought regarding the future direction of the Committee. There is overall support for whole-of-system national perioperative mortality review to be conducted with the ultimate goal of focusing on deaths that were both considered and could potentially be classified as preventable events. Although rates of avoidable harm may be low, many deaths could potentially be prevented due to the high volumes of procedures undertaken each year.

26. There was an emphasis placed on a system that is simple to use and integrated with existing data collection modalities.

27. Views differed slightly around where the emphasis of mortality review should be, with a slight favouring of case review over an epidemiological approach. Having peer-reviewed cases in reporting was emphasised as useful as an educative tool and more important on a day-to-day basis for understanding perioperative mortality.

28. The Committee is developing a system that will enable the reporting of contextual information to enable peer review and better understanding of the causes of perioperative mortality.

Second Report Recommendations

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

The Committee recommends that:

- All patients should be formally assessed preoperatively for risk of venous thromboembolism and appropriate thromboprophylaxis implemented, taking into account the individual risk/benefit profile.
- All health care professionals should participate actively in the World Health Organization Surgical Safety Checklist, including the question on thromboprophylaxis.*
- 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.
- Non-operative care pathways should be developed and used when surgical procedures are deemed inappropriate because of excessive risk.

For further investigation and reporting:

- Case studies are developed to highlight current good practice or recommend practice change.
- Psychosocial issues contributing to mortality following procedures require further investigation.
- Given the relative mortality of acute (1.0%) and elective (0.16%) cholecystectomy, further research is conducted into the management of acute cholecystitis.
- 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.
- There is a continuing focus on ASA 1 and 2 elective surgery mortality (as, for these patients, a positive outcome was anticipated).

* Not all health care facilities currently include a check for thromboprophylaxis on their checklist. This will be investigated in collaboration with the reducing perioperative harm work programme of the Commission.

Inaugural Report Recommendations: Progress Summary

Table 1 is a summary of progress made against the recommendations of the inaugural report.

Table 1. Progress Summary of Inaugural Report Recommendations

RECOMMENDATIONS OF INAUGURAL REPORT (FEBRUARY 2012)	PROGRESS TO DATE (FEBRUARY 2013)
1. A whole-of-system perioperative mortality review process is developed that 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.	
Key components: a. The enhancement and standardisation of existing data collections and current mortality review processes to ensure a uniform, efficient and meaningful national methodology.	The system developed first identifies clinically important groups of procedures for investigation and uses Australian Classification of Health Interventions (ACHI) codes to select these procedures and reviews 30-day mortality using NMDS and NMC. Other methodologies were investigated, resulting in a number of lessons learned: • Selection of cases based on the presence on surgical subspecialty codes in the NMDS would have resulted in a large number of operative procedures being excluded from analysis. • The use of anaesthetic codes in isolation would be insufficient to identify all procedures under the Committee's scope. • The denominator for total perioperative mortality rates cannot be readily identified via the NMDS. The denominator is more complete when using Statistics New Zealand data. • NMDS and NMC review is cost-effective and provides useful baseline information. There is near-complete coverage of publicly funded procedures and relatively complete demographic information. • Private hospital coverage is incomplete, particularly private day-stay providers. This methodology provides limited contextual information. However, it does provide important baseline information. A stocktake of local mortality review processes is being conducted.
b. A coding mechanism that recognises both procedures and deaths within the remit of the Committee. This will require investigation to determine optimal methodology.	Reviewing perioperative deaths requires a 'flag' in the system for early identification of cases. This can be achieved in a number of ways. The Burial and Cremation Act 1964 is currently under review. The Commission responded to the Law Commission's consultation regarding this Act. The Act review also queried whether the circumstances in which doctors are required to report deaths that are "without known cause" or deaths that occur "during medical, surgical, or dental operation, treatment, etc." need to be better defined under the Coroners Act 2006. The Committee recommended consideration of additional definitions in relation to medical or surgical procedures and anaesthesia. A recommendation was also made to include deaths that occurred before a person was discharged from hospital following an operation or procedure or that occurred within 30 days of an operation or procedure of that kind.

RECOMMENDATIONS OF INAUGURAL REPORT (FEBRUARY 2012)	PROGRESS TO DATE (FEBRUARY 2013)
c. 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 recommendation is key to understanding contextual information around perioperative mortality. This will be the focus of the next work plan.
d. Secure national data storage hosted by, and under the guardianship of, the Commission.	All data is either stored or handled at an 'in confidence' level of security.
e. The ability to carry out whole-of-system and focused (subgroup) analysis of both qualitative and quantitative data.	See response to 1b.
f. 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.	An endoscopy working group has been established. A form is being developed to enable national, regional and local reporting.
g. The ability to generate evidence-based peer-reviewed recommendations for reinforcing current 'good practice' or system improvements leading to practice change.	As methodologies for data collection and analysis are developed, the Committee will be able to formulate more specific recommendations.
2. Formalised memorandum of understanding between the Committee and Coronial Services to enable enhanced and standardised data access.	A central process has been established for contact with Coronial Services and the Mortality Review Committees.
3. Work with the National Health Board to ensure that the NMDS and NMC collections are enhanced and standardised by: a. ensuring that the ASA score is recorded for all procedures b. separately identifying existing conditions from those acquired during that admission c. 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. The items listed have been completed.
4. 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.

Consultation and Future Directions

Following the release of the Committee's inaugural report (February 2012), feedback was sought regarding the future direction of the Committee's work. Responses were received in April 2012. Appendix 5 summarises the feedback received and highlights some of the key messages contained in the responses.

While there was not a large number of responses received, feedback came from some of the key organisations that will be pivotal to ensuring the success of a national perioperative mortality review system. With feedback from both the Royal Australasian College of Surgeons (RACS) and the Australian and New Zealand College of Anaesthetists (ANZCA), two district health boards (DHBs) (Bay of Plenty and Counties Manukau), one major private provider (Southern Cross Hospitals) and feedback and letters of support from the Health and Disability Commissioner and the Ministry of Health, this provided the basis of understanding what would be useful for the sector and, therefore, how to progress with a national perioperative mortality review system.

In addition to the formal responses received, the Committee has engaged with many parts of the health care sector with an interest in mortality review in general and the Committee's work in particular to introduce the work of the Committee and build a model for perioperative mortality review. Face-to-face consultation has taken place with the following organisations (with further sector engagement planned for this year):

- ANZCA
- Council of Medical Colleges
- Medical Council of New Zealand
- Ministry of Health
- National Chief Medical Officer Group
- New Zealand Medical Association
- New Zealand Private Surgical Hospitals Association
- Office of the Chief Coroner
- RACS.

Themes

Given the composition of the Committee, which has broad representation, there was concordance with the views expressed by the respondents to the consultation as well as the organisations that the Committee has met with. These views have been drawn upon to form the basis of the coming year's work programme.

1. Support for perioperative mortality review

There is overall support for high-quality national perioperative mortality review to be conducted with the ultimate goal of focusing on deaths that were considered preventable and could potentially be classified as preventable events. Focusing on these events could inform system and practice change that leads to a safer and higher-quality health care system. This view was also tempered with the importance of developing information for patients about the risks and benefits of procedures undertaken in the health care setting. National perioperative mortality review can build an incremental risk profile for a range of procedures, and this has the potential to directly benefit the quality of information being provided to consumers of health services.

2. Simplicity and integration

There was an emphasis placed on a system that is simple to use and integrated with existing data collection modalities. Background epidemiological data can be obtained, in part, from the NMDS and NMC with denominator data derived from Statistics New Zealand. This is useful when examining perioperative mortality broadly. Integration in terms of reporting with these public data sets has been achieved and scoping of other sets such as the Coroners' Case Management System and the Cancer Registry has been completed. Integration with established case review systems used by RACS and ANZCA is planned as an essential component of maintaining a system that is integrated and as simple to use as possible for the end-user. Integration also means that all health care facilities are able to report on perioperative mortality (ie, both publicly funded and private facilities, including day-stay). There is support for 100% participation from both the public and private sectors to ensure robust information is available to all facilities and consumers.

3. Epidemiology: useful if supplemented with case review

Views differed slightly around where the emphasis of mortality review should be, with a slight favouring of case review over an epidemiological approach. It was acknowledged, however, that an epidemiological approach serves as a useful background and has the potential to highlight where further in-depth review is required. Epidemiology of perioperative mortality has been presented in the inaugural report and this current report, focusing on particular areas of interest (Table 2):

Table 2. Reporting for Years One and Two

YEAR ONE REPORTING (MORTALITY 2005–2009)	CURRENT REPORT (MORTALITY 2006–2010)
Hip and Knee Arthroplasty	Cholecystectomy
Colorectal Resection	Pulmonary Embolism
Cataract Surgery	Postoperative Mortality (80 Years and Older)
General Anaesthesia	Elective Admissions (ASA 1 and 2)

An investigation of endoscopy-related mortality as well as a continuation of review of mortality in individuals classified as having an ASA score of 1 or 2 is planned.

4. Develop contextual information

The epidemiological data presented form part of the picture nationally. Having peer-reviewed cases in reporting was emphasised as useful as an educative tool and more important on a day-to-day basis for understanding perioperative mortality. There are limits under the legislation governing the Committee's work in terms of identifying cases. This does not preclude the development of composite case studies in future reporting. With the volume of deaths, it may also be possible to report on certain cases in the future without compromising confidentiality as long as a number of unique identifiers are removed. In-depth case review will also make it possible to address the underlying causes of the death and identify themes that can be reported on to inform practice change or reinforce current good practice. The forward work programme will develop this aspect of data collection, review and reporting in particular as a priority.

5. Whole-of-system perioperative mortality review

Overall, there is continuing support for a whole-of-system approach to perioperative mortality review. This would encompass epidemiological overview as well as specific in-depth case review. Letters of support from the Ministry of Health and the Health and Disability Commission noted the importance of the whole-of-system approach in understanding perioperative mortality nationally.

Future directions

In the coming year, the Committee will continue to work with the sector to develop an integrated perioperative mortality review system. Form development is a top priority to enable analysis of contextual information surrounding perioperative mortality. The Committee's key activities to date and year three priorities are summarised in Table 3.

Table 3. Overview of Broad Committee Priorities

YEAR ONE (JULY 2010 – JUNE 2011)	YEAR TWO (JULY 2011 – JUNE 2012)	YEAR THREE (JULY 2012 – JUNE 2013)
Committee establishment	Inaugural report published February 2012	Committee at full membership
Sector engagement/consultation	Sector engagement/consultation	Sector engagement/consultation
Data scoping	Developing data analysis methodology	Publication of second report
Determine reporting focus	Reviewing additional data collection modalities	**Endoscopy working group**
Transition from the Ministry of Health to the Commission		**Inaugural workshop (13 June 2013)**
		Development of integrated perioperative mortality review form

Perioperative Mortality 2006–2010

It has been estimated that more than 230 million major surgical procedures are undertaken worldwide each year (Bainbridge et al 2012), but the risk of death related to surgery and anaesthesia is not well known and remains rarely measured at the national level. Recent interest has focused on whether the safety of surgery has improved over time and whether underdeveloped countries share the benefit of any improvement (Chu et al 2010). The results from a recent systematic review suggest that, despite increasing patient risk before surgery, perioperative mortality has declined significantly over the past 50 years, with the greatest decline in developed countries (Bainbridge et al 2012). Mortality solely attributable to anaesthesia has declined from 357 per million (95% CI 324–394) before the 1970s to 34 per million (29–39) in the 1990s–2000s ($p<0{\cdot}00001$). Total perioperative mortality has also decreased over time from 10,603 per million (95% CI 10,423–10,784) before the 1970s to 1176 per million (1148–1205) in the 1990s–2000s ($p<0{\cdot}0001$) (Bainbridge et al 2012).

In the section that follows, the NMDS and the NMC are analysed for the period 2006–2010, focusing on four areas of clinical importance:

- Cholecystectomy
- Elective admissions for those classified as ASA 1 or 2
- Patients aged 80 years and older (following general anaesthetic or neuraxial block)
- Pulmonary embolus.

Mortality in these areas is first presented, followed by information regarding admissions at the conclusion of each section.

Mortality Following Cholecystectomy

The following section uses information from the NMDS and the NMC to review mortality in the first 30 days following cholecystectomy. Additional background information on hospital admissions for cholecystectomy is provided at the end of this chapter.

Key findings

- In New Zealand during 2006–2010, malignant neoplasms were the most frequently listed main underlying cause of death in those dying within 30 days of a cholecystectomy. Gallbladder calculi and other disorders of the gallbladder, biliary tract and pancreas, and myocardial infarction/ischaemic heart disease were also common causes of mortality.

- Mortality in the first 30 days following a cholecystectomy was relatively infrequent (120 deaths following 29,473 cholecystectomy admissions during 2006–2010). Cumulative 30-day mortality was higher for acute admissions (1040.9 per 100,000 initial procedures, or 1.0%) than for elective admissions (164.6 per 100,000 initial procedures, or 0.16%).

- Mortality following an acute cholecystectomy was highest in the first five days following surgery, while for elective admissions mortality was highest on day two post-surgery.

- Mortality following acute admission for cholecystectomy was relatively infrequent in those aged under 50 years but rose thereafter, with the highest rates being seen in those aged 90+ years. Mortality following elective admissions was relatively infrequent in those aged under 70 years, and while rates rose thereafter, they remained lower than for acute admissions at all ages from 50 years onwards.

- Mortality following cholecystectomy was relatively infrequent amongst those with an ASA score of 1 or 2, irrespective of whether the admission was acute or elective. For those with an ASA score of 3 or more, mortality rates increased with increasing ASA score, with the highest rates within each ASA category being seen for acute admissions. As expected, there were no elective admissions with a first ASA score of 5.

Data sources and methods

Definition

1. Hospital admissions for cholecystectomy.

2. Mortality in the first 30 days following a cholecystectomy.

Data sources

Hospital admissions for cholecystectomy

Numerator: NMDS: All hospital admissions with a cholecystectomy listed in any of the first 70 procedure codes (Appendix 2 lists the ACHI procedure codes included). Note: In a small proportion of cases, other procedures were undertaken at the same time as the cholecystectomy (for example, liver resections). In such cases, the risk of mortality may have been higher than if a cholecystectomy was the sole procedure. However, in order to preserve the consistency of the analysis, all admissions have been included where a cholecystectomy was one of the listed procedures.

Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Mortality following cholecystectomy

Numerator: NMC: All those who died within 30 days of a cholecystectomy (with cases being selected from the cohort of those undergoing cholecystectomy, as identified in the NMDS).

Denominator: NMDS: All hospital admissions with a cholecystectomy listed in any of the first 70 procedure codes.

Notes on interpretation

Readmissions: In a small number of cases, a second admission for a procedure meeting the ACHI cholecystectomy code criteria outlined in Appendix 2 occurred within 30 days of the initial procedure. In such cases, this was considered to be a revision of the initial procedure (for example, due to complications arising from the first operation), and in such cases, the outcomes arising from the second procedure were attributed to the first. Further, these readmissions were not included in the denominator used to calculate mortality rates by procedure. If a readmission occurred >30 days from the original procedure, however, this was considered to be a new procedure in the calculation of mortality rates.

Acute, arranged (semi-acute) and waiting list admissions: NMDS defines an acute admission as an unplanned admission occurring on the day of presentation, while an arranged admission is a non-acute admission with an admission date less than seven days after the date the decision was made by the specialist that the admission was necessary. Similarly, waiting list admissions arise when the planned admission date is seven or more days after the date the decision was made that the admission was necessary. These definitions are inconsistently used by private hospitals uploading their data to the NMDS, however, with a significant proportion of private hospital admissions being coded as arranged when in reality they meet the criteria for a waiting list admission outlined above. As a result, in the sections that follow, all arranged private hospital cases have been included in the elective category, while arranged admissions occurring in public hospitals have been included in the public hospital semi-acute admission category. Thus, unless otherwise specified, acute and elective admissions include both public and private cases, while semi-acute admissions are confined to public hospital cases only.

Privately funded hospital admissions: 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 are publicly funded maternity events. 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 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 are privately funded or ACC-funded events or publicly funded long-stay geriatric cases. Thus, in the section that follows, it must be remembered that the data presented are likely to undercount some private hospital events, with the magnitude of this undercount being difficult to quantify (although it is assumed to be significant).

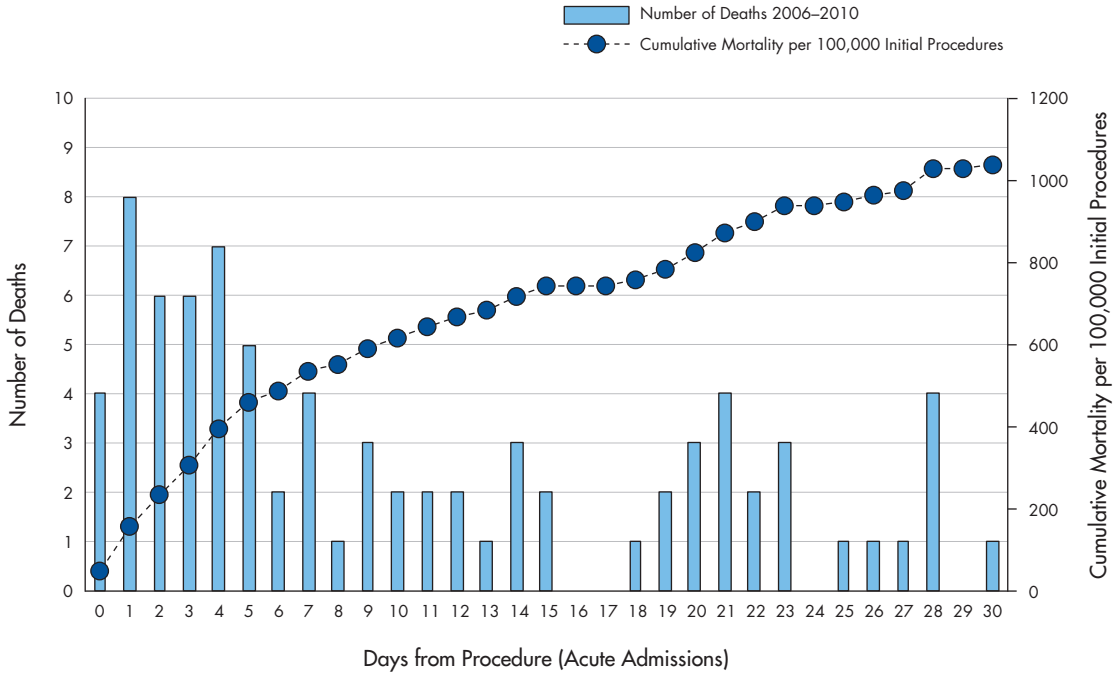
Mortality following cholecystectomy

Table 4. Mortality Following Cholecystectomy by Admission Type and Main Underlying Cause of Death, New Zealand 2006–2010

MAIN UNDERLYING CAUSE OF DEATH	Total Deaths 2006–2010	Annual Average	Percent of Deaths in Category (%)
Cholecystectomy			
Acute			
Malignant Neoplasms	19	3.8	23.5
Gallbladder Calculi: With Acute Cholecystitis	11	2.2	13.6
Gallbladder Calculi: All Other Types	7	1.4	8.6
Other Disorders Gallbladder, Biliary Tract and Pancreas	12	2.4	14.8
Myocardial Infarction/Other Ischaemic Heart Disease	8	1.6	9.9
Other Cardiovascular Causes	8	1.6	9.9
Other Causes	16	3.2	19.8
Total Acute	81	16.2	100.0
Public Hospital Semi-Acute			
All Causes	4	0.8	100.0
Total Public Hospital Semi-Acute	4	0.8	100.0
Elective			
Malignant Neoplasms	14	2.8	40.0
Gallbladder Calculi: All Types	5	1.0	14.3
Myocardial Infarction/Other Ischaemic Heart Disease	9	1.8	25.7
Other Causes	7	1.4	20.0
Total Elective	35	7.0	100.0

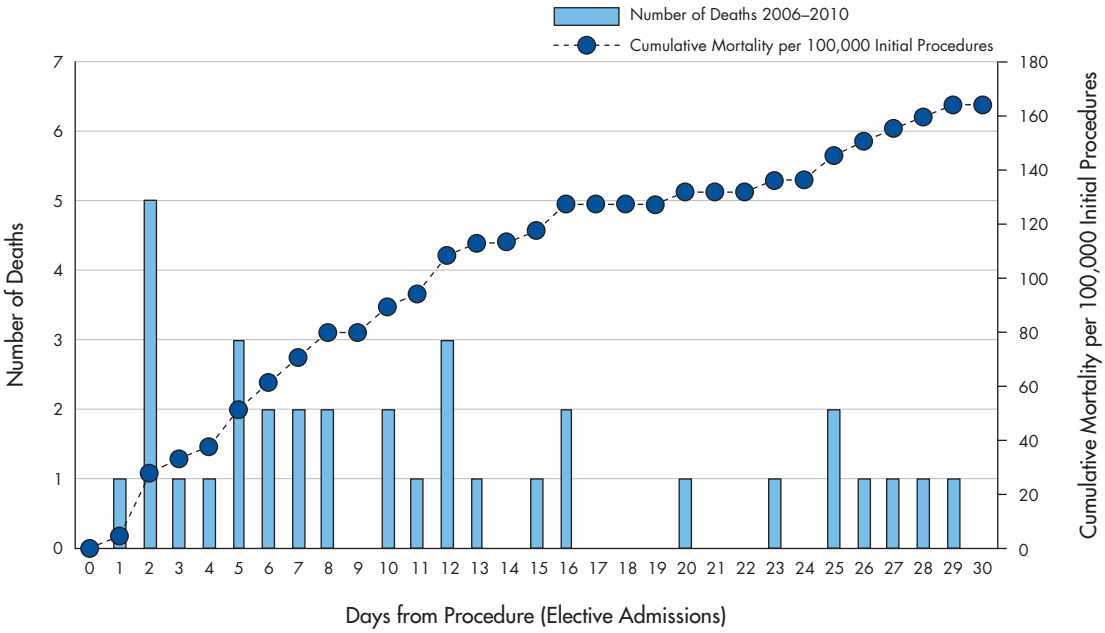
Data source: NMC: Deaths occurring within 30 days of a cholecystectomy, as recorded in the NMDS.

Figure 1. Mortality Following Acute Admission for Cholecystectomy by Day from Procedure, New Zealand 2006–2010



Numerator: NMC: Deaths occurring within 30 days of an acute cholecystectomy, as recorded in the NMDS.
Denominator: NMDS: Acute admissions with a cholecystectomy listed in any of the first 70 procedures.

Figure 2. Mortality Following Elective Admission for Cholecystectomy by Day from Procedure, New Zealand 2006–2010



Numerator: NMC: Deaths occurring within 30 days of an elective cholecystectomy, as recorded in the NMDS.
Denominator: NMDS: Elective admissions with a cholecystectomy listed in any of the first 70 procedures.

Mortality by admission type and cause of death

In New Zealand during 2006–2010, malignant neoplasms were the most frequently listed main underlying cause of death in those dying within 30 days of an acute or elective admission for cholecystectomy. Gallbladder calculi and other disorders of the gallbladder, biliary tract and pancreas, and myocardial infarction/ischaemic heart disease were also common causes of mortality (Table 4).

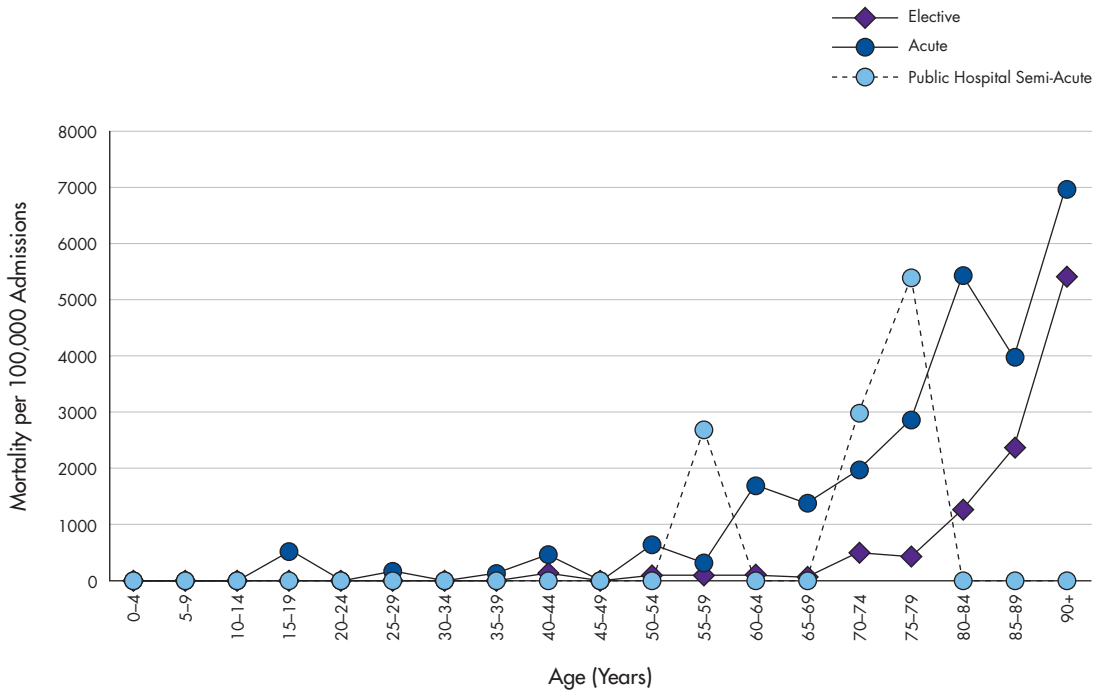
Mortality by day from procedure

Mortality following acute cholecystectomy during 2006–2010 was highest in the first five days following surgery, with deaths then being relatively sporadic over the next three weeks. Similarly, mortality following an elective admission for cholecystectomy was highest on day two post-surgery, with deaths then being sporadic over the next three weeks. Cumulative 30-day mortality was higher for acute admissions (1040.9 per 100,000 initial procedures, or 1.0%) than for elective admissions (164.6 per 100,000 initial procedures, or 0.16%) (Figures 1 and 2).

Mortality by age

Mortality following acute admission for cholecystectomy during 2006–2010 was relatively infrequent in those aged under 50 years but rose thereafter, with the highest rates being seen in those aged 90+ years. Mortality following elective admissions was relatively infrequent in those aged under 70 years, and while rates rose thereafter, they remained lower than for acute admissions at all ages from 50 years onwards (Figure 3).

Figure 3. Mortality Following Cholecystectomy by Admission Type and Age, New Zealand 2006–2010

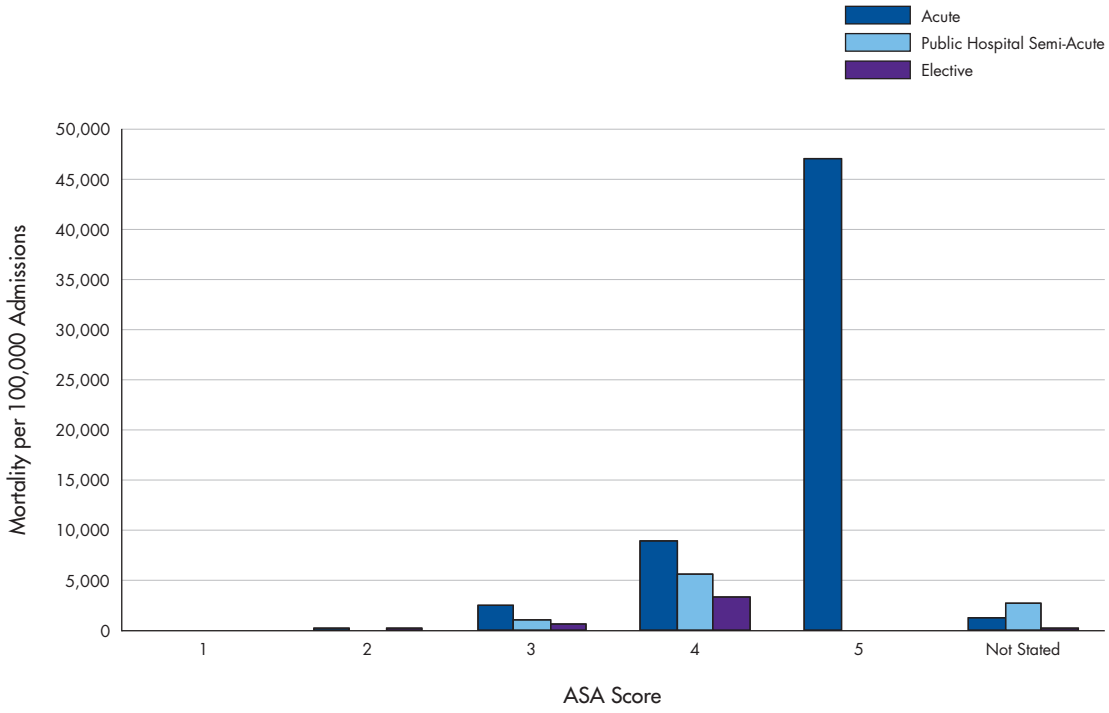


Numerator: NMC: Deaths occurring within 30 days of a cholecystectomy, as recorded in the NMDS.
Denominator: NMDS: Admissions with a cholecystectomy listed in any of the first 70 procedures.

Mortality by ASA score

During 2006–2010, mortality following cholecystectomy was relatively infrequent amongst those with an ASA score of 1 or 2, irrespective of whether the admission was acute or elective. For those with an ASA score of 3 or more, mortality rates increased with increasing ASA score, with the highest rates within each ASA category being seen for acute admissions. As expected, there were no elective admissions with a first ASA score of 5 (Figure 4).

Figure 4. Mortality Following Cholecystectomy by Admission Type and ASA Score, New Zealand 2006–2010



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 70 procedures.

Mortality by sociodemographic factors and ASA score

Acute admissions: During 2006–2010, mortality following an acute admission for cholecystectomy was *significantly* higher for those aged 45 years and over (vs. 0–44 years) and for those with ASA scores of 3, 4 or 5 (vs. ASA score 1–2). These differences persisted, even when the risk was adjusted for other sociodemographic factors (age, gender, ethnicity, New Zealand Deprivation Index (NZDep) deprivation) and ASA score (although differences for those aged 45–64 years were no longer statistically significant). While at the univariate level, mortality was *significantly* higher for males. This difference did not remain statistically significant in the multivariate model. No significant differences were evident by ethnicity or NZDep decile, with the exception of mortality for those from NZDep decile 9–10 areas, where rates were *significantly* higher (vs. NZDep 1–2) in the multivariate model (Table 5).

Elective admissions: During the same period, mortality following an elective admission for cholecystectomy was *significantly* higher for males, for those aged 65 years and over (vs. 0–44 years) and for those with an ASA score of 3 or 4 (vs. ASA score 1–2). These differences persisted, even when the risk was adjusted for other sociodemographic factors (age, gender, ethnicity, NZDep deprivation) and ASA score. Mortality was also *significantly* higher for Pacific peoples (univariate and multivariate models) and for MELAA peoples (multivariate model) than for European peoples, although care should be taken when interpreting these differences due to the small number of deaths involved. No significant differences were evident by NZDep Index decile (Table 6).

Table 5. Mortality Following Acute Admission for Cholecystectomy by Age Group, Gender, First ASA Score, Ethnicity and NZ Deprivation Index Decile, New Zealand 2006–2010

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
Cholecystectomy									
Acute									
Age Group	0–44 Years	6	3,200	187.5	0.19	1.00		1.00	
	45–64 Years	16	2,482	644.6	0.64	*3.45	1.35–8.84	2.51	0.93–6.78
	65–79 Years	32	1,575	2,031.8	2.03	*11.04	4.61–26.45	*4.96	1.86–13.21
	80+ Years	27	525	5,142.9	5.14	*28.86	11.86–70.24	*10.81	3.83–30.50
Gender	Male	47	2,649	1,774.3	1.77	1.00		1.00	
	Female	34	5,133	662.4	0.66	*0.37	0.24–0.58	0.67	0.42–1.07
ASA Status	1 or 2	11	5,365	205.0	0.21	1.00		1.00	
	3	32	1,240	2,580.7	2.58	*12.89	6.48–25.65	*6.27	2.94–13.39
	4	18	200	9,000.0	9.00	*48.14	22.41–103.40	*19.33	8.34–44.79
	5	8	17	47,058.8	47.06	H	H	H	H
	Not Stated	12	960	1,250.0	1.25	*6.16	2.71–14.00	*5.12	2.18–12.00
Ethnicity	European	61	5,046	1,208.9	1.21	1.00		1.00	
	Māori	13	1,204	1,079.7	1.08	0.89	0.49–1.63	1.39	0.67–2.89
	Pacific	5	680	735.3	0.74	0.61	0.24–1.51	1.03	0.39–2.77
	Asian/ MELAA/ Other	<3	734	s	s	s	s	s	s
NZ Deprivation Index Decile	Decile 1–2	6	1,054	569.3	0.57	1.00		1.00	
	Decile 3–4	5	1,222	409.2	0.41	0.72	0.22–2.36	0.69	0.20–2.40
	Decile 5–6	21	1,547	1,357.5	1.36	2.40	0.97–5.98	2.27	0.87–5.92
	Decile 7–8	24	1,782	1,346.8	1.35	2.39	0.97–5.85	2.20	0.86–5.67
	Decile 9–10	25	2,103	1,188.8	1.19	2.10	0.86–5.14	*2.70	1.03–7.12

Numerator: NMC: Deaths occurring within 30 days of an acute cholecystectomy, as recorded in the NMDS.
Denominator: NMDS: Acute admissions with a cholecystectomy listed in any of the first 70 procedures.
* Significantly different from reference category.
MELAA: Middle Eastern/Latin American/African.
H Odds ratios supressed due to high mortality rates. Caution should also be observed when interpreting ORs where mortality exceeds 10% (see **Appendix 3** for details).
s Rates suppressed due to small numbers.

Table 6. Mortality Following Elective Admission for Cholecystectomy by Age Group, Gender, First ASA Score, Ethnicity and NZ Deprivation Index Decile, New Zealand 2006–2010

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
Cholecystectomy									
Elective									
Age Group	0–44 Years	3	7,776	38.58	0.04	1.00		1.00	
	45–64 Years	6	8,407	71.4	0.07	1.85	0.46–7.40	1.70	0.42–6.95
	65–79 Years	13	4,326	300.5	0.30	*7.81	2.22–27.42	*5.55	1.46–21.14
	80+ Years	13	760	1,710.5	1.71	*45.09	12.82–158.57	*28.85	7.13–116.66
Gender	Male	20	5,847	342.1	0.34	1.00		1.00	
	Female	15	15,422	97.3	0.10	*0.28	0.15–0.55	*0.48	0.24–0.97
ASA Status	1 or 2	10	10,654	93.9	0.09	1.00		1.00	
	3	14	1,840	760.9	0.76	*8.16	3.62–18.40	*3.88	1.61–9.37
	4	3	88	3,409.1	3.41	*37.57	10.16–138.92	*11.78	2.92–47.47
	5	0	0	–	–	–	–	–	–
	Not Stated	8	8,686	92.1	0.09	0.98	0.39–2.49	1.39	0.53–3.65
Ethnicity	European	23	16,381	140.4	0.14	1.00		1.00	
	Māori	4	2,239	178.7	0.18	1.27	0.44–3.68	2.08	0.66–6.57
	Pacific	3	551	544.5	0.54	*3.89	1.17–13.01	*6.69	1.81–24.78
	Asian/ MELAA/ Other	4	1,334	299.9	0.30	2.14	0.74–6.19	*3.81	1.26–11.52
NZ Deprivation Index Decile	Decile 1–2	3	3,638	82.5	0.08	1.00		1.00	
	Decile 3–4	3	3,923	76.5	0.08	0.93	0.19–4.60	0.50	0.08–3.02
	Decile 5–6	11	4,363	252.1	0.25	3.06	0.85–10.98	2.58	0.71–9.40
	Decile 7–8	7	5,090	137.5	0.14	1.67	0.43–6.46	1.26	0.32–5.02
	Decile 9–10	11	4,204	261.7	0.26	3.18	0.89–11.40	2.22	0.58–8.43

Numerator: NMC: Deaths occurring within 30 days of an elective cholecystectomy, as recorded in the NMDS.
Denominator: NMDS: elective admissions with a cholecystectomy listed in any of the first 70 procedures;
* Significantly different from reference category.
MELAA: Middle Eastern/Latin American/African.

Background: hospital admissions for cholecystectomy

Admissions by primary diagnosis

In New Zealand during 2006–2010, gallbladder calculi with acute cholecystitis was the most frequent primary diagnosis assigned in those admitted acutely for cholecystectomy, followed by gallbladder calculi with other (including chronic) cholecystitis. Amongst elective admissions, gallbladder calculi with other (including chronic) cholecystitis was the most frequent diagnosis assigned, followed by unspecified diseases of the gallbladder (Table 7).

Admissions by admission type and procedure

Laparoscopic cholecystectomy was the most frequent procedure performed in those admitted for cholecystectomy during 2006–2010, although a small number each year went on to an open cholecystectomy. A similar small number was open procedures from the outset. During this period, 74.7% of laparoscopic cholecystectomies were elective procedures, while 24.3% were undertaken during an acute admission. Of open cholecystectomies, 57.2% were elective procedures, while 36.9% were undertaken during an acute admission (Table 8).

Admissions by age

While the number of cholecystectomy admissions during 2006–2010 peaked in those aged 45–49 years, because of the underlying age structure of the New Zealand population, the highest admission rates were seen in those aged 75–79 years (Figure 5).

Admissions by age and admission type

Elective admissions for cholecystectomy were infrequent in children under 14 years, but increased thereafter, reaching a peak in those aged 75–79 years. Rates then declined rapidly amongst those in their 80s and 90s. Acute admissions were also infrequent in children under 14 years but then increased amongst those in their late teens and 20s. Rates remained relatively static amongst those in their 30s and 40s, before increasing again to reach a peak at 75–79 years. Acute admission rates, however, remained lower than for elective admission rates at all ages from the late teens through to the early 80s (Figure 6).

Admissions by age, admission type and gender

When acute and elective admissions for cholecystectomy were broken down by gender, the age distribution for females was shifted towards the left, with higher admission rates being seen for females from 15–19 years through to 55–59 years for acute admissions and to 75–79 years for elective admissions. For acute admissions, rates were higher for males than for females from 65–69 years onwards, while elective admissions were similar for males and females from 80–84 years (Figure 7).

Table 7. Hospital Admissions for Cholecystectomy by Primary Diagnosis and Admission Type, New Zealand 2006–2010

PRIMARY DIAGNOSIS	Number: Total 2006–2010	Number: Annual Average	Percent of Admissions (%)
Cholecystectomy Admissions			
Acute			
Gallbladder Calculi: With Acute Cholecystitis	2,875	575.0	36.9
Gallbladder Calculi: With Other Cholecystitis	2,217	443.4	28.5
Gallbladder Calculi: Without Cholecystitis	163	32.6	2.1
Gallbladder Calculi: Other	435	87.0	5.6
Acute Pancreatitis	619	123.8	8.0
Cholecystitis: Chronic	307	61.4	3.9
Cholecystitis: Other/Unspecified	603	120.6	7.7
Diseases of Gallbladder: Other Specified	77	15.4	1.0
Other Diseases of Biliary Tract	21	4.2	0.3
Malignant Neoplasms of Digestive Organs	135	27.0	1.7
Other Diagnoses	330	66.0	4.2
Total Acute	7,782	1,556.4	100.0
Public Hospital Semi-Acute			
Gallbladder Calculi: With Acute Cholecystitis	45	9.0	10.7
Gallbladder Calculi: With Other Cholecystitis	164	32.8	38.9
Gallbladder Calculi: Without Cholecystitis	15	3.0	3.6
Gallbladder Calculi: Other	35	7.0	8.3
Malignant Neoplasms of Digestive Organs	48	9.6	11.4
Acute Pancreatitis	21	4.2	5.0
Cholecystitis: Chronic	19	3.8	4.5
Cholecystitis: Other/Unspecified	9	1.8	2.1
Diseases of Gallbladder: Other Specified	2	0.4	0.5
Other Diagnoses	64	12.8	15.2
Total Public Hospital Semi-Acute	422	84.4	100.0
Elective			
Gallbladder Calculi: With Acute Cholecystitis	771	154.2	3.6
Gallbladder Calculi: With Other Cholecystitis	9,495	1,899.0	44.6
Gallbladder Calculi: Without Cholecystitis	1,461	292.2	6.9
Gallbladder Calculi: Other	479	95.8	2.3
Diseases of Gallbladder: Other Specified	207	41.4	1.0
Diseases of Gallbladder: Unspecified	5,404	1,080.8	25.4
Cholecystitis: Chronic	1,677	335.4	7.9
Cholecystitis: Other/Unspecified	299	59.8	1.4
Other Diseases of Biliary Tract	180	36.0	0.8
Malignant Neoplasms of Digestive Organs	367	73.4	1.7
Acute Pancreatitis	109	21.8	0.5
Other Diagnoses	820	164.0	3.9
Total Elective	21,269	4,253.8	100.0

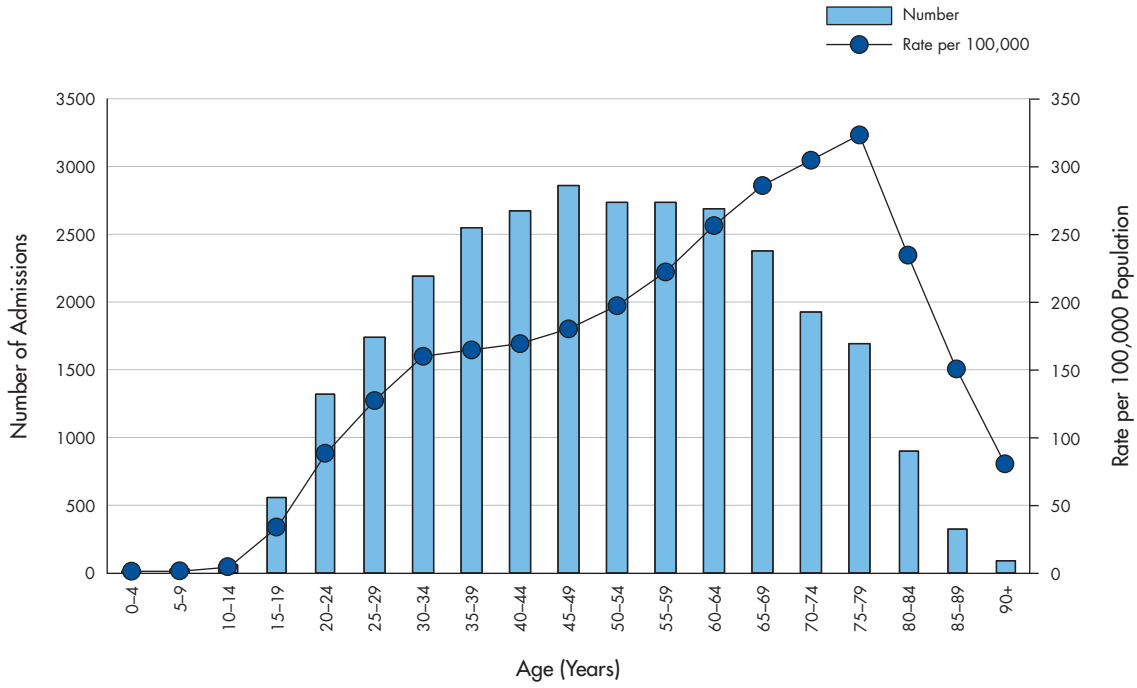
Data source: NMDS: Hospital admissions with a cholecystectomy listed in any of their first 70 procedures.

Table 8. Hospital Admissions for Cholecystectomy by Admission Type and Procedure Type, New Zealand 2006–2010

PROCEDURE TYPE	Acute	Public Hospital Semi-Acute	Elective	Total
Number of Admissions: Total 2006–2010				
Laparoscopic Cholecystectomy	6,254	257	19,229	25,740
Laparoscopic Proceeding to Open	679	28	697	1,404
Open Cholecystectomy	877	140	1,360	2,377
Any Cholecystectomy	7,782	422	21,269	29,473
Number of Admissions: Annual Average				
Laparoscopic Cholecystectomy	1,250.8	51.4	3,845.8	5,148.0
Laparoscopic Proceeding to Open	135.8	5.6	139.4	280.8
Open Cholecystectomy	175.4	28.0	272.0	475.4
Any Cholecystectomy	1,556.4	84.4	4,253.8	5,894.6
Percent of Admissions Within Procedure Category				
Laparoscopic Cholecystectomy	24.3	1.0	74.7	100.0
Laparoscopic Proceeding to Open	48.4	2.0	49.6	100.0
Open Cholecystectomy	36.9	5.9	57.2	100.0
Any Cholecystectomy	26.4	1.4	72.2	100.0

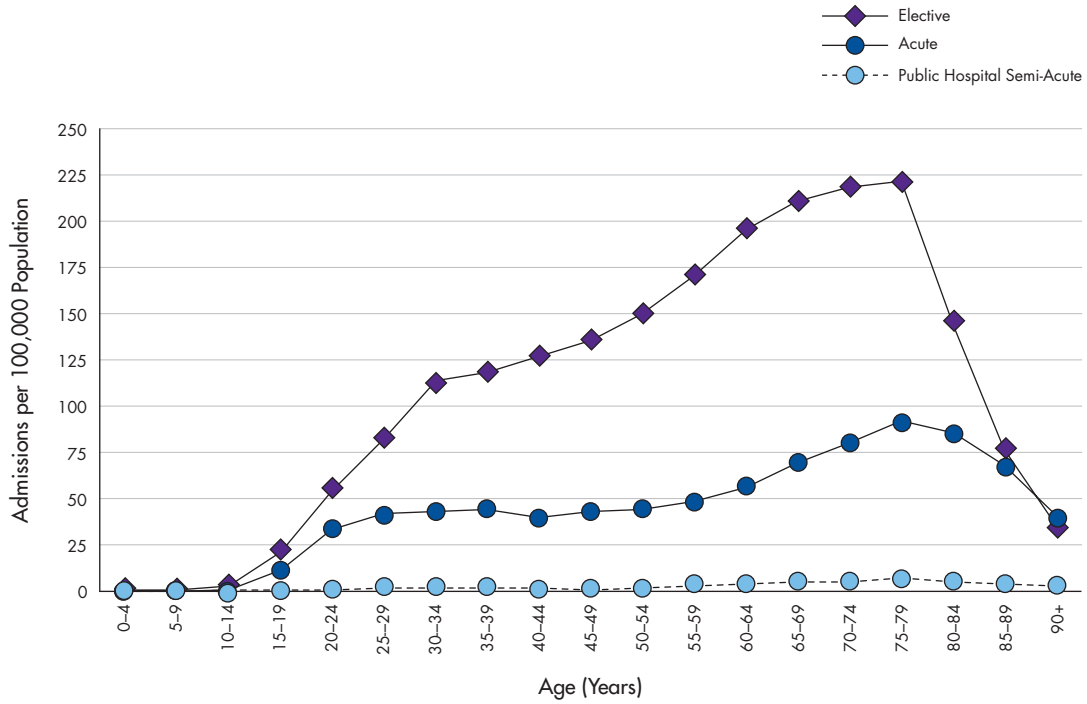
Data source: NMDS: Hospital admissions with a cholecystectomy listed in any of their first 70 procedures.
Note: Procedure type numbers do not sum to 'Any Cholecystectomy' total as in 48 cases more than one procedure type was listed.

Figure 5. Hospital Admissions for Cholecystectomy by Age, New Zealand 2006–2010



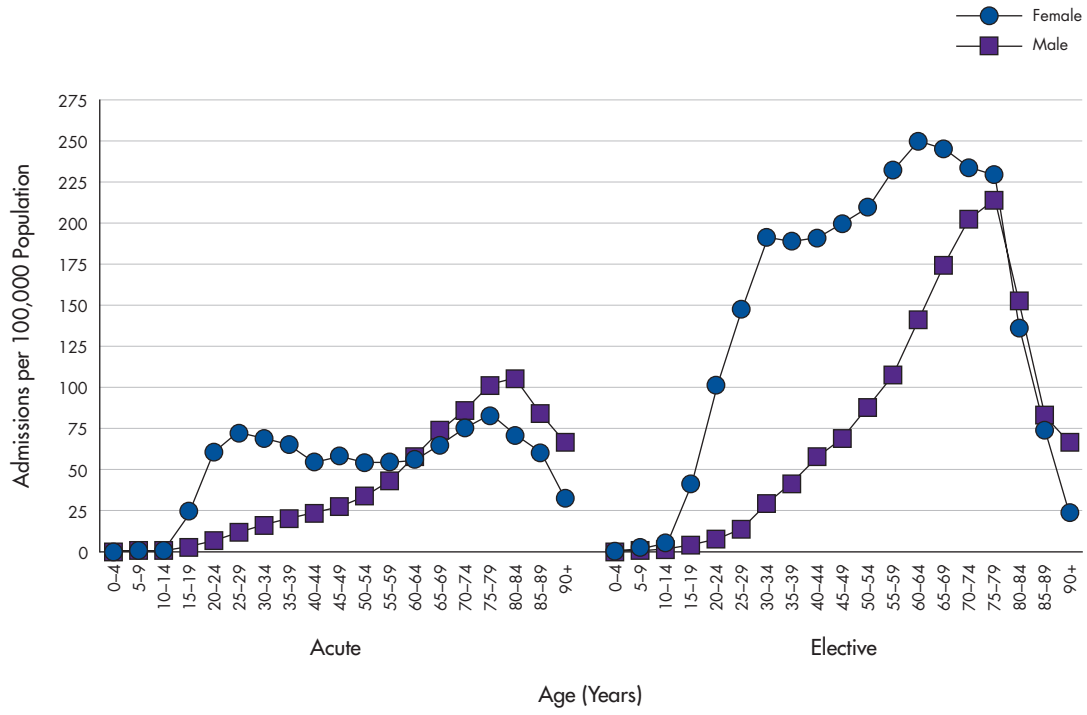
Numerator: NMDS: Hospital admissions with a cholecystectomy listed in any of their first 70 procedures.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Figure 6. Hospital Admissions for Cholecystectomy by Age and Admission Type, New Zealand 2006–2010



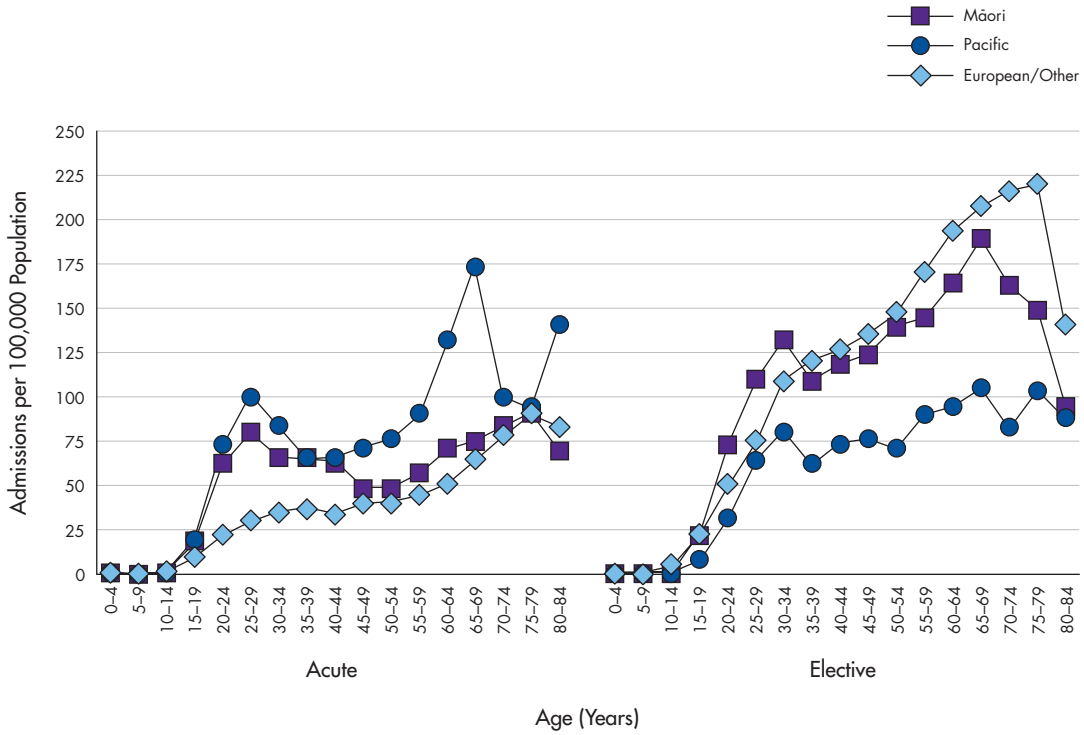
Numerator: NMDS: Hospital admissions with a cholecystectomy listed in any of their first 70 procedures.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Figure 7. Hospital Admissions for Cholecystectomy by Age, Admission Type and Gender, New Zealand 2006–2010



Numerator: NMDS: Hospital admissions with a cholecystectomy listed in any of their first 70 procedures.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Figure 8. Hospital Admissions for Cholecystectomy by Age, Admission Type and Ethnicity, New Zealand 2006–2010



Numerator: NMDS: Hospital admissions with a cholecystectomy listed in any of their first 70 procedures.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).
Ethnicity is Level 1 Prioritised.
Small numbers precluded a valid analysis after 84 years of age.

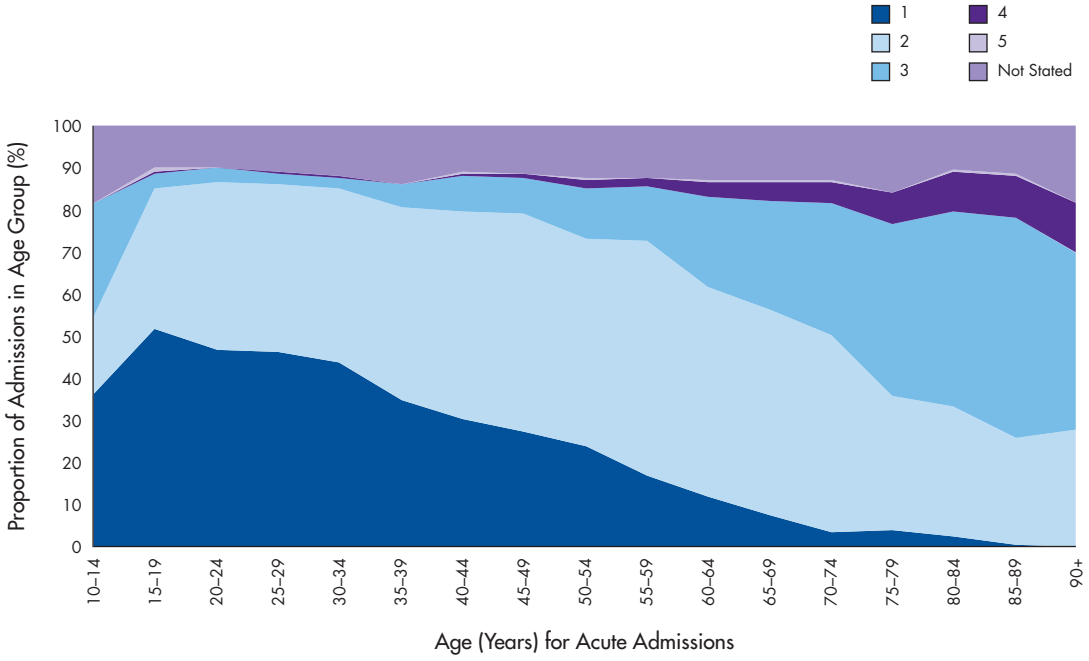
Admissions by age, admission type and ethnicity

During 2006–2010, acute admission rates for cholecystectomy were higher for Māori and Pacific peoples than for European/Other peoples at all ages from 15–19 years to 70–74 years. Acute admissions for Pacific peoples were also higher than for Māori in their late 40s to their early 70s. In contrast, elective admissions for cholecystectomy were higher for European peoples than for Māori and Pacific peoples at all ages from 35–39 years onwards. In addition, elective admissions for Pacific peoples were lower than for Māori at all ages from 15–19 years onwards (Figure 8).

Distribution of admissions by age and ASA score

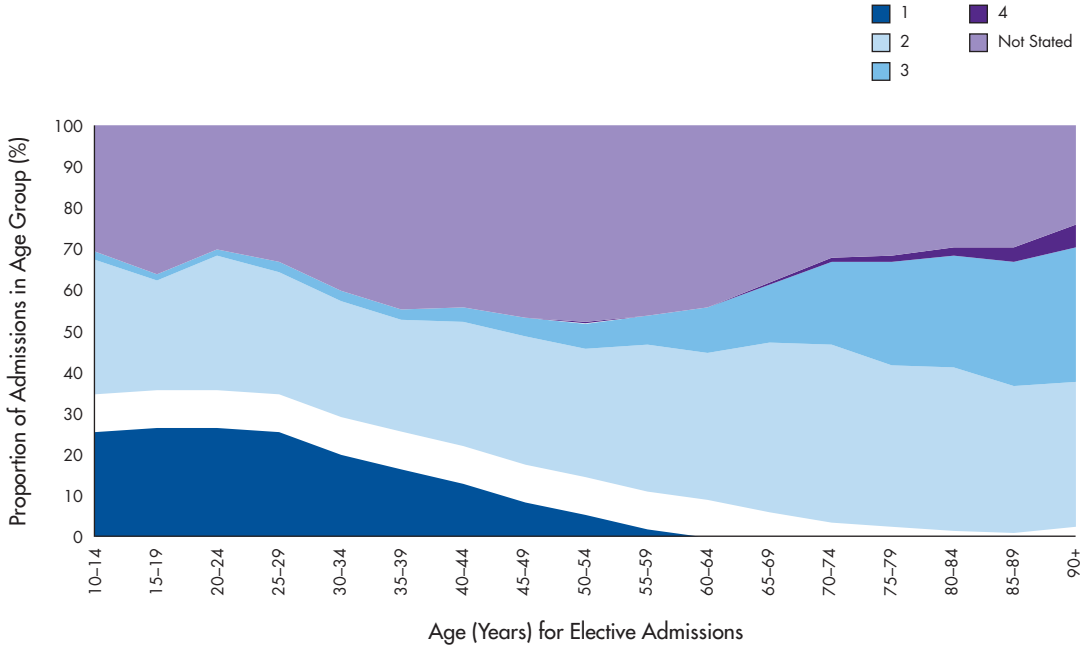
During 2006–2010, the proportion of acute cholecystectomy admissions where the first documented ASA score was 3 or higher increased after 34 years of age, with 41.9% of those aged 90+ years having an ASA score of 3 and 11.6% an ASA score of 4. The proportion of admissions where the ASA score was not stated, however, was over 10% in nearly all age groups (Figure 9). While similar patterns were seen for elective admissions, the proportion of admissions with an ASA score of 3 or 4 was lower than for acute admissions. However, the ASA score was not documented in at least 30% of cases, across nearly all age groups, making precise interpretation of this data difficult (Figure 10).

Figure 9. Acute Hospital Admissions for Cholecystectomy by Age and ASA Score, New Zealand 2006–2010



Data source: NMDS: Hospital admissions with a cholecystectomy listed in any of their first 70 procedures.
Small numbers precluded a valid analysis for children under 10 years of age.

Figure 10. Elective Admissions for Cholecystectomy by Age and ASA Score, New Zealand 2006–2010



Data source: NMDS: Hospital admissions with a cholecystectomy listed in any of their first 70 procedures.
Small numbers precluded a valid analysis for children under 10 years of age.

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. Additional background information on elective admissions in those with ASA scores of 1 or 2 that included a general anaesthetic or neuraxial block, is provided at the end of this chapter.

Key findings

- In New Zealand during 2006–2010, injuries/external causes and malignant/other neoplasms were the most frequent causes of mortality in the first 30 days following an initial general anaesthetic or neuraxial block in children and young people aged 0–24 years admitted electively with a first ASA score of 1 or 2, while malignant/other neoplasms were the most frequent causes of mortality in those aged 25–44 years. Malignant/Other neoplasms, myocardial infarctions/other ischaemic heart disease and other cardiovascular causes were also the most frequent causes of mortality in the first 30 days following an anaesthetic in those aged 45–64 and 65–79 years, as well as those aged 80+ years who were admitted electively with an ASA score of 1 or 2.

- Thirty-day mortality in those admitted electively with an ASA score of 1 or 2 was relatively infrequent (259 deaths per 376,454 initial anaesthetics), with mortality being highest on the second postoperative day, although a number of deaths occurred each day right up until 30 days following the initial anaesthetic. Cumulative 30-day mortality was 68.8 per 100,000 initial anaesthetics, or 0.07%.

- Thirty-day mortality in those admitted electively with an ASA score of 1 or 2 was relatively infrequent in those aged under 50 years but rose progressively thereafter, with the highest rates being seen in those aged 90+ years. The largest number of actual deaths, however, occurred in those aged 80–84 years.

- Thirty-day mortality was *significantly* higher in those who subsequently received two or more anaesthetics (vs. one anaesthetic), those whose last anaesthetic was undertaken as an emergency (vs. non-emergency or not stated) and those whose last anaesthetic for the index admission had an ASA score of 3 or 4 (vs. ASA score 1–2).

Data sources and methods

Definition

1. Elective admissions in those with a first ASA score of 1 or 2 that included a general anaesthetic or a neuraxial block.
2. 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.

Data sources

Hospital admissions

Numerator: NMDS: Elective admissions in those with a first ASA score of 1 or 2 that included a general anaesthetic (ACHI Procedure Code 92514-XX) or neuraxial block (ACHI Procedure Code 92508-XX).

Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Mortality

Numerator: NMC: All those admitted electively or from the waiting list with a first ASA score of 1 or 2, who died within 30 days of the first general anaesthetic or neuraxial block relating to that admission.

Denominator: NMDS: All elective admissions with a first ASA score of 1 or 2 and a general anaesthetic or a neuraxial block.

Notes on interpretation

Elective 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 occurred, and in some cases, the ASA score for these later anaesthetics 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 anaesthetics was 3 or more. Similarly, only deaths within 30 days of the index anaesthetic have been included, even if later anaesthetics 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). Similarly, in a small number of cases (n<5), two elective admissions occurred within 30 days of death. In such cases, the first elective admission in the 30-day period has been taken to be the index event.

Acute, arranged and waiting list admissions: The NMDS defines an acute admission as an unplanned admission occurring on the day of presentation, while an arranged admission is a non-acute admission with an admission date less than seven days after the date the decision was made that the admission was necessary. Similarly, waiting list admissions arise when the planned admission date is seven or more days after the date the decision was made that the admission was necessary. These definitions are inconsistently used by private hospitals uploading their data to the NMDS, with a significant proportion of private hospital admissions being coded as arranged when in reality they meet the criteria for a waiting list admission outlined above. As a result, in the sections that follow, all arranged private hospital cases have been included in the elective category while arranged admissions occurring in public hospitals have been excluded.

Privately funded 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 are publicly funded maternity events. 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 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 are privately funded or ACC-funded events or publicly funded long-stay geriatric cases. Thus, in the section that follows, it must be remembered that the data presented are likely to undercount some private hospital events, with the magnitude of this undercount being difficult to quantify (although it is assumed to be significant).

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

Mortality by cause of death

In New Zealand during 2006–2010, injuries/external causes and malignant/other neoplasms were the most frequent causes of mortality in the first 30 days following an initial general anaesthetic or neuraxial block in children and young people aged 0–24 years admitted electively with a first ASA score of 1 or 2, while malignant/other neoplasms were the most frequent causes of mortality in those aged 25–44 years. Malignant/Other neoplasms, myocardial infarctions/other ischaemic heart disease and other cardiovascular causes were the most frequent causes of mortality in the first 30 days following an anaesthetic in those aged 45–64 and 65–79 years, as well as those aged 80+ years who were admitted electively with an ASA score of 1 or 2 (Table 9).

Table 9. Thirty-Day Mortality Following Elective Admissions with a First ASA Score of 1 or 2 by Age Group and Cause, New Zealand 2006–2010

MAIN UNDERLYING CAUSE OF DEATH	Number: Total 2006–2010	Number: Annual Average	% of Deaths in Age Group
0–24 Years			
Injuries/External Causes	3	0.6	30.0
Malignant/Other Neoplasms	<3	s	s
Other Causes	5	1.0	50.0
Total 0–24 Years	10	2.0	100.0
25–44 Years			
Malignant/Other Neoplasms	8	1.6	53.3
Other Causes	7	1.4	46.7
Total 25–44 Years	15	3.0	100.0
45–64 Years			
Malignant/Other Neoplasms	31	6.2	53.4
Myocardial Infarction/Other Ischaemic Heart Disease	8	1.6	13.8
Other Cardiovascular Causes	4	0.8	6.9
Respiratory Diseases	3	0.6	5.2
Other Causes	12	2.4	20.7
Total 45–64 Years	58	11.6	100.0
65–79 Years			
Malignant/Other Neoplasms	47	9.4	46.5
Myocardial Infarction/Other Ischaemic Heart Disease	24	4.8	23.8
Other Cardiovascular Causes	11	2.2	10.9
Injuries/External Causes	4	0.8	4.0
Gastrointestinal Diseases	4	0.8	4.0
Other Causes	11	2.2	10.9
Total 65–79 Years	101	20.2	100.0
80+ Years			
Malignant/Other Neoplasms	31	6.2	41.3
Myocardial Infarction/Other Ischaemic Heart Disease	13	2.6	17.3
Other Cardiovascular Causes	10	2.0	13.3
Gastrointestinal Diseases	7	1.4	9.3
Respiratory Diseases	5	1.0	6.7
Other Causes	9	1.8	12.0
Total 80+ Years	75	15.0	100.0

Data source: 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.
s Rates suppressed due to small numbers.

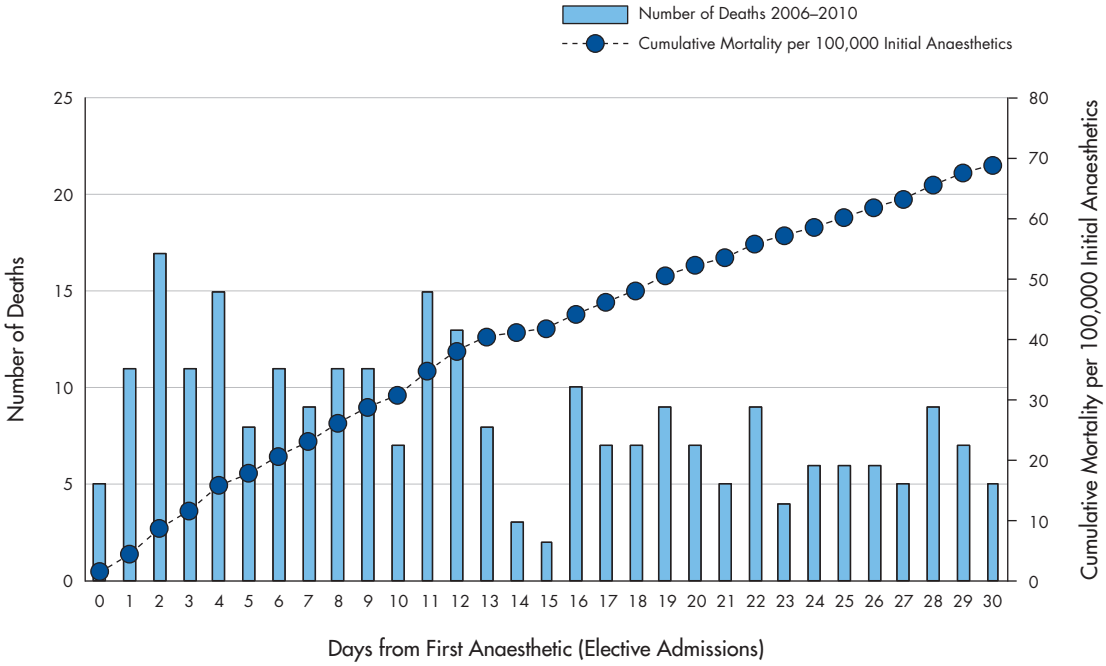
Mortality by day from first anaesthetic

Mortality in the first 30 days following an initial general anaesthetic or neuraxial block in those admitted electively with an ASA score of 1 or 2 during 2006–2010 was highest on the second postoperative day, although a number of deaths occurred each day right up until 30 days following the initial anaesthetic. Cumulative 30-day mortality was 68.8 per 100,000 initial anaesthetics, or 0.07% (Figure 11).

Mortality by age

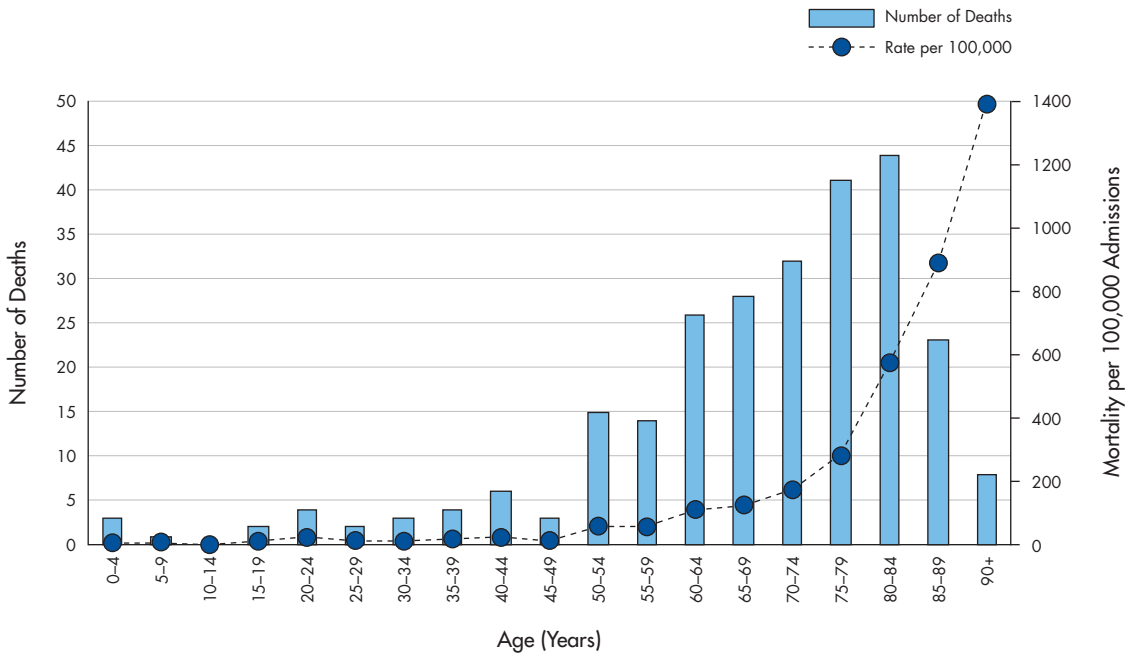
Mortality in the first 30 days following an initial general anaesthetic or neuraxial block in those with an ASA score of 1 or 2 during 2006–2010 was relatively infrequent in those aged under 50 years but rose progressively thereafter, with the highest rates being seen in those aged 90+ years. The largest number of actual deaths, however, occurred in those aged 80–84 years (Figure 12).

Figure 11. Thirty-Day Mortality Following Elective Admissions with a First ASA Score of 1 or 2 by Day from First Anaesthetic, New Zealand 2006–2010



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 admissions in those with a first ASA score of 1 or 2 and either a general anaesthetic or a neuraxial block.

Figure 12. Thirty-Day Mortality Following Elective Admissions with a First ASA Score of 1 or 2 by Age, New Zealand 2006–2010



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 admissions in those with a first ASA score of 1 or 2 and either a general anaesthetic or a neuraxial block.

Mortality by sociodemographic and clinical factors

First anaesthetic: During 2006–2010, mortality in the first 30 days following an initial general anaesthetic or neuraxial block in those with an ASA score of 1 or 2 was *significantly* higher for males and those aged 45 years and over (vs. 0–24 years). These differences persisted, even when the risk was adjusted for other sociodemographic factors (age, gender, ethnicity, NZDep deprivation). While, at the univariate level, mortality was *significantly* lower for Māori and Asian/MELAA/Other peoples (vs. European peoples), these differences did not remain statistically significant in the multivariate model. No consistent socioeconomic gradients were evident by NZDep decile, although mortality for those from NZDep decile 7–8 areas was *significantly* higher (vs. NZDep 1–2) in both the univariate and multivariate models (Table 10).

Last anaesthetic: In addition to the sociodemographic factors outlined above, mortality in the first 30 days following an initial general anaesthetic or neuraxial block in those with an ASA score of 1 or 2 was also *significantly* higher for those with a last ASA score of 3 or 4 (vs. ASA 1–2), those undergoing emergency procedures and those receiving two or more anaesthetics during their admission. While these factors remained *significant* in the multivariate model, the magnitude of the odds ratios reduced considerably (Table 11).

Table 10. Thirty-Day Mortality Following Elective Admissions with a First ASA Score of 1 or 2 by Age Group, Gender, Ethnicity and NZ Deprivation Index Decile, New Zealand 2006–2010

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 1 or 2 and a General Anaesthetic or Neuraxial Block									
Elective									
Age Group	0–24	10	119,416	8.4	0.01	1.00		1.00	
	25–44	15	87,886	17.1	0.02	2.04	0.92–4.54	2.20	0.97–4.97
	45–64	58	103,360	56.1	0.06	*6.70	3.43–13.12	*7.19	3.64–14.21
	65–79	101	54,884	184.0	0.18	*22.02	11.50–42.16	*23.59	12.14–45.84
	80+	75	10,908	687.6	0.69	*82.67	42.72–159.96	*88.85	44.98–175.53
Gender	Female	111	211,770	52.4	0.05	1.00		1.00	
	Male	148	164,683	89.9	0.09	*1.72	1.34–2.19	*1.59	1.24–2.05
Ethnicity	European	215	268,660	80.0	0.08	1.00		1.00	
	Māori	20	55,415	36.1	0.04	*0.45	0.29–0.71	1.13	0.69–1.83
	Pacific	8	20,271	39.5	0.04	0.49	0.24–1.00	1.20	0.55–2.60
	Asian/ MELAA/ Other	9	26,164	34.4	0.03	*0.43	0.22–0.84	0.79	0.40–1.54
NZ Deprivation Index Decile	Decile 1–2	30	56,701	52.9	0.05	1.00		1.00	
	Decile 3–4	32	64,686	49.5	0.05	0.94	0.57–1.54	0.92	0.55–1.53
	Decile 5–6	61	76,809	79.4	0.08	1.50	0.97–2.33	1.46	0.93–2.29
	Decile 7–8	76	88,922	85.5	0.09	*1.62	1.06–2.47	*1.58	1.02–2.44
	Decile 9–10	59	88,553	66.6	0.07	1.26	0.81–1.96	1.59	1.00–2.52

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 admissions in those with a first ASA score of 1 or 2 and either a general anaesthetic or a neuraxial block.
* Significantly different from reference category.
MELAA: Middle Eastern/Latin American/African.

Table 11. Thirty-Day Mortality in Elective Admissions with a First ASA Score of 1 or 2 by Age Group, Gender, Ethnicity, NZ Deprivation Index Decile, Last ASA Score, Emergency Status and Number of Anaesthetics, New Zealand 2006–2010

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 1 or 2 and a General Anaesthetic or Neuraxial Block									
Elective									
Age Group	0–24	10	119,416	8.4	0.01	1.00		1.00	
	25–44	15	87,886	17.1	0.02	2.04	0.92–4.54	2.13	0.94–4.81
	45–64	58	103,360	56.1	0.06	*6.70	3.43–13.12	*6.05	3.06–11.97
	65–79	101	54,884	184.0	0.18	*22.02	11.50–42.16	*15.95	8.16–31.19
	80+	75	10,908	687.6	0.69	*82.67	42.72–159.96	*55.40	27.79–110.44
Gender	Female	111	211,770	52.4	0.05	1.00		1.00	
	Male	148	164,683	89.9	0.09	*1.72	1.34–2.19	*1.57	1.22–2.03
Ethnicity	European	215	268,660	80.0	0.08	1.00		1.00	
	Māori	20	55,415	36.1	0.04	*0.45	0.29–0.71	1.10	0.67–1.79
	Pacific	8	20,271	39.5	0.04	0.49	0.24–1.00	1.06	0.49–2.32
	Asian/ MELAA/ Other	9	26,164	34.4	0.03	*0.43	0.22–0.84	0.77	0.39–1.52
NZ Deprivation Index Decile	Decile 1–2	30	56,701	52.9	0.05	1.00		1.00	
	Decile 3–4	32	64,686	49.5	0.05	0.94	0.57–1.54	0.87	0.52–1.47
	Decile 5–6	61	76,809	79.4	0.08	1.50	0.97–2.33	1.47	0.93–2.31
	Decile 7–8	76	88,922	85.5	0.09	*1.62	1.06–2.47	*1.57	1.01–2.44
	Decile 9–10	59	88,553	66.6	0.07	1.26	0.81–1.96	1.54	0.97–2.45
ASA Score of Last Anaesthetic	1 or 2	208	375,242	55.4	0.06	1.00		1.00	
	3	17	490	3,469.4	3.47	*64.80	39.20–107.12	*5.59	2.84–11.00
	4	15	141	10,638.3	10.64	*214.65	123.55–372.91	*12.39	5.79–26.53
	5	4	11	36,363.6	36.36	s	s	s	s
	Not Stated	15	570	2,631.6	2.63	*48.82	28.72–82.99	*8.95	4.93–16.26
Emergency Status of Last Anaesthetic	Non-Emergency /Not Stated	222	372,123	59.7	0.06	1.00		1.00	
	Emergency	37	4,331	854.3	0.85	*14.44	10.18–20.47	*2.45	1.42–4.24
Number of Anaesthetics	One	155	357,443	43.4	0.04	1.00		1.00	
	Two Plus	104	19,011	547.1	0.55	*12.68	9.89–16.26	*3.62	2.62–5.01

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 admissions in those with a first ASA score of 1 or 2 and either a general anaesthetic or a neuraxial block.
* Significantly different from reference category.
MELAA: Middle Eastern/Latin American/African.
s ASA 5 left out of univariate and multivariate models due to small numbers.
Caution should also be observed when interpreting ORs where mortality exceeds 10% (see **Appendix 3** for details).

Background: elective admissions with an ASA score of 1 or 2

Admissions by age and primary procedure

In New Zealand during 2006–2010, dental procedures, grommets and tonsillectomy +/- adenoidectomy were the leading reasons for elective admissions in children and young people aged 0–24 years with a first ASA score of 1 or 2, while laparoscopic sterilisations, hysterectomies and elective lower segment caesarean sections were the leading reasons in those aged 25–44 years (Table 12).

Table 12. Elective Admissions in Those with a First ASA Score of 1 or 2 by Primary Procedure and Age Group in Those Aged 0–44 Years, New Zealand 2006–2010

PRIMARY PROCEDURE	Number: Total 2006–2010	Number: Annual Average	% of Admissions in Age Group
0–24 Years			
Dental Procedures	23,535	4,707	19.71
Grommets	18,178	3,636	15.22
Tonsillectomy +/- Adenoidectomy	13,318	2,664	11.15
Removal of Screw, Pin, Wire, Plate, Rod or Nail	3,939	788	3.30
Inguinal Hernia Repair	2,895	579	2.42
Myringoplasty with Associated Procedures	2,189	438	1.83
Adenoidectomy without Tonsillectomy	2,020	404	1.69
Male Circumcision	1,436	287	1.20
Excision/Incision of Pilonidal Sinus or Cyst	1,139	228	0.95
Laparoscopy	1,036	207	0.87
Other Procedures	49,731	9,946	41.65
Total 0–24 Years	119,416	23,883	100.00
25–44 Years			
Laparoscopic Sterilisation	4,353	871	4.95
Hysterectomy: Abdominal and Vaginal	4,216	843	4.80
Elective Lower Segment Caesarean Section	3,580	716	4.07
Cholecystectomy: Laparoscopic and Open	3,507	701	3.99
Dilation and Curettage of Uterus	3,378	676	3.84
Procedures on the Cervix	2,417	483	2.75
Diagnostic Hysteroscopy	2,228	446	2.54
Septoplasty	1,967	393	2.24
Laparoscopy	1,771	354	2.02
Arthroscopic Meniscectomy of Knee	1,561	312	1.78
Other Procedures	58,908	11,782	67.03
Total 25–44 Years	87,886	17,577	100.00

Data source: NMDS: Elective admissions in those with a first ASA score of 1 or 2 and either a general anaesthetic or a neuraxial block.

Similarly, hysterectomies were the most frequent reasons for elective admissions in those aged 45–64 years, followed by hip arthroplasties and dilation and curettage of the uterus, while in those aged 65–79 years, hip and knee arthroplasties and inguinal hernia repairs were the leading reasons for admission. Finally, knee and hip arthroplasties followed by excision of lesions of the skin and subcutaneous tissue were the leading reasons for admission in those aged 80+ years (Table 13).

Table 13. Elective Admissions in Those with a First ASA Score of 1 or 2 by Primary Procedure and Age Group in Those Aged 45+ Years, New Zealand 2006–2010

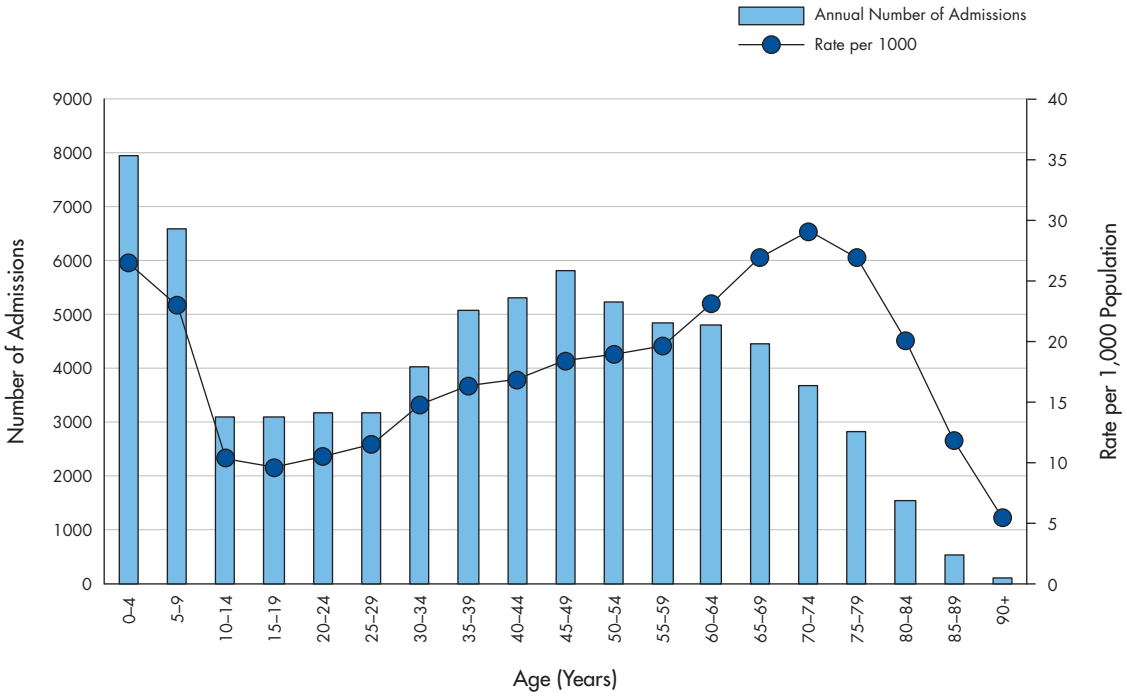
PRIMARY PROCEDURE	Number: Total 2006–2010	Number: Annual Average	% of Admissions in Age Group
45–64 Years			
Hysterectomy: Abdominal and Vaginal	5,399	1,080	5.22
Hip Arthroplasty Including Revisions	5,087	1,017	4.92
Dilation and Curettage of Uterus	4,073	815	3.94
Cholecystectomy: Laparoscopic and Open	3,606	721	3.49
Knee Arthroplasty Including Revisions	3,456	691	3.34
Inguinal Hernia Repair	3,347	669	3.24
Excision of Lesion of Breast Including Re-Excisions	3,563	713	3.45
Diagnostic Hysteroscopy	2,502	500	2.42
Arthroscopic Meniscectomy of Knee	2,357	471	2.28
Mastectomy	2,001	400	1.94
Other Procedures	67,969	13,594	65.76
Total 45–64 Years	103,360	20,672	100.00
65–79 Years			
Hip Arthroplasty Including Revisions	6,256	1,251	11.40
Knee Arthroplasty Including Revisions	5,780	1,156	10.53
Inguinal Hernia Repair	2,210	442	4.03
Transurethral Resection of Prostate	2,088	418	3.80
Cholecystectomy: Laparoscopic and Open	1,704	341	3.10
Hysterectomy: Abdominal and Vaginal	1,075	215	1.96
Excision of Lesion of Breast Including Re-Excisions	1,001	200	1.82
Mastectomy	947	189	1.73
Dilation and Curettage of Uterus	608	122	1.11
Arthroscopic Meniscectomy of Knee	548	110	1.00
Other Procedures	32,667	6,533	59.52
Total 65–79 Years	54,884	10,977	100.00
65–79 Years			
Knee Arthroplasty Including Revisions	1,090	218	9.99
Hip Arthroplasty Including Revisions	1,056	211	9.68
Excision of Lesions of Skin and Subcutaneous Tissue	822	164	7.54
Endoscopic Resection/Destruction of Bladder Lesion or Tissue	648	130	5.94
Transurethral Resection of Prostate	619	124	5.67
Inguinal Hernia Repair	456	91	4.18
Mastectomy	280	56	2.57
Cholecystectomy: Laparoscopic and Open	268	54	2.46
Right Hemicolectomy with Anastomosis	244	49	2.24
Cataract Surgery	165	33	1.51
Other Procedures	5,260	1,052	48.22
Total 80+ Years	10,908	2,182	100.00

Data source: NMDS: Elective admissions in those with a first ASA score of 1 or 2 and either a general anaesthetic or a neuraxial block.

Admissions by age

The highest number of elective admissions in those with a first ASA score of 1 or 2 during 2006–2010 were in those aged 0–4 years followed by those aged 5–9 years. Numbers then declined and remained relatively low amongst those aged 10–29 years, before increasing again to reach a peak at 45–49 years of age. Numbers then tapered off again, reaching their lowest point in those 90+ years. Because of the underlying age structure of the New Zealand population, however, the highest admission rates were seen in those aged 70–74 years (Figure 13).

Figure 13. Elective Admissions in Those with a First ASA Score of 1 or 2 by Age, New Zealand 2006–2010



Numerator: NMDS: Elective admissions in those with a first ASA score of 1 or 2 and either a general anaesthetic or a neuraxial block.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

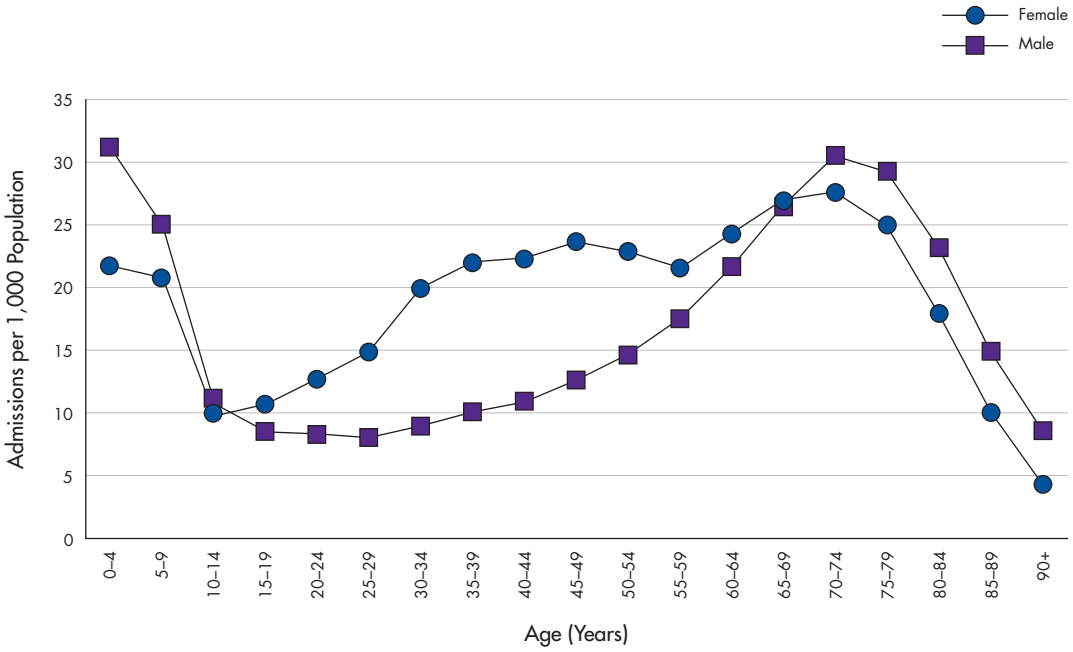
Admissions by age and gender

Elective admissions in those with a first ASA score of 1 or 2 were higher for males than for females prior to 10 years of age during 2006–2010. Admission rates then increased disproportionately for females, with admission rates remaining higher for females than for males between 15 and 64 years. From 70 years of age onwards, however, admission rates again became higher for males than for females (Figure 14).

Admissions by age and ethnicity

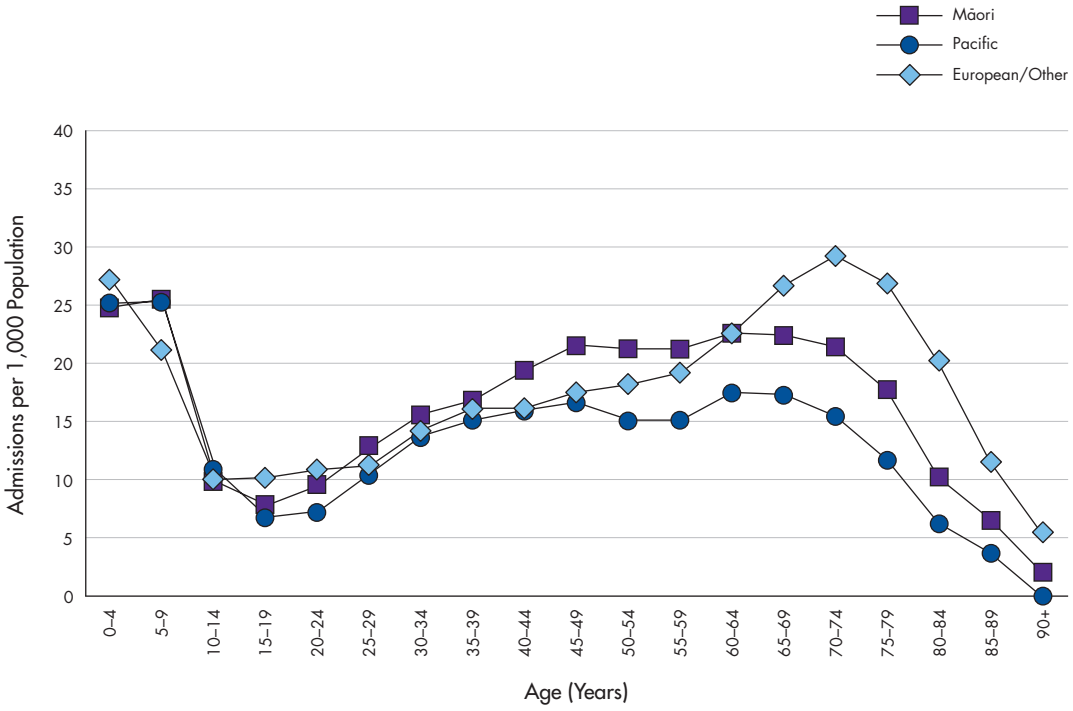
During 2006–2010, there were no consistent ethnic differences in elective admissions for children aged 0–14 years with a first ASA score of 1 or 2. From 15–19 years of age onwards, however, admission rates were higher for Māori than for Pacific peoples. Admission rates for European/Other peoples were also higher than for Māori and Pacific peoples from 65–69 years of age onwards (Figure 15).

Figure 14. Elective Admissions in Those with a First ASA Score of 1 or 2 by Age and Gender, New Zealand 2006–2010



Numerator: NMDS: Elective admissions in those with a first ASA score of 1 or 2 and either a general anaesthetic or a neuraxial block.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Figure 15. Elective Admissions in Those with a First ASA Score of 1 or 2 by Age and Ethnicity, New Zealand 2006–2010



Numerator: NMDS: Elective admissions in those with a first ASA score of 1 or 2 and either a general anaesthetic or a neuraxial block.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).
Ethnicity is Level 1 Prioritised.

Mortality in Those Aged 80+ Years Following a General Anaesthetic or Neuraxial Block

The following section uses information from the NMDS and the NMC to review mortality in the first 30 days following a general anaesthetic or neuraxial block in those aged 80+ years. Additional background information on hospital admissions in those aged 80+ years that included a general anaesthetic or neuraxial block is provided at the end of this chapter.

Key findings

- In New Zealand during 2006–2010, falls, followed by myocardial infarction/other ischaemic heart disease were the most frequently listed main underlying causes of death in those aged 80+ years dying within 30 days of a general anaesthetic or neuraxial block who were admitted acutely, while malignant/other neoplasms and myocardial infarction/other ischaemic heart disease were the most frequent cause of mortality for public hospital semi-acute and elective admissions.

- Mortality in the first 30 days following a general anaesthetic or neuraxial block in those aged 80+ years was relatively frequent (2799 deaths following 62,230 initial anaesthetics during 2006–2010). Cumulative 30-day mortality, however, was higher for acute admissions (9008.6 per 100,000 initial anaesthetics, or 9.0%) than for elective admissions (1210.9 per 100,000 initial anaesthetics, or 1.2%).

- Mortality following a general anaesthetic or neuraxial block in those admitted acutely was highest on day one or two, with the number of deaths then tapering off over the first week. For elective admissions, mortality was highest on the second day following the anaesthetic. However, deaths still occurred right up until 30 days for both admission types.

- Mortality increased with increasing age for all admission types (acute, public hospital semi-acute and elective), with the highest rates being seen in those 90+ years. Within each age group, mortality was higher for acute than for elective admissions.

- Mortality was similar for those with ASA scores of 1 or 2 but increased with increasing ASA score thereafter, with the highest rates being seen in those with an ASA score of 5. Within each ASA category, mortality was higher for acute than for elective admissions, although as expected, no elective admissions occurred in those with an ASA score of 5. Thus, for those admitted acutely with an ASA score of 5, mortality was 49.7%.

- In those aged 80+ years, 13.4% of acute admissions had two or more anaesthetics, with mortality in those undergoing two or more anaesthetics being *significantly* higher than for those only undergoing one anaesthetic — mortality rate 11.0 per 100 admissions, univariate OR 1.30 (95% CI 1.15–1.46), multivariate OR 1.23 (95% CI 1.09–1.39). Mortality rates for those acute admissions where the last anaesthetic was undertaken as an emergency were also *significantly* higher than for those where the last anaesthetic's emergency status was either non-emergency or not stated — mortality rate 11.2 per 100 admissions, univariate OR 1.59 (95% CI 1.46–1.73), multivariate OR 1.43 (95% CI 1.29–1.57).

- Similarly, 9.4% of elective admissions in those aged 80+ years had two or more anaesthetics, with mortality in this group again being *significantly* higher than for those undergoing only one anaesthetic — mortality rate 4.3 per 100 admissions, univariate OR 4.98 (95% CI 4.04–6.13), multivariate OR 3.72 (95% CI 2.94–4.71). Mortality rates for those elective admissions where the last anaesthetic was undertaken as an emergency were also *significantly* higher than for those where the status was either non-emergency or not stated — mortality rate 10.4 per 100 admissions, univariate OR 10.7 (95% CI 7.86–14.55), multivariate OR 3.38 (95% CI 2.34–4.89).

Data sources and methods

Definition

1. Hospital admissions in those aged 80+ years that included a general anaesthetic or neuraxial block.
2. Mortality in the first 30 days following an initial general anaesthetic or neuraxial block in those aged 80+ years.

Data sources

Hospital admissions

Numerator: NMDS: Hospital admissions in those aged 80+ years that included a general anaesthetic (ACHI Procedure Code 92514-XX) or neuraxial block (ACHI Procedure Code 92508-XX).

Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Mortality

Numerator: NMC: Mortality in the first 30 days following an initial general anaesthetic or neuraxial block in those aged 80+ years (as identified in the NMDS).

Denominator: NMDS: All hospital admissions in those aged 80+ years that included a general anaesthetic or neuraxial block.

Notes on interpretation

All admissions in those aged 80+ years that had a general anaesthetic or neuraxial block were included, with the date of the first anaesthetic being taken as the index event for calculating 30-day mortality, even if further anaesthetics occurred during the same admission. Similarly, in a small number of cases (n=45), two admissions occurred within 30 days of death. In such cases, the first admission in the 30-day period has been taken to be the index event, with the repeat admission being excluded from both the numerator and the denominator in mortality rate calculations.

Acute, arranged (semi-acute) and waiting list admissions: The NMDS defines an acute admission as an unplanned admission occurring on the day of presentation, while an arranged admission is a non-acute admission with an admission date less than seven days after the date the decision was made by the specialist that the admission was necessary. Similarly, waiting list admissions arise when the planned admission date is seven or more days after the date the decision was made that the admission was necessary. These definitions are inconsistently used by private hospitals uploading their data to the NMDS, however, with a significant proportion of private hospital admissions being coded as arranged when in reality they meet the criteria for a waiting list admission outlined above. As a result, in the sections that follow, all arranged private hospital cases have been included in the elective category, while arranged admissions occurring in public hospitals have been included in the public hospital semi-acute admission category. Thus, unless otherwise specified, acute and elective admissions include both public and private cases, while semi-acute admissions are confined to public hospital cases only.

Privately funded 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 are publicly funded maternity events. 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 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 are privately funded or ACC-funded events or publicly funded long-stay geriatric cases. Thus, in the section that follows, it must be remembered that the data presented are likely to undercount some private hospital events, with the magnitude of this undercount being difficult to quantify (although it is assumed to be significant).

Mortality in those aged 80+ years following a general anaesthetic or neuraxial block

Mortality by admission type and cause of death

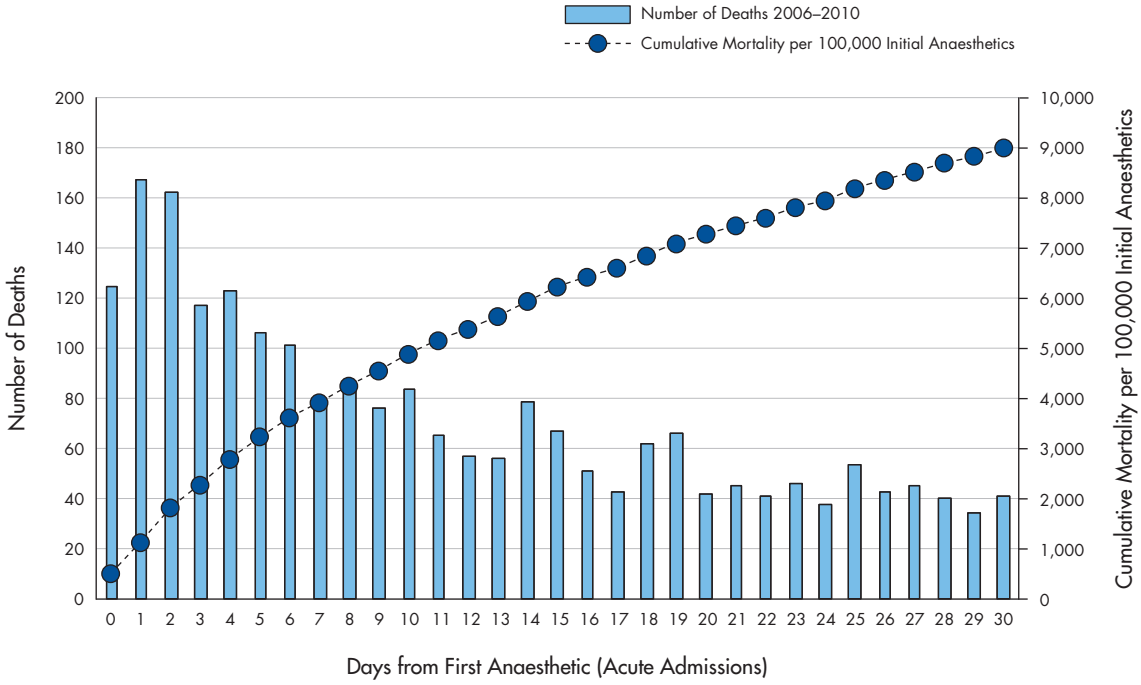
In New Zealand during 2006–2010, falls, followed by myocardial infarction/other ischaemic heart disease were the most frequently listed main underlying causes of death in those aged 80+ years dying within 30 days of a general anaesthetic or neuraxial block who were admitted acutely, while malignant/other neoplasms and myocardial infarction/other ischaemic heart disease were the most frequent cause of mortality for public hospital semi-acute and elective admissions (Table 14).

Table 14. Mortality in Those Aged 80+ Years Following a General Anaesthetic or Neuraxial Block by Cause and Admission Type, New Zealand 2006–2010

MAIN UNDERLYING CAUSE OF DEATH	Total Deaths 2006–2010	Annual Average	Percent of Deaths in Category (%)
Mortality 80+ Years			
Acute			
Falls	444	88.8	19.8
Other Injuries/External Causes	47	9.4	2.1
Myocardial Infarction/Other Ischaemic Heart Disease	439	87.8	19.6
Other Cardiovascular Causes	364	72.8	16.3
Malignant/Other Neoplasms	341	68.2	15.2
Emphysema and COPD	87	17.4	3.9
Other Respiratory Diseases	29	5.8	1.3
Paralytic Ileus/Intestinal Obstruction	68	13.6	3.0
Other Gastrointestinal Diseases	186	37.2	8.3
Dementia/Alzheimer's/CNS Degeneration	53	10.6	2.4
Chronic Renal Failure	32	6.4	1.4
Non-Insulin Dependent Diabetes	31	6.2	1.4
Other Causes	118	23.6	5.3
Total Acute	2,239	447.8	100.0
Public Hospital Semi-Acute			
Malignant/Other Neoplasms	45	9.0	30.6
Myocardial Infarction/Other Ischaemic Heart Disease	35	7.0	23.8
Other Cardiovascular Causes	21	4.2	14.3
Falls	14	2.8	9.5
Gastrointestinal Diseases	10	2.0	6.8
Respiratory Diseases	7	1.4	4.8
Other Causes	15	3.0	10.2
Total Public Hospital Semi-Acute	147	29.4	100.0
Elective			
Malignant/Other Neoplasms	126	25.2	30.5
Myocardial Infarction/Other Ischaemic Heart Disease	97	19.4	23.5
Other Cardiovascular Causes	76	15.2	18.4
Gastrointestinal Diseases	32	6.4	7.7
Emphysema and COPD	21	4.2	5.1
Other Respiratory Diseases	11	2.2	2.7
Non-Insulin Dependent Diabetes	5	1.0	1.2
Other Causes	45	9.0	10.9
Total Elective	413	82.6	100.0

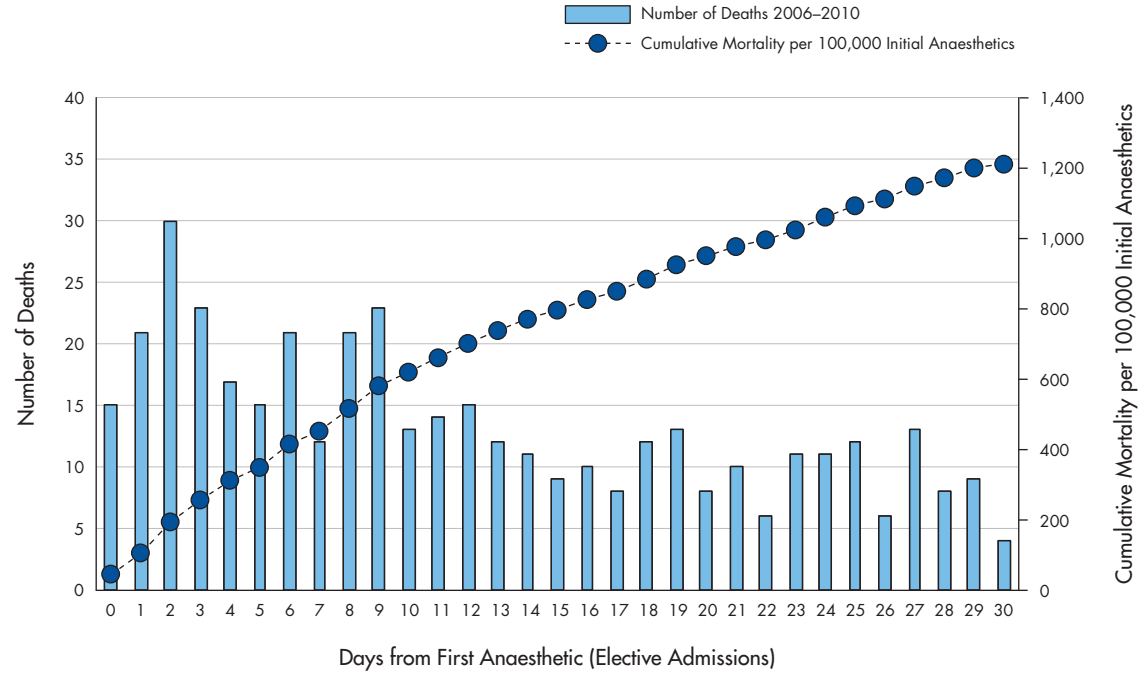
Data source: NMC: Deaths in those aged 80+ years occurring within 30 days of a general anaesthetic or neuraxial block as recorded in the NMDS.

Figure 16. Mortality in Those Aged 80+ Years Following an Acute Admission that Included a General Anaesthetic or Neuraxial Block by Day from First Anaesthetic, New Zealand 2006–2010



Numerator: NMC: Deaths in those aged 80+ years occurring within 30 days of a general anaesthetic or neuraxial block, as recorded in the NMDS (acute admissions only).
Denominator: NMDS: Acute admissions in those aged 80+ years that included a general anaesthetic or neuraxial block.

Figure 17. Mortality in Those Aged 80+ Years Following an Elective Admission that Included a General Anaesthetic or Neuraxial Block by Day from First Anaesthetic, New Zealand 2006–2010



Numerator: NMC: Deaths in those aged 80+ years occurring within 30 days of a general anaesthetic or neuraxial block, as recorded in the NMDS (elective admissions only).
Denominator: NMDS: Elective admissions in those aged 80+ years that included a general anaesthetic or neuraxial block.

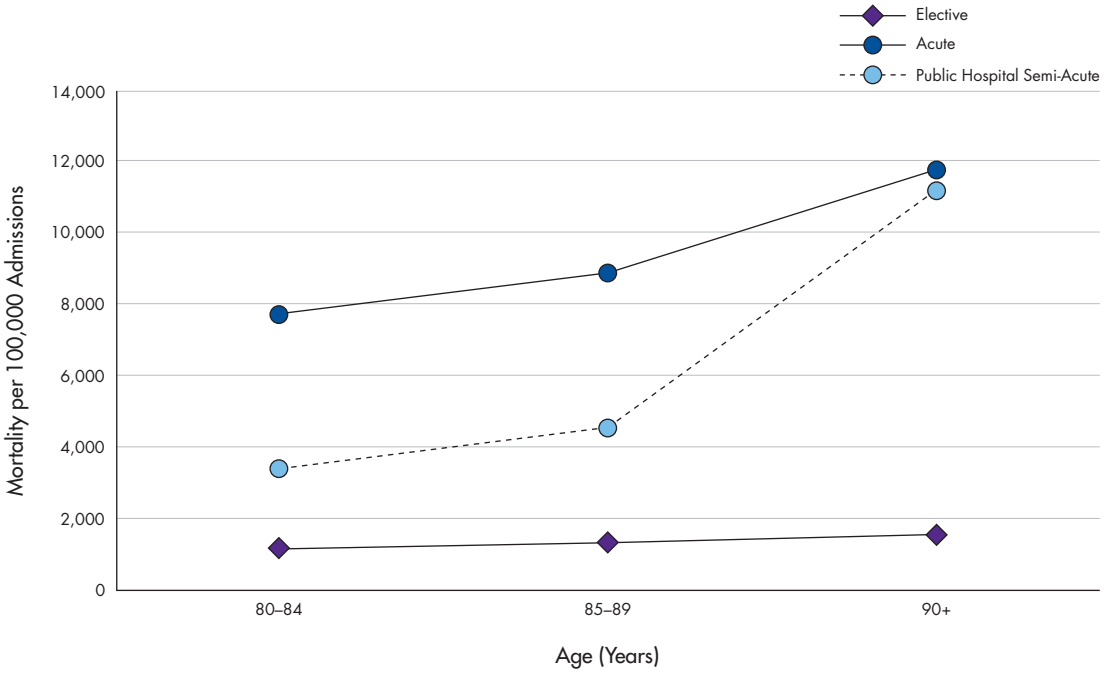
Mortality by day from first anaesthetic

Mortality following a general anaesthetic or neuraxial block in those admitted acutely was highest on day one or two during 2006–2010, with the number of deaths then tapering off over the first week. However, a number of deaths still occurred each day, right up until 30 days. For elective admissions, mortality was highest on the second day following the initial anaesthetic, although, again, deaths continued to occur right up until 30 days. Cumulative 30-day mortality was higher for acute admissions (9008.6 per 100,000 initial anaesthetic, or 9.0%) than for elective admissions (1210.9 per 100,000 initial anaesthetic, or 1.2%) (Figures 16 and 17).

Mortality by age

Mortality following a general anaesthetic or neuraxial block in those aged 80+ years during 2006–2010 increased with increasing age for all admission types (acute, public hospital semi-acute and elective), with the highest rates being seen in those 90+ years. Within each age group, mortality was higher for acute admissions than for elective admissions (Figure 18).

Figure 18. Mortality in Those Aged 80+ Years Following a General Anaesthetic or Neuraxial Block by Admission Type and Age, New Zealand 2006–2010

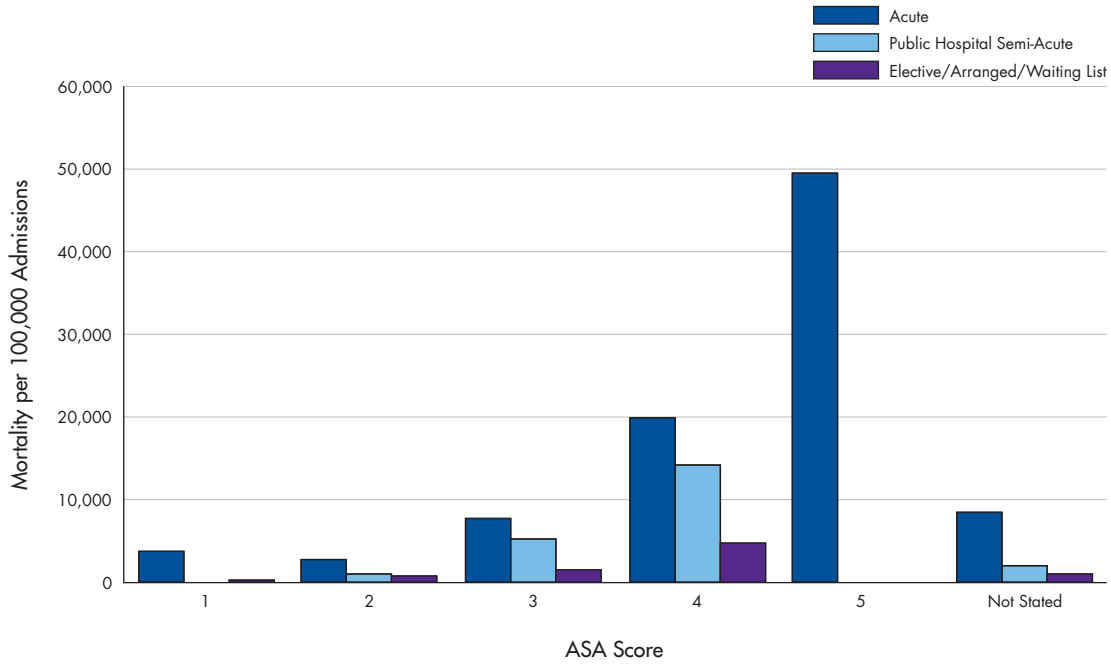


Numerator: NMC: Deaths in those aged 80+ years occurring within 30 days of a general anaesthetic or neuraxial block, as recorded in the NMDS.
Denominator: NMDS: Hospital admissions in those aged 80+ years that included a general anaesthetic or neuraxial block.

Mortality by ASA score

During 2006–2010, mortality following a general anaesthetic or neuraxial block in those aged 80+ years was similar for those with ASA scores of 1 or 2 but then increased with increasing ASA score thereafter, with the highest rates being seen in those with an ASA score of 5. Within each ASA score category, mortality was higher for acute than for elective admissions, although as expected, no elective admissions occurred amongst those with an ASA score of 5 (Figure 19).

Figure 19. Mortality in Those Aged 80+ Years Following a General Anaesthetic or Neuraxial Block by Admission Type and ASA Score, New Zealand 2006–2010



Numerator: NMC: Deaths in those aged 80+ years occurring within 30 days of a general anaesthetic or neuraxial block, as recorded in the NMDS.
Denominator: NMDS: Hospital admissions in those aged 80+ years that included a general anaesthetic or neuraxial block.
Rates for public hospital semi-acute ASA 5 suppressed due to small numbers.

Mortality by sociodemographic and clinical factors

Acute admissions

First anaesthetic: During 2006–2010, mortality in the first 30 days following an initial general anaesthetic or neuraxial block in those aged 80+ years admitted acutely was *significantly* higher for males and those with a first ASA score of 3 or more (vs. ASA 1–2). These differences persisted, even when the risk was adjusted for other sociodemographic and clinical factors (gender, ethnicity, NZDep deprivation, first ASA score). No significant ethnic differences were evident, although mortality was *significantly* higher for those from more deprived (NZDep decile 7–8 and 9–10) areas in both the univariate and multivariate model (Table 15).

Last anaesthetic: During this period, 13.4% of acute admissions in those aged 80+ years that included a general anaesthetic or neuraxial block had two or more anaesthetics, with mortality in those undergoing two or more anaesthetics being *significantly* higher than for those only undergoing one anaesthetic — mortality rate 11.0 per 100 admissions, univariate OR 1.30 (95% CI 1.15–1.46), multivariate OR 1.23 (95% CI 1.09–1.39). When the ASA score of the last rather than the first anaesthetic was considered (as 86.6% of admissions had only one anaesthetic, the first and last ASA scores were the same for many cases), mortality rates for those with a last ASA score of 3 or more were *significantly* higher than for those with an ASA score of 1–2. Mortality rates for those acute admissions where the last anaesthetic was undertaken as an emergency were also *significantly* higher than for those where the last anaesthetic's emergency status was either non-emergency or not stated — mortality rate 11.2 per 100 admissions, univariate OR 1.59 (95% CI 1.46–1.73), multivariate OR 1.43 (95% CI 1.29–1.57). (Note that multivariate OR is adjusted for age, ethnicity, NZDep decile, gender, last ASA score, emergency status and number of anaesthetics.)

Table 15. Mortality in Those Aged 80+ Years Following an Acute Admission that Included a General Anaesthetic or Neuraxial Block by Gender, Ethnicity, NZ Deprivation Index Decile and First ASA Score, New Zealand 2006–2010

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
Mortality 80+ Years									
Acute									
Gender	Female	1,297	16,548	7,837.8	7.84	1.00		1.00	
	Male	942	8,306	11,341.2	11.34	*1.50	1.38–1.64	*1.38	1.26–1.52
Ethnicity	European	2,078	23,088	9,000.4	9.00	1.00		1.00	
	Māori	48	437	10,984.0	10.98	1.25	0.92–1.69	1.08	0.79–1.48
	Pacific	18	244	7,377.1	7.38	0.81	0.50–1.30	0.63	0.38–1.05
	Asian/ MELAA/ Other	57	640	8,906.3	8.91	0.99	0.75–1.30	1.11	0.84–1.48
NZ Deprivation Index Decile	Decile 1–2	308	4,030	7,642.7	7.64	1.00		1.00	
	Decile 3–4	381	4,433	8,594.6	8.60	1.14	0.97–1.33	1.16	0.99–1.37
	Decile 5–6	503	5,644	8,912.1	8.91	*1.18	1.02–1.37	1.15	0.99–1.34
	Decile 7–8	596	6,262	9,517.7	9.52	*1.27	1.10–1.47	*1.25	1.07–1.44
	Decile 9–10	446	4,392	10,154.8	10.16	*1.37	1.17–1.59	*1.32	1.12–1.54
ASA Score of First Anaesthetic	1 or 2	137	4,921	2,784.0	2.78	1.00		1.00	
	3	891	11,472	7,766.7	7.77	*2.94	2.45–3.53	*2.95	2.45–3.56
	4	742	3,720	19,946.2	19.95	*8.70	7.21–10.50	*8.48	7.00–10.27
	5	73	147	49,659.9	49.66	H	H	H	H
	Not Stated	396	4,594	8,619.9	8.62	*3.29	2.70–4.02	*3.28	2.67–4.01

Numerator: NMC: Deaths in those aged 80+ years occurring within 30 days of a general anaesthetic or neuraxial block as recorded in the NMDS.
Denominator: NMDS: Acute admissions in those aged 80+ years which included a general anaesthetic or neuraxial block.
* Significantly different from reference category.
MELAA: Middle Eastern/Latin American/African.
H Odds ratios supressed due to high mortality rates. Caution should also be observed when interpreting ORs where mortality exceeds 10% (see **Appendix 3** for details).

Elective admissions

First anaesthetic: During 2006–2010, mortality in the first 30 days following an initial general anaesthetic or neuraxial block in those aged 80+ years admitted electively was *significantly* higher for those with a first ASA score of 3 or 4 (vs. ASA 1–2). These differences persisted, even when the risk was adjusted for other sociodemographic and clinical factors (gender, ethnicity, NZDep deprivation, first ASA score). No significant gender, ethnic or socioeconomic differences were evident, however (Table 16).

Last anaesthetic: During this period, 9.4% of elective admissions in those aged 80+ years that included a general anaesthetic or neuraxial block had two or more anaesthetics, with mortality in those undergoing two or more anaesthetics being *significantly* higher than for those only undergoing one anaesthetic — mortality rate 4.3 per 100 admissions, univariate OR 4.98 (95% CI 4.04–6.13), multivariate OR 3.72 (95% CI 2.94–4.71). When the ASA score of the last, rather than the first anaesthetic was considered (as 90.6% of admissions had only one anaesthetic, the first and last ASA scores were the same for many cases), mortality rates for those with a last ASA score of 3 or 4 were *significantly* higher than for those with an ASA score of 1–2. Mortality rates for those elective admissions where the last anaesthetic was undertaken as an emergency were also *significantly* higher than for those where the last anaesthetic's emergency status was either non-emergency or not stated — mortality rate 10.4 per 100 admissions, univariate OR 10.7 (95% CI 7.86–14.55), multivariate OR 3.38 (95% CI 2.34–4.89). (Note that multivariate OR is adjusted for age, ethnicity, NZDep decile, gender, last ASA score, emergency status and number of anaesthetics.)

Table 16. Mortality in Those Aged 80+ Years Following an Elective Admission that Included a General Anaesthetic or Neuraxial Block by Gender, Ethnicity, NZ Deprivation Index Decile and First ASA Score, New Zealand 2006–2010

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
Mortality 80+ Years									
Elective									
Gender	Female	185	16,704	1,107.5	1.11	1.00		1.00	
	Male	228	17,402	1,310.2	1.31	1.19	0.98–1.44	1.10	0.90–1.34
Ethnicity	European	387	31,388	1,233.0	1.23	1.00		1.00	
	Māori	9	482	1,867.2	1.87	1.52	0.78–2.97	1.39	0.71–2.74
	Pacific	0	167	–	–	–	–	–	–
	Asian/ MELAA/ Other	8	755	1,059.6	1.06	0.86	0.42–1.73	0.89	0.44–1.80
NZ Deprivation Index Decile	Decile 1–2	63	5,255	1,198.9	1.20	1.00		1.00	
	Decile 3–4	68	6,510	1,044.6	1.05	0.87	0.62–1.23	0.87	0.62–1.24
	Decile 5–6	99	7,907	1,252.1	1.25	1.05	0.76–1.44	1.00	0.73–1.39
	Decile 7–8	117	8,961	1,305.7	1.31	1.09	0.80–1.48	1.07	0.79–1.47
	Decile 9–10	66	5,416	1,218.6	1.22	1.02	0.72–1.44	0.98	0.69–1.39
ASA Score of First Anaesthetic	1 or 2	75	10,908	687.6	0.69	1.00		1.00	
	3	176	11,240	1,565.8	1.57	*2.30	1.75–3.02	*2.30	1.75–3.03
	4	51	1,075	4,744.2	4.74	*7.19	5.01–10.33	*7.14	4.95–10.30
	5	0	<5	–	–	–	–	–	–
	Not Stated	111	10,878	1,020.4	1.02	*1.49	1.11–2.00	*1.57	1.16–2.12

Numerator: NMC: Deaths in those aged 80+ years occurring within 30 days of a general anaesthetic or neuraxial block as recorded in the NMDS.
Denominator: NMDS: Elective admissions in those aged 80+ years which included a general anaesthetic or neuraxial block.
* Significantly different from reference category.
MELAA: Middle Eastern/Latin American/African.

Background: hospital admissions in those aged 80+ years with a general anaesthetic or neuraxial block

Admissions by admission type

In New Zealand during 2006–2010, 40.0% of admissions in those aged 80+ years that included a general anaesthetic or neuraxial block were acute events, while 5.3% were public hospital semi-acute (occurring within seven days of referral) and 54.8% were elective or drawn from the waiting list (Table 17).

Table 17. Hospital Admissions in Those Aged 80+ Years that Included a General Anaesthetic or Neuraxial Block by Admission Type, New Zealand 2006–2010

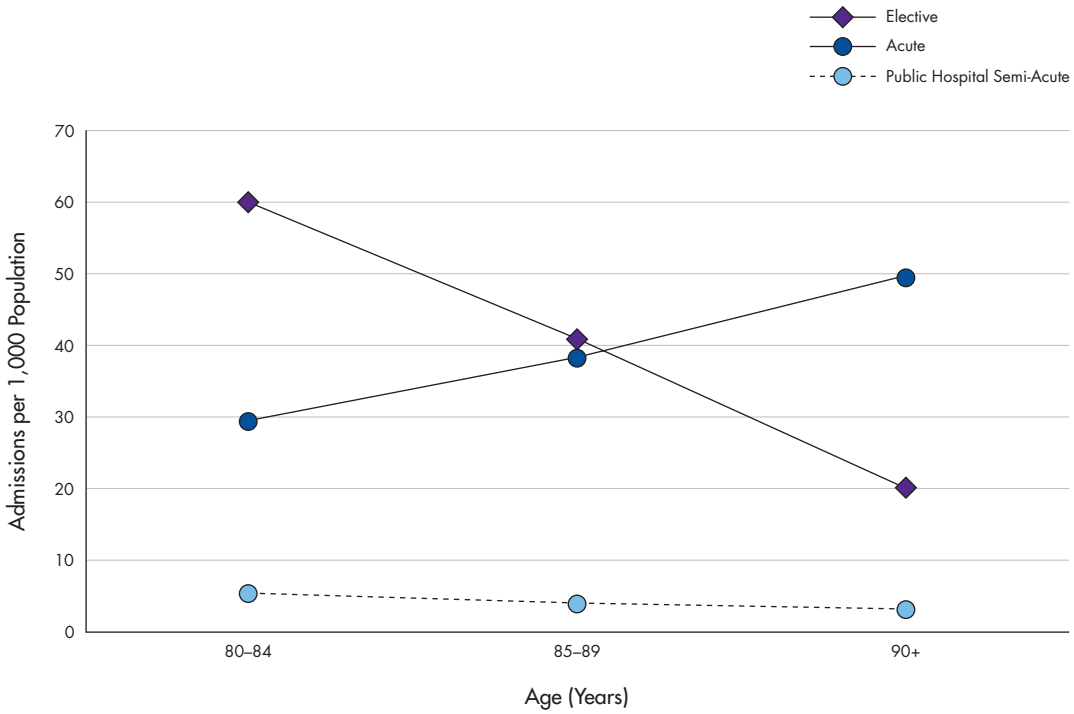
ADMISSION TYPE	Total Admission Events 2006–2010	Annual Average	Percent of Admissions (%)
Admissions 80+ Years			
Acute	24,885	4,977.0	40.0
Public Hospital Semi-Acute	3,283	656.6	5.3
Elective	34,107	6,821.4	54.8
Total	62,275	12,455.0	100.0

Data source: NMDS: Hospital admissions in those aged 80+ years which included a general anaesthetic or neuraxial block.

Admissions by admission type and age

Elective admissions with a general anaesthetic or neuraxial block decreased with increasing age for those aged 80+ years during 2006–2010, with the lowest rates being seen in those aged 90+ years. In contrast, acute admissions increased with increasing age, with the highest rates being seen in those aged 90+ years (Figure 20).

Figure 20. Hospital Admissions in Those Aged 80+ Years that Included a General Anaesthetic or Neuraxial Block by Admission Type and Age Group, New Zealand 2006–2010



Numerator: NMDS: Hospital admissions in those aged 80+ years that included a general anaesthetic or neuraxial block.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Table 18. Hospital Admissions in Those Aged 80+ Years that Included a General Anaesthetic or Neuraxial Block by Primary Procedure and Admission Type, New Zealand 2006–2010

PRIMARY PROCEDURE	Total Admission Events 2006–2010	Annual Average	Percent of Admissions (%)
Admissions 80+ Years			
Acute			
Procedures on Fracture of Femur	7,070	1,414.0	28.4
Hemiarthroplasty of Femur	3,799	759.8	15.3
Other Arthroplasty of Hip (Including Revisions)	931	186.2	3.7
Excisional Debridement of Skin and Subcutaneous Tissue	582	116.4	2.3
Division of Abdominal Adhesions	516	103.2	2.1
Closed Reduction of Dislocation of Hip	419	83.8	1.7
Repair of Incarcerated, Obstructed or Strangulated Hernia	382	76.4	1.5
Excisional Debridement of Soft Tissue	339	67.8	1.4
Other Procedures	10,847	2,169.4	43.6
Total Acute	24,885	4,977.0	100.0
Public Hospital Semi-Acute			
Electroconvulsive Therapy	340	68.0	10.4
Procedures on Fracture of Femur	136	27.2	4.1
Other Arthroplasty of Hip (Including Revisions)	107	21.4	3.3
Hemi-Colectomy (Left or Right)	95	19.0	2.9
Endoscopic Laser Excision/Ablation of Prostate or TURP	92	18.4	2.8
Excisional Debridement of Skin and Subcutaneous Tissue	87	17.4	2.7
Hemiarthroplasty of Femur	66	13.2	2.0
Replacement of Aortic Valve with Bioprosthesis	61	12.2	1.9
Other Procedures	2,299	459.8	70.0
Total Public Hospital Semi-Acute	3,283	656.6	100.0
Elective			
Hip Arthroplasty (Including Revisions)	3,769	753.8	11.1
Knee Arthroplasty (Including Revisions)	3,063	612.6	9.0
Excision of Lesion of Skin and Subcutaneous Tissue	2,597	519.4	7.6
TURP	2,027	405.4	5.9
Inguinal Hernia Repair	1,724	344.8	5.1
Endoscopic Resection of Bladder Lesion/Tissue/Tumour	1,241	248.2	3.6
Hemi-Colectomy (Left or Right)	905	181.0	2.7
Mastectomy	735	147.0	2.2
Cholecystectomy (Including Laparoscopic)	668	133.6	2.0
Other Procedures	17,378	3,475.6	51.0
Total Elective	34,107	6,821.4	100.0

Data source: NMDS: Hospital admissions in those aged 80+ years which included a general anaesthetic or neuraxial block.
TURP: Transurethral resection of prostate.

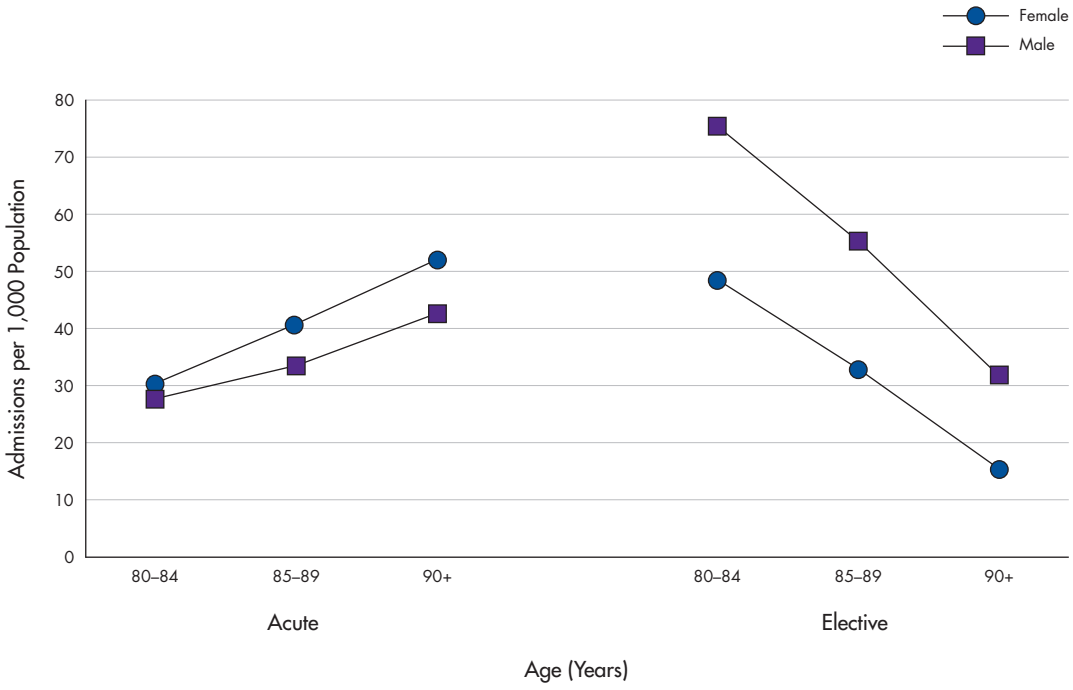
Admissions by admission type and primary procedure

Amongst those aged 80+ years, during 2006–2010, procedures associated with repairing fractures of the femur and other types of femur/hip arthroplasty were the most frequent reasons for an acute admission that included a general anaesthetic or neuraxial block. In contrast, electroconvulsive therapy was the most frequent reason for a public hospital semi-acute admission, while hip and knee arthroplasties and the excision of lesions of the skin and subcutaneous tissue were the most frequent reasons for elective admissions (Table 18).

Admissions by admission type and gender

Amongst those aged 80+ years during 2006–2010, acute admissions that included a general anaesthetic or neuraxial block were higher for females than males at all ages (80–84, 85–89 and 90+ years), while elective admissions were higher for males than females (Figure 21).

Figure 21. Hospital Admissions in Those Aged 80+ Years that Included a General Anaesthetic or Neuraxial Block by Admission Type and Gender, New Zealand 2006–2010



Numerator: NMDS: Hospital admissions in those aged 80+ years that included a general anaesthetic or neuraxial block.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

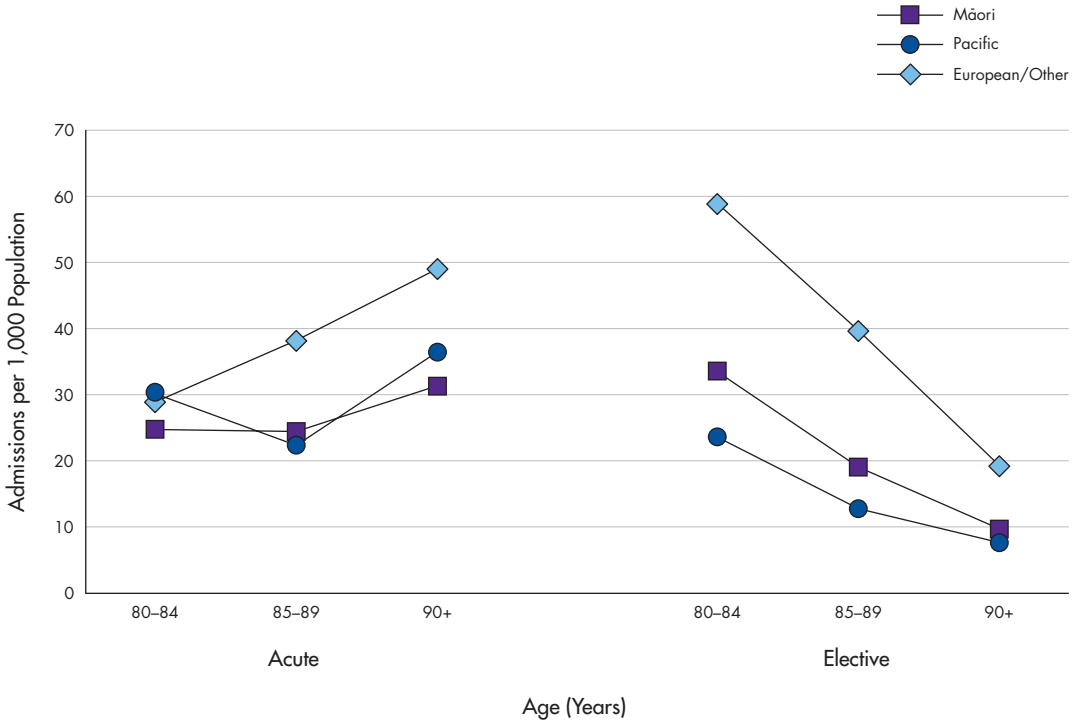
Admissions by age, admission type and ethnicity

During 2006–2010, acute admission rates in those aged 85–89 and 90+ years were higher for European/Other peoples than for Māori or Pacific peoples. For elective admissions, rates for European/Other peoples were higher than for Māori or Pacific peoples in every age group (80–84, 85–89 and 90+ years). Care should be taken when interpreting rates for Pacific peoples aged 90+ years due to the small number of elective admissions (n=5) in this age group (Figure 22).

Proportion of admissions by age and ASA score

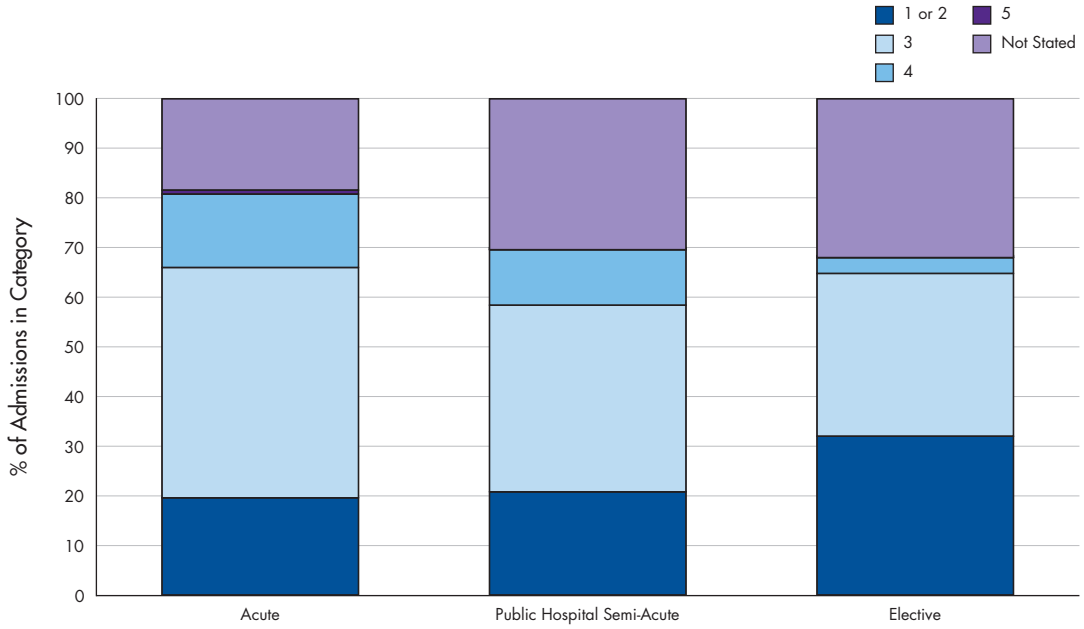
During 2006–2010, 19.8% of acute admissions in those aged 80+ years had an ASA score of 1 or 2 at the time of their first anaesthetic, while 15.6% had an ASA score of 4 or 5. In contrast, 32.0% of elective/waiting list admissions had an ASA score of 1 or 2, while only 3.2% had an ASA score of 4 or 5 (Figure 23).

Figure 22. Hospital Admissions in Those Aged 80+ Years that Included a General Anaesthetic or Neuraxial Block by Admission Type and Ethnicity, New Zealand 2006–2010



Numerator: NMDS: Hospital admissions in those aged 80+ years that included a general anaesthetic or neuraxial block.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).
Ethnicity is Level 1 Prioritised.

Figure 23. Hospital Admissions in Those Aged 80+ Years that Included a General Anaesthetic or Neuraxial Block by Admission Type and ASA Score, New Zealand 2006–2010



Data source: NMDS: Hospital admissions in those aged 80+ years that included a general anaesthetic or neuraxial block.

Pulmonary Embolus-Associated and Attributed Mortality

The following section 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 an anaesthetic that was either associated with or attributed to a pulmonary embolus.

Key findings

- In New Zealand during 2006–2010, pulmonary embolus-associated hospital admissions were infrequent in children and young people aged 0–24 years but increased thereafter, with the highest rates being seen in those aged 80+ years. In each age group, pulmonary embolus-associated admission rates were higher for acute admissions than for elective admissions.

- Repairs of fractures of the femur were the most frequently undertaken procedures to occur during acute admissions associated with pulmonary emboli, followed by hemi-arthroplasties of the femur and hip arthroplasty. Similarly, knee and hip arthroplasties were the procedures most frequently undertaken during elective admissions associated with pulmonary emboli.

- Falls, malignant/other neoplasms and myocardial infarction/other ischaemic heart disease were the most frequently listed main underlying causes of death in those meeting the criteria for a pulmonary embolus-associated death (ie, death within 30 days of the first anaesthetic of a pulmonary embolus-associated admission) who were admitted acutely. Similarly, malignant/other neoplasms were the most frequently listed main underlying causes of death in those admitted electively/from the waiting list who met the criteria for a pulmonary embolus-associated death.

- Pulmonary embolus-associated mortality was a rare event when the denominator for calculating rates was all hospital admissions with a general anaesthetic or neuraxial block (241 deaths per 1,259,032 admissions during 2006–2010). However, when the denominator was taken to be pulmonary-associated hospital admissions, mortality rates were considerably higher (241 deaths per 2379 pulmonary embolus-associated admissions, or 10.1%).

- Pulmonary embolus-associated mortality in those admitted acutely during 2006–2010 was highest on the same day or the day immediately after a general anaesthetic or neuraxial block. Mortality following elective admissions associated with a pulmonary embolus was highest during the first two weeks. Cumulative 30-day mortality was higher for acute admissions (54.5 per 100,000 initial anaesthetics, or 0.05%) than for elective admissions (7.6 per 100,000 initial anaesthetics, or 0.008%).

- Pulmonary embolus-associated and attributed mortality during 2006–2010 was infrequent in those aged under 45 years, with the vast majority of deaths occurring in those who were admitted acutely and who had an ASA score of 4. Amongst older age groups, while mortality was again higher for those with an ASA score of 4, differences between those with ASA scores of 1, 2 and 3 were less consistent. Within each ASA score category, mortality rates were generally (although not always) higher for acute than for elective admissions.

Data sources and methods

In this analysis, hospital admissions occurring during 2006–2010 were included if a general anaesthetic or neuraxial block was listed in any of their procedure codes. The date of the first anaesthetic for each of these admissions (referred to as index admissions) was identified, and then each was followed through for a period of 30 days to determine whether any met the criteria for a pulmonary embolus-associated admission outlined below. Pulmonary embolus-associated deaths were deaths occurring in the pulmonary embolus-associated admission cohort that occurred within 30 days of the first anaesthetic date of the index admission. As not all deaths were causally associated with a pulmonary embolus, a second category — pulmonary embolus-attributed deaths — was developed, which comprised all deaths occurring within 30 days of the first anaesthetic date of the index admission where a pulmonary embolus was listed as the main underlying cause of death or as a contributory cause in the NMC. In a number of these cases, a pulmonary embolus had not previously been identified in either the index admission or any subsequent readmission.

Definitions and criteria

Pulmonary embolus-associated admission: A hospital admission where the patient received a general anaesthetic or neuraxial block AND where:

- a pulmonary embolus was diagnosed during that admission OR
- the patient was readmitted within 30 days (of the first anaesthetic of the index admission) with a pulmonary embolus OR
- the patient died within 30 days (of the first anaesthetic of the index admission) and where a pulmonary embolus was identified as the main or a contributory cause of death.

Pulmonary embolus-associated mortality: 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 embolism-associated admission outlined above. Rates are calculated:

- per 100,000 anaesthetic-related admissions
- per 100,000 pulmonary embolus-associated admissions.

Pulmonary embolism-attributed mortality: 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 (this is a subset of pulmonary embolus-associated mortality above).

Data sources

Pulmonary embolism-associated hospital admissions

Numerator: NMDS: All hospital admissions where the patient received a general anaesthetic (ACHI Procedure Code 92514-XX) or neuraxial block (ACHI Procedure Code 92508-XX) AND where 1) a pulmonary embolus (ICD-10-AM I26.0, I26.8, I26.9) 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.
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.

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

Pulmonary embolism-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 embolism-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 embolism-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

In a small number of cases (n=10), 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 embolism-associated admission rates). Similarly, only deaths occurring within 30 days of the first anaesthetic date of the index admission were included, even if later anaesthetics 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).

Acute, arranged (semi-acute) and waiting list admissions: The NMDS defines an acute admission as an unplanned admission occurring on the day of presentation, while an arranged admission is a non-acute admission with an admission date less than seven days after the date the decision was made by the specialist that the admission was necessary. Similarly, waiting list admissions arise when the planned admission date is seven or more days after the date the decision was made that the admission was necessary. These definitions are inconsistently used by private hospitals uploading their data to the NMDS, however, with a significant proportion of private hospital admissions being coded as arranged when in reality they meet the criteria for a waiting list admission outlined above. As a result, in the sections that follow, all arranged private hospital cases have been included in the elective category, while arranged admissions occurring in public hospitals have been included in the public hospital semi-acute admission category. Thus, unless otherwise specified, acute and elective admissions include both public and private cases, while semi-acute admissions are confined to public hospital cases only.

Privately funded 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 are publicly funded maternity events. 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 are privately funded or ACC-funded events or publicly funded long-stay geriatric cases. Thus, in the section that follows, it must be remembered that the data presented are likely to undercount some private hospital events, with the magnitude of this undercount being difficult to quantify (although it is assumed to be significant).

Pulmonary embolus-associated and attributed mortality

Pulmonary embolus-associated mortality by admission type and cause of death

In New Zealand during 2006–2010, falls, malignant/other neoplasms and myocardial infarction/other ischaemic heart disease were the most frequently listed main underlying causes of death in those meeting the criteria for a pulmonary embolus-associated death (ie, death within 30 days of the first anaesthetic of a pulmonary embolus-associated admission) who were admitted acutely. Similarly, malignant/other neoplasms were the most frequently listed main underlying causes of death in those admitted electively/from the waiting list who met the criteria for a pulmonary embolus-associated death (Table 19).

Table 19. Pulmonary Embolus-Associated Mortality by Main Underlying Cause of Death and Admission Type, New Zealand 2006–2010

MAIN UNDERLYING CAUSE OF DEATH	Total Deaths 2006–2010	Annual Average	Percent of Deaths in Category (%)
Pulmonary Embolus-Associated Mortality			
Acute			
Falls	52	10.4	31.5
Other Injuries/External Causes	5	1.0	3.0
Malignant/Other Neoplasms	37	7.4	22.4
Myocardial Infarction/Other Ischaemic Heart Disease	19	3.8	11.5
Pulmonary Embolism	7	1.4	4.2
Other Cardiovascular Causes	13	2.6	7.9
Gastrointestinal Diseases	14	2.8	8.5
Respiratory Diseases	5	1.0	3.0
Other Causes	13	2.6	7.9
Total Acute	165	33.0	100.0
Public Hospital Semi-Acute			
Malignant/Other Neoplasms	5	1.0	38.5
Pulmonary Embolism	<3	s	s
Other Causes	7	1.4	53.8
Total Public Hospital Semi-Acute	13	2.6	100.0
Elective			
Malignant/Other Neoplasms	31	6.2	49.2
Myocardial Infarction/Other Ischaemic Heart Disease	4	0.8	6.3
Other Cardiovascular Causes	9	1.8	14.3
Other Causes	19	3.8	30.2
Total Elective	63	12.6	100.0

Data source: NMC: Pulmonary embolus-associated deaths within 30 days of first anaesthetic of index admission.
s Rates suppressed due to small numbers.

Pulmonary embolus-attributed mortality by admission type and cause of death

During 2006–2010, falls and malignant neoplasms were the most frequently listed main underlying causes of death in those admitted acutely who met the criteria for a pulmonary embolus-attributed death (ie, death within 30 days of a general anaesthetic or neuraxial block and where a pulmonary embolus was listed as the main underlying cause or as a contributory cause of death in the NMC). Malignant neoplasms and cardiovascular causes (other than pulmonary emboli) were the most frequently listed main underlying causes of death in those admitted electively/from the waiting list who met the criteria for a pulmonary embolus-attributed death (Table 20).

Table 20. Pulmonary Embolus-Attributed Mortality by Main Underlying Cause of Death and Admission Type, New Zealand 2006–2010

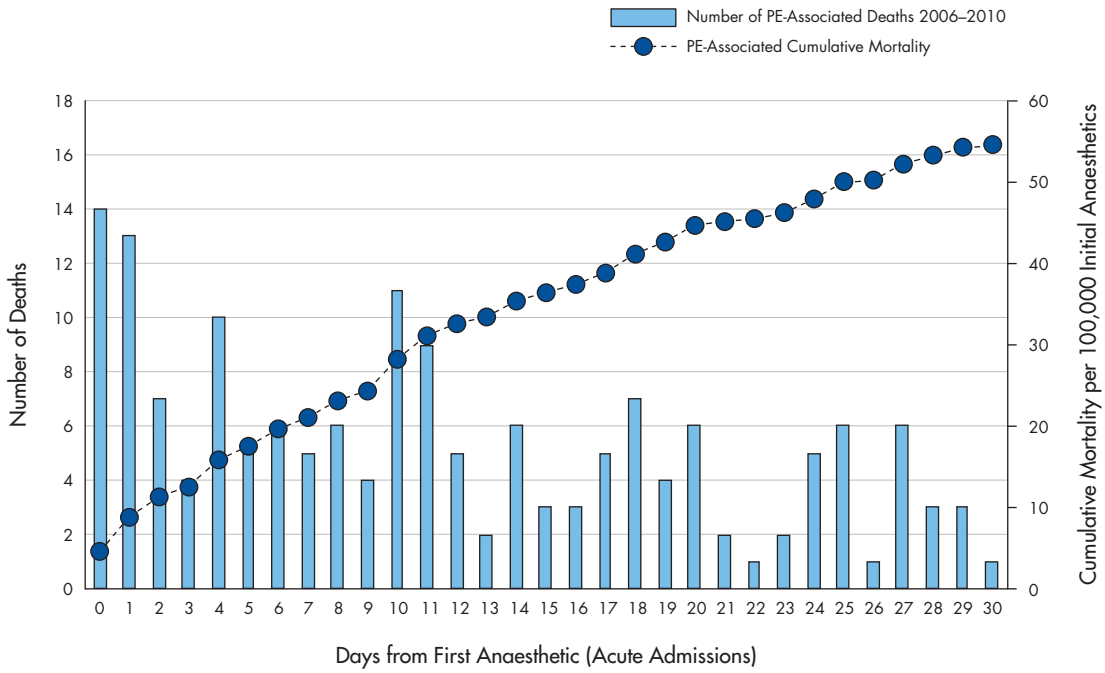
MAIN UNDERLYING CAUSE OF DEATH	Total Deaths 2006–2010	Annual Average	Percent of Deaths in Category (%)
Pulmonary Embolus-Attributed Mortality			
Acute			
Falls	15	3.0	33.3
Malignant/Other Neoplasms	12	2.4	26.7
Pulmonary Embolism	7	1.4	15.6
Other Causes	11	2.2	24.4
Total Acute	45	9.0	100.0
Public Hospital Semi-Acute			
All Causes	2	0.4	100.0
Total Public Hospital Semi-Acute	2	0.4	100.0
Elective			
Malignant/Other Neoplasms	11	2.2	47.8
Cardiovascular Causes	4	0.8	17.4
Other Causes	8	1.6	34.8
Total Elective	23	4.6	100.0

Data source: NMC: Pulmonary embolus-attributed deaths within 30 days of first anaesthetic of index admission.

Mortality by day from first anaesthetic

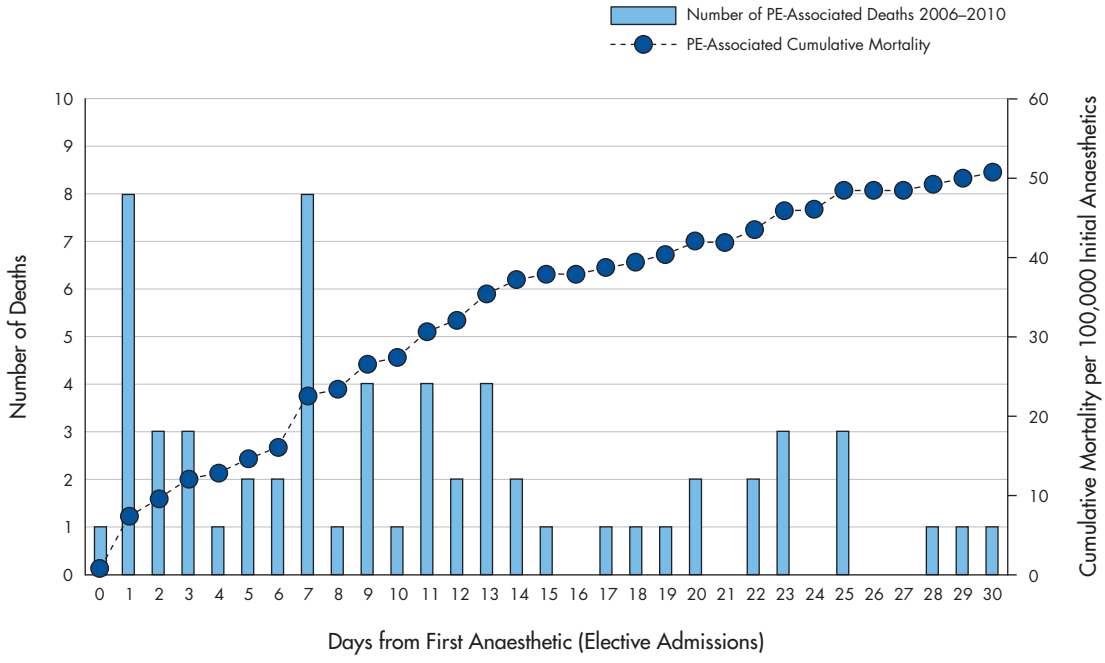
Pulmonary embolus-associated mortality in those admitted acutely during 2006–2010 was highest on the same day or the day immediately after a general anaesthetic or neuraxial block. A number of deaths, however, occurred each day up until 30 days after the initial anaesthetic, with small spikes also occurring on days 4, 10 and 11 (Figure 24). Mortality following elective admissions associated with a pulmonary embolus was highest during the first two weeks, with spikes occurring on days one and seven (Figure 25). Cumulative 30-day mortality was higher for acute admissions (54.5 per 100,000 initial anaesthetics, or 0.05%) than for elective admissions (7.6 per 100,000 initial anaesthetics, or 0.008%).

Figure 24. Pulmonary Embolus-Associated Mortality in Acute Admissions by Day from First Anaesthetic, New Zealand 2006–2010



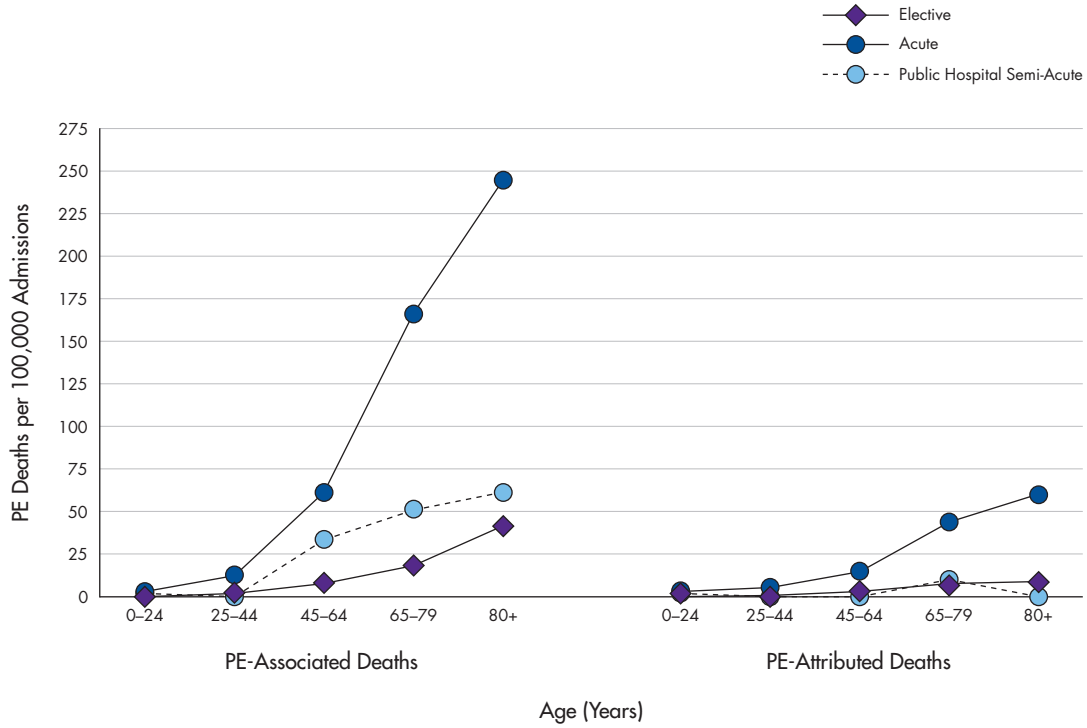
Numerator: NMC: Pulmonary embolus-associated deaths within 30 days of first anaesthetic of an acute index admission.
Denominator: NMDS: All acute admissions with a general anaesthetic or neuraxial block.

Figure 25. Pulmonary Embolus-Associated Mortality in Elective Admissions by Day from First Anaesthetic, New Zealand 2006–2010



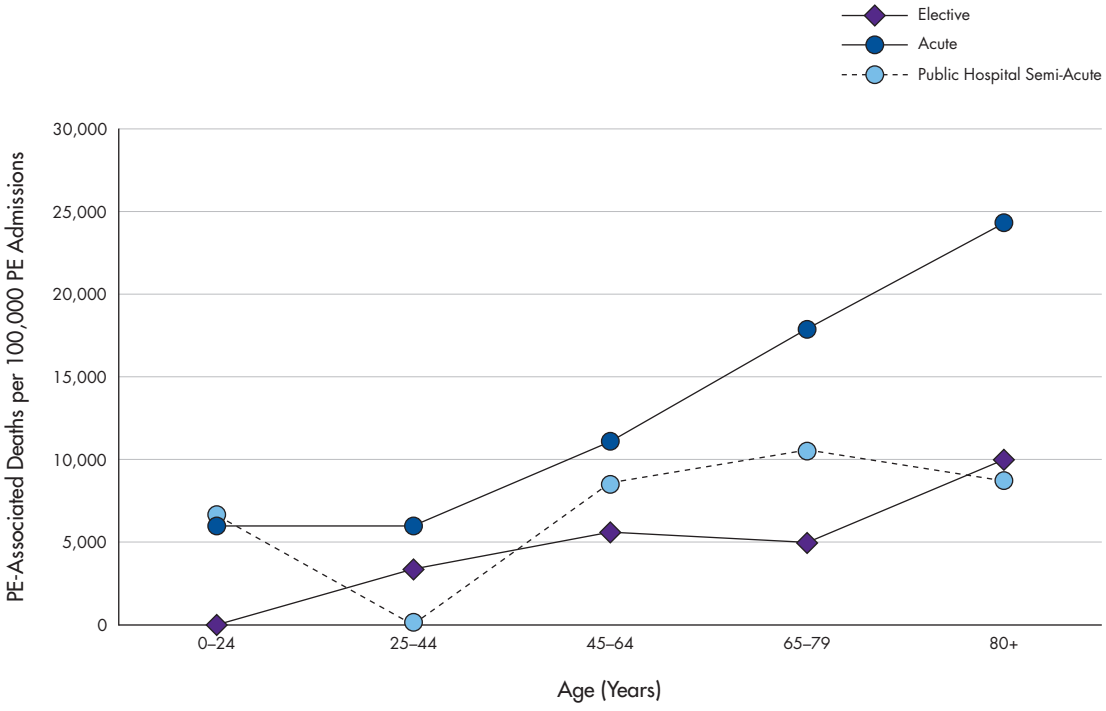
Numerator: NMC: Pulmonary embolus-associated deaths within 30 days of first anaesthetic of an elective index admission.
Denominator: NMDS: All elective admissions with a general anaesthetic or neuraxial block.

Figure 26. Pulmonary Embolus-Associated and Attributed Mortality by Age and Admission Type, New Zealand 2006–2010



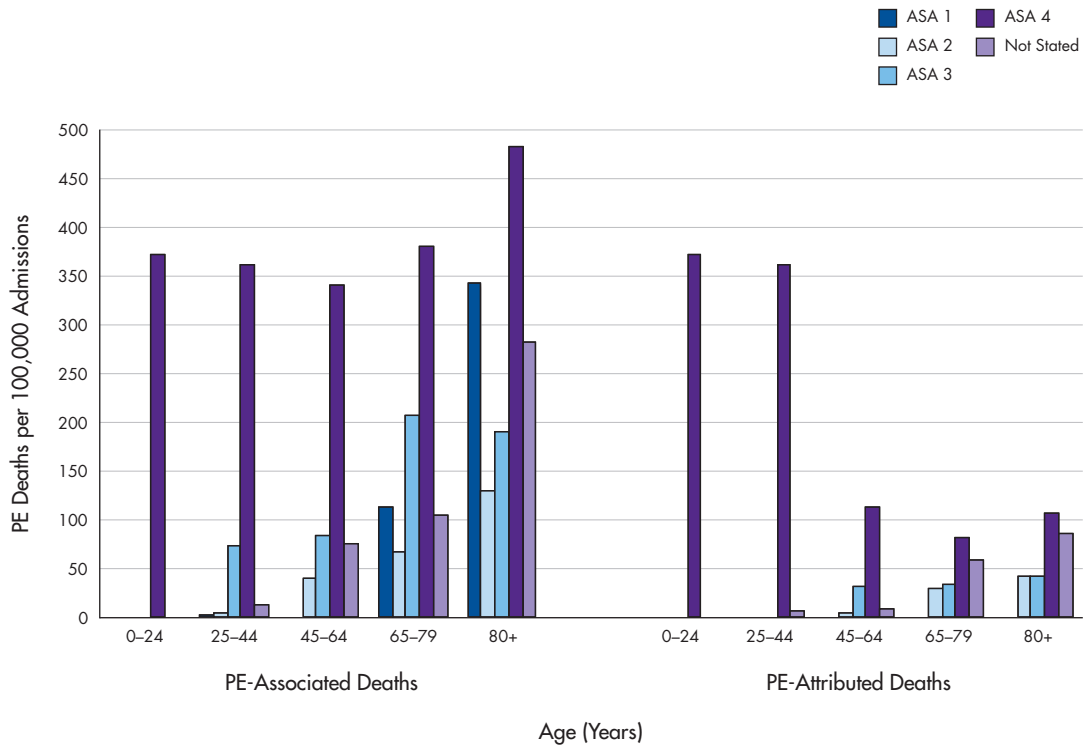
Numerator: NMC: Pulmonary embolus-associated and attributed deaths within 30 days of first anaesthetic of index admission.
Denominator: NMDS: All admissions with a general anaesthetic or neuraxial block.

Figure 27. Thirty-Day Mortality in Pulmonary Embolus-Associated Admissions by Age and Admission Type, New Zealand 2006–2010



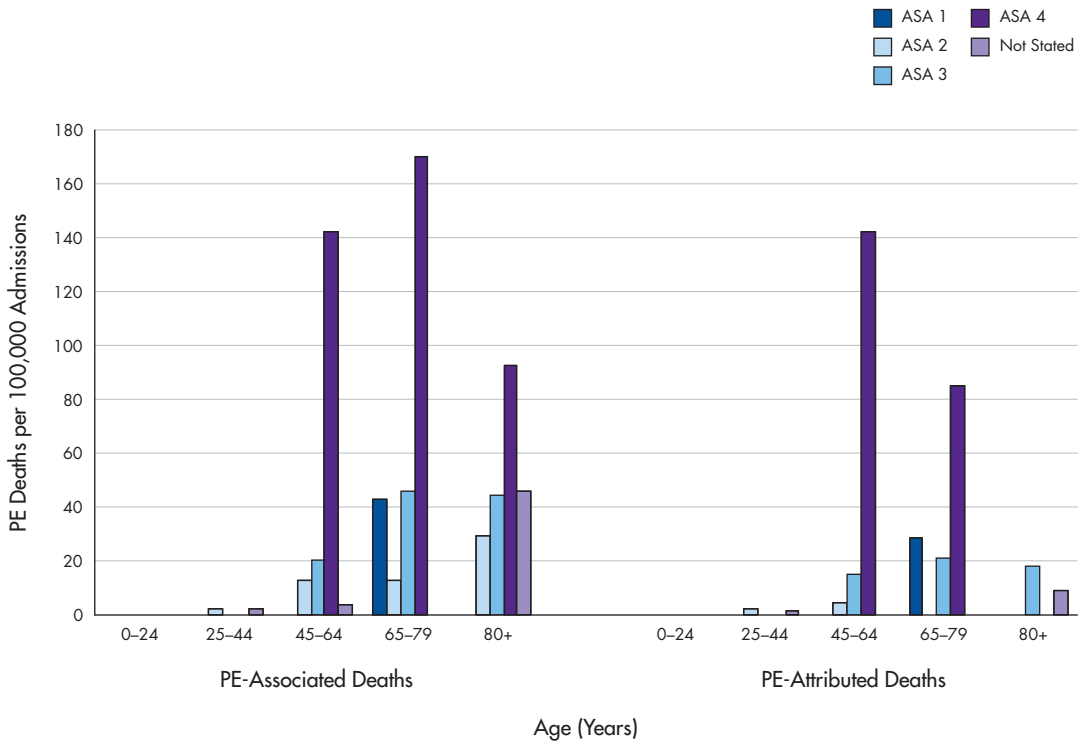
Numerator: NMC: Pulmonary embolus-associated deaths within 30 days of first anaesthetic of index admission.
Denominator: NMDS: All pulmonary embolus-associated hospital admissions.

Figure 28. Pulmonary Embolus-Associated and Attributed Mortality in Acute Admissions by Age and ASA Score, New Zealand 2006–2010



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

Figure 29. Pulmonary Embolus-Associated and Attributed Mortality in Elective Admissions by Age and ASA Score, New Zealand 2006–2010



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

Mortality by age

Pulmonary embolus-associated mortality during 2006–2010 was relatively infrequent in those aged under 25 years, but rose rapidly thereafter, with the highest rates being seen in those aged 80+ years. Within most age groups, mortality was higher for acute, which was higher than for public hospital semi-acute, which was higher than for elective admissions. Similarly, pulmonary embolus-attributed mortality increased with increasing age for acute and elective admissions, although patterns for public hospital semi-acute admissions were less consistent (possibly as a result of small numbers) (Figure 26).

When the analysis was confined only to those with a pulmonary embolus-associated admission, 30-day mortality rates were much higher than when all admissions with a general anaesthetic or neuraxial block were included in the denominator. Thus for those aged 80+ years who were admitted acutely and who experienced a pulmonary embolus, mortality rates were 24.3% (Figure 27).

Mortality by age, admission type and ASA score

Pulmonary embolus-associated and attributed mortality during 2006–2010 was infrequent in those aged under 45 years, with the vast majority of deaths occurring in those who were admitted acutely and who had an ASA score of 4. Amongst older age groups, while mortality was again higher for those with an ASA score of 4, differences between those with ASA scores of 1, 2 and 3 were less consistent, with the clear stepwise increase in risk with increasing ASA score seen for pulmonary embolus-associated admissions not being evident for mortality (possibly as a result of small numbers). Within each ASA score category, mortality rates were generally (although not always) higher for acute than for elective admissions (Figures 28 and 29).

Mortality by sociodemographic and clinical factors

Pulmonary embolus-associated mortality: During 2006–2010, pulmonary embolus-associated mortality rates were *significantly* higher for those admitted acutely (vs. elective admissions), those aged 25 years and over (vs. 0–24 years) and those with ASA scores of 3, 4 or 5 (vs. ASA score 1–2). These differences persisted, even when the risk was adjusted for other sociodemographic (age, gender, ethnicity, NZDep deprivation) and clinical (ASA score, admission type) factors. While at the univariate level, mortality was *significantly* lower for Māori, Pacific and Asian/MELAA/Other peoples (vs. European peoples), these differences did not remain statistically significant in the multivariate model. No significant differences were evident by NZ Deprivation Index decile (Table 21). When the analysis was confined to only those with a pulmonary embolus-associated admission, mortality was *significantly* higher for those admitted acutely (vs. elective admissions), those aged 80+ years (vs. 0–24 years), those with an ASA score of 3,4 or 5 and those from the most deprived (NZDep decile 9–10 vs. decile 1–2) areas (Table 22).

Pulmonary embolus-attributed mortality: In New Zealand during 2006–2010, pulmonary embolus-attributed mortality rates were *significantly* higher for those admitted acutely (vs. elective admissions), those aged 45 years and over (vs. 0–24 years) and those with ASA scores of 3 or 4 (vs. ASA score 1–2). These differences persisted, even when the risk was adjusted for other sociodemographic (age, gender, ethnicity, NZDep deprivation) and clinical (ASA score, admission type) factors. While at the univariate level, mortality was *significantly* lower for Māori (vs. European peoples), these differences did not remain statistically significant in the multivariate model. No consistent socioeconomic gradients were evident by NZ Deprivation Index decile (Table 23).

Table 21. Pulmonary Embolus-Associated Mortality by Admission Type, Age Group, Gender, First ASA Score, Ethnicity and NZ Deprivation Index Decile, New Zealand 2006–2010

VARIABLE	CATEGORY	No. PE-Associated Deaths	No. Admissions with GA or Neuraxial Block	Rate per 100,000 Admissions	Rate per 100 Admissions (%)	Univariate OR	95% CI	Multivariate OR	95% CI
Pulmonary Embolus-Associated Mortality									
Admission Type	Elective	63	826,466	7.6	0.01	1.00		1.00	
	Public Hospital Semi-Acute	13	129,669	10.0	0.01	1.32	0.72–2.39	*1.85	1.01–3.40
	Acute	165	302,849	54.5	0.05	*7.15	5.35–9.56	*5.50	4.00–7.55
Age Group	0–24 Years	4	374,061	1.1	0.00	1.00		1.00	
	25–44 Years	13	322,920	4.0	0.00	*3.77	1.23–11.55	*3.72	1.21–11.43
	45–64 Years	59	317,419	18.6	0.02	*17.39	6.32–47.86	*16.13	5.81–44.81
	65–79 Years	88	182,358	48.3	0.05	*45.15	16.58–122.98	*30.50	10.97–84.80
	80+ Years	77	62,277	123.6	0.12	*115.77	42.37–316.31	*38.00	13.43–107.49
Gender	Female	129	679,129	19.0	0.02	1.00		1.00	
	Male	112	579,903	19.3	0.02	1.02	0.79–1.31	0.93	0.72–1.20
First ASA Score	1 or 2	51	646,388	7.9	0.01	1.00		1.00	
	3	83	122,557	67.7	0.07	*8.59	6.06–12.17	*2.71	1.86–3.95
	4	56	20,454	273.8	0.27	*34.80	23.81–50.86	*6.99	4.61–10.62
	5	5	742	673.9	0.67	*85.98	34.22–216.03	*14.26	5.57–36.49
	Not Stated	46	468,797	9.8	0.01	1.24	0.84–1.85	1.31	0.87–1.98
Ethnicity	European	207	887,287	23.3	0.02	1.00		1.00	
	Māori	15	172,174	8.7	0.01	*0.37	0.22–0.63	0.63	0.37–1.10
	Pacific	7	71,147	9.8	0.01	*0.42	0.20–0.90	0.65	0.30–1.42
	Asian/ MELAA/ Other	9	83,607	10.8	0.01	*0.46	0.24–0.90	0.76	0.39–1.49
NZ Deprivation Index Decile	Decile 1–2	34	213,744	15.9	0.02	1.00		1.00	
	Decile 3–4	39	224,076	17.4	0.02	1.09	0.69–1.73	1.06	0.67–1.69
	Decile 5–6	45	253,415	17.8	0.02	1.12	0.72–1.74	1.00	0.64–1.57
	Decile 7–8	60	281,251	21.3	0.02	1.34	0.88–2.04	1.17	0.76–1.79
	Decile 9–10	62	280,029	22.1	0.02	1.39	0.92–2.12	1.45	0.94–2.24

Numerator: NMC: Pulmonary embolus-associated deaths within 30 days of first anaesthetic of index admissions.
Denominator: NMDS: All admissions with a general anaesthetic or neuraxial block.
* Significantly different from reference category.

Table 22. Pulmonary Embolus-Associated Mortality in Pulmonary Embolus-Associated Admissions by Admission Type, Age Group, Gender, First ASA Score, Ethnicity and NZ Deprivation Index Decile, New Zealand 2006–2010

VARIABLE	CATEGORY	No. PE-Associated Deaths	No. PE-Associated Admissions	Rate per 100,000 PE Admissions	Rate per 100 PE-Admissions (%)	Univariate OR	95% CI	Multivariate OR	95% CI
Pulmonary Embolus-Associated Mortality in PE-Associated Admissions									
Admission Type	Elective	63	1,116	5,645.2	5.65	1.00		1.00	
	Public Hospital Semi-Acute	13	171	7,602.3	7.60	1.41	0.76–2.62	1.22	0.64–2.32
	Acute	165	1,092	15,109.9	15.11	*2.98	2.20–4.04	*2.35	1.69–3.27
Age Group	0–24 Years	4	76	5,263.2	5.26	1.00		1.00	
	25–44 Years	13	284	4,577.46	4.58	0.87	0.27–2.74	1.16	0.36–3.77
	45–64 Years	59	718	8,217.3	8.22	1.62	0.57–4.60	2.25	0.76–6.64
	65–79 Years	88	886	9,932.3	9.93	2.00	0.71–5.59	*2.99	1.01–8.86
	80+ Years	77	415	18,554.2	18.55	*4.11	1.46–11.60	*4.58	1.52–13.78
Gender	Female	129	1,252	10,303.5	10.30	1.00		1.00	
	Male	112	1,127	9,937.9	9.94	0.96	0.73–1.25	1.02	0.77–1.36
ASA Score	1 or 2	51	854	5,971.9	5.97	1.00		1.00	
	3	83	660	12,575.8	12.58	*2.26	1.57–3.26	*1.52	1.04–2.24
	4	56	231	24,242.4	24.24	H	H	H	H
	5	5	8	62,500.0	62.50	H	H	H	H
	Not Stated	46	626	7,348.2	7.35	1.25	0.83–1.89	1.08	0.71–1.66
Ethnicity	European	207	1,989	10,407.2	10.41	1.00		1.00	
	Māori	15	189	7,936.5	7.94	0.75	0.43–1.29	0.88	0.48–1.60
	Pacific	7	63	11,111.1	11.11	1.07	0.48–2.38	1.23	0.52–2.88
	Asian/ MELAA/ Other	9	80	11,250.0	11.25	1.09	0.54–2.21	1.22	0.56–2.67
NZ Deprivation Index Decile	Decile 1–2	34	383	8,877.3	8.88	1.00		1.00	
	Decile 3–4	39	464	8,405.2	8.41	0.94	0.58–1.53	0.93	0.56–1.53
	Decile 5–6	45	484	9,297.5	9.30	1.05	0.66–1.68	1.09	0.67–1.78
	Decile 7–8	60	588	10,204.1	10.20	1.17	0.75–1.81	1.19	0.75–1.89
	Decile 9–10	62	445	13,932.6	13.93	*1.68	1.08–2.61	*1.75	1.08–2.84

Numerator: NMC: Pulmonary embolus-associated deaths within 30 days of first anaesthetic of index admissions.
Denominator: NMDS: All pulmonary embolus-associated admissions.
H Odds ratios supressed due to high mortality rates.
Caution should also be observed when interpreting ORs where mortality exceeds 10% (see **Appendix 3** for details).
* Significantly different from reference category.

Table 23. Pulmonary Embolus-Attributed Mortality by Admission Type, Age Group, Gender, First ASA Score, Ethnicity and NZ Deprivation Index Decile, New Zealand 2006–2010

VARIABLE	CATEGORY	No. PE-Attributed Deaths	No. Admissions with GA or Neuraxial Block	Rate per 100,000 Admissions	Rate per 100 Admissions (%)	Univariate OR	95% CI	Multivariate OR	95% CI
Pulmonary Embolus-Attributed Mortality									
Admission Type	Elective	23	826,466	2.8	0.00	1.00		1.00	
	Public Hospital Semi-Acute	<3	s	s	s	s	s	s	s
	Acute	45	302,849	14.9	0.01	*5.34	3.23–8.83	*3.65	2.10–6.34
Age Group	0–24 Years	4	374,061	1.1	0.00	1.00		1.00	
	25–44 Years	6	322,920	1.9	0.00	1.74	0.49–6.16	1.69	0.47–6.01
	45–64 Years	16	317,419	5.0	0.01	*4.71	1.58–14.10	*3.59	1.18–10.99
	65–79 Years	26	182,358	14.3	0.01	*13.33	4.65–38.20	*6.11	2.00–18.66
	80+ Years	18	62,277	28.9	0.03	*27.03	9.15–79.87	*5.76	1.77–18.79
Gender	Female	38	679,129	5.6	0.01	1.00		1.00	
	Male	32	579,903	5.5	0.01	0.99	0.62–1.58	0.86	0.54–1.39
First ASA Score	1 or 2	14	646,388	2.2	0.00	1.00		1.00	
	3	23	122,557	18.8	0.02	*8.67	4.46–16.84	*4.01	1.94–8.28
	4	20	20,454	97.8	0.10	*45.19	22.82–89.48	*15.23	7.04–32.94
	5	<3	s	s	s	s	s	s	s
	Not Stated	12	468,797	2.6	0.00	1.18	0.55–2.56	1.36	0.62–2.97
Ethnicity	European	61	887,287	6.9	0.01	1.00		1.00	
	Māori	4	172,174	2.3	0.00	*0.34	0.12–0.93	0.47	0.16–1.34
	Pacific	<3	s	s	s	s	s	s	s
	Asian / MELAA / Other	3	83,607	3.6	0.00	0.52	0.16–1.66	0.78	0.24–2.50
NZ Deprivation Index Decile	Decile 1–2	6	213,744	2.8	0.00	1.00		1.00	
	Decile 3–4	17	224,076	7.6	0.01	*2.70	1.07–6.85	*2.56	1.01–6.48
	Decile 5–6	14	253,415	5.5	0.01	1.97	0.76–5.12	1.73	0.66–4.51
	Decile 7–8	16	281,251	5.7	0.01	2.03	0.79–5.18	1.76	0.69–4.50
	Decile 9–10	17	280,029	6.1	0.01	2.16	0.85–5.48	2.25	0.87–5.79

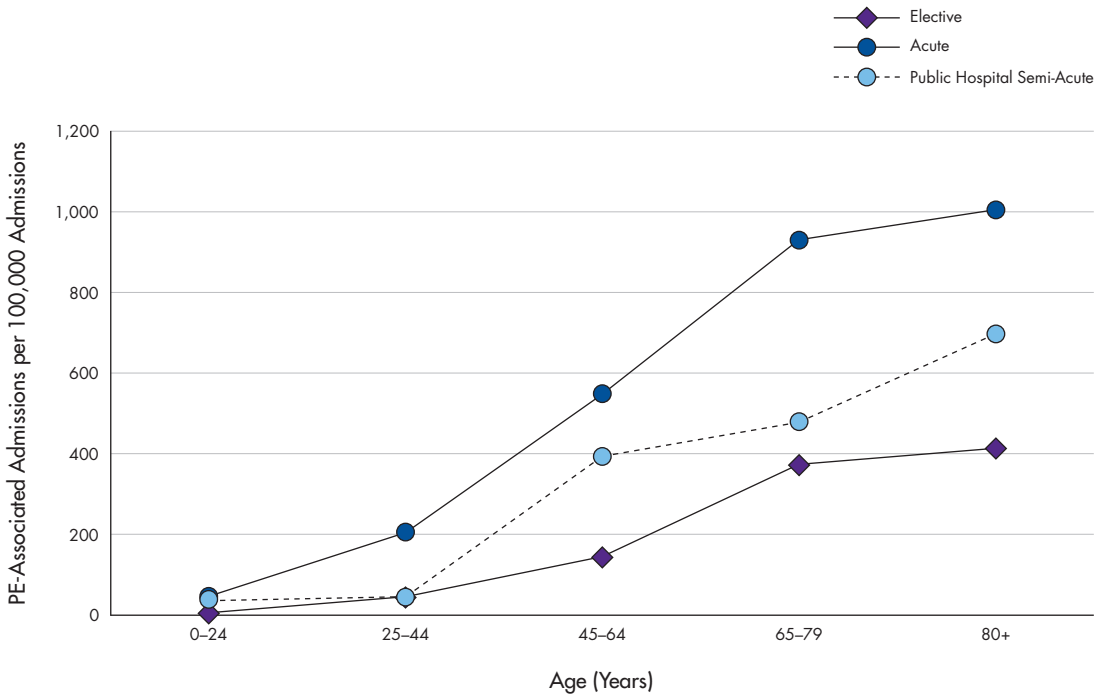
Numerator: NMC: Pulmonary embolus-attributed deaths within 30 days of first anaesthetic of index admissions.
Denominator: NMDS: All admissions with a general anaesthetic or neuraxial block.
* Significantly different from reference category.
s Rates suppressed due to small numbers.

Background: pulmonary embolus-associated hospital admissions

Admissions by age and admission type

In New Zealand during 2006–2010, pulmonary embolus-associated hospital admissions were infrequent in children and young people aged 0–24 years, but increased thereafter, with the highest rates being seen in those aged 80+ years. In each age group, pulmonary embolus-associated admission rates were higher for acute admissions than for elective admissions, with rates for public hospital semi-acute admissions being intermediate between the two (Figure 30).

Figure 30. Pulmonary Embolus-Associated Hospital Admissions by Age and Admission Type, New Zealand 2006–2010



Numerator: NMDS: All admissions meeting the criteria for a pulmonary embolus-associated admission as outlined above.
Denominator: NMDS: All admissions with a general anaesthetic or neuraxial block.

Admissions by primary procedure

During 2006–2010, repairs of fractures of the femur were the most frequently undertaken procedures to occur during acute admissions associated with pulmonary emboli, followed by hemi-arthroplasties of the femur and hip arthroplasty. Similarly, knee and hip arthroplasties were the procedures most frequently undertaken during elective admissions associated with pulmonary emboli (Table 24).

Table 24. Pulmonary Embolus-Associated Hospital Admissions by Admission Type and Primary Procedure, New Zealand 2006–2010

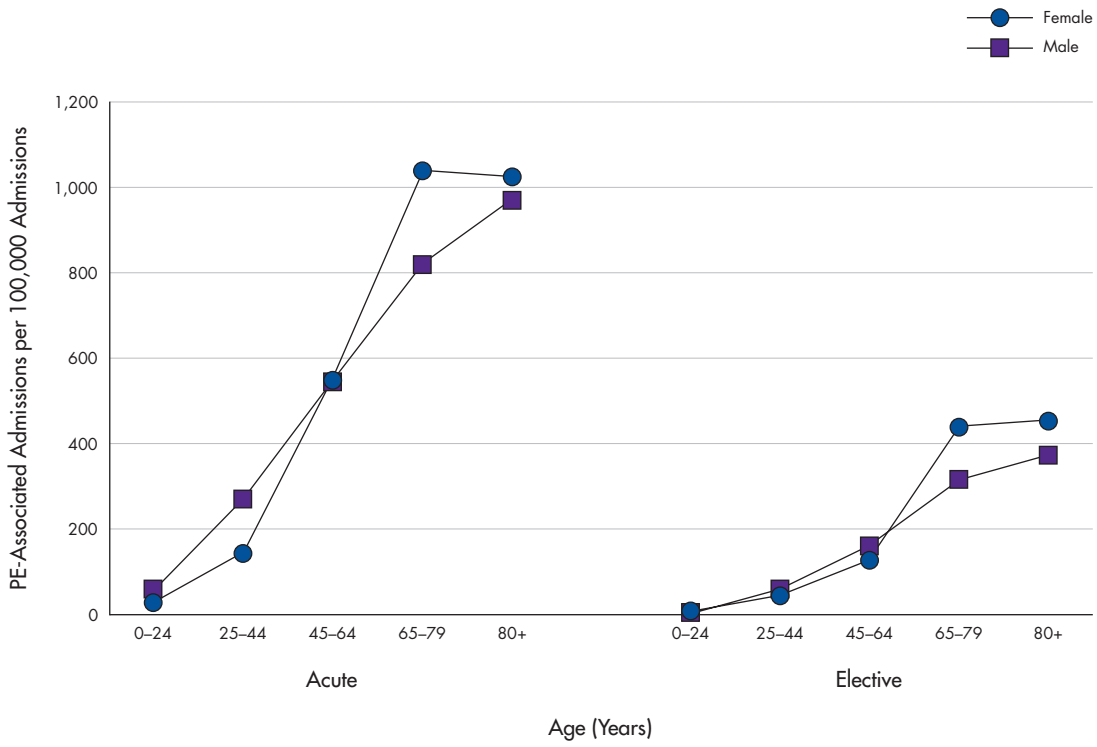
PRIMARY PROCEDURE	Total Admission Events 2006–2010	Annual Average	Percent of Admissions (%)
Pulmonary Embolus-Associated Admissions			
Acute			
Procedures on Fracture of Femur	157	31.4	14.4
Hemiarthroplasty of Femur	71	14.2	6.5
Hip Arthroplasty (Including Revisions)	37	7.4	3.4
Open Reduction of Fracture of Ankle	30	6.0	2.7
Open Reduction Fracture of Tibia	29	5.8	2.7
Closed Reduction Fracture of Tibia	14	2.8	1.3
Right Hemicolectomy	24	4.8	2.2
Resection of Small Intestine	21	4.2	1.9
Division of Abdominal Adhesions	21	4.2	1.9
Appendicectomy (Including Laparoscopic)	21	4.2	1.9
Other Procedures	667	133.4	61.1
Total Acute	1,092	218.4	100.0
Public Hospital Semi-Acute			
Insertion of Implantable Vascular Infusion Device	10	2.0	5.8
Coronary Artery Bypass	7	1.4	4.1
Procedures on Fracture of Femur	8	1.6	4.7
Hip Arthroplasty (Including Revisions)	7	1.4	4.1
Other Procedures	139	27.8	81.3
Total Public Hospital Semi-Acute	171	34.2	100.0
Elective			
Knee Arthroplasty (Including Revisions)	329	65.8	29.5
Hip Arthroplasty (Including Revisions)	153	30.6	13.7
Hysterectomy	44	8.8	3.9
Mastectomy	17	3.4	1.5
Cholecystectomy (Open and Laparoscopic)	19	3.8	1.7
Prostatectomy	16	3.2	1.4
Interruption of Sapheno-Femoral Junction Varicose Veins	14	2.8	1.3
Total Excision of Bladder	13	2.6	1.2
Other Procedures	511	102.2	45.8
Total Elective	1,116	223.2	100.0

Data source: NMDS: All admissions meeting the criteria for a pulmonary embolus-associated admission as outlined above.

Admissions by age, admission type and gender

Pulmonary embolus-associated admissions during 2006–2010 were higher for females than for males aged 65+ years, irrespective of whether they were acute or elective/drawn from the waiting list. Gender differences at younger ages, however, were less consistent (Figure 31).

Figure 31. Pulmonary Embolus-Associated Hospital Admissions by Age, Admission Type and Gender, New Zealand 2006–2010



Numerator: NMDS: All admissions meeting the criteria for a pulmonary embolus-associated admission as outlined above.
Denominator: NMDS: All admissions with a general anaesthetic or neuraxial block.
Note: Obstetric-related PE excluded.

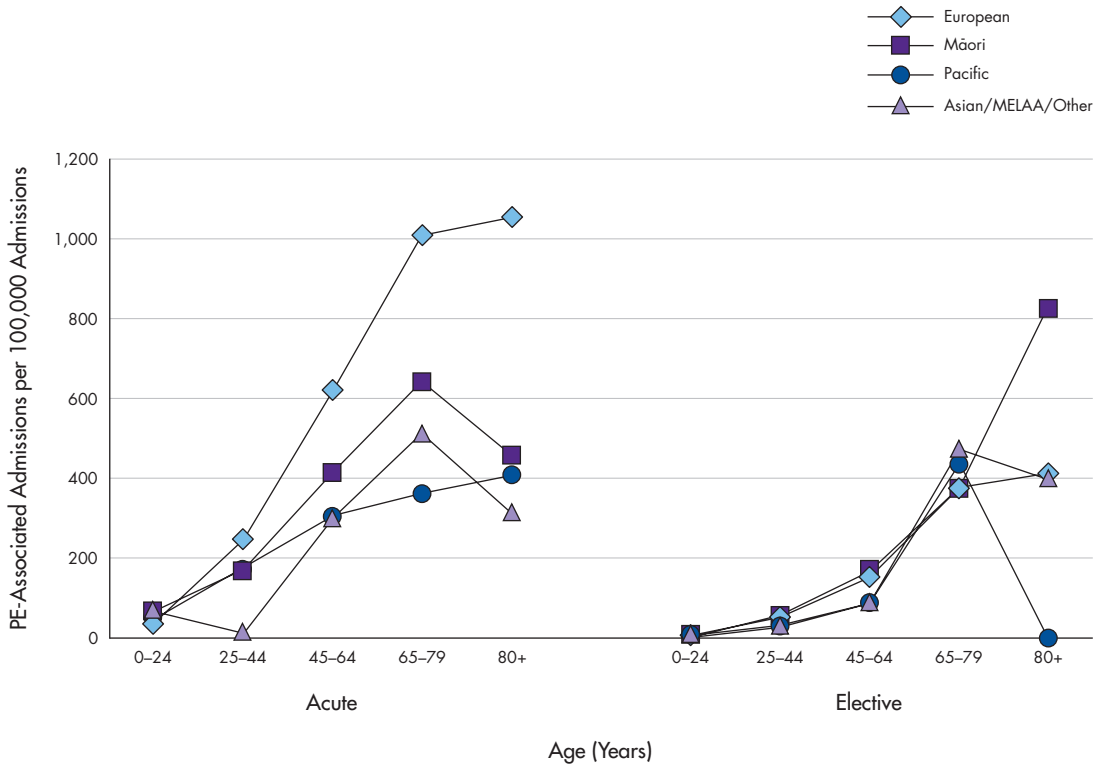
Admissions by age, admission type and ethnicity

Pulmonary embolus-associated admissions were infrequent in children and young people of all ethnic groups during 2006–2010. Amongst acute admissions, rates increased with increasing age thereafter, with European peoples having higher rates than Māori, Asian/MELAA/Other or Pacific peoples aged 25+ years. For elective admissions, however, ethnic differences were less evident. Care should be taken when interpreting admission rates for Māori, Pacific and Asian/MELAA/Other peoples aged 80+ years, however, due to the small number of cases (n<5) in each category (Figure 32).

Admissions by age, admission type and NZ Deprivation Index decile

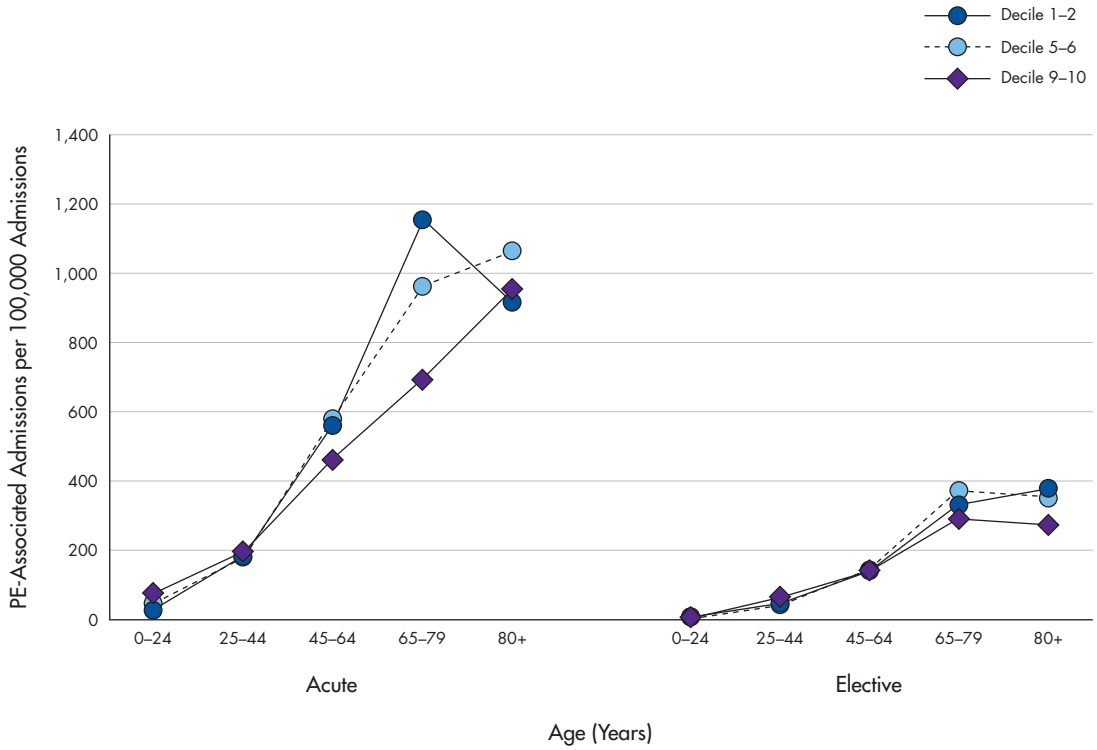
When admission rates were broken down by NZ Deprivation Index decile, there were no consistent socioeconomic gradients in acute or elective pulmonary embolus-associated admissions during 2006–2010, although rates in some age groups were lower for those from the most deprived (NZDep decile 9–10) areas (Figure 33).

Figure 32. Pulmonary Embolus-Associated Hospital Admissions by Age, Admission Type and Ethnicity, New Zealand 2006–2010



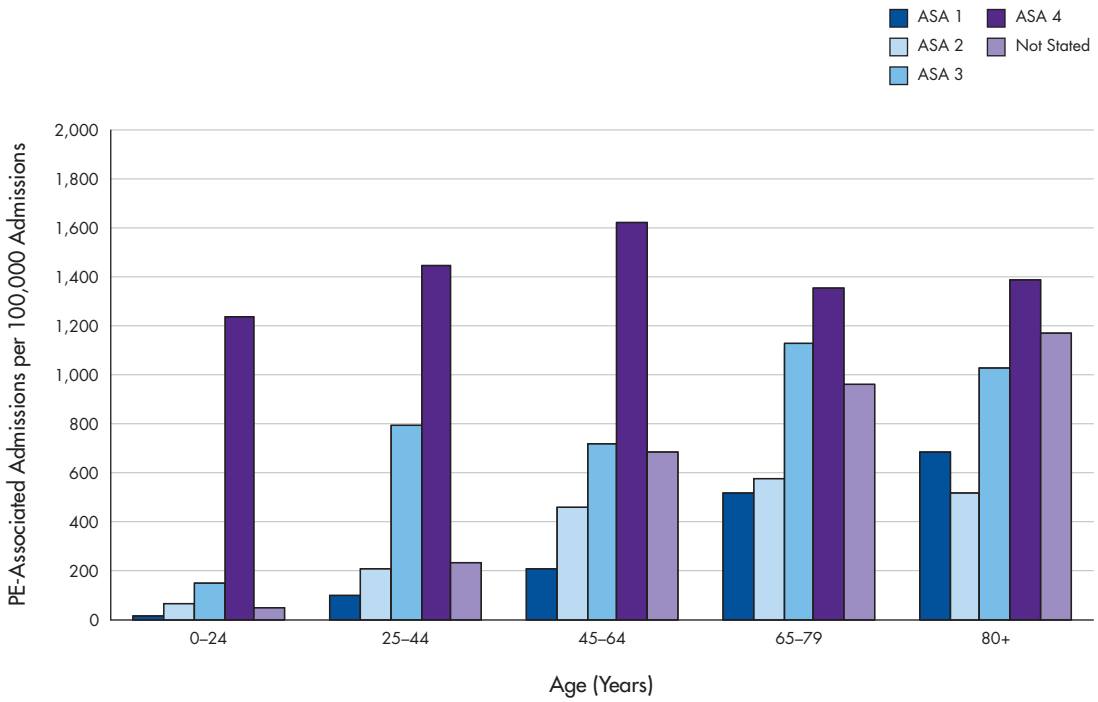
Numerator: NMDS: All admissions meeting the criteria for a pulmonary embolus-associated admission as outlined above.
Denominator: NMDS: All admissions with a general anaesthetic or neuraxial block.
Ethnicity is Level 1 Prioritised.
Care should be taken when interpreting rates for Māori, Pacific and MELAA peoples aged 80+ years due to the small number of cases (n<5) in each category.

Figure 33. Pulmonary Embolus-Associated Hospital Admissions by Age, Admission Type and NZ Deprivation Index Decile, New Zealand 2006–2010



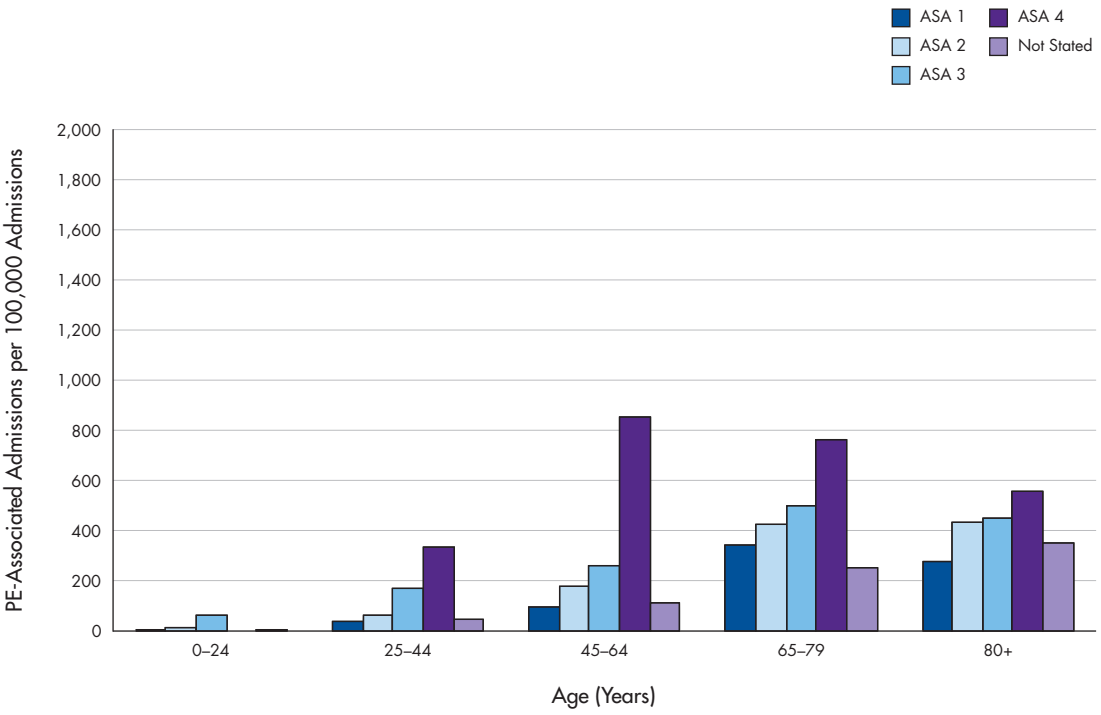
Numerator: NMDS: All admissions meeting the criteria for a pulmonary embolus-associated admission as outlined above.
Denominator: NMDS: All admissions with a general anaesthetic or neuraxial block.
Decile is NZDep01.

Figure 34. Pulmonary Embolus-Associated Acute Admissions by Age and First ASA Score, New Zealand 2006–2010



Numerator: NMDS: All acute admissions meeting the criteria for a pulmonary embolus-associated admission as outlined above.
Denominator: NMDS: All acute admissions with a general anaesthetic or neuraxial block.
ASA 5 excluded due to small numbers.

Figure 35. Pulmonary Embolus-Associated Elective Admissions by Age and First ASA Score, New Zealand 2006–2010



Numerator: NMDS: All elective admissions meeting the criteria for a pulmonary embolus-associated admission as outlined above.
Denominator: NMDS: All elective admissions with a general anaesthetic or neuraxial block.
ASA 5 excluded due to small numbers.

Admissions by age, admission type and ASA score

During 2006–2010, acute pulmonary embolus-associated admissions increased with increasing ASA score for those aged 0–24, 25–44, 45–64 and 65–79 years. For those aged 80+ years, rates were similar for those with an ASA score of 1 or 2 but then increased with increasing ASA score thereafter, with rates in all age groups being highest in those with an ASA score of 4 (small numbers precluded a valid analysis for those with an ASA score of 5) (Figure 34). With the exception of those aged 0–24 years, similar patterns were seen for elective admissions, although in each ASA category, admission rates for elective admissions were lower than for acute admissions (Figure 35).

Pulmonary embolus-associated admissions by sociodemographic and clinical factors

Pulmonary embolus-associated admissions during 2006–2010 were *significantly* higher for those admitted acutely (vs. elective admissions), those aged 25 years and over (vs. those 0–24 years) and those with ASA scores of 3, 4 or 5 (vs. ASA 1–2). These differences persisted, even when the risk was adjusted for other sociodemographic (age, gender, ethnicity, NZDep deprivation) and clinical (ASA score, admission type) factors. In contrast, admission rates were *significantly* lower for Māori, Pacific and Asian/MELAA/Other peoples (vs. European peoples), although no consistent socioeconomic gradients (as assessed by NZDep Index decile were evident) (Table 25).

Table 25. Pulmonary Embolus-Associated Hospital Admissions by Admission Type, Age Group, Gender, First ASA Score, Ethnicity and NZ Deprivation Index Decile, New Zealand 2006–2010

VARIABLE	CATEGORY	No. PE-Associated Admissions	No. Admissions with GA or Neuraxial Block	Rate per 100,000 Admissions	Rate per 100 Admissions (%)	Univariate OR	95% CI	Multivariate OR	95% CI
Pulmonary Embolus-Associated Hospital Admissions									
Admission Type	Elective	1,116	826,466	135.0	0.14	1.00		1.00	
	Public Hospital Semi-Acute	171	129,669	131.9	0.13	0.98	0.83–1.15	*1.44	1.22–1.71
	Acute	1,092	302,849	360.6	0.36	*2.68	2.46–2.91	*2.72	2.48–2.98
Age Group	0–24 Years	76	374,061	20.3	0.02	1.00		1.00	
	25–44 Years	284	322,920	87.95	0.09	*4.33	3.36–5.58	*4.28	3.31–5.54
	45–64 Years	718	317,419	226.2	0.23	*11.16	8.81–14.13	*11.48	9.01–14.63
	65–79 Years	886	182,358	485.9	0.49	*24.02	19.01–30.37	*20.66	16.19–26.37
	80+ Years	415	62,277	666.4	0.67	*33.01	25.85–42.16	*18.63	14.37–24.14
Gender	Female	1,252	679,129	184.4	0.18	1.00		1.00	
	Male	1,127	579,903	194.3	0.19	1.05	0.97–1.14	0.98	0.90–1.06
First ASA Score	1 or 2	854	646,388	132.1	0.13	1.00		1.00	
	3	660	122,557	538.5	0.54	*4.09	3.70–4.53	*1.74	1.56–1.95
	4	231	20,454	1,129.4	1.13	*8.63	7.46–9.99	*2.79	2.38–3.26
	5	8	742	1,078.2	1.08	*8.24	4.09–16.59	*2.31	1.14–4.68
	Not Stated	626	468,797	133.5	0.13	1.01	0.91–1.12	1.01	0.91–1.13
Ethnicity	European	1,989	887,287	224.2	0.22	1.00		1.00	
	Māori	189	172,174	109.8	0.11	*0.49	0.42–0.57	*0.85	0.72–0.99
	Pacific	63	71,147	88.6	0.09	*0.40	0.31–0.51	*0.65	0.50–0.84
	Asian/ MELAA/ Other	80	83,607	95.7	0.10	*0.43	0.34–0.53	*0.60	0.47–0.75
NZ Deprivation Index Decile	Decile 1–2	383	213,744	179.2	0.18	1.00		1.00	
	Decile 3–4	464	224,076	207.1	0.21	*1.16	1.01–1.32	1.12	0.98–1.29
	Decile 5–6	484	253,415	191.0	0.19	1.07	0.93–1.22	0.99	0.87–1.14
	Decile 7–8	588	281,251	209.1	0.21	*1.17	1.03–1.33	1.08	0.95–1.23
	Decile 9–10	445	280,029	158.9	0.16	0.89	0.77–1.02	0.95	0.83–1.10

Numerator: NMDS: All admissions meeting the criteria for a pulmonary embolus-associated admission as outlined above.
Denominator: NMDS: All admissions with a general anaesthetic or neuraxial block.
* Significantly different from reference category.

Perioperative Mortality Review in New Zealand and International Comparisons

Comparing New Zealand data

It can be difficult to compare the New Zealand perioperative data with those of other countries. Many studies use different reporting times (for example, 24–48 hours, 7 days, 30 days), specific surgical cohorts (for example, vascular, cardiac, transplant), limited hospital participation or variable reporting periods. In addition, causes of deaths are measured from death certificates, ICD-9 or ICD-10 codes or other non-standardised sources. Reporting processes are varied within contributing states, provinces or regions. Finally, data are reported in different ways, with some studies using population-based indices whilst others report as procedural incidences. As such, there are few, if any, national, ongoing, perioperative mortality studies that include elective and emergent data that can be easily compared with the New Zealand data. This has been highlighted in recent publications, but as yet, no international consensus has been agreed upon on which to make reporting terms consistent and hence comparable.

The present lack of consistency in perioperative mortality coding, reporting and publishing significantly limits comparison between the New Zealand data and other international sources. The New Zealand perioperative mortality reporting system, however, is unique in being prospective, ongoing, covering the vast majority of New Zealand hospitals and covering both elective and emergent surgical procedures.

A meta-analysis of 87 studies involving over 21 million procedures internationally evaluated anaesthetic-related mortality, perioperative mortality and cardiac arrest as outcomes (Bainbridge et al 2012). The investigators also identified high and low-income countries and compared mortality rates between these two groups. There were considerable differences between reductions in mortality in high-income versus low-income countries over time. Anaesthesia-related mortality reduced over time from 357 deaths per million before the 1970s to 34 per million in the 1990s–2000s. Total perioperative mortality in the same two periods dropped from 10,603 to 1176 deaths per million population. Importantly, baseline ASA risk has also increased over the decades despite a drop in mortality rate. However, whilst there has been a significant reduction in perioperative mortality in developed countries, the reduction in developing countries has been considerably less impressive.

In the ongoing prospective case review of Australian anaesthesia-related mortality, the three contributing states (New South Wales, Western Australia and Victoria) demonstrated a rate of three deaths per million population solely attributable to anaesthetic causes (Gibbs 2009). In comparison, a French study over a 12-month period in 1999 identified seven deaths per million totally related to anaesthesia (Lienhart et al 2006).

A United States study of all perioperative deaths attributable to anaesthesia using specific ICD-10 codes over a six-year period demonstrated an annual mortality rate of 10 per million population (Yu 2011). This equates to anaesthesia being causal in the perioperative deaths in 34 patients and being contributory in a further 281 deaths per year in the United States. A Japanese study of 2,363,038 patients over a five-year period using voluntary reporting gave an overall perioperative mortality rate of 718 deaths per million procedures and 21 deaths per million procedures totally attributable to anaesthesia (Kawashima et al 2003). A Brazilian review of both international and Brazilian perioperative and anaesthetic mortality data reconfirmed the huge variability in rates. The international data showed anaesthetic-related mortality to range from 10 per million to 570 per million procedures with Brazilian anaesthetic-related mortality ranging from 12–228 deaths per million anaesthetics. The perioperative mortality rates for international and Brazilian studies ranged from 2820–141 and 5100–1900 deaths per million anaesthetics respectively (Braz et al 2009). Many of these studies were from single centres. Other countries have produced similar mortality rates from much smaller surgical or anaesthetic populations.

Cholecystectomy

Reports describing the national experience of postoperative mortality following cholecystectomy are rare. In the United States, the National Surgical Quality Improvement Program (NSQIP) has led the way by documenting mortality rates for a range of procedures, including cholecystectomy, that includes 30-day mortality rates based on inpatient as well as post-discharge deaths occurring within the time period (Yu et al 2011). The NSQIP data from 2005 to 2008 suggest that cholecystectomy is associated with low mortality in the United States – approximately 0.53%.The mortality rate in New Zealand associated with cholecystectomy is similar (also approximately 0.4% of all procedures) to the United States. Consistently, mortality in both countries is also higher among those patients who undergo emergency cholecystectomy procedures, and a significant proportion of cholecystectomy deaths occur post discharge (Ingraham et al 2010). In common with the United States, most patients in New Zealand (approximately 87%) undergo a laparoscopic procedure, and these patients are much less likely to die compared with those patients who receive an open procedure. Also, the highest mortality in both the United States and New Zealand rate is among those patients who undergo emergency cholecystectomy procedures. Fatalities occur among 6% of these patients in the United States and approximately 5% in New Zealand.

ASA score

The American Society of Anesthesiologists (ASA) physical status classification system was developed in 1941 (Saklad 1941) to provide a concise summary of a patient's preoperative medical status and to help predict which patients would have an increased mortality or serious morbidity following a major surgical procedure (Wolters et al 1996). Few studies have specifically focused on the mortality associated with admissions with an ASA score of 1 or 2. Patients with these scores would be expected to be in good general health at the time the score was made and therefore likely to survive the following 30 days after an anaesthetic and a procedure. Bainbridge et al (2012) estimated the mortality for patients with ASA grade 1 or 2 in their meta-analysis of studies where this information had been reported by authors usually in addition to the experience of patients with ASA grades 3–5. Their estimate for the mortality associated with ASA grades 1 and 2 was 557 (95% CI: 458–678) and 1408 (1254–1582) per million. They noted that the mortality rate successively increased with each grade of ASA score such that the death rate for patients with ASA grade 5 was 273,534 (253,688–294,320) per million. The finding of a mortality rate of 688 per million for patients with an ASA score of 1 or 2 in New Zealand is broadly consistent with this meta-analysis result, although it should be noted that the New Zealand data were restricted to elective patients and excluded urgent or acute cases for whom the risk of death may be higher. Despite overseas concerns about the inter-rater reliability of the assignment of the tool by different anaesthetists (Aronson et al 2003), the score has been shown to be an important predictor of mortality for surgical patients in New Zealand (Hooper et al 2012). A number of probability models have been developed to describe the risk of death related to a surgical procedure and anaesthetic. These models have generally highlighted the importance of the ASA score as the major determinant of postoperative mortality risk (Glance et al 2012). Using these models, patients with ASA scores of 1 or 2 are associated with a low risk of mortality (less than 0.5%). However, because the number of these patients is so high, the number of deaths is not insignificant. A number of groups have highlighted the potential for mortality rates among low-risk patients to be an important outcome in the assessment of any intervention seeking to improve surgical safety. To this end, deaths occurring among procedures associated with low mortality rates has been developed as an important indicator of patient safety by the Agency for Healthcare Research and Quality, with the underlying rationale that such occurrences may be a useful flag for when care may have been suboptimal (Agency for Healthcare Research and Quality 2012).

Surgery in the elderly

A number of publications have described the elevated mortality risk associated with the elderly undergoing a particular procedure (Lomazzi et al 2011; Polanczyk et al 2001; Klima et al 2012; Turrentine et al 2006). Assessments of the mortality risk borne by the elderly across a variety of procedures are, however, rare particularly at a national level. Differences in the characteristics of the patients and the procedures make comparisons between countries particularly difficult. Within a country increasing age has been noted to be a key determinant of postoperative mortality in analyses that have controlled for preoperative clinical and functional characteristics and the type of procedure (Polanczyk et al 2001). Increasing age is also an important determinant of anaesthesia-related deaths (Lienhart et al 2006; Kawashima et al 2003).

Those elderly undergoing an acute procedure are at particularly high risk of perioperative mortality (Griner et al 2011; Palmberg and Hirsjarvi 1979). In the United States, major disparities exist between organisations in relation to postoperative mortality rates after emergency surgical care for the elderly, and a number of processes of care urgently need to be examined in order to improve outcomes (Ingraham et al 2011b).

Pulmonary embolism

High rates of pulmonary embolism-associated mortality have been reported before in relation to the elderly (Kuroiwal et al 2006), acute admissions (Tuttle-Newhall et al 1997) and those undergoing repair of fractures of the femur or hip arthroplasty (Fender et al 1997; Zhan et al 2007; Seah et al 2007). Estimates of the postoperative mortality rate associated with pulmonary embolism in different settings are difficult to compare due to variations in the populations, procedures and diagnostic methods. However, the mortality rate associated with pulmonary embolism in New Zealand for either acute or elective admissions (0.05% or 0.008%) is broadly similar to that reported for the Japanese surgical population (0.08%) (Sakon et al 2004) and markedly lower than an estimate for general Western surgical populations (0.9%) (Geerts et al 2001). The New Zealand figure also includes fatalities occurring among inpatients and up to 30 days postoperatively, which is consistent with evidence that thromboembolism may often occur days after surgery when the patient may have been discharged (Bjornara et al 2006). Guidelines exist to promote thromboprophylaxis among surgical patients (Samama et al 2006; Roderick et al 2005), although it should be recognised that there are competing risks with preventing clotting and promoting bleeding in the postoperative phase (Lotke 2005; Poultsides et al 2012). Recent shifts in recommendations for prophylaxis administration have occurred among surgical specialty groups after observations have been made of a lower rate of venous thromboembolism among patients undergoing elective operations (Qadan et al 2008). Many surgical patients have more than one risk factor for venous thromboembolism, and therefore it is important to stratify the patient's risk to tailor an appropriate prophylaxis strategy (Petralia and Kakkar 2008).

Coronial Files and Perioperative Mortality Review

The Committee requested a review of data held by Coronial Services to understand:

- which deaths under the remit of the Committee are considered by the coroner
- what additional data are available solely from the coronial files, particularly to provide contextual information surrounding a perioperative death.

The following is a summary of the relevant findings of a report commissioned by the Committee and conducted by the New Zealand Child and Youth Epidemiology Service, University of Otago.

Coroners' role in reviewing perioperative death

The selection of cases that are subject to coronial investigation is influenced by the Coroners Act 2006. The Act specifies the unexpected deaths that are to be reported. Clause 13 is relevant to perioperative mortality and states the following are to be reported to New Zealand Police.

During medical, surgical, or dental operation, treatment, etc.

(c) every death—

(i) that occurred while the person concerned was undergoing a medical, surgical, dental, or similar operation or procedure; or

(ii) that appears to have been the result of an operation or procedure of that kind; or

(iii) that appears to have been the result of medical, surgical, dental, or similar treatment received by that person; or

(iv) that occurred while that person was affected by an anaesthetic; or

(v) that appears to have been the result of the administration to that person of an anaesthetic or a medicine (as defined in section 3 of the Medicines Act 1981).

The Committee uses similar criteria to the Coroners Act, with the exception that the Committee considers all cases within a specified period from the procedure (30 days), whether considered resulting from the procedure or not, while the Coroners Act covers cases that occur during or as a result of a procedure, with no time limit on the interval between the procedure and death.

The Coroners Act indicates that New Zealand Police are to be informed in the cases noted in the Act. The process is often that a hospital doctor consults with the coroner to determine if the coroner considers that the case comes under a coroners' jurisdiction or, if the doctor is prepared to sign the death certificate, it can be certified satisfactorily at the hospital. Hospital consultants or other medical staff will sometimes advise the coroner that a post mortem should be taken because they are concerned about the case and the post mortem is likely to answer such questions.

In many of the deaths following surgery and anaesthesia, the certifying authority may be a doctor or a coroner. This could be expected in cases where the procedures carry a high risk of no survival or the patient had recognised co-morbidities that could compromise their survival. There is a further check on cases under the legislation around cremations. Medical referees are employed independently of the coroner and the hospital, with responsibility to ensure that a cremation does not take place if they are not satisfied that "the fact and cause of death have been definitely ascertained". Under clause 7 of the Cremation Regulations 1973, medical referees can refer cases to a coroner.

Reviewing coronial files: characteristics of the research sample

The 240 deaths selected for the qualitative analysis were derived from the linked NMDS and NMC data sets used in the 2011 POMRC Report as outlined below.

Case selection criteria and methods used in qualitative analysis

Initial case selection criteria

The cases selected for the qualitative analysis were derived from the linked NMDS and NMC data sets used by the Committee in its 2011 report. The inclusion criteria were those who:

- were admitted to hospital electively/from the waiting list AND
- were subsequently discharged (either alive or dead) during 2005–2009 AND
- received a general anaesthetic during their admission AND
- had an initial ASA score of 1 or 2 AND
- died within 30 days of the date of the first general anaesthetic of their admission.

Additional information on these cases (n=240) was obtained from the Ministry of Health, and these cases were then linked to the relevant coronial files via a coroner reference number or other information.

Selection of the coronial cases for further review

Of the 240 deaths that met the inclusion criteria, 79 were certified by a coroner. Analysis of 20 coroners' reports was proposed, so a subset of 24 was selected using computer-derived random numbers (to allow for files being unavailable within the given timeframe). Purposeful adjustments were then made to ensure that the sample contained a mixture of cases with the following characteristics:

- Coroner-certified deaths either with or without an inquest.
- Deaths occurring both within and outside of hospital.
- A balance by age (if possible): child (<15), adult and older adult (>65).
- Cases where the primary diagnosis and cause of death were similar as well as those where they were seemingly unrelated.
- A range of different procedures and causes of death.

A total of 20 cases were reviewed.

Qualitative analysis

Iterative readings of the coronial files and sorting of the quantitative data set by its various fields were carried out, with notes taken on relevant information and possible points of interest. The documents in the coronial files were read and their content compared to the corresponding cases in the quantitative data set. Additional information available in the coronial files was recorded.

With each file examined, previously identified factors and themes were reconsidered in light of the new information. Areas of concern identified by the Committee or in the literature (for example, pulmonary embolism, the management of pre-existing medical conditions, staff communication) were examined and emergent themes noted. The following were sought:

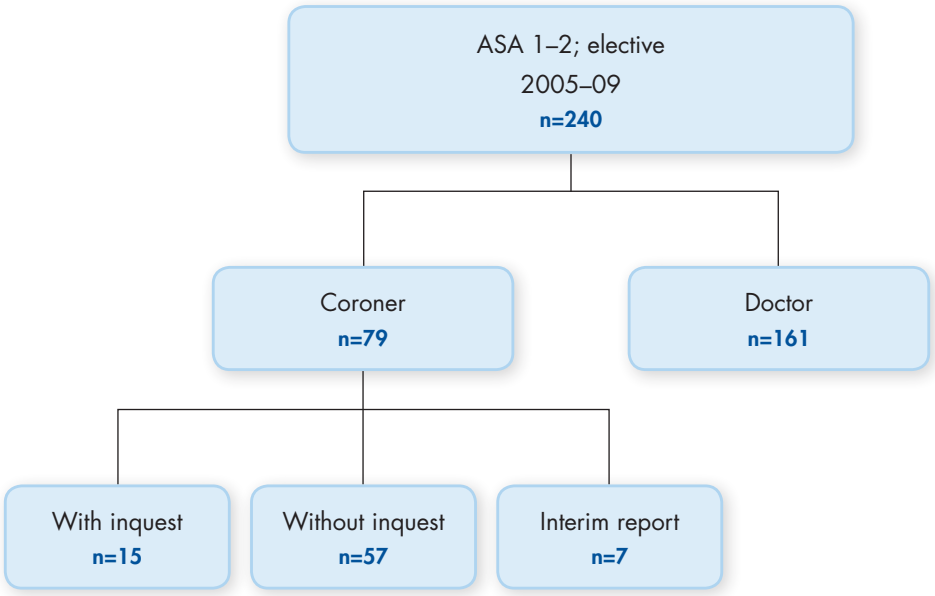
- Information on circumstances, context and chronological sequences in individual cases.
- Common themes across cases (for example, common circumstances or events).
- Divergent themes across cases (for example, diverse experiences or one-off critical lessons).

Results

Of the 240 cases in the data set (referred to as QualData in this report), coroners had certified 79 deaths with a report, without a report or with an interim report. The remaining deaths were certified by a doctor and therefore had no coroner's report (Figure 36). Perioperative deaths occurred equally in hospital or following discharge from the index admission. Two-thirds of these deaths did not have a post mortem. Within the other third, the Ministry of Health staff read the post mortem in 21% of cases (and in 4% of cases, the information regarding the cause of death was changed). In 12% of cases, a post mortem was undertaken but was not received by the Ministry of Health for reasons not stated.

From the 79 coroner-certified deaths, 24 cases were selected (as outlined above), and their files were requested from Coronial Services. It was not expected that all of these files would be found within the short time available. Of the 24 cases selected, one was active (that is, with a coroner) and three could not be readily retrieved using the details provided in the timeframe. A total of 20 perioperative deaths certified by a coroner were included in the qualitative review.

Figure 36. Certification of Selected Deaths



Death certifier and main underlying cause of death

In attempting to understand why two-thirds of the deaths were certified by a doctor (n=161) while others received a coronial review (n=79), a comparison of the cause of death by certifying authority was undertaken (Table 26). Both coroners and doctors certified a range of medical causes of death, but only coroners certified deaths due to injuries and other external causes. Three-quarters of the cases certified by a doctor were due to malignant and other neoplasms and myocardial infarctions.

Table 26. Main Underlying Cause of Death by Certifying Death Authority from the QualData Set

PRIMARY CAUSE OF DEATH (USING ICD-10-AM)	Certifying Authority			
	Coroner		Doctor	
	n	%	n	%
Malignant Neoplasm Related to Reason for Surgery	13	16.5	55	34.2
Other Neoplasms	9	11.4	50	31.1
Myocardial Infarction	10	12.7	17	10.6
Cardiovascular Disease Related	3	3.8	11	6.8
Other Ischaemic Heart Disease	17	21.5	5	3.1
Pulmonary Embolism	1	1.3	1	0.6
Renal Failure	2	2.5	1	0.6
Other Respiratory Related (including COPD, Emphysema)	1	1.3	4	2.5
Pneumonia	0	0.0	3	1.9
Gastrointestinal	4	5.1	4	2.5
Cerebral Infarction	0	0.0	2	1.2
Diabetes Related	0	0.0	1	0.6
Other Causes	8	10.1	7	4.3
External Cause of Death (E-Code)				
Suicide	4	5.1	0	0.0
Assault	1	1.3	0	0.0
Sudden Unexpected Death of an Infant (Sudden Infant Death Syndrome)	2	2.5	0	0.0
Fire	2	2.5	0	0.0
Other External Cause of Death	2	2.5	0	0.0
Total	79	100.0	161	100.0

Content of coronial files

One of the aims of this review was to assess the scope and quality of the information contained in the coronial files and its relative utility for perioperative mortality review. The nature of the information held in the coronial files was documented.

The contents of the coronial files examined varied greatly. Generally, they contained more information when an inquest had been held, but this could not be assumed. Information was provided through one or more of the following:

- The coroner's finding, giving date, place and cause of death and possibly a recommendation or comment.
- A formal notification that an inquest was unnecessary, if this was the coroner's conclusion following initial enquiries and a post mortem.
- A post mortem report.
- A Report for Coroner, prepared by New Zealand Police.

The most rigorous post mortem reports gave the following details:

- The direct cause of death (injury, disease or complication directly leading to death).
- The antecedent causes of death (morbid conditions, if any, giving rise to the above).
- The underlying condition.
- Other significant conditions contributing to the death but not related to the disease or condition causing it.
- Other significant conditions not contributing to the death.

Few of the post mortems of the cases selected contained all of these details, although the template for collating coronial data introduced with the Case Management System (CMS) in 2007 specifies these points.

The Report for Coroner contained a plain-English summary of the information gathered about the death and pertinent circumstances surrounding it. These reports drew their information from hospital staff, observations made by New Zealand Police and statements with relevant information from family and witnesses. In the case of in-hospital deaths, this report usually provided the most easily understood outline of events in chronological order, generally including the key procedures and treatment.

Table 27 provides a summary of the type of information that may be available in a coronial file. With the exception of the formal ruling and the post mortem that are required by law, information on the circumstances surrounding the death from these sources may or may not be present.

Table 27. Information Likely to be Available in Coronial Files in New Zealand, Alternative Sources of Such Information and its Potential Value to POMRC

ITEMS THAT MAY BE IN THE CORONIAL FILE	ALTERNATIVE SOURCES OF SIMILAR INFORMATION	POTENTIAL VALUE TO POMRC
Depositions: statements obtained for inquests from witnesses, including hospital staff, on what they found, what happened, what they knew of the person and/or the circumstances leading up to the death.	There is no other source of formal witness statements.	May contain relevant information related to events in hospital, hospital systems or communication issues.
Accounts of the surgery, care and any complications formally requested by the coroner from hospital doctors, nurses and specialists involved with the patient, for example, surgeon, anaesthetist.	This information may also be available in hospital records, but not as succinctly. The information provided is specific to the coroner's questions about the cause of death. In the cases reviewed, this included reflections that were not in the hospital records or were not easily identified in the records.	These accounts have considerable value for understanding the procedures prior to and the circumstances surrounding the death. Requested when an inquest is being held.
Correspondence with other health professionals, for example, general practitioner, psychiatrist.	This information was provided formally in direct response to the coroner's request. The information could be sought whether or not an inquest was held. Alternative sources are limited, as even if GP files were obtained, these letters provide a coherent synopsis.	These accounts have considerable value for understanding the procedures prior to and the circumstances surrounding the death. Requested when an inquest is being held.
Reports from any hospital inquiry called on the case may be included (cannot be assumed to be in the file).	If the hospital has carried out its own investigation, this information should be available.	This was useful information for detail on the clinical and systemic issues around the event.
Expert second opinions on the case requested by the coroners.	This information was formally provided in direct response to the coroner's request seeking independent expert opinion. There is no other source unless the experts are requested to comment on the particular case. The coroner has the powers to request this information.	Contained useful and usually detailed information on aspects of the case. The independent nature of the opinion is useful where systems issues are involved.
Interviews with family members or significant others.	Information obtained from family, not in formal depositions, about the circumstances around the death and information about the deceased.	May provide a useful third-party commentary on systems and/or communication issues in a hospital that would not be gathered elsewhere.
Hospital records that are either in summary form or as copies of the relevant portion of the patient's file.	The hospital records provide detail of the procedures. If full records relevant to the direct and antecedent causes of death and co-morbidities were included, the quantity of material was considerable and repetitious. A summary was easier to analyse but had the potential to leave out what, in hindsight, was relevant information.	Valuable information was contained in the hospital records. If not obtained by the coroner, these records would have to be obtained from each DHB, which could be time-consuming.
Informal communications between the coroner and the doctor/consultant involved may be found in the coronial file, but it may be that these are not necessarily kept.	Such communication provides a brief indication of the chief areas of concern but may not be routinely kept by coroners. In two examples, copies appeared in both the coronial files and the hospital records provided.	May provide insights into initial concerns.
Correspondence between the coroner and the family. Examples of this are generally in response to the coroner communicating about possible decisions regarding holding an inquest. The information from these communiqués is not to be taken from the file.	This information was treated as confidential by Coronial Services. Such information was not considered relevant to this study.	
Sealed envelopes in the coronial file held items such as suicide notes, police photographs and other personal material.	This information was treated as confidential by Coronial Services. These envelopes were present in cases where there was an external cause of death.	

Additional insights gained from the qualitative analysis of coronial data

The Committee determined three key questions related to the ability of qualitative analyses of coronial files to provide insights into the circumstances surrounding particular types of death:

1. Can coronial files be used to identify any other potential underlying causes of death that are not captured by the formal ICD-10-AM classifications of death recorded in the NMC?

2. What overt and covert factors can be identified in the coronial data that moderate or mediate for a positive outcome, and how do they operate?

3. What additional information can be obtained on perioperative mortality using qualitative methodologies, and how does this compare to the findings yielded from a quantitative analysis of the NMC and the NMDS for specific cases?

The following sections review the findings in each of these areas in turn.

Identifying potential underlying causes

Question 1: Can coronial files be used to identify other potential underlying causes of death that are not captured by the formal ICD-10-AM classifications of death recorded in the NMC?

Qualitative analysis of coronial files revealed a number of potential causes that were not captured by the NMC's ICD-10-AM coding. The coronial files provided the following additional information:

a) *The sequence and timing of events and complications prior to/during/after surgery that may be pertinent to the classification of death:* Using the NMDS and the NMC, it was often difficult to determine the chain of events that led to a particular death. In contrast, the coroners' reports were usually clear about the sequence of events. For example, surgery to remove a malignant neoplasm might or might not be related to the malignant neoplasm identified as actually causing the death, although the surgery might have influenced the timing of the outcome. If coronial data are available, the qualitative analysis suggests it should be used in preference to the NMDS and the NMC for determining the temporal relationships between various potential causes and a mortality outcome.

b) *The relationship between the cause of death and the reason for admission:* In a number of cases, the cause of death was unrelated to the original reason for admission, for example, postoperative deaths due to house fires or assaults. Among the selected cases, three had an external cause of injury listed as the cause of death that was unrelated to the reason for admission or the procedures undertaken. However, in other cases, potential links between the external injury and the diagnosis indicated that the automatic removal of cases with an external cause of injury from the analysis could diminish the value of the conclusions made. For example, in a small number of cases, suicide was the underlying cause of death, and in such cases, the likelihood that suicide could be linked with specific diagnoses and/or procedures should be examined further, as the identification of a relationship may indicate benefits could be accrued from attention being paid to mental health pre-operatively and postoperative psychological care.

c) *Details of the case from key informants:* Coroners can request relevant information on a person's medical history from general practitioners or other health professionals. In a few of the cases, these details included information on co-morbidities, the effects on daily living of conditions the patient had, indications of family circumstances and histories, and relevant past history, say, of traumatic brain injury that could have a bearing on the circumstances surrounding the death and its association with the surgery or general anaesthetic.

d) *The relevance of the psychological state of the person to their diagnosis, procedures and subsequent outcome:* Although ICD-10-AM coding is able to document the presence of a mental illness, circumstances or risk factors that may impact negatively on subsequent outcomes, coronial data may permit a more detailed understanding of the relationships between these factors and an eventual outcome. However, even in cases where coroners' reports were available, it was often difficult to determine whether alcohol or drug abuse or psychiatric/psychological conditions had been identified

before the surgical procedures were undertaken. The early identification of such factors (preferable pre-operatively), however, may identify patient factors that may affect the ASA score or that could be beneficial for planning pre- and postoperative care.

Overt and covert moderators and mediators

Question 2: What overt and covert factors can be identified in the coronial data that moderate or mediate for a positive outcome, and how do they operate?

Communication and procedural issues

A number of coronial files contained considerable detail on systems issues and other non-patient interactions that could potentially moderate or mediate for positive outcomes. The amount of detail, however, varied significantly with the scope of the coroner's report. While most cases were unique, a few common themes emerged:

a) More than one coroner's report identified poor communication (for example, between staff and patients, between staff members within and between wards or between staff or hospital administration and family members) as being of concern.

b) In more than one case, hospital procedures and protocols had not been followed or needed amending.

c) The level of investigation undertaken by hospitals following an unexpected death where systemic issues were implicated also differed between institutions. One hospital undertook a review following an unexpected perioperative death, with its review indicating that it would do little differently in the future. The review undertaken was internal and, as the coroner noted, was not a root cause review that would have been likely to provide greater insight into avoiding a similar incident. In contrast, faced with a perioperative death following a very complicated procedure, a different hospital undertook a thorough review, calling in expert opinion from outside its organisation. The changes it made were commended by the coroner.

Coroners' reports, therefore, may provide valuable insights into the responses of institutions following perioperative deaths as well as into policies and procedures that may potentially moderate or mediate positive outcomes.

Misclassification of anaesthetic risk

Another issue identified in a number of cases was a discrepancy between the ASA scores assigned in the NMDS and information from the coronial files, which suggested that a higher ASA score may have been warranted. All of the cases in QualData were selected on the basis that they were elective cases with an initial ASA score of 1 or 2. While this assessment may have changed following surgery, it was assumed that the initial ASA score was a factor that medical staff took into account when planning surgery. A few of the coroners' reports, however, contained information from the post mortem or, more commonly, requested by the coroner from a general practitioner or other specialist or given by family or friends that indicated that there were serious limitations on the individual's activity that were related to systemic disturbances, including a past history of myocardial infarction or angina.

A number of cases also appeared to have a relatively high risk of poor or no survival despite being elective and having an ASA score of 1 or 2. As a proportion of all surgery undertaken, these may constitute a small proportion, but nevertheless, should there be questions asked as to whether the risk of surgery was justified and whether the specialist had all the relevant information on the patient to prepare for possible complications that a patient's co-morbidities may generate for the procedures?

While it is unclear whether the misclassifications of ASA score identified were of clinical significance (ie, a real misclassification of anaesthetic risk on the part of clinicians) or merely a data quality issue with the NMDS (which could be improved by coder training), the number of discrepancies identified following review of such a small case series (n=20) suggests that further investigation in this area is warranted.

Additional information

Question 3: What additional information can be obtained on perioperative mortality using qualitative methodologies, and how does this compare to the findings yielded from a quantitative analysis of the NMC and the NMDS for specific cases?

While hospital discharge diagnoses and causes of death were recorded in routinely collected data, the coronial files were much better able to capture the complexity of the circumstances leading up to individual deaths. Additional information was also often available on diagnoses, procedures, co-morbidities, lifestyle, communication issues and the care given, all of which served to provide a better understanding of the contexts surrounding particular deaths. In addition, events or influences that may have exposed a patient to increased risks were sometimes identified – these were not captured in the NMDS data.

When coroners requested further information from experts and medical professionals, communication from the latter was generally highly informative about issues such as pre-existing medical conditions, communication and decision-making issues, procedures, complications and their possible outcomes. These communiqués often included details on pre-existing medical conditions that appeared not to have been considered in the allocation of the initial ASA score. One example was a general practitioner's communication with a specialist checking on the impact of a patient's heart conditions in light of the proposed surgery. In another case, the magnitude of a surgical 'mistake' implicated in the death was identified in the coroner's report but not in the QualData.

Little of the contextual information provided by the coronial data was available from the NMC or the NMDS.

Strengths and limitations of the qualitative analysis of coronial data

To date, the Committee's quantitative analysis of linked NMC and NMDS data has provided a cost-effective method of rapidly reviewing mortality following operative procedures and general anaesthesia. These analyses, however, have failed to provide a detailed understanding of the circumstances and systems issues leading up to particular types of death or information that would lead to the development of evidence-based policies and practices that could be implemented at the individual clinician, hospital or DHB level to prevent future perioperative deaths. In contrast, qualitative analyses of coronial data offer insights into both clinical and systemic issues.

Advantages

Qualitative analysis of coronial data has a number of distinct advantages:

a) In New Zealand, coronial data are now held in a centralised CMS that contains information on every death reported to a coroner since 1 July 2007. This includes details of the person who died, the circumstances surrounding their death and the findings of the coroner and other agencies reviewing the death. The CMS provides a readily accessible source of information on all deaths reported to coroners nationally, which ensures a large sample of diverse cases (for example, by region, age, ethnicity, cause of death) for qualitative analysis. (Deaths prior to 1 July 2007 are also held by Coronial Services but the detail available from them is likely to be more limited.)

b) While much of the clinical information held in the CMS duplicates the information held by other agencies (for example, the clinical information held in hospital patient management systems), the existence of a national repository means that this information can be reviewed centrally rather than having to request the individual files from each of the agencies involved. Many of the files held provide concise summaries of all of the relevant information, thereby avoiding the need for detailed reviews of individual clinical records or other reports.

c) The narrative information contained in many coronial files allows for a more detailed understanding of the temporal sequence of events leading up to individual deaths, including the inter-relationships between the reasons for hospital admissions, the risks posed by any pre-existing medical conditions, the procedures undertaken, any ensuing complications and the main underlying and contributory causes of death. In this context, qualitative analysis enables an examination of the 'one case of' and the insight that a single case may provide to perioperative mortality review, without being

confined by how common or rare the event is, so multiple errors are not required before action can be taken. One case that is indistinguishable from others of a similar nature in the routinely collected data may offer key insights that improve practice across a number of contexts.

d) Qualitative analysis of the narratives contained in coronial reports may also lead to the identification of systems issues in institutional policies and practices. For example, by considering how well communication and information-sharing systems work for patients or whether there are recognised and accepted protocols in place to minimise surgical complications, qualitative analysis can potentially identify areas where hospital systems could operate more effectively for patient health.

e) As little of the information provided in the post mortem is routinely stored in the NMC, the detail available in the post mortem reports held in coronial files provides considerable information on specific cases that is relevant to the Committee and its deliberations.

Limitations

Qualitative analysis of coronial data also has a number of limitations that need to be taken into account when considering its usefulness to perioperative mortality review:

a) A major limitation is that not all perioperative deaths are referred to a coroner (in the current sample, only 79 out of 240 cases were certified by a coroner). Further, these figures may overestimate the number of cases referred to a coroner more generally, given that the sample was restricted to elective cases with an ASA score of 1 or 2 that, with a relatively low risk of mortality, may have been more likely to undergo a coronial review. The proportion of cases reviewed by a coroner may, therefore, be lower for, say, cohorts of older patients admitted acutely with significant pre-existing medical conditions.

b) There were some cases for which there were no coroners' reports, yet they appeared to be little different from others that received a coroner's attention. One example was myocardial infarctions following hip replacements. Both coroners and doctors certified such deaths. Without seeing the hospital files, it was not possible to identify what differences existed, if any, between these cases in terms of their severity or other implications.

Conclusions

Coronial files are a potentially excellent source of information for perioperative mortality review. Where inquests have been held, considerable information may be available on the circumstances surrounding specific deaths, leading to greater insights into the sequence of events leading up to the death, the nature of surgical complications, the existence of pre-existing medical conditions and hospital treatment and care.

They are also able to identify a number of more generic or systemic issues that may be implicated in or linked to a perioperative death. These include the reliability of the ASA scoring, a possible link between suicide and surgical interventions, institutional protocols and reviews, and the impact of the presence or lack of good communication between staff inside their institution and with patients and their families.

None of these advantages, however, address the major disadvantage of coronial data – namely that the majority of perioperative deaths do not have a coroner's report or a post mortem. Further, even amongst cases that were reviewed, there were examples where the coroner's report added little information to the quantitative data. It is likely that additional sources of information, over and above that provided by the CMS, NMDS and NMC, will be always be required if we are to more fully understand the circumstances leading up to perioperative deaths.

Although coronial files contain information on deaths that initially appear unrelated to perioperative care (for example, SUDI, fire or suicide), changes to care or other factors may have prevented these deaths.

Implications for perioperative mortality review

This investigation highlighted the fact that while coronial data are a valuable source of information for perioperative mortality review, a significant proportion of postoperative deaths do not undergo coronial review and thus other data sources will also be required. There is a number of instances, however, where coronial files add important contextual information to further understand the circumstances surrounding perioperative deaths. These circumstances include:

- when the cause of death is uncertain, post-mortem results are helpful
- when an inquest has taken place, expert opinion may provide useful additional information
- when the death occurred out of hospital and there was subsequent coronial review.

Appendices

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

Table A1. Thirty-Day Mortality Rates in New Zealand Resident Population

AGE GROUPS (5-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	1,011.37	801.21
90	1,841.84	1,722.66

* 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: ACHI ICD-10-AM-V3 Cholecystectomy Codes

In the hospital admission data set, health interventions were coded using the ICD-10-AM (Third Edition) ACHI. Table A2 lists the ACHI codes included in the analysis of mortality following cholecystectomy.

Table A2. ACHI (Version 3) Cholecystectomy Codes Included in the Analysis

ACHI CODE	PROCEDURE
3044300	Cholecystectomy
3044500	Laparoscopic cholecystectomy
3044600	Laparoscopic cholecystectomy proceeding to open cholecystectomy
3044800	Laparoscopic cholecystectomy with removal of common bile duct calculus via cystic duct
3044900	Laparoscopic cholecystectomy with removal of common bile duct calculus via laparoscopic choledochotomy
3045401	Cholecystectomy with choledochotomy
3045500	Cholecystectomy with choledochotomy and biliary intestinal anastomosis

Appendix 3: Odds Ratios Versus Rate Ratios

Logistic regression is a useful technique that is often used to assess the effects of multiple risk factors (for example, age, ASA score, gender) on an outcome (for example, perioperative mortality), with these effects being able to be explored both individually and simultaneously. Thus in multivariate models, the effects of one risk factor can be explored, while the effects of other risk factors are taken into account, for example, the effects of age can be explored independently of the fact that older age cohorts tend to have a higher proportion of those with ASA scores of 3 or more (Szklo and Nieto 2004).

One limitation of logistic regression, however, is that the results generated are reported as odds ratios (the odds of an event occurring in an exposed group versus the odds of it occurring in an unexposed group) rather than as relative risks (the risk of an event occurring in an exposed group divided by the risk of it occurring in an unexposed group). While odds ratios are valid measures in their own right, they are often used to approximate rate ratios (ie, to estimate how many times higher the risk is in an exposed group compared to an unexposed group). The use of an odds ratio to estimate a relative risk, however, biases the result away from the null (ie, it tends to exaggerate the magnitude of any association seen). Where the outcome is relatively rare, this built-in bias is negligible, with the odds ratio being very similar to the rate ratio. However, when the outcome is not rare (for example, mortality rates for those aged 80+ years or with ASA scores of 4 or 5), this bias can be substantial (Szklo and Nieto 2004). This is illustrated in Table A3, where the odds ratio for 30-day mortality for those with an ASA score of 5 (vs. an ASA score of 1) is 49.7 as compared to a rate ratio of 17.8.

Thus, in this report, all odds ratios derived from figures where the mortality rate exceeds 20% have been suppressed (as indicated by an H), with caution also being urged when interpreting any odds ratio where the associated mortality is in the 10–19% range, as in such cases, the odds ratio presented is likely to overestimate the rate ratio and hence the magnitude of any association seen.

Table A3. Mortality in Those Aged 80+ Years Following an Acute Admission that Included a General Anaesthetic or Neuraxial Block by Gender, Ethnicity and First ASA Score, New Zealand 2006–2010 (Odds Ratio vs. Rate Ratio)

VARIABLE	CATEGORY	Mortality per 100,000 Admissions	Mortality per 100 Admissions (%)	Univariate OR	Rate Ratio
Mortality 80+ Years					
Acute					
Gender	Female	7,832.2	7.83	1.00	1.00
	Male	11,330.5	11.33	1.50	1.45
Ethnicity	European	8,992.5	8.99	1.00	1.00
	Māori	10,984.0	10.98	1.25	1.22
	Pacific	7,377.1	7.38	0.81	0.82
	Asian/MELAA/ Other	8,906.3	8.91	0.99	0.99
ASA Score of First Anaesthetic	1 or 2	2,784.0	2.78	1.00	1.00
	3	7,758.7	7.76	2.94	2.79
	4	19,946.2	19.95	8.70	7.16
	5	49,659.9	49.66	34.45	17.84
	Not Stated	8,619.9	8.62	3.29	3.10

Appendix 4: Methodology Used in Qualitative Review of Coronial Files

The following describes a practical method for undertaking a qualitative analysis of coronial data. The method was trialled with respect to a specific population of interest: patients admitted electively with an initial ASA score of 1 or 2 who died within 30 days of a general anaesthetic.

Identifying a feasible methodology

The choice of a qualitative methodology and methods depends on the intent of the study and the research questions posed. In this study, the overall intent of the enquiry was to investigate whether coronial files could offer a greater understanding of how and why perioperative deaths occur so that solutions may be developed to improve patient outcomes. The interest in 'how' and 'why' questions indicated that a 'case study' research approach was appropriate (Yin 2002).

The definition of a 'case study' has been given as: "An empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." (Yin 2002)

This definition fitted the task of investigating coronial files, which were an untried source of information, and addressing the questions likely to arise about their content in the future. Coronial files have a common purpose, and while they are independent, methodologically, they can be considered a collective case characterised by the occurrence of similar events (perioperative deaths). A 'case study' approach is appropriate given that the quantity and quality of the information found in coronial files is unknown, although the contextual conditions and descriptions will be important. The approach is also pertinent to the review being oriented towards discovering themes rather than providing proof (Yin 2002; Stake 1994; Robson 1993). Because the term case is commonly understood in a medical context to refer to the single patient, to avoid confusion, when referring to the methodology as a 'case study', quotation marks are used. The word case (without quotation marks) will be used in its traditional medical sense of a single patient.

Establishing the research questions

Qualitative analyses require research questions to direct the investigation and determine the information being sought from the data source. The following three research questions were framed, in discussion with members of the Committee, to direct the qualitative enquiry proposed in the piloting of this method:

1. Can coronial files be used to identify any other potential underlying causes of death that are not captured by the formal ICD-10-AM classifications of death recorded in the NMC?
2. What overt and covert factors can be identified in the coronial data that moderate or mediate for a positive outcome, and how do they operate?
3. What additional information can be obtained on perioperative mortality using qualitative methodologies, and how does this compare to the findings yielded from a quantitative analysis of the NMC and the NMDS for specific cases?

Sources of data

Two sources of information were used to address these questions using data from 2005–2009:

- A subset of routinely collected hospital admission and mortality data.
- Coroners' reports.

Subset of routinely collected data

The first source of information was a subset of cases previously identified in the 2011 POMRC Report as deaths following an elective admission that included a general anaesthetic and with an admission ASA score of 1 or 2. A de-identified quantitative data set was created that linked the hospital admission data for these patients from the NMDS with data from the NMC. The advantages and limitations of these data were outlined in the 2011 POMRC Report, in particular, acknowledging that information may be missing from these data sets. While there are requirements on hospitals to complete the NMDS fields, relevant information may not be recorded in routinely collected data, for example, factors within a patient's perioperative period.

The cases selected for qualitative analysis were derived from the linked NMDS and NMC data sets as outlined above, with the specific selection criteria being all those who:

- were admitted to hospital electively/from the waiting list AND
- were subsequently discharged (either alive or dead) during 2005–2009 AND
- received a general anaesthetic during their admission AND
- had an initial ASA score of 1 or 2 AND
- died within 30 days of the date of the first general anaesthetic of their admission.

Further details on the method are available Dr Jean Simpson, New Zealand Child and Youth Epidemiology Service, University of Otago.

Selected fields

The choice of topic and the research questions will guide the selection of fields for future investigations of perioperative mortality, and a number of issues or concerns would be worth investigating, such as factors associated with age groups, deprivation index, ASA score, specific type of procedure, anaesthetic type or specific cause of death. For this pilot, the QualData data set contained the following NMC and NMDS fields:

Facility, facility type and funder (private/public)	Date of death
Date of birth and age at discharge	The first three diagnoses
DHB and NZDep Index decile	The first three procedures
Ethnicity	The first three injuries
Discharge status	Other contributing factors
Place of death (in hospital or other)	Underlying cause of death
Discharge date (including year, month and day)	Post mortem reported

Case selection for qualitative analysis

The selection of cases for a qualitative investigation depends on the research questions. Case numbers need to be limited when undertaking qualitative analysis to avoid gathering more information than can be properly analysed. Commonly, in-depth case studies may have between 2 and 20 cases, with the size of the data sources and the research questions influencing the number selected and the selection process. For this pilot, the following set of investigative criteria, determined in consultation with Committee members, was used for selecting cases. The selection was to be around 20 deaths to include a mix of cases:

- Coroner-certified deaths, either with or without an inquest.
- Deaths that occurred either within the hospital or outside the hospital.
- A balance (if possible) between three main age groups: child (<15), adult and older adult (>65).
- A balance between primary diagnoses and causes of death being similar and being seemingly unrelated.
- A range of procedures and causes of death (ie, not all cardiac deaths or all colorectal procedures).

Selected cases will be described in terms of the characteristics of the whole set. In this pilot, case selection was undertaken in two stages. The initial step used a set of computer-derived random numbers to select 24 cases (more than 20 because files might not be available). Purposeful adjustments were then made to create a selection that could match as closely as possible the requirements of the investigative criteria to obtain the range of patient profiles requested.

Analysis

The process of analysis comprised of iterative readings of both the coroners' documents and the QualData set. The content was considered deductively, based on the key themes that have been identified previously, and inductively, for new or emergent themes. Developing the coding used in some of the analysis was also an iterative process involving identifying existing themes, seeking advice from members of the Committee and identifying previously unrecognised aspects of the problem. In this study, these were aspects considered worth investigating further.

Individual cases in the data set were examined, and the whole of QualData was subjected to a range of sorting exercises by the different fields to gain a sense of the information available. This step was repeated as insights changed with increasing knowledge.

The individual coronial files were read and reread, with notes taken on the relevant information and possible points of interest. Known areas of concern that had been raised in the literature (for example, pulmonary embolism, management of particular conditions such as cardiovascular or respiratory conditions or communication between staff) were examined, as were the themes that emerged. Both commonalities of circumstances and diverse events could indicate alternative interpretations of events or conditions described.

Some of the files included information on the context and circumstances of the condition for which the person was undergoing surgery. Some, but not all, included narratives of the procedures and processes undertaken. A few files had notes about the care of the patient in relation to complications. Where hospital records were provided, key summaries were read and discrepancies in the records were noted where possible, as these were thought to potentially indicate communication breakdowns that some research has implicated in perioperative deaths. The drugs used and the specialist decisions made by the medical staff were outside the expertise of the researcher and were not critiqued. The pathologist's analysis and interpretation was accepted.

Following the reading of the files, the information was checked against the data in the QualData set and additional information added where possible. The information from the coroners' reports was compared to the data available from the QualData set, and the information the reports added was noted. Themes were tentatively identified, with some reflecting points of concern raised in other research, while others were new issues.

Appendix 5: Summary of Responses to Inaugural Report Consultation

Table A5. Summary of Responses to Inaugural Report Consultation

QUESTIONS	RACS	ANZCA	SOUTHERN CROSS HOSPITALS	MOH (CLPR BUSINESS UNIT)	BOPDHB
As a patient, what type of information about risk do you need from your doctor in order to make an informed decision regarding surgery?	Risks and benefits of not having surgery; specific risks and benefits related to surgery(1); general risks related to anaesthesia(2).	Shared understanding of 'informed consent'. Shared expectations in accordance with Health and Disability Service Consumer's Rights.	What risks means to the patient/ consumer. What does the individual want to achieve by having surgery? Discussion of all options, including non-surgical. Success rate and common complications.	Complications as well as mortality, stratified by age and ASA score.	Mortality and morbidity risks are important as well as the related likelihood of benefit.
As a health care practitioner or provider, what type of perioperative mortality and morbidity information would help you in your practice or your facility to improve patient care?	Post mortem findings; details of pre-existing conditions and any contributory role, type of anaesthetic and difficulty/ complication, any difficulties during surgery, postoperative management concerns(3), whether standard protocols were followed(4).	Procedure and patient information that enables assessment of anaesthetic risk.	Accurate information from all providers, including procedure type, ASA, co-morbidities, correct cause of mortality.	As above.	28-day, 90-day, 1-year and 2-year data should be available. Morbidity should include length of stay, need for transfusion, return to work/normal activities and other needs.
How should perioperative mortality data be used to improve health outcomes?	An educational resource identifying any weaknesses or deficiencies in care. De-identified. All incidents discussed at departmental surgical audit meetings and hospital quality meetings. National summated data could inform changes in practice or alert practitioners.	Assist with informed consent for individual patients. Enable targeting of initiatives to improve practice in areas of high risk.	Baseline mortality and morbidity data should be defined. Timely information that can be easily communicated. Lessons learned translated into clinical protocols or existing standards highlighted.	Analyses of preventable causes of perioperative mortality.	Use Jarman methodology for comparing HSMR with New Zealand and Australian hospitals. Information can be broken down. Socioeconomic status a factor.
POMRC recommends a whole-of-system approach. Do you agree?	Strongly supported with the caveat that epidemiological data will be of limited value in improving outcomes. Individual case review also essential.	Yes, important to look at all types of perioperative management.	This makes sense but will be complex to deliver. System-wide process favoured over case review.	An important approach as it provides accurate descriptive epidemiology. Analysis needed on preventable causes.	Yes. Caution around denying patients operations as clinicians focus on survival as a measure of quality of care.
Would you support a core data set of all surgical and anaesthetic mortality and morbidity?	Yes and aligned with RACS audits.	Yes.	Yes.	Yes.	Yes.

QUESTIONS	RACS	ANZCA	SOUTHERN CROSS HOSPITALS	MOH (CLPR BUSINESS UNIT)	BOPDHB
Would you support a standardised mortality and morbidity review process across the entire sector?	Yes, including all public and private events. 50% of elective surgery is completed outside DHBs.	Yes.	Yes. Needs to include all providers that fit within definition. Health practitioners could be reminded of reporting obligations as part of the APC application and confirmation process.	Yes, but it may need to be sample-based to be cost-effective.	Yes, with strong input from clinicians and biostatisticians.
Where should the emphasis on perioperative mortality review be (case peer review/ system-wide epidemiological analysis)?	Peer review for selected cases. If epidemiological analysis was the major emphasis, this would limit the opportunity to identify issues that would inform practice change.	Both are important. Case review provides valuable education; system-wide can address systems issues.	Both are important, but numbers might be too small for individual case review.	Sample-based case peer review within the context of system-wide epidemiological analysis.	Case peer review is ideal. It is hard to collect and compare but is meaningful to professionals, patients and families. Epidemiological approach is not as ideal.
What role should the professional colleges and societies play in perioperative mortality data collection and dissemination?	Colleges have a fundamental role in postgraduate surgical and anaesthetic training and maintenance of standards, therefore they should play a key advisory and leadership role.	Colleges can disseminate information and encourage support of the process. Colleges can target education.	Colleges' and societies' mortality and morbidity review processes should complement this system. Encouragement and support important for participation.	Key role in designing and implementing changes to achieve improvements in outcomes.	A large role as the learned bodies. They can influence teaching and training.
If the recommended system was to be adopted, what would the implications be for your practice or facility?	Unclear what the current system would be.	Important to focus on avoiding duplication. All hospital deaths are examined at Waikato Hospital, for example, and could be linked into a system-wide data collection initiative.	Useful for planning and improvement and giving assurance that resources are targeted towards evidence-based quality improvement activities.		
What additional resources would be required?	A simple system to flag perioperative death within 30 days. Simple software programme preloaded with data from NMDS and CMS. Readily accessible, intuitive. Centrally stored.		Resources to coordinate process, ensure data quality and that review processes were undertaken, including recommendations for system improvements.		Staff and storage for data collection and capture.
What current resources or activities could be utilised for this purpose?	Some hospitals detect and review all deaths as part of regular three-monthly surgical audit.		Well established existing clinical governance structure. Clinical safety and risk management networks also well established.		Some of this occurs but it is important to know the size of the data set.

QUESTIONS	RACS	ANZCA	SOUTHERN CROSS HOSPITALS	MOH (CLPR BUSINESS UNIT)	BOPDHB
What, if any, process (es) for the review of perioperative mortality do you or your facility currently use?	All surgeons and anaesthetists have access to an adequate audit software program with close to 100% patient registration.		Incident event forms. Clinical cases for review process. Lessons learned are shared. MOH ACC treatment injury notifications. SSE handbook includes frameworks and methodologies.		ICU collects AORTIC database. Most surgeons keep logbooks and submit to colleges.
Further comments	RACS is very supportive of this initiative. Encourages formal peer review of deaths.	Important to have complete data for all health care facilities. Analysed in an accessible way. Presented in a non-judgemental manner.	Standardised single form is important. A service for data coding to ICD-10 will need to be provided as this is not mandatory for providers. Memorandum of understanding with Coronial Services supported. Ensure that a whole-of-system approach is positive.		Using quantitative data can have severe limitations. Inherent risk in surgeons fearing poor outcomes impacting on employment. Important to use data in reflective way.

(1) Likelihood of success and failure, infection, haemorrhage and need for transfusion, complications which might arise and their consequences, potential for additional surgery, modified to reflect the individual (eg, age, ethnicity, gender, pre-existing and current health issues, smoking, alcohol consumption, BMI, exercise tolerance).

(2) Aspiration, atelectasis, pneumonia, myocardial infarction, spinal complications such as infection, nerve injury, thromboembolism, urinary retention and catheterisation.

(3) Fluid balance, anaemia, renal and hepatic function and interplay of medications, cardio-respiratory issues, operation technical failure – secondary haemorrhage, deep infection, specific technical failure such as anastomosis leakage, dislocation of prostheses, failure of fracture fixation, implant failure etc.

(4) Surgical Safety Checklist, preoperative antibiotics, thromboembolism prophylaxis, rehabilitation pathways.

List of Abbreviations

ACC	Accident Compensation Corporation
ACHI	Australian Classification of Health Interventions
ANZCA	Australian and New Zealand College of Anaesthetists
ASA	American Society of Anesthesiologists
CMS	Coroners' Case Management System
DHB	District health board
MELAA	Middle Eastern/Latin American/African
NMC	National Mortality Collection
NMDS	National Minimum Dataset
NZDep	New Zealand Deprivation Index
OR	Odds ratio
POMRC	Perioperative Mortality Review Committee

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