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

POMRC
Perioperative Mortality Review Committee

Perioperative Mortality in New Zealand:

Third report of the Perioperative Mortality Review Committee

Report to the Health Quality & Safety Commission New Zealand

June 2014

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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 Commisison). The Commission welcomes the Committee's third report.

This report details the epidemiology of perioperative mortality for the years 2007–2011 in five clinically important areas, compares previously published perioperative mortality rates and examines the World Health Organization's (WHO's) standardised public health metrics for surgical care. Mortality rates are useful indicators of the quality and safety of health care. The WHO standardised metrics are the first attempt to provide internationally consistent definitions of this rate. By engaging with these metrics, the Committee is contributing to an important global initiative that will make between-country comparisons possible.

Within New Zealand, comparisons can now be made across three years of the Committee's national reporting (2005–2009, 2006–2010 and the current report of 2007–2011). No clinically important changes have occurred over the last three years, which is understandable given this short time period. The latest 30-day perioperative mortality rates are 391 per 100,000 for cholecystectomy, 3311 per 100,000 for colorectal resection, 62.9 per 100,000 for Elective ASA 1 and 2 admissions, 125 per 100,000 for those within one day of general anaesthesia and 21.8 per 100,000 for pulmonary embolism-associated admissions.

This report continues to validate the use of the American Society of Anesthesiologists' Physical Status Classification System (or ASA) as the strongest predictor of mortality. It is clear from the data that, as one might expect, higher mortality rates are associated with increasing age, poorer health (higher ASA status) and acute admission.

Work is already underway to collect contextual information surrounding perioperative mortality in the coming year. I am impressed by the sophisticated approach being taken by this relatively new committee to collecting and analysing these data. They form a very important part of the Commission's overall framework for measuring the safety of health care in New Zealand, and are pivotally important for driving and demonstrating improvement.

I am encouraged by this detailed and thoughtful report, and by the direction that the Committee is taking. 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

The purpose of the Perioperative Mortality Review Committee ('POMRC' or 'the Committee') is to review and report on perioperative deaths with a view to reducing these deaths. The Committee advises on matters related to perioperative mortality and morbidity, and makes recommendations aimed at improving the quality and safety of the perioperative journey for the patient.

I am pleased to present the third report of the POMRC. This report details the epidemiology of perioperative mortality in five clinically important areas for 2007–2011 and, where applicable, compares perioperative mortality rates with previously reported data.

In the past year, the Committee has focused on five areas:

1. Cholecystectomy
2. Colorectal resection
3. General anaesthesia
4. Elective admissions for those classified as ASA 1 or 2
5. Pulmonary embolus-associated and attributed mortality.

Colorectal resection, general anaesthesia and elective admissions for those classified as ASA 1 or 2 have been repeated from earlier reports as a first step towards ongoing surveillance of perioperative mortality rates in New Zealand.

The Committee has also begun investigating the proposed World Health Organization (WHO) metrics for surgical care, giving an overall day of surgery mortality rate and inpatient mortality rates. Further metrics will be investigated in the coming year. This endeavour will produce data that are piloting these standardised metrics and will prove useful when other jurisdictions begin to adopt the metrics, leading to comparable global data focusing on the safety of surgery and anaesthesia.

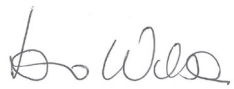
The unique legislation under which the POMRC was formed enables the Committee to collect data from a range of sources and thereby improves the quality of the data. There are necessary provisions that prohibit the dissemination of data in a way that is identifiable. The structure of this report reflects adherence to those provisions. The Committee is also mindful that it is the individual cases that can generate useful conversations that lead to health system improvements. As special topics are further explored by the Committee, it will become increasingly possible to produce composite case studies to complement the epidemiology of perioperative mortality.

The second aspect of enhancing our understanding of perioperative mortality (and morbidity) is to collect local data following a perioperative death. The Committee noted in its recent progress report[1] the project to develop an integrated form to collect multidisciplinary data following a death under the terms of reference of the Committee (Health Partners Consulting Group 2013). This project worked in close collaboration with the Committee, the Health Quality & Safety Commission and wider stakeholders; notably the Royal Australasian College of Surgeons, the Australian and New Zealand College of Anaesthetists and the Ministry of Health. The integrated form has undergone internal piloting. In the coming year, both external piloting and further development of a data collection infrastructure are planned.

1 http://www.hqsc.govt.nz/our-programmes/mrc/pomrc/publications-and-resources/publication/1451/

Perioperative deaths are reviewed variably at the local level across health care facilities, with some facilities conducting in-depth multidisciplinary reviews and others having little resource to undertake such review activities. The Committee is mindful of these variations and looks forward to working with all facilities in the coming year to develop a data infrastructure.

We remain very grateful for the support shown and advice given by the sector.



Dr Leona Wilson, ONZM
Chair, Perioperative Mortality Review Committee

Executive Summary

The Perioperative Mortality Review Committee's (the Committee's) role is to review and report on perioperative deaths with a view to reducing mortality and morbidity, and thereby improving the quality and safety of health and disability services in New Zealand.

Perioperative deaths are defined as any death that occurred following an operative procedure within 30 days or after 30 days but before discharge to home or a rehabilitation facility. Perioperative deaths also include deaths that occurred while under the care of a surgeon in hospital, even though an operation was not undertaken.

Operative procedure is broadly defined and includes gastroscopies, colonoscopies and cardiac or vascular angiographic procedures (diagnostic or therapeutic) carried out in designated endoscopy or radiological rooms as well as operative procedures.

Comparing New Zealand's perioperative mortality rates internationally

Although drawing comparisons between the perioperative mortality rates across differing health care systems can be problematic, New Zealand's rates are broadly consistent with those reported in other jurisdictions.

The Committee has investigated the use of the proposed World Health Organization (WHO) metrics for surgical care to start to address the challenges inherent in making international comparisons.

The day of surgery mortality rate per 100,000 for 2007–2011 as a percentage of all admissions (and within one day of general anaesthesia) was 80.2 per 100,000 or 0.08% for all surgical patients. The inpatient mortality rate for the same time period was 383.3 per 100,000 (0.38%) for all surgical patients and 370.5 per 100,000 (0.37%) for all deaths related to patients who had undergone a general anaesthetic. These two were chosen as the best indicators of mortality related to all procedures for the New Zealand health data.

Cumulative 30-day mortality: 2005–2011

With analyses now undertaken across several years, cumulative 30-day mortality rates for the clinical areas reported can be compared (Table 1). In the case of general anaesthesia, cumulative one-day mortality can be compared.

Table 1: Cumulative Mortality (per 100,000), New Zealand 2005–2011

TOPICS ANALYSED OVER TIME	2005–2009	2006–2010	2007–2011
		Cumulative 30-Day Mortality Rate per 100,000	
Cholecystectomy: Acute		1040.9 (1.04%)	975 (0.98%)
Cholecystectomy: Elective/Waiting List		164.6 (0.16%)	151 (0.15%)
Colorectal Resection: 45 Yrs+ Acute	9818.3 (9.82%)		8456 (8.46%)
Colorectal Resection: 45 Yrs+ Elective/Waiting List	2057.7 (2.06%)		1700.6 (1.7%)
Hip Arthoplasty 45 Yrs+ Acute	7268.6 (7.27%)		6608.9 (6.61%)
Hip Arthoplasty 45 Yrs+ Elective/Waiting List	235.3 (0.24%)		180.5 (0.18%)
Low-Risk Anaesthesia (ASA* 1 & 2, Elective/Waiting List)		68.8 (0.07%)	62.9 (0.06%)
Pulmonary Embolism (Cause of Death): Acute		54.5 (0.05%)	61.7 (0.06%)
Pulmonary Embolism (Cause of Death): Elective/Waiting List		7.6 (0.008%)	8.7 (0.009%)
		Cumulative One-Day Mortality	
General Anaesthesia	119.08 (0.12%)		125.47 (0.13%)

ASA: American Society of Anesthesiologists Physical Status Classification System.

Cumulative mortality (both acute and elective/waiting list) for cholecystectomy, colorectal resection (>45 years), hip arthroplasty (>45 years) and low-risk anaesthesia has remained stable or was lower in 2007–2011. There has been an insignificant increase in general anaesthesia one-day cumulative mortality and pulmonary embolism-attributed and associated mortality was higher in 2007–2011. One possible explanation for the latter apparent rise is that more cases of pulmonary embolism are now being identified due to an increased awareness of the issue and better diagnostics.

Perioperative mortality: 2007–2011

The following summarises the key findings of the areas analysed in this report for 2007–2011. For all areas of clinical significance analysed, there were a number of common themes. Higher mortality is associated with:

- increasing age
- poorer health (higher ASA status)
- whether the patient's admission to hospital was arranged or resulting from an emergency.

With the exception of general anaesthesia, malignant neoplasm was the most frequently listed cause of death. However, for many procedures, the malignancy is the reason for the procedure rather than the event leading to the patient's demise.

The American Society of Anesthesiologists Physical Status Classification System (ASA) score remains the strongest predictor of mortality. This finding persists for all analyses and is consistent with previous reports. In recent years, the reporting of ASA status has improved and has increased from 57% of cases in 2005–2009 to 63% in 2007–2011.

Colorectal resection (45+ years)

- There were 555 deaths, with most deaths occurring among acute admissions to public hospitals (n=362 or 66%).
- Cumulative mortality in the first 30 days after the procedure was 3311 per 100,000 (3.3%).
- The highest number of deaths occurred on the first and second days after an acute colorectal resection. For elective/waiting list admissions, mortality was higher on days two, three and five after the procedure.

The above findings were consistent with those recorded for the 2005–2009 period (POMRC 2011) with the following main additions or exceptions in 2007–2011:

- Regardless of admission type, cumulative mortality in the first 30 days was lower in 2007–2011.
- Deaths due to myocardial infarction were less frequent.

Cholecystectomy

- There were 118 deaths within 30 days following a cholecystectomy procedure.
- Cumulative mortality in the first 30 days after the procedure was 391 per 100,000 (0.4%).
- The cumulative mortality rate for open procedures was 4409 per 100,000 (4.4%) and 74 per 100,000 for laparoscopic procedures (0.07%).
- Mortality rates were highest on the first day after surgery for acute admissions, and on the fifth day after surgery for elective/waiting list admissions.

All of the above results were consistent with the 2006–2010 period (POMRC 2013). However, the cumulative mortality rates for both acute and elective/waiting list admissions was lower in 2007–2011. This comparison, though, may be affected by the removal of patients with more complex procedures from the 2007–2011 period.

General anaesthesia

- There were 1465 deaths. Most of these deaths occurred among acute admissions and at public hospitals.
- Cardiovascular causes were the most common underlying reason for mortality within the first day of receiving a general anaesthetic.
- For those admitted acutely or electively and from the waiting list, the risk of mortality after a general anaesthetic was significantly higher for those aged over 65 years, those who received more than one anaesthetic during their admission, and those with a first ASA score of 3 or more. The risk of mortality was significantly lower for those aged 25–44 years. These differences were present at the multivariate level (that is, when each sociodemographic and clinical factor had been adjusted for the other factors).

All of the above results were consistent with the 2005–2009 period with the following main exceptions or additions:

- The mortality rate is slightly higher, with 125 deaths per 100,000 in 2007–2011 compared with 119 deaths per 100,000.
- There was a modest rise in the number of deaths for all types of admissions, and public hospital semi-acute admissions in particular.
- The increase in public hospital semi-acute admission deaths was related to a higher number of deaths due to other injuries and other cardiovascular causes. Among acute admissions there were more deaths due to gastrointestinal conditions and falls. Deaths for those admitted electively or from the waiting list were higher due to cancer and other cardiovascular causes. By contrast, there were fewer deaths due to myocardial infarction in 2007–2011 for all admission types.

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

- There were 249 deaths within 30 days of an anaesthetic or neuraxial block.
- Mortality was highest on the second day after the initial general anaesthetic or neuraxial block.
- Mortality in the first 30 days was significantly higher for males than females, and for those over 25 years of age.

These findings were all consistent with those noted for the 2006–2010 period with the exception that cumulative mortality was slightly lower.

Pulmonary embolus-attributed and associated mortality

For pulmonary embolism-associated admissions:

- There were 276 deaths and the overall cumulative mortality for the 30-day period was 21.8 deaths per 100,000 initial anaesthetics (0.02%).
- Mortality was highest up to the second day following anaesthesia or neuraxial block.

For pulmonary embolism-attributed admissions:

- There were 136 deaths and the overall cumulative mortality for the 30-day period was 10.7 deaths per 100,000 initial anaesthetics (0.01%).

In relation to both pulmonary embolism-associated and attributed mortality, these findings were consistent with the 2006–2010 period with the following exceptions or additions:

- Cumulative mortality rates were higher in the 2007–2011 period for both acute and elective/waiting list admissions.
- The number of pulmonary embolism-attributed deaths was also higher, especially among acute admissions and people aged over 44 years.

Data limitations

Data in this report has been provided by the National Minimum Dataset (NMDS) and the National Mortality Collection (NMC). These databases have limitations associated with the completeness and accuracy of their information. For example, data from some privately funded procedures undertaken at private hospitals are not included in the NMDS. Both databases are reliant on the quality of the information obtained from clinical records and classification systems. This may vary over time and limit usefulness of comparisons between periods.

Report recommendations

The following recommendations have been developed by the Committee and are informed by the data presented in this report and the previous years' work of the Committee.

The Committee recommends for *improving perioperative* care that:

- the ASA Physical Status Classification for each patient is collected and communicated to all theatre staff. The Committee considers this is best done in the time-out part of the WHO Surgical Safety Checklist
- a continuing focus on promotion of formal and timely assessment of the risk of venous thromboembolism is warranted, including with acutely admitted patients, given the apparent minor increase in pulmonary embolism mortality.

The Committee recommends for *system development* that:

- the Committee works with health care providers to develop recommendations for standardised perioperative mortality reporting and reviewing.

The Committee recommends for *further analysis* that:

- the proposed WHO measures of surgical care are incorporated into perioperative mortality analysis and reporting
- a standard out-of-hospital death notification process be explored as a mechanism to identify deaths that occurred within 30 days of an operative procedure but after discharge
- the Commission considers developing a resource on hospital standardised mortality ratios.

New Zealand perioperative mortality and international comparison

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

There are increasing efforts to improve standardisation of data collection and reporting, and, therefore, increase the possibility of international comparison with other jurisdictions. For instance, the WHO has developed proposed standardised public health metrics for surgical care, summarised below.

Developing WHO metrics

The *WHO Guidelines for Safe Surgery 2009* (WHO 2009) recommend that for surgical surveillance at the national level, the following data should be collected systematically by WHO member states:

- number of operating theatres
- number of surgical procedures performed in an operating room
- number of trained surgeons and number of trained anaesthetists
- day of surgery mortality rate
- postoperative in-hospital mortality rate.

The Committee has looked at the last two metrics listed here: day of surgery and postoperative inpatient deaths.

Table 2: World Health Organization's Proposed Standardised Public Health Metrics for Surgical Care Analysed by the Committee

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

The day of surgery death ratio can be equated with the analysis of general anaesthesia deaths as presented in the Committee's inaugural report and provisionally presented here with adjustment for *same day*. The challenge for exploring this metric and providing an overall day of surgery mortality rate and postoperative mortality rate is defining and identifying all admissions undergoing surgery and then identifying the day of the procedure (which can be multiple).

Despite challenges inherent in exploring this particular metric, the Committee will continue to investigate its use and work with other metrics to explain New Zealand's rates of perioperative mortality and draw from international examples where appropriate.

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

- number of operating rooms by location: hospital, ambulatory, public/private
- number of trained surgeons by specialty
- number of other surgical providers
- number of trained anaesthetists
- number of perioperative nurses
- number of surgical procedures performed in operating rooms for the 10 most frequent procedures in the country, emergent or elective
- proportion of deaths on the day of surgery by procedure for the 10 most frequent procedures in the country
- proportion of in-hospital deaths after surgery by procedure for the 10 most frequent procedures in the country.

The Committee will investigate these metrics in future reports. Table 3 presents the total number of inpatient surgical procedures provided in New Zealand (2007–2011), the proportion of same-day fatalities and the proportion of inpatient deaths related to the admissions.

Table 3: Inpatient Deaths for All Surgical Procedures, New Zealand 2007–2011

	Number of Deaths on Same Day as Operation 2007–2011 *(Deaths Within 1 Day of General Anaesthesia)*	Number of Deaths as Inpatient 2007–2011	Number of Admissions 2007–2011	Day of Surgery Mortality Rate per 100,000 2007–2011 (% All Admissions) *(Deaths Within 1 Day of General Anaesthesia)*	Inpatient Mortality Rate per 100,000 2007–2011 (% All Admissions)
All surgical patients (specialty)	1,575	7,527	1,963,679	80.2 (0.08%)	383.3 (0.38%)
Deaths related to patients who undergo a general anaesthetic	1,465	4,326	1,167,573	125.5 0.13%	370.5 (0.37%)

Comparing existing data

With three complete years of analysis that cover 2005–2011 in selected areas of clinical relevance, some comparison can be drawn with other published studies of perioperative mortality. As noted above, however, there are inherent challenges in drawing comparisons. Table 4 provides comparison between New Zealand's perioperative mortality data and selected publications.

Table 4: New Zealand's Perioperative Mortality: Selected Procedures and Cause of Death, 2005–2011

	Proportion – Up to 30 Days Post-Surgery			Rate – Cumulative 30-Day Mortality per 100,000			International Comparison
	2005–2009	2006–2010	2007–2011	2005–2009	2006–2010	2007–2011	
Procedure: Cholecystectomy	-	120 deaths/ 29,473 admissions	118 deaths/ 30,157 admissions	-	1040.9 (1.04%) acute 164.6 (0.16%) elective	975 (0.98%) acute 151 (0.15%) elective	Similar to United States (US) (0.53%). (Yu et al 2011)
Procedure: Colorectal resection (45 yrs+)	652 deaths/ 16,238 admissions	-	555 deaths/ 16,760 admissions	9818.3 (9.82%) acute 2057.7 (2.06%) elective	-	8456 (8.46%) acute 1700.6 (1.7%) elective	Similar to US for elective operations but lower mortality with emergency procedures (US 15% mortality for emergency operations and 1.9% elective). (Ingraham et al 2010) 15% following acute surgery in Hong Kong. (Kwan et al 2008) Denmark reported significant variation between providers (3.5–44%). (Iversen 2012)
General anaesthesia	1387 deaths/ 1,164,764 anaesthetics	-	1465 deaths/ 1,167,573 anaesthetics	119.08 (0.12%)	-	125.47 (0.13%)	
Anaesthesia high-risk: 80 years and older	2799 deaths/ 62,230 initial anaesthetics	-	-	9008.6 (9.01%) acute 1210.9 (1.21%) elective	-	-	Lack of relevant national audits makes comparison difficult.
Anaesthesia low-risk: Elective admissions (ASA 1 and 2)		259 deaths/ 376,454 initial anaesthetics	249 deaths/ 395,982 initial anaesthetics		68.8 (0.07%)	62.9 (0.06%)	Broadly consistent but rarely specifically reported. (Bainbridge et al 2012)
Cause of death: Pulmonary embolism	-	241 deaths/ 1,259,032 – general anaesthetic or neuraxial block 241 deaths/ 2379 – pulmonary embolus-associated admissions	276 deaths/ 1,268,360 – general anaesthetic or neuraxial block 276 deaths/ 2312 – pulmonary embolus-associated admissions	-	54.5 (0.05%) acute 7.6 (0.008%) elective	61.7 (0.06%) acute 8.7 (0.009%) elective	Broadly similar to Japan (0.08%) (Sakon et al 2004) and lower than the estimate for the general Western surgical populations (0.9%). (Geerts et al 2001) The New Zealand figure includes mortality of inpatients and up to 30 days, consistent with evidence that thromboembolism may occur days after surgery post-discharge.

Perioperative Mortality 2007–2011

New initiatives are addressing the lack of information about the risk of death for surgical patients at the national level.

Recently the European Surgical Outcomes Study outlined mortality rates for patients undergoing non-cardiac surgery across 28 European countries (Pearse et al 2012). The Lancet Commission on Global Surgery has announced its plan to define clear metrics for tracking surgical mortality at the national level (Meara et al 2014). In the meantime, the National Surgical Quality Improvement Programme has highlighted the important impact that providing surgical outcome information can make to reducing mortality, morbidity and cost in the United States (Maggard-Gibbons 2014). Hospitals in the United States have reported benefits from employing mortality review as a tool to reduce perioperative deaths (Barbieri et al 2013; Heslin et al 2014). International interest remains focused on identifying proven clinical interventions to reduce perioperative mortality (Landoni et al 2012).

The Committee continues to use existing data sets to report perioperative mortality while also working to develop a method to capture more clinically relevant data in order to enhance quality improvement. Ongoing surveillance is important to enable changes over time to be explored and new insights learned (Weiser et al 2009). This report revisits several key areas that have been described in the previous reports. Mortality following colorectal resection and cholecystectomy are presented again. These procedures were revisited because they are common operations undertaken at a wide range of hospitals and there are a relatively high number of deaths. In this report, the risk of death following cholecystectomy is assessed without the occurrence of more extensive surgery. Deaths within one day of general anaesthesia are also revisited to continue surveillance on these cases as a general indicator of the quality of perioperative care close to the time of anaesthesia and surgery. Deaths among elective patients assessed to be ASA category 1 or 2 remains a focus as mortality is expected to be an unlikely occurrence among these low-risk patients. Finally, in keeping with the Health Quality & Safety Commission's focus on improving perioperative care and the use of the World Health Organization's Surgical Safety Checklist, rates of pulmonary embolism-associated or attributed mortality are re-examined.

Colorectal Resection

The following section uses information from the National Minimum Dataset (NMDS) and the National Mortality Collection (NMC) to review hospital admissions for colorectal resections, as well as mortality in the first 30 days following these procedures for adults 45+ years of age.

Future reports will provide more data about mortality trends over time and should examine the mortality associated with laparoscopic and open procedures separately. The reduction in deaths due to myocardial infarction is welcome and ongoing surveillance will help establish whether improvements in perioperative care may be responsible.

Key findings

- In New Zealand during 2007–2011 following colorectal resections for adults 45+ years of age, there were 555 deaths, with most deaths occurring among acute admissions to public hospitals (n=362 or 66%).
- Cumulative mortality in the first 30 days after the procedure was 3311 per 100,000 (3.3%).
- Cumulative mortality in the first 30 days after the procedure was higher for acute admissions (8456 per 100,000 procedures or 8.5%) than for elective/waiting list admissions (1701 per 100,000 or 1.7%).
- The highest number of deaths occurred on the first and second days after an acute colorectal resection. For elective/waiting list admissions, mortality was higher on days two, three and five after the procedure.
- Regardless of admission type the number of deaths steadily tapers off after the first 5–7 days following the procedure.
- Acute admissions had a higher rate of mortality than elective/waiting list admissions in every age group (especially the older age groups), and every American Society of Anesthesiologists (ASA) score category.
- As the ASA score increased, so did the mortality rates for acute and semi-acute admissions for colorectal resection. Mortality rates for elective/waiting list admissions also increased as ASA scores increased from 1 to 4.
- Malignant neoplasms of the colon were the most frequent main underlying cause of death for those undergoing colorectal resection, regardless of whether the admission was acute, semi-acute, or elective/from the waiting list.
- For acute admissions, there were significantly higher rates of mortality for those aged 65–79 and 80+ years (compared with 45–64 years), those with an ASA score of 3, 4 or 5 (vs. an ASA score of 1–2) and those living in more deprived areas (decile 9–10 areas vs. those in decile 1–2). These differences were significant after the effects from other factors (age, gender, ethnicity, New Zealand Deprivation Index (NZDep) decile and ASA score) had been adjusted for.
- For elective/waiting list admissions, mortality rates were significantly higher for males, people aged 65–79 and 80+ years (compared with 45–64 years) and those with an ASA score of 3 or 4 (vs. an ASA score of 1–2). These differences were significant after the effects from other factors (age, gender, ethnicity, NZDep decile and ASA score) had been adjusted for.

The above findings were consistent with those recorded for the 2005–2009 period with the following main additions or exceptions in 2007–2011:

- Regardless of admission type, cumulative mortality in the first 30 days has decreased. Previous cumulative mortality from 2005–2009 was 9818 per 100,000 or 1% for acute admissions and 2058 per 100,000 or 0.2% for elective/waiting list resections.
- Mortality rates for both elective/waiting list and acute admissions have dropped in most age groups.
- For both acute and elective/waiting list procedures, deaths due to myocardial infarction were less frequent.
- For acute admissions there were small differences in the multivariate model, mortality rates for people of decile 9–10 were statistically significant and the odds ratio for mortality for Māori was slightly lower and no longer statistically significant.
- For elective/waiting list admissions, there were no longer statistically significant reductions in the odds ratios for mortality across all NZDep deciles in the multivariate analysis. The increase in the odds ratio for mortality among people with Asian/MELAA (Middle Eastern/Latin American/African) and other ethnicities was no longer statistically significant.

Data sources and limitations

Hospital admissions for a colorectal resection (all age groups) are presented along with information about mortality in the first 30 days following a colorectal resection in adults 45+ years of age (resulting from their first colorectal resection only).

Data in this report have been provided by the NMDS and the NMC. These databases have limitations associated with the completeness and accuracy of their information. For example, data from some privately funded procedures undertaken at private hospitals are not included in the NMDS. Both databases are reliant on the quality of the information obtained from clinical records and classification systems.

Changes over time should be interpreted with caution as a range of factors could influence the apparent improvement in mortality rates. Analyses in subsequent reports will further examine this finding.

For the period 2007–2011 the NMDS does not include separate procedure codes for laparoscopic and open colorectal resection procedures. These data are available from 2012 and will be included in future reports.

Detailed information about data sources and methods is presented in Appendix 2.

Definitions

1. Hospital admissions for a colorectal resection (all age groups).
2. Mortality in the first 30 days following a colorectal resection in adults 45+ years of age (resulting from their first colorectal resection only).

Mortality following colorectal resection

Mortality following colorectal resection by hospital and admission type and cause of death

In New Zealand during 2007–2011, 555 deaths occurred after colorectal resection. Among these deaths, 548 were at public hospitals, predominantly among acute patients (n=362, 66%). Malignant neoplasm of the colon was the most frequent main underlying cause of death for those undergoing colorectal resection, regardless of whether the admission was acute, semi-acute or elective/waiting list. However, the malignant neoplasm may have been the reason for the operation with a complication causing death. Diverticular disease was the leading cause of non-cancer death for those acutely admitted for colorectal resection, while gastrointestinal diseases were the most common non-cancer cause for those admitted electively or from the waiting list. Compared to 2005–2009, myocardial infarction has decreased in number for all admission types, especially for elective/waiting list admissions where they were the leading cause of non-cancer mortality following colorectal resection for 2005–2009 but have changed to being the least frequent in 2007–2011 (Table 5).

Table 5: Mortality Following Colorectal Resection by Admission and Hospital Type and Main Underlying Cause of Death in Adults 45+ Years of Age, New Zealand 2007–2011

MAIN UNDERLYING CAUSE OF DEATH	Total Deaths 2007–2011	Annual Average	Deaths in Category (%)
Colorectal Resection			
Acute Admissions			
Malignant Neoplasm Colorectal	130	26.0	35.9
Other Neoplasms	10	2.0	2.8
Diverticular Disease	54	10.8	14.9
Paralytic Ileus/Intestinal Obstruction	41	8.2	11.3
Vascular Disorders Intestine	38	7.6	10.5
Other Gastrointestinal Diseases	44	8.8	12.2
Myocardial Infarction	3	0.6	0.8
Other Cardiovascular Causes	12	2.4	3.3
Emphysema/COPD/Other Respiratory	<3	s	s
Other Causes	29	5.8	8.0
Total Acute	362	72.8	100.0
Public Hospital Semi-Acute			
Malignant Neoplasm Colorectal	10	2.0	40.0
Other Neoplasms	<3	s	s
Diverticular Disease	3	0.6	12.0
Other Gastrointestinal Diseases	<3	s	s
Myocardial Infarction/Other Cardiovascular	3	0.6	12.0
No Diagnosis/Other Causes	7	1.4	28.0
Total Public Hospital Semi-Acute	25	5.0	100.0
Elective/Waiting List Admissions			
Malignant Neoplasm Colorectal	123	24.6	73.2
Other Neoplasms	14	2.8	8.3
Other Cardiovascular Causes	10	2.0	6.0
Gastrointestinal Diseases	12	2.4	7.1
Other Causes	9	1.8	5.4
Total Elective/Waiting List	168	33.6	100.0
Grand Total	555	111	

Data source: NMC: Deaths occurring within 30 days of a colorectal resection, as recorded in the NMDS.
COPD: Chronic obstructive pulmonary disease.
s: Rates supressed due to small numbers.

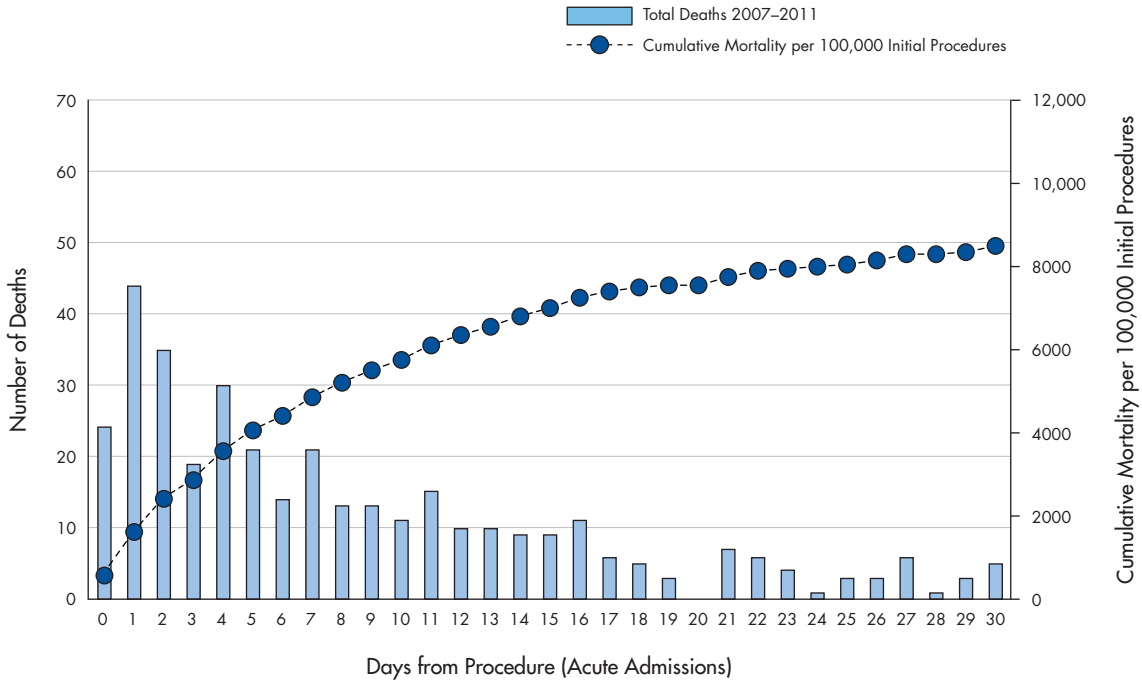
Mortality following colorectal resection by day from procedure

For acute admissions during 2007–2011, the highest mortality occurred on the first and second days after a colorectal resection procedure (Figure 1). This is the same as for the 2005–2009 period.

The highest number of deaths for those admitted electively/from the waiting list occurred on the fifth day after the procedure, followed by the second and third days. During 2005–2009, the second and third days had the highest mortality following elective/waiting list colorectal resections, followed by day five.

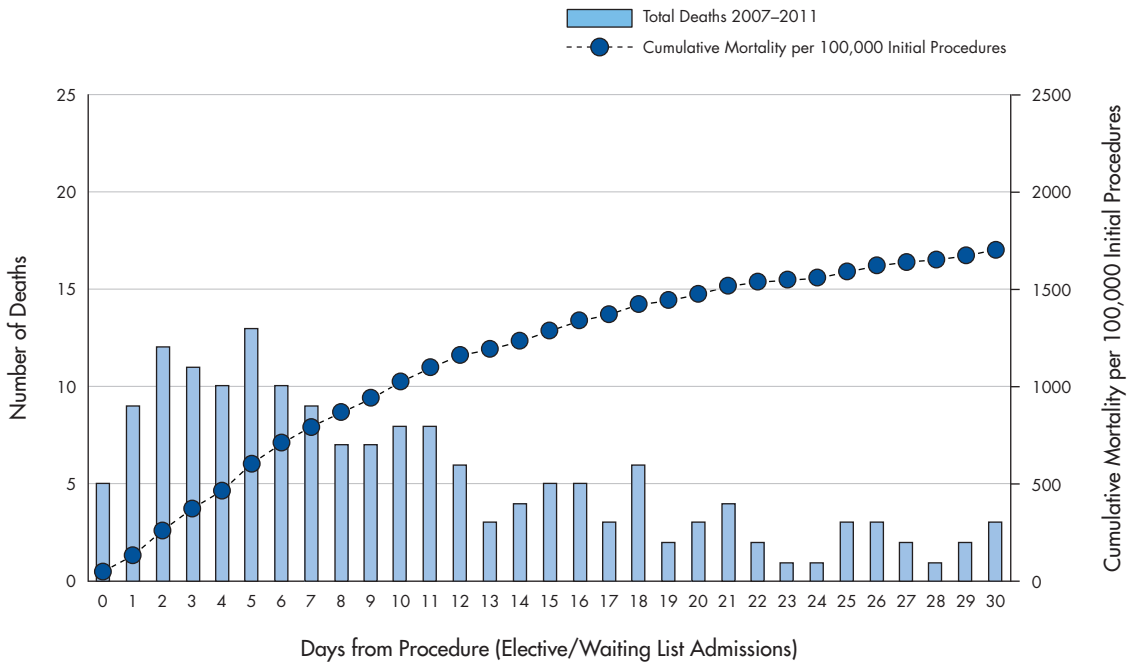
During 2007–2011, cumulative mortality rates for those admitted electively/from the waiting list were lower over the first 30-day period (1701 per 100,000 initial procedures) than for the acute admissions (8456 per 100,000 initial procedures) (Figure 2). Cumulative mortality in the first 30 days has dropped for both admission types compared to 2005–2009 (previous rates for 2005–2009 were 9818 per 100,000 or 1% for acute admissions and 2058 per 100,000 or 0.2% for elective/waiting list resections). Regardless of admission type, the number of deaths steadily tapers off after the first 5–7 days following the initial procedure for both the 2007–2011 period and 2005–2009 period.

Figure 1: Mortality Following Acute Admission for Colorectal Resection by Day from Procedure in Adults 45+ Years, New Zealand 2007–2011



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

Figure 2: Mortality Following Elective/Waiting List Admission for Colorectal Resection by Day from Procedure in Adults 45+ Years, New Zealand 2007–2011

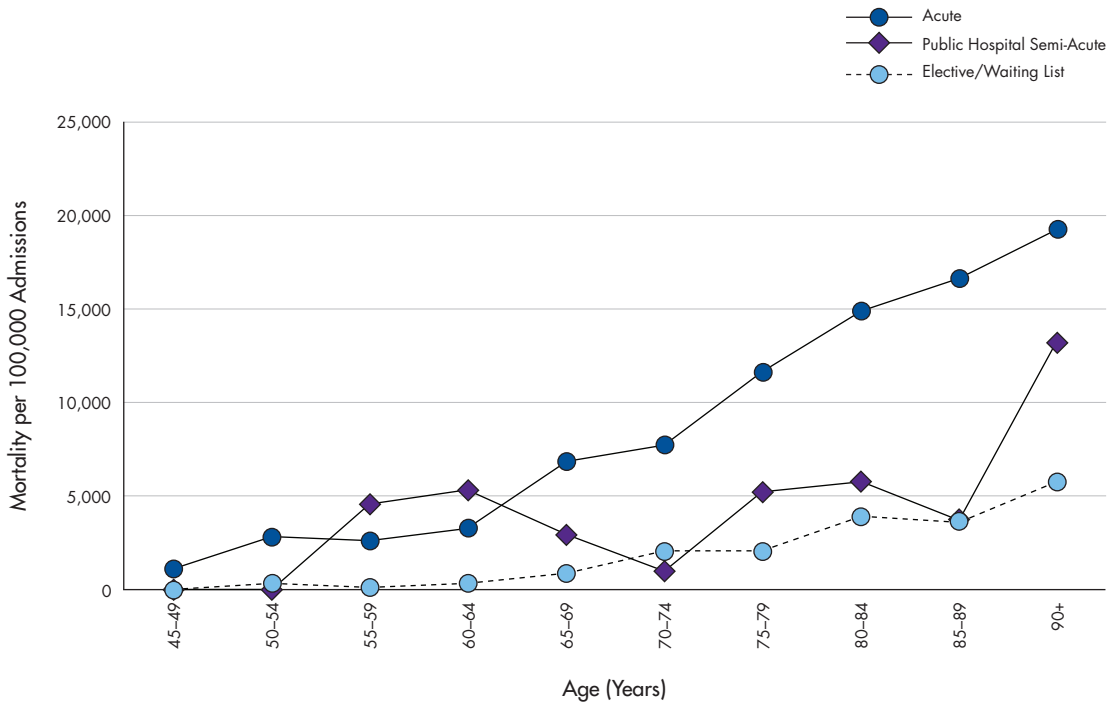


Numerator: NMC: Deaths occurring within 30 days of an elective/waiting list colorectal resection, as recorded in the NMDS.
Denominator: NMDS: Elective/Waiting list hospital admissions with a colorectal resection listed in any of the first 90 procedures.

Mortality following colorectal resection by age

In New Zealand during 2007–2011, mortality in adults over 45 years following a colorectal resection increased with age, reaching the highest rates at 90+ years for all admission types (Figure 3). Acute admissions had a higher rate of mortality than elective/waiting list admissions in every age group. Compared to the 2005–2009 period, mortality rates for both acute and elective/waiting list admissions have dropped in most age groups, while changes in semi-acute admissions were more varied (likely due to the smaller sample sizes in this category).

Figure 3: Mortality Following Colorectal Resection by Admission Type and Age in Adults 45+ Years, New Zealand 2007–2011

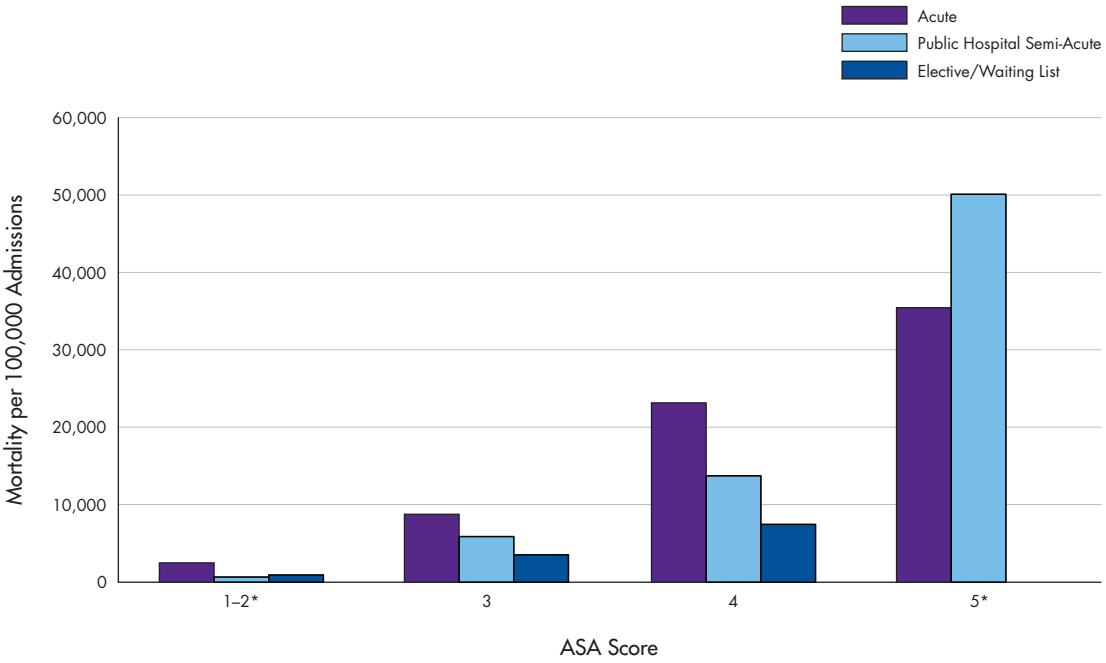


Numerator: NMC: Deaths occurring within 30 days of a colorectal resection, as recorded in the NMDS.
Denominator: NMDS: Hospital admissions with a colorectal resection listed in any of the first 90 procedures.

Mortality following colorectal resection by ASA score

During 2007–2011, mortality rates following colorectal resection increased as the ASA score increased for all hospital admission types (Figure 4). ASA scores of 5 continued to have the highest rates of mortality for acute and semi-acute admissions. Those admitted electively/from the waiting list had lower rates of mortality in almost every ASA category. However, caution is needed when interpreting the semi-acute category for ASA 1–2 scores, as well as semi-acute and elective/waiting list admissions in the ASA 5 category, as sample sizes were small for each (n<3 deaths). These smaller sample sizes have also likely caused the large changes in mortality rates for 2007–2011 related to the semi-acute and elective/waiting list categories for ASA 4–5 admissions in comparison with those presented in the 2005–2009 period.

Figure 4: Mortality Following Colorectal Resection by Admission Type and ASA Score in Adults 45+ Years, New Zealand 2007–2011



Numerator: NMC: Deaths occurring within 30 days of a colorectal resection, as recorded in the NMDS.
Denominator: NMDS: Hospital admissions with a colorectal resection listed in any of the first 90 procedures.
* Care should be taken when interpreting ASA 1–2 rates for semi-acute admissions, as well as ASA 5 rates for semi-acute and elective/waiting list admissions, as each are based on <3 deaths.

Mortality following colorectal resection by sociodemographic factors and ASA score

Acute admissions

During 2007–2011, mortality rates for those admitted for colorectal resection were significantly higher for people aged 65–79 and 80+ years (compared with 45–64 years), had an ASA score of 3, 4 or 5 (vs. an ASA score of 1–2) and who were living in decile 9–10 areas according to the NZDep (vs. those of decile 1–2) (Table 6). These differences prevailed, even after the effects from other sociodemographic factors (that is, age, gender, ethnicity, NZDep decile) and ASA score had been adjusted for. When compared to the 2005–2009 period, most of the above results are repeated. However, there was no statistical difference in mortality for people of decile 9–10 areas (vs. decile 1–2) at the multivariate level in the previous report, and there was a slightly higher mortality rate for people of Māori ethnicity that was statistically significant (after the other factors had been accounted for) for the 2005–2009 period.

Elective/Waiting list admissions

For the same period, mortality rates for elective/waiting list admissions were significantly higher for males, people aged 65–79 and 80+ years (compared with 45–64 years), and people with an ASA score of 3 or 4 (compared to an ASA score of 1–2) (Table 7). These differences persisted, even after the risks from other factors (that is, age, gender, ethnicity, NZDep decile and ASA score) were adjusted for. At the univariate level, those living in NZDep decile 7–8 areas were also significantly more likely to die after colorectal resection than those living in decile 1–2 areas. However, once the other sociodemographic factors and the ASA score were adjusted for, there was no longer any significant difference. The mortality rates for people of Māori ethnicity were significantly higher than European mortality rates, only after age, gender, ethnicity, NZDep decile and ASA score were accounted for. The main differences observed in the 2007–2011 data compared with the last report (2005–2009) are that previously across all levels of deprivation there were statistically significant reductions in the odds ratio of mortality. In addition, the multivariate mortality estimate for Asian/MELAA/Other ethnicities was statistically significant in the previous report but the univariate estimate for people in NZDep deciles 7–8 was not statistically significant.

Table 6: Mortality Following Acute Admission for Colorectal Resection by Age Group, Gender, ASA Score, Ethnicity and NZ Deprivation Index Decile in Adults 45+ Years, New Zealand 2007–2011

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
Colorectal Resection									
Acute									
Age Group	45–64 Years	36	1,381	2,606.8	2.61	1.00		1.00	
	65–79 Years	170	1,925	8,831.2	8.83	3.62*	2.51–5.22	3.00*	2.06–4.39
	80+ Years	156	975	16,000.0	16.00	7.12*	4.90–10.33	5.14*	3.46–7.62
Gender	Male	171	1,997	8,562.8	8.56	1.00		1.00	
	Female	191	2,284	8,362.5	8.36	0.97	0.79–1.21	0.88	0.70–1.11
ASA Score	1–2	42	1,634	2,570.4	2.57	1.00		1.00	
	3	123	1,413	8,704.9	8.70	3.61*	2.53–5.17	2.60*	1.79–3.76
	4	127	548	23,175.2	23.18	H	H	H	H
	5	16	45	35,555.6	35.56	H	H	H	H
	Not Stated	54	641	8,424.3	8.42	3.49*	2.30–5.28	2.87*	1.88–4.39
Ethnicity	European	306	3,641	8,404.3	8.40	1.00		1.00	
	Māori	31	293	10,580.2	10.58	1.29	0.87–1.91	1.33	0.86–2.07
	Pacific	6	98	6,122.4	6.12	0.71	0.31–1.64	0.80	0.33–1.97
	Asian/ MELAA/ Other	13	160	8,125.0	8.13	0.96	0.54–1.72	1.03	0.56–1.92
NZ Deprivation Index Decile	Decile 1–2	41	629	6,518.3	6.52	1.00		1.00	
	Decile 3–4	50	706	7,082.2	7.08	1.09	0.71–1.68	1.04	0.66–1.63
	Decile 5–6	76	922	8,243.0	8.24	1.29	0.87–1.91	1.15	0.76–1.75
	Decile 7–8	94	1,073	8,760.5	8.76	1.38	0.94–2.02	1.20	0.80–1.80
	Decile 9–10	101	920	10,978.3	10.98	1.77*	1.21–2.58	1.54*	1.02–2.33

Numerator: NMC: Deaths occurring within 30 days of an acute colorectal resection, as recorded in the NMDS.
Denominator: NMDS: Hospital admissions with a colorectal resection listed in any of the first 90 procedures.
* Significantly different from reference category.
MELAA: Middle Eastern/Latin American/African.
OR: Odds ratio.
CI: Confidence interval.
Caution should be observed when interpreting ORs where mortality exceeds 10% (see Appendix 2 for details).
H: Odds ratios suppressed due to high mortality rates.

Table 7: Mortality Following Elective/Waiting List Admission for Colorectal Resection by Age Group, Gender, ASA Score, Ethnicity and NZ Deprivation Index Decile in Adults 45+ Years, New Zealand 2007–2011

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
Colorectal Resection									
Elective/Waiting List									
Age Group	45–64 Years	7	3,120	224.4	0.22	1.00		1.00	
	65–79 Years	83	4,805	1,727.4	1.73	7.82*	3.61–16.93	6.49*	2.97–14.17
	80+ Years	78	1,954	3,991.8	3.99	18.49*	8.52–40.15	13.35*	6.01–29.64
Gender	Male	101	4,993	2,022.8	2.02	1.00		1.00	
	Female	67	4,886	1,371.3	1.37	0.67*	0.49–0.92	0.64*	0.47–0.88
ASA Score	1–2	38	4,642	818.6	0.82	1.00		1.00	
	3	84	2,364	3,553.3	3.55	4.46*	3.03–6.57	2.95*	1.99–4.37
	4	18	243	7,407.4	7.41	9.69*	5.45–17.25	6.13*	3.41–11.04
	5	<3	s	s	s	s	s	s	s
	Not Stated	28	2,628	1,065.4	1.07	1.31	0.80–2.13	1.33	0.81–2.18
Ethnicity	European	153	8,711	1,756.4	1.76	1.00		1.00	
	Māori	9	403	2,233.3	2.23	1.28	0.65–2.52	2.05*	1.01–4.18
	Pacific	<3	s	s	s	s	s	s	s
	Asian/ MELAA/ Other	5	324	1,543.2	1.54	0.88	0.36–2.15	1.20	0.48–2.98
NZ Deprivation Index Decile	Decile 1–2	4	99	4,040.4	4.04	1.00		1.00	
	Decile 3–4	3	118	2,542.4	2.54	0.89	0.50–1.58	0.80	0.45–1.43
	Decile 5–6	3	160	1,875.0	1.88	1.25	0.74–2.09	1.08	0.64–1.83
	Decile 7–8	8	138	5,797.1	5.80	1.68*	1.04–2.71	1.38	0.85–2.24
	Decile 9–10	6	109	5,504.6	5.50	1.12	0.64–1.95	0.90	0.51–1.59

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

Background: hospital admissions for colorectal resection

Colorectal resection admissions by hospital and admission type

In New Zealand during 2007–2011, the majority of admissions (65.2%) for colorectal resection were elective/drawn from the waiting list, while 30.6% of admissions were acute events, and 4.3% were semi-acute (occurring within the first seven days of referral) (Table 8). No acute or semi-acute admissions occurred at private hospitals. Compared with 2005–2009, the 2007–2011 data showed increases in the number of both acute and elective/waiting list admissions, while public hospital semi-acute admissions declined.

Table 8: Hospital Admissions for Colorectal Resections by Admission Type, New Zealand 2007–2011

ADMISSION TYPE	Total Admission Events 2007–2011	Annual Average	Admissions (%)
Colorectal Resection			
Acute	5,122	1,024.4	30.6
Public Hospital Semi-Acute	717	143.4	4.3
Private Hospital Elective/Waiting List	1,779	355.8	10.6
Public Hospital Elective/Waiting List	9,142	1,828.4	54.5
Total Admissions	16,760	3,352.0	100.0

Data source: NMDS: Hospital admissions with a colorectal resection listed in any of the first 90 procedures.

Colorectal resection admissions by primary diagnosis

In New Zealand during 2007–2011, malignant neoplasm of the colon, rectum or anus, followed by diverticular disease, were the two most common causes for acute, semi-acute and elective/waiting list admissions for those undergoing colorectal resection (Table 9). Volvulus was the third most frequent cause of acute admissions, while Crohn's disease was the third most common cause for semi-acute and elective/waiting list admissions.

Compared with 2005–2009, the most common causes for each admission type remain largely unchanged, with the only exception being semi-acute admission types, where benign neoplasm of the colon, rectum or anus, and ulcerative colitis were both the third most frequent cause of semi-acute admissions.

Table 9: Hospital Admissions for Colorectal Resection by Primary Diagnosis and Admission Type, New Zealand 2007–2011

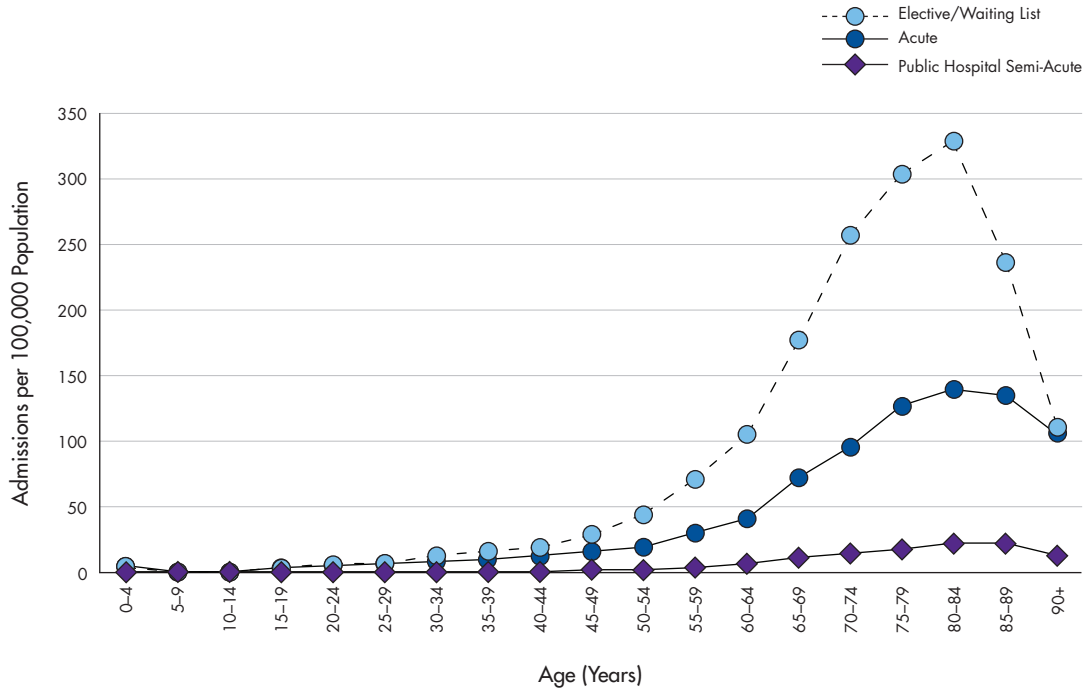
PRIMARY DIAGNOSIS	Total Admission Events 2007–2011	Annual Average	Admissions (%)
Colorectal Resection			
Acute			
Malignant Neoplasm Colon/Rectum/Anus	2,051	410.2	40.0
Diverticular Disease	838	167.6	16.4
Volvulus	261	52.2	5.1
Crohn's Disease	153	30.6	3.0
Ulcerative Colitis	107	21.4	2.1
Benign Neoplasm Colon/Rectum/Anus	26	5.2	0.5
Other Diagnoses	1,686	337.2	32.9
Total	5,122	1,024.4	100.0
Public Hospital Semi-Acute			
Malignant Neoplasm Colon/Rectum/Anus	466	93.2	65.0
Diverticular Disease	37	7.4	5.2
Benign Neoplasm Colon/Rectum/Anus	12	2.4	1.7
Crohn's Disease	20	4.0	2.8
Ulcerative Colitis	18	3.6	2.5
Volvulus	5	1.0	0.7
Other Diagnoses	159	31.8	22.2
Total	717	143.4	100.0
Elective/Waiting List			
Malignant Neoplasm Colon/Rectum/Anus	6,842	1,368.4	62.6
Diverticular Disease	541	108.2	5.0
Benign Neoplasm Colon/Rectum/Anus	523	104.6	4.8
Crohn's Disease	287	57.4	2.6
Ulcerative Colitis	228	45.6	2.1
Volvulus	44	8.8	0.4
Other Diagnoses	2,456	491.2	22.5
Total	10,921	2,184.2	100.0

Data source: NMDS: Hospital admissions with a colorectal resection listed in any of the first 90 procedures.

Colorectal resection admissions by age and admission type

Colorectal resection admission rates increased with age during 2007–2011, peaking at age 80–84 for elective/waiting list and acute admissions, and 85–89 for semi-acute admissions, before declining (Figure 5). Elective/Waiting list admissions were generally more common than acute or semi-acute admissions for colorectal resection, especially in the older age groups. These patterns are similar to the 2005–2009 results, except that elective/waiting list admissions peaked at a slightly younger age (75–79 years) in the earlier data.

Figure 5: Hospital Admissions for Colorectal Resection by Age and Admission Type, New Zealand 2007–2011

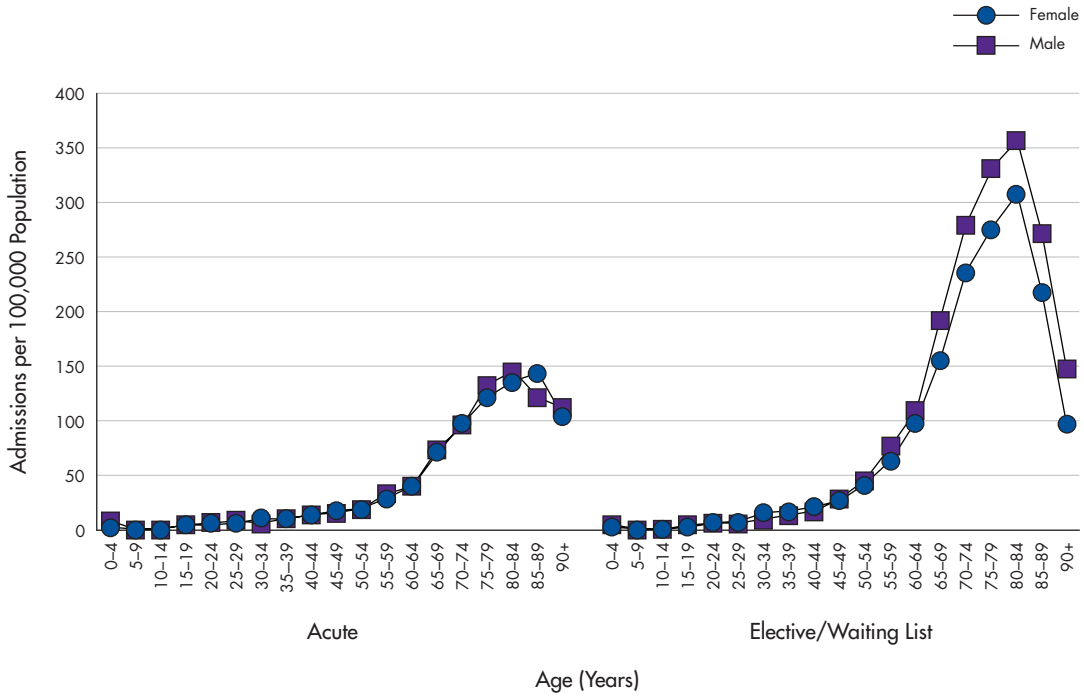


Numerator: NMDS: Hospital admissions with a colorectal resection listed in any of the first 90 procedures.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Colorectal resection admissions by age, admission type and gender

Acute admission rates for colorectal resections were similar for males and females during 2007–2011, increasing after 40 years and peaking at age 80–84 for males and 85–89 for females (Figure 6). Elective/Waiting list admissions were most common at age 80–84 for both genders (compared to 75–79 years during 2005–2009); however, after 55 years of age, more males than females were admitted for colorectal resection. Elective/Waiting list admission rates have increased for the older age groups since the earlier report. From 2007–2011, there were 357 males admitted per 100,000 elective/waiting list admissions (compared to 322 per 100,000 during 2005–2009) and 307 females admitted per 100,000 admissions (compared to 284 per 100,000 previously).

Figure 6: Hospital Admissions for Colorectal Resection by Age, Admission Type and Gender, New Zealand 2007–2011

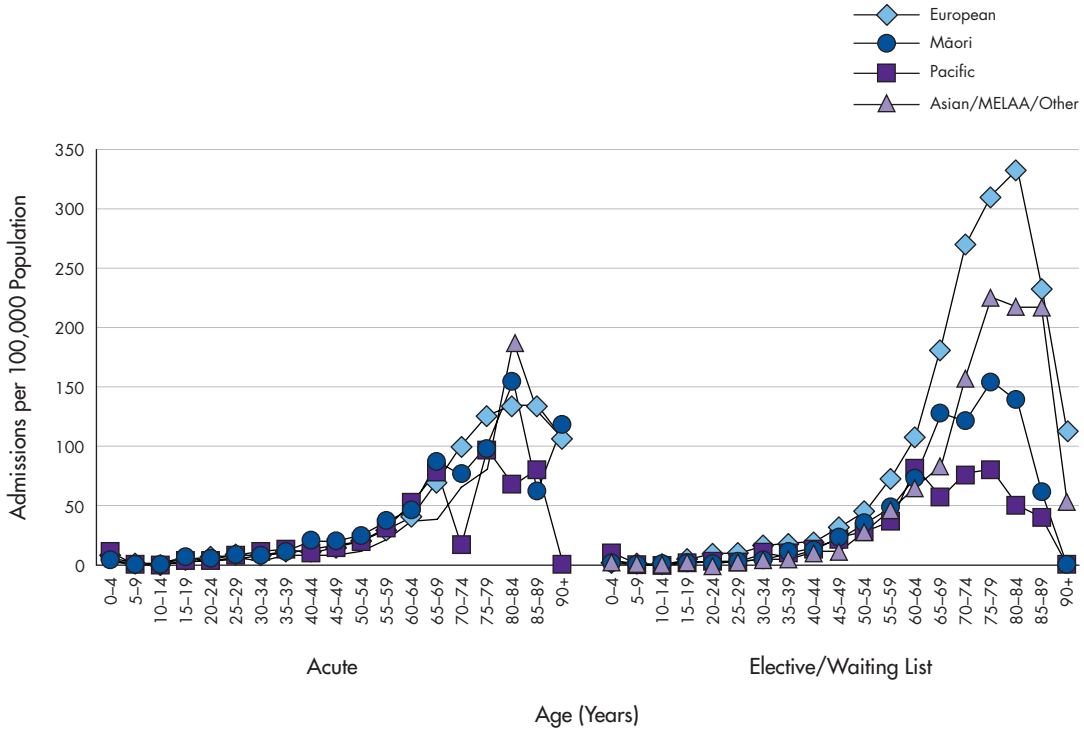


Numerator: NMDS: Hospital admissions with a colorectal resection listed in any of the first 90 procedures.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Colorectal resection admissions by age, admission type and ethnicity

During 2007–2011 in New Zealand, acute hospital admissions for colorectal resections increased with age for all ethnic groups up to 65 years (Figure 7). Due to the smaller numbers of admissions in the older age groups (70+ years), the results are more difficult to interpret for these age groups. For elective/waiting list admissions, European people were admitted at a higher rate than all other ethnic groups. These results are similar to the 2011 report findings, with the exception of a noticeable increase in elective/waiting list admissions for the Asian/MELAA/Other ethnic groups aged 70–89 years in 2007–2011.

Figure 7: Hospital Admissions for Colorectal Resection by Age, Admission Type and Ethnicity, New Zealand 2007–2011

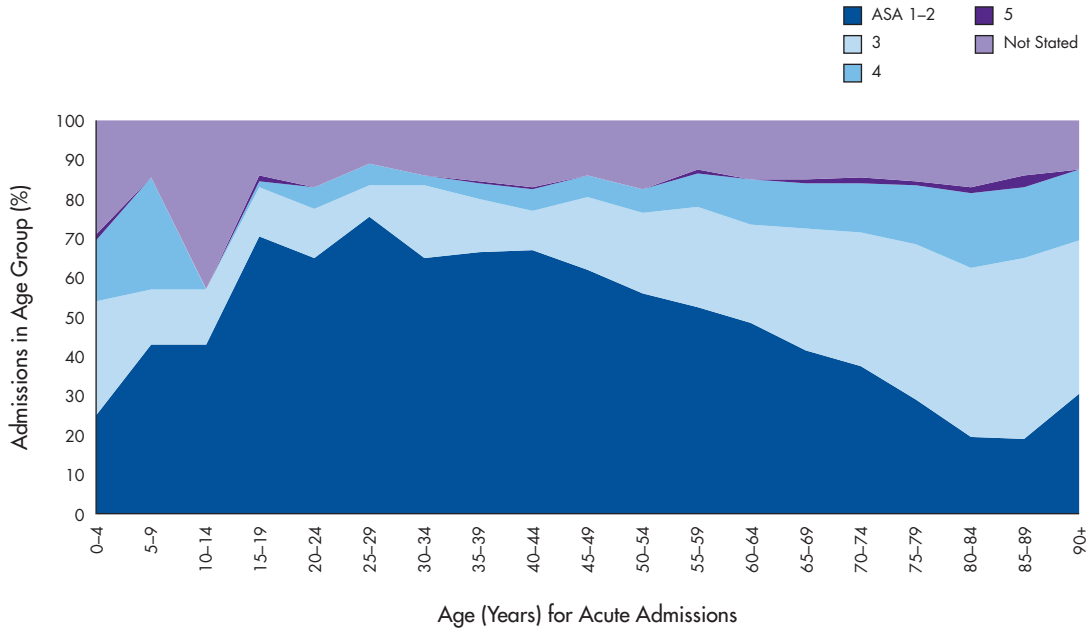


Numerator: NMDS: Hospital admissions with a colorectal resection listed in any of the first 90 procedures.
Denominator: Statistics New Zealand: Estimated Resident Population. Ethnicity is level 1 prioritised.
MELAA: Middle Eastern/Latin American/African.

Colorectal resection admissions by age and ASA score

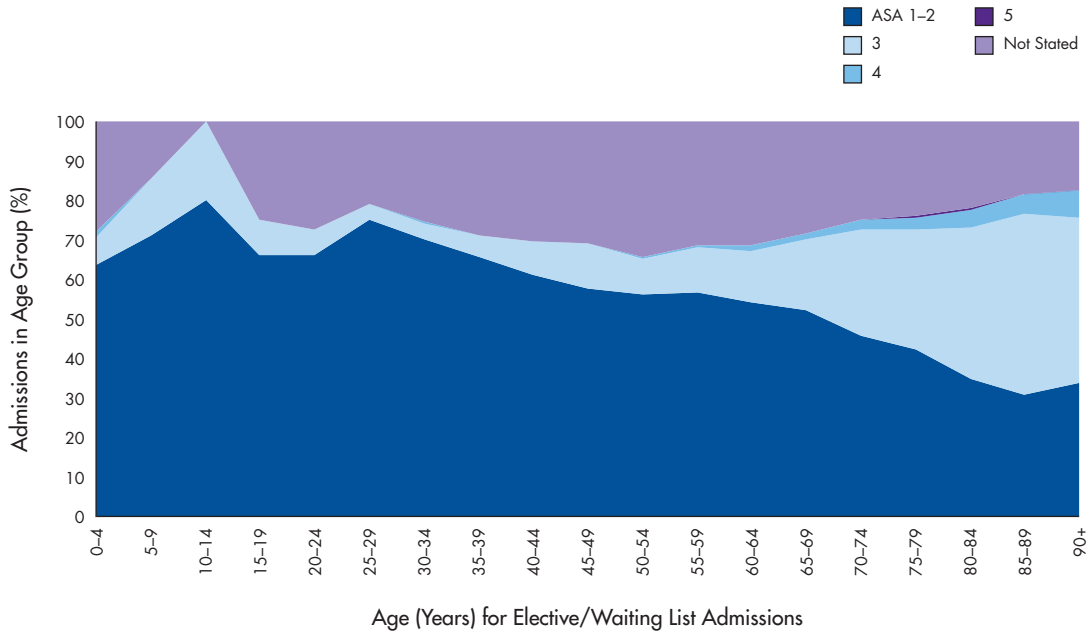
The proportion of acute hospital admissions for colorectal resection with ASA scores of 1–2 (indicating the healthiest patients) was highest amongst the 15–40-year age groups, with ASA scores of 3 or more being more common at either end of the age distribution (Figure 8). These results are broadly similar to the findings of the last report. For elective/waiting list admissions during 2007–2011, ASA scores of 3 or more were most common amongst the older age groups (Figure 9). Better reporting of elective/waiting list admissions in the 5–14-year age groups has resulted in an increase in ASA scores of 1–3 for these age groups compared to the 2005–2009 period, where 50% of 5–9-year-old admissions did not have their ASA score recorded.

Figure 8: Acute Hospital Admissions for Colorectal Resection by Age and ASA Score, New Zealand 2007–2011



Numerator: NMDS: Acute hospital admissions with a colorectal resection listed in any of the first 90 procedures.

Figure 9: Elective/Waiting List Admissions for Colorectal Resection by Age and ASA Score, New Zealand 2007–2011



Numerator: NMDS: Elective/Waiting list hospital admissions with a colorectal resection listed in any of the first 90 procedures.

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. Mortality following cholecystectomy was examined in the 2012 report for the 2006–2010 period; however, those results included a small number of procedures (approximately 280) in which cholecystectomy was performed as part of a more extensive procedure, such as liver resection. It is likely that the mortality associated with these procedures more closely relates to that of the extensive operation and therefore this report has revisited this topic. Those procedures in which a cholecystectomy was conducted as a minor component of a more extensive operation have been removed from these analyses.

Key findings

- In New Zealand during 2007–2011, there were 118 deaths within 30 days following a cholecystectomy procedure. The overall cumulative mortality rate was 391 per 100,000 (0.4%). Most of these deaths were after either an open procedure (69.5%) or an acute admission (71%).
- The cumulative mortality rate for open procedures was 4409 per 100,000 (4.4%) and 74 per 100,000 for laparoscopic procedures (0.07%).
- Cumulative mortality rates in the first 30 days following a cholecystectomy were higher for those admitted acutely (975 per 100,000 (1%)) than those admitted electively or from the waiting list (151 per 100,000 (0.2%)).
- Mortality rates were highest on the first day after surgery for acute admissions, and on the fifth day after surgery for elective/waiting list admissions.
- Malignant neoplasms were the most frequently listed main underlying cause for those dying within 30 days of an acute or elective/waiting list admission for cholecystectomy.
- When broken down by age, mortality rates following cholecystectomy show an increase after the age of around 60 years for acute and elective/waiting list admission types. Acute admissions show a peak in mortality at 80–84 years, while elective/waiting list admissions reach a peak in mortality at 90+ years.
- Mortality rates generally rose with increasing ASA score for all admission types, although mortality was higher in those admitted acutely.
- Mortality rates following acute admissions for cholecystectomy in 2007–2011 were significantly higher in those groups aged over 65 years (compared to those aged 0–44 years) and in those with a first ASA score of 3–4 (compared to an ASA score of 1–2) after various clinical and sociodemographic factors were adjusted for.
- For elective or waiting list cholecystectomy admissions during 2007–2011, mortality rates were significantly higher for those groups aged 65 years and over (compared to those aged 0–44 years), those with an ASA score of 3 (compared to an ASA score of 1–2) and those of Pacific ethnicity (compared to the European ethnic group) after various clinical and sociodemographic factors were adjusted for.

All of the above results were consistent with the 2006–2010 period with the following main exceptions or additions:

- The cumulative mortality rates for both acute and elective/waiting list admissions have decreased slightly (down from 1040 per 100,000 and 164 per 100,000 for acute and elective/waiting list admissions to 975 per 100,000 and 151 per 100,000 respectively).
- Since the last report, mortality for acute admissions among those aged 80–84 has increased and mortality for those aged over 85 years for both acute and elective/waiting list admission types has decreased.
- For elective or waiting list cholecystectomy admissions, the decrease in the mortality odds ratio for women was not statistically significant in the 2007–2011 multivariate data when adjustments for other sociodemographic or clinical factors were made.

Data sources and limitations

Information about hospital admissions for cholecystectomy was obtained from the NMDS and data about deaths within 30 days of the procedure were sourced from the NMC.

In a small proportion of cases (n=289), other more complex procedures were undertaken at the same time as the cholecystectomy (for example, liver resections). In such cases where a cholecystectomy was performed as part of a more complex procedure, the risk of mortality is likely to have been significantly higher than if a cholecystectomy was either the main or the only procedure undertaken at the time of the operation. These admissions were not included in this analysis. This differs from the previous report in which these cases were included.

A second admission for a procedure meeting the Australian Classification of Health Interventions (ACHI) cholecystectomy code criteria outlined in Appendix 2 occurred within 30 days of the initial procedure in a small number of cases. These cases were analysed in the same way as in previous reports and were not included separately in the admission and procedure counts.

The NMDS and NMC have limitations associated with the completeness and accuracy of their information. For example, data from some privately funded procedures undertaken at private hospitals are not included in the NMDS. Both databases are reliant on the quality of the information obtained from clinical records and classification systems.

Changes over time should be interpreted with caution as a range of factors could influence the apparent improvement in mortality rates. Analyses in subsequent reports will further examine this finding.

Further information about data sources and methods is provided in Appendix 2.

Definition

1. Hospital admissions for cholecystectomy.
2. Mortality in the first 30 days following a cholecystectomy.

Mortality following cholecystectomy

Mortality by type of procedure

In New Zealand during 2007–2011, most deaths (69.5%) were associated with an open procedure (Table 10). The mortality rate for open procedures during 2007–2011 was 4408.6 per 100,000 or 4.4%. This was considerably higher than the rate associated with laparoscopic procedures (74.3 per 100,000 or 0.07%) and also higher than the rate associated with those laparoscopic procedures that became an open procedure (1116.5 per 100,000 or 1.1%).

Table 10: Mortality Following Cholecystectomy by Main Procedure Type, New Zealand 2007–2011

MAIN UNDERLYING CAUSE OF DEATH	Total Deaths 2007–2011	Number of Procedures	Annual Average	Deaths in Category (%)
Cholecystectomy				
Laparoscopic	20	26,930	4	16.9
Laparoscopic Proceeding to Open	16	1433	3.2	13.6
Open	82	1860	16.4	69.5
Total	118	30,157	23.6	100.0

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

Mortality by admission type and cause of death

In New Zealand during 2007–2011, malignant neoplasms were the most frequently listed main underlying cause for those dying within 30 days of an acute or elective/waiting list admission for cholecystectomy (Table 11). However, it is possible that the malignant neoplasm may have been the reason for the operation with a complication causing death. Gallbladder calculi and other disorders of the gallbladder, biliary tract and pancreas, as well as myocardial infarction/ischaemic heart disease, also featured prominently. These trends were consistent with the findings for 2006–2010.

Table 11: Mortality Following Cholecystectomy by Admission Type and Main Underlying Cause of Death, New Zealand 2007–2011

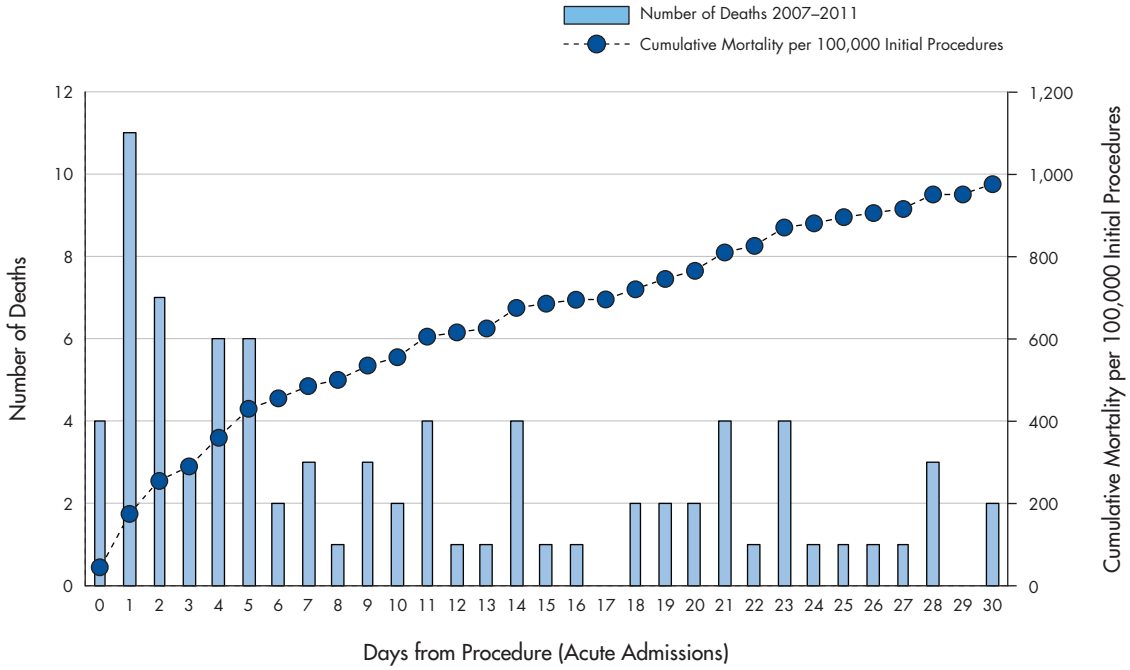
MAIN UNDERLYING CAUSE OF DEATH	Total Deaths 2007–2011	Annual Average	Deaths in Category (%)
Cholecystectomy			
Acute			
Malignant Neoplasms	18	3.6	21.4
Gallbladder Calculi: With Acute Cholecystitis	13	2.6	15.5
Gallbladder Calculi: All Other Types	7	1.4	8.3
Other Disorders Gallbladder, Biliary Tract and Pancreas	13	2.6	15.5
Myocardial Infarction/Other Ischaemic Heart Disease	7	1.4	8.3
Other Cardiovascular Causes	9	1.8	10.7
Other Causes	17	3.4	20.2
Total Acute	84	16.8	100.0
Public Hospital Semi-Acute			
All Causes	2	0.4	100.0
Elective/Waiting List			
Malignant Neoplasms	12	2.4	37.5
Gallbladder Calculi: All Types	6	1.2	18.8
Myocardial Infarction/Other Ischaemic Heart Disease	6	1.2	18.8
Other Causes	8	1.6	25.0
Total Elective/Waiting List	32	6.4	100.0
Grand Total	118	23.6	

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

Mortality by day from procedure

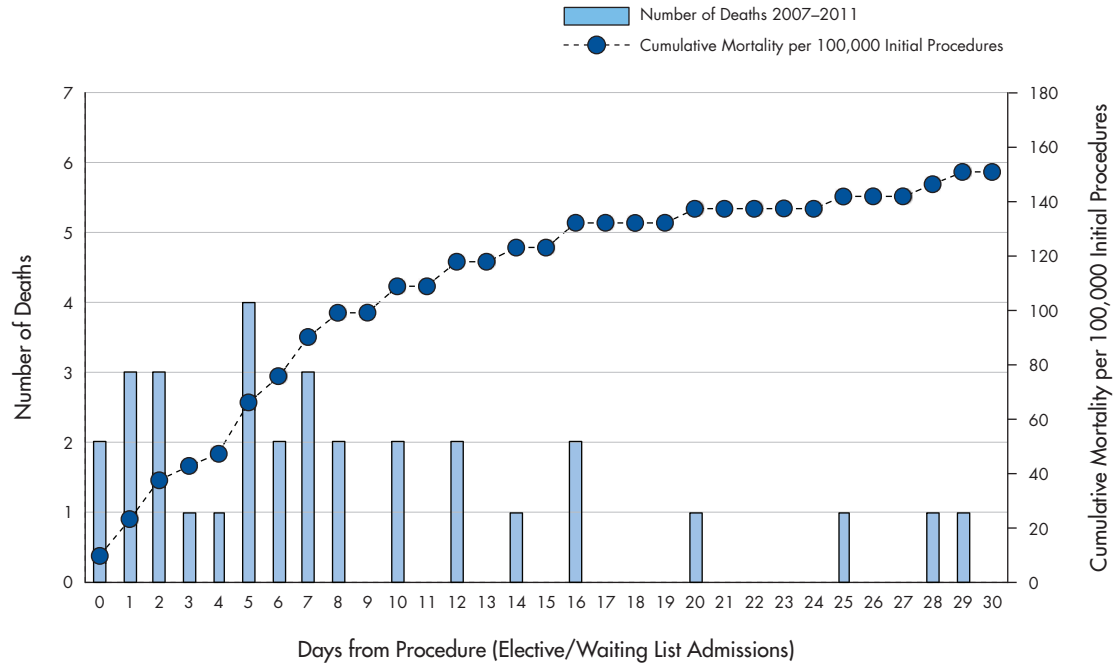
Mortality following acute cholecystectomy during 2007–2011 was highest on the first day after surgery (Figure 10), whilst for elective or waiting list admissions, the highest number of deaths occurred five days after surgery (Figure 11). The number of deaths was more sporadic over the following three weeks for both admission types. Cumulative 30-day mortality was higher for acute admissions (974.8 per 100,000 initial procedures) than elective/waiting list admissions (151.1 per 100,000 initial procedures). Compared with 2006–2010, cumulative mortality has decreased slightly for both admission types (down from 1040 per 100,000 and 164 per 100,000 for acute and elective/waiting list admissions respectively in 2006–2010).

Figure 10: Mortality Following Acute Admission for Cholecystectomy by Day from Procedure, New Zealand 2007–2011



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 90 procedures.

Figure 11: Mortality Following Elective/Waiting List Admission for Cholecystectomy by Day from Procedure, New Zealand 2007–2011

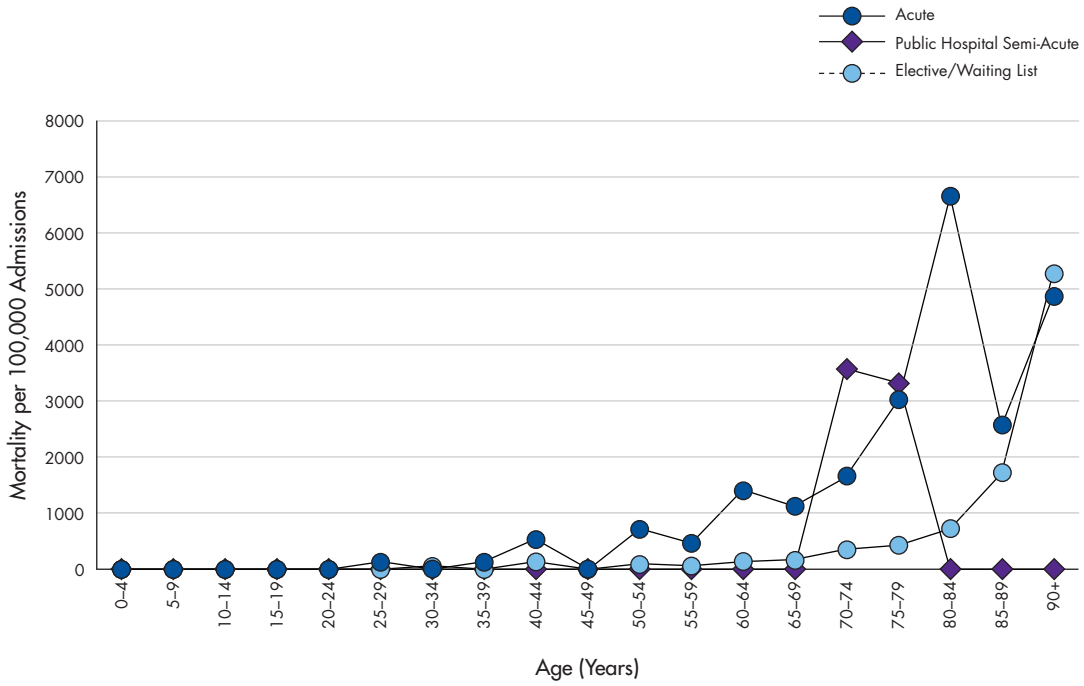


Numerator: NMC: Deaths occurring within 30 days of an elective/waiting list cholecystectomy, as recorded in the NMDS.
Denominator: NMDS: Elective/Waiting list admissions with a cholecystectomy listed in any of the first 90 procedures.

Mortality by age

During 2007–2011, mortality following cholecystectomy for acute admissions was relatively infrequent in those younger than 60 years, after which rates increased to reach a maximum at 80–84 years (Figure 12). Elective/Waiting list admissions had relatively low rates of mortality until the age of about 70 years where the rates increased, reaching their highest point at age 90+ years. Elective/Waiting list admissions had lower rates of mortality than those admitted acutely up until 90 years of age. Since the last report for 2006–2010, there has been an increase in mortality following acute admissions for those aged 80–84, and a decrease in mortality for those aged above 85 years in both admission types.

Figure 12: Mortality Following Cholecystectomy by Admission Type and Age, New Zealand 2007–2011

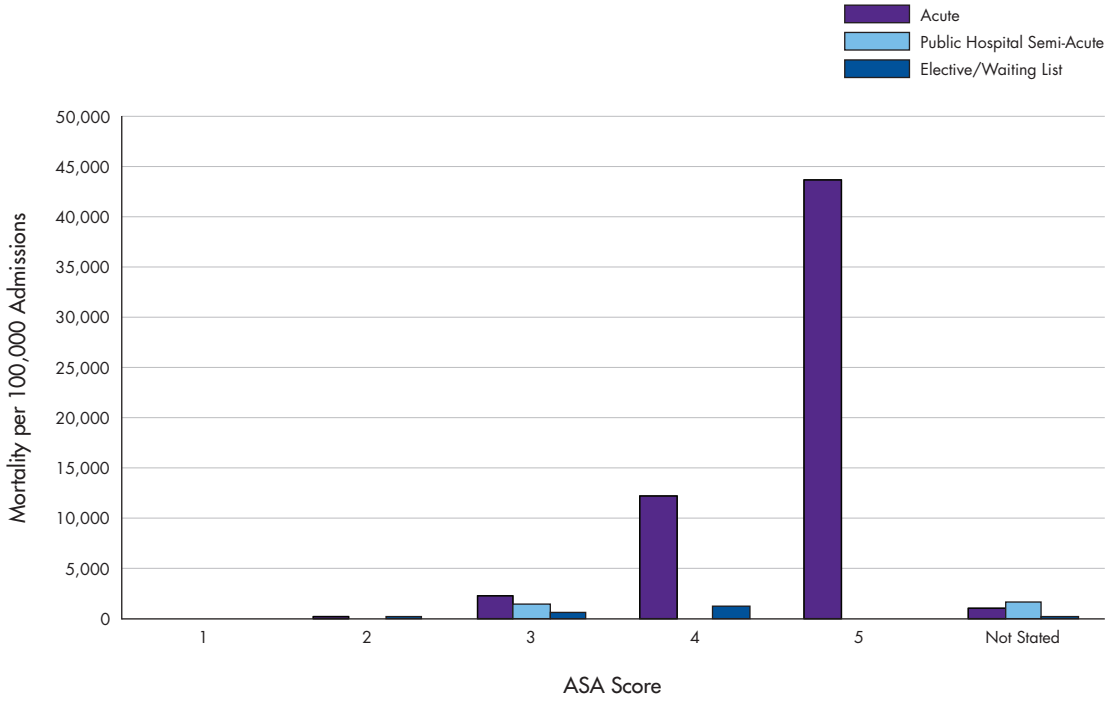


Numerator: NMC: Deaths occurring within 30 days of a cholecystectomy, as recorded in the NMDS.
Denominator: NMDS: Admissions with a cholecystectomy listed in any of the first 90 procedures.

Mortality by ASA score

Mortality rates following cholecystectomy during 2007–2011 generally increased with increasing ASA score for all admission types (Figure 13). Higher rates of mortality were observed for those admitted acutely in each ASA score category. These patterns are consistent with those previously observed in the earlier report with data from 2006–2010.

Figure 13: Mortality Following Cholecystectomy by Admission Type and ASA Score, New Zealand 2007–2011



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

Mortality by sociodemographic factors and ASA score

Acute admissions

Mortality rates following acute admissions for cholecystectomy in New Zealand during 2007–2011 were significantly higher for those groups aged over 45 years of age (compared to 0–44 years), and for those with a first ASA score of 3–4 (compared with an ASA score of 1–2) (Table 12). These differences persisted even when the model was adjusted for other sociodemographic risk factors (age, gender, ethnicity and NZDep decile) and ASA score (although for those aged 45–64 years, the difference was no longer statistically significant). At the univariate level, the risk of mortality was significantly higher for males than females; however, this difference was no longer statistically significant at the multivariate level. These trends were consistent with the findings from 2006–2010. However, by contrast, the increase in mortality associated with NZDep decile 9–10 was no longer statistically significant in the 2007–2011 multivariate model compared with the previous report, which included 2006–2010 data.

Elective/Waiting list admissions

During 2007–2011, mortality following elective/waiting list admissions for cholecystectomy was significantly higher for males than females, those groups aged 65 years and over (vs. 0–44 years), those with an ASA score of 3 (vs. ASA score 1–2) and those of Pacific ethnicity (compared to Europeans) (Table 13). When other sociodemographic and clinical risk factors (age, gender, ethnicity, NZDep decile and ASA score) were accounted for, the differences between genders were no longer statistically significant. Also, Māori were statistically more likely than Europeans to die following a cholecystectomy at the multivariate level; however, the statistical significance is marginal. Compared with 2006–2010, the only difference in the univariate results was the inclusion of a significant increase in the odds ratio for mortality associated with ASA 4 with the inclusion of more deaths in the 2006–2010 data. Likewise, results for Asian/MELAA/Other peoples were included in the earlier data but were suppressed due to small numbers in 2007–2011. During 2006–2010, after the other sociodemographic and clinical factors were accounted for, there was a significant difference between males and females that did not show up at the multivariate level for 2007–2011.

Table 12: Mortality Following Acute Admission for Cholecystectomy by Age Group, Gender, First ASA Score, Ethnicity and NZ Deprivation Index Decile, New Zealand 2007–2011

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	3598	166.8	0.17	1.00		1.00	
	45–64 Years	17	2,784	610.6	0.61	3.68*	1.45–9.33	2.42	0.91–6.41
	65–79 Years	31	1,678	1,847.4	1.85	11.26*	4.69–27.03	4.28*	1.62–11.26
	80+ Years	30	557	5,386.0	5.39	34.05*	14.11–82.18	10.35*	3.73–28.67
Gender	Male	50	2,907	1,720.0	1.72	1.00		1.00	
	Female	34	5,710	595.4	0.60	0.34*	0.22–0.53	0.65	0.40–1.03
First ASA Score	1–2	10	6,083	164.4	0.16	1.00		1.00	
	3	30	1,319	2,274.5	2.27	14.13*	6.89–28.99	6.40*	2.98–13.74
	4	26	213	12,206.6	12.21	84.44*	40.14–177.63	30.46*	13.65–67.95
	5	7	16	43,750.0	43.75	H	H	H	H
	Not Stated	11	986	1,115.6	1.12	6.85*	2.90–16.18	5.22*	2.19–12.44
Ethnicity	European	64	5,623	1,138.2	1.14	1.00		1.00	
	Māori	13	1,336	973.1	0.97	0.85	0.47–1.55	1.56	0.76–3.22
	Pacific	6	755	794.7	0.79	0.70	0.30–1.61	1.44	0.57–3.65
	Asian/ MELAA/ Other	<3	785	s	s	s	s	s	s
NZ Deprivation Index Decile	Decile 1–2	9	1,172	767.9	0.77	1.00		1.00	
	Decile 3–4	6	1,387	432.6	0.43	0.56	0.20–1.58	0.51	0.17–1.50
	Decile 5–6	21	1,667	1,259.7	1.26	1.65	0.75–3.61	1.42	0.62–3.25
	Decile 7–8	26	2,008	1,294.8	1.29	1.70	0.79–3.63	1.37	0.61–3.08
	Decile 9–10	22	2,314	950.7	0.95	1.24	0.57–2.70	1.26	0.53–2.99

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 90 procedures.
* Significantly different from reference category.
H: Odds ratios supressed due to high mortality rates.
s: Rates suppressed due to small numbers.
Caution should also be observed when interpreting ORs where mortality exceeds 10% (see Appendix 2 for details).
CI: Confidence interval.
MELAA: Middle Eastern/Latin American/African.
OR: Odds ratio.

Table 13: Mortality Following Elective/Waiting List Admission for Cholecystectomy by Age Group, Gender, First ASA Score, Ethnicity and NZ Deprivation Index Decile, New Zealand 2007–2011

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/Waiting List									
Age Group	0–44 Years	4	7,895	50.7	0.05	1.00		1.00	
	45–64 Years	6	8,278	72.5	0.07	1.43	0.40–5.07	1.47	0.41–5.31
	65–79 Years	13	4,247	306.1	0.31	6.06*	1.97–18.59	5.76*	1.73–19.17
	80+ Years	9	763	1,179.6	1.18	23.55*	7.23–76.64	19.53*	5.11–74.72
Gender	Male	15	5,727	261.9	0.26	1.00		1.00	
	Female	17	15,456	110.0	0.11	0.42*	0.21–0.84	0.70	0.34–1.47
First ASA Score	1–2	10	10,948	91.3	0.09	1.00		1.00	
	3	11	1,831	600.8	0.60	6.61*	2.80–15.59	3.25*	1.28–8.25
	4	<3	79	s	s	s	s	s	s
	5	<3	s	s	s	s	s	s	s
	Not Stated	10	8,324	120.1	0.12	1.32	0.55–3.16	1.75	0.70–4.36
Ethnicity	European	21	16,254	129.2	0.13	1.00		1.00	
	Māori	5	2,366	211.3	0.21	1.64	0.62–4.35	2.94*	1.01–8.56
	Pacific	3	576	520.8	0.52	4.05*	1.20–13.61	6.81*	1.86–24.98
	Asian/ MELAA/ Other	<3	1,340	s	s	s	s	s	s
NZ Deprivation Index Decile	Decile 1–2	4	3,660	109.3	0.11	1.00		1.00	
	Decile 3–4	5	3,890	128.5	0.13	1.18	0.32–4.38	0.79	0.20–3.18
	Decile 5–6	9	4,357	206.6	0.21	1.89	0.58–6.15	1.53	0.47–5.05
	Decile 7–8	5	5,064	98.7	0.10	0.90	0.24–3.37	0.71	0.19–2.69
	Decile 9–10	9	4,171	215.8	0.22	1.98	0.61–6.42	1.32	0.38–4.60

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

Background: hospital admissions for cholecystectomy

Admissions by admission type, hospital type and procedure

Laparoscopic cholecystectomy was the most common procedure performed on those admitted for cholecystectomy during 2007–2011, although a small number each year went on to open cholecystectomy (Table 14). Similar numbers to those laparoscopic procedures that became open operations were open procedures from the outset. During 2007–2011, 72.4% of laparoscopic cholecystectomies were performed electively/from the waiting list, while 26.7% were for those admitted acutely. For open cholecystectomies during the same period, 53.4% were elective/waiting list admissions, while 42.0% were admitted acutely. All of the acute and semi-acute procedures and most (63.2%) elective/waiting list procedures were performed in public hospitals. The total number of admissions for any cholecystectomy was higher in the 2007–2011 period compared with 2006–2010. The number of open cholecystectomy procedures has decreased while the number of laparoscopic cholecystectomies shows a slight increase in 2007–2011 compared with 2006–2010.

Table 14: Hospital Admissions for Cholecystectomy by Admission Type and Procedure Type, New Zealand 2007–2011

PROCEDURE TYPE	Acute	Public Hospital Semi-Acute	Elective/ Waiting List	Total
		Number of Admissions: Total 2007–2011		
Laparoscopic Cholecystectomy	7,183	249	19,498	26,930
Laparoscopic Proceeding to Open	693	26	714	1,433
Open Cholecystectomy	782	85	993	1,860
Any Cholecystectomy	8,617	357	21,183	30,157
		Number of Admissions: Annual Average		
Laparoscopic Cholecystectomy	1,436.6	49.8	3,899.6	5,386.0
Laparoscopic Proceeding to Open	138.6	5.2	142.8	286.6
Open Cholecystectomy	156.4	17.0	198.6	372.0
Any Cholecystectomy	1,723.4	71.4	4,236.6	6,031.4
		Percent of Admissions Within Procedure Category		
Laparoscopic Cholecystectomy	26.7	0.9	72.4	100.0
Laparoscopic Proceeding to Open	48.4	1.8	49.8	100.0
Open Cholecystectomy	42.0	4.6	53.4	100.0
Any Cholecystectomy	28.6	1.2	70.2	100.0

Data source: NMDS: Hospital admissions with a cholecystectomy listed in any of the first 90 procedures. Note: Procedure type numbers do not sum to 'Any Cholecystectomy' total as in 41 cases more than one procedure type was listed.

Admissions by primary diagnosis

In New Zealand during 2007–2011, gallbladder calculi with acute cholecystitis was the most common primary diagnosis for those admitted acutely for cholecystectomy, followed by gallbladder calculi with other cholecystitis (Table 15). For elective/waiting list admissions, gallbladder calculi with other cholecystitis was the most frequent initial primary diagnosis, while unspecified diseases of the gallbladder were the second most common. Compared with 2006–2010, the most frequent primary diagnoses have not changed for acute and elective/waiting list cholecystectomy admissions. The total number of acute admissions for cholecystectomy has increased during the 2007–2011 period, while the number of elective/waiting list admissions has remained similar.

Table 15: Hospital Admissions for Cholecystectomy by Primary Diagnosis and Admission Type, New Zealand 2007–2011

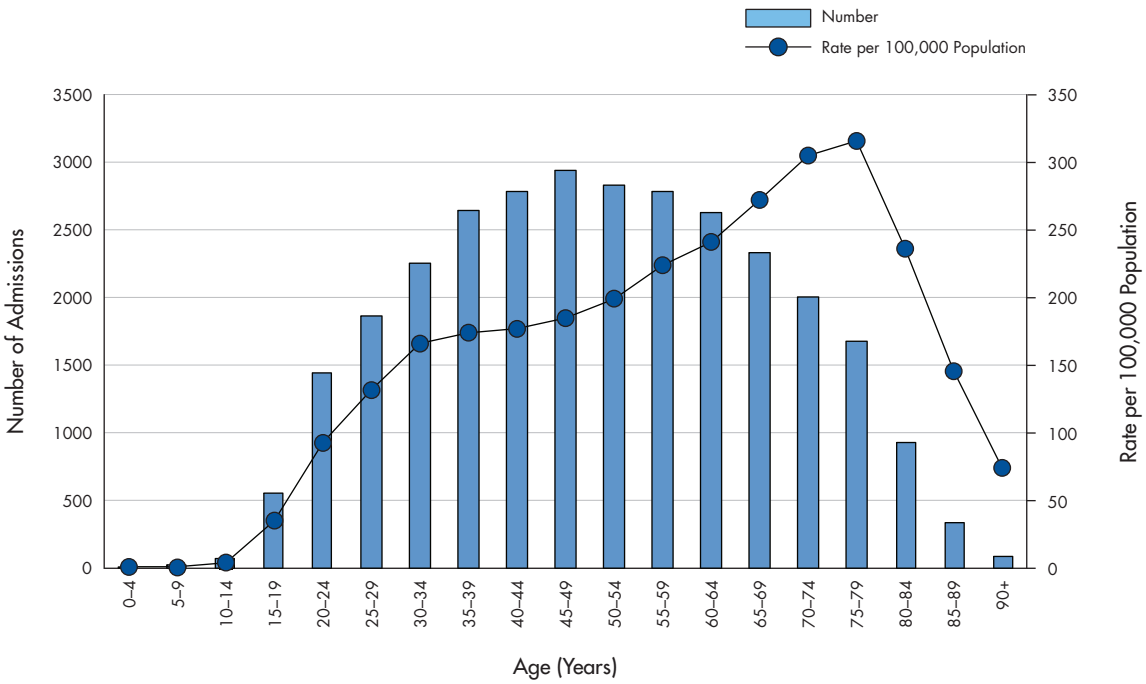
PRIMARY DIAGNOSIS	Total 2007–2011	Number: Annual Average	Admissions (%)
Cholecystectomy Admissions			
Acute			
Gallbladder Calculi: With Acute Cholecystitis	3,231	646.2	37.5
Gallbladder Calculi: With Other Cholecystitis	2,472	494.4	28.7
Gallbladder Calculi: Without Cholecystitis	180	36.0	2.1
Gallbladder Calculi: Other	522	104.4	6.1
Acute Pancreatitis	746	149.2	8.7
Cholecystitis: Chronic	336	67.2	3.9
Cholecystitis: Other/Unspecified	644	128.8	7.5
Diseases of Gallbladder: Other Specified	78	15.6	0.9
Other Diseases of Biliary Tract	24	4.8	0.3
Malignant Neoplasms of Digestive Organs	95	19.0	1.1
Other Diagnoses	289	57.8	3.4
Total Acute	8,617	1,723.4	100.0
Public Hospital Semi-Acute			
Gallbladder Calculi: With Acute Cholecystitis	47	9.4	13.2
Gallbladder Calculi: With Other Cholecystitis	152	30.4	42.6
Gallbladder Calculi: Without Cholecystitis	11	2.2	3.1
Gallbladder Calculi: Other	36	7.2	10.1
Malignant Neoplasms of Digestive Organs	24	4.8	6.7
Acute Pancreatitis	25	5.0	7.0
Cholecystitis: Chronic	20	4.0	5.6
Cholecystitis: Other/Unspecified	10	2.0	2.8
Diseases of Gallbladder: Other Specified	<3	s	s
Other Diagnoses	30	6.0	8.4
Total Public Hospital Semi-Acute	357	71.4	100.0
Elective/Waiting List			
Gallbladder Calculi: With Acute Cholecystitis	750	150.0	3.5
Gallbladder Calculi: With Other Cholecystitis	9,859	1,971.8	46.5
Gallbladder Calculi: Without Cholecystitis	1,388	277.6	6.6
Gallbladder Calculi: Other	529	105.8	2.5
Diseases of Gallbladder: Other Specified	216	43.2	1.0
Diseases of Gallbladder: Unspecified	5,388	1,077.6	25.4
Cholecystitis: Chronic	1,724	344.8	8.1
Cholecystitis: Other/Unspecified	292	58.4	1.4
Other Diseases of Biliary Tract	17	3.4	0.1
Malignant Neoplasms of Digestive Organs	280	56.0	1.3
Acute Pancreatitis	164	32.8	0.8
Other Diagnoses	576	115.2	2.7
Total Elective/Waiting List	21,183	4,236.6	100.0

Data source: NMDS: Hospital admissions with a cholecystectomy listed in any of the first 90 procedures.
s: Rates suppressed due to small numbers.

Admissions by age

While the number of cholecystectomy admissions during 2007–2011 peaked in those aged 45–49 years, the underlying age structure of the New Zealand population meant that the highest rate of admissions per 100,000 perople were seen in those aged 75–79 years (Figure 14). This has not changed since the last report for 2006–2010.

Figure 14: Hospital Admissions for Cholecystectomy by Age, New Zealand 2007–2011

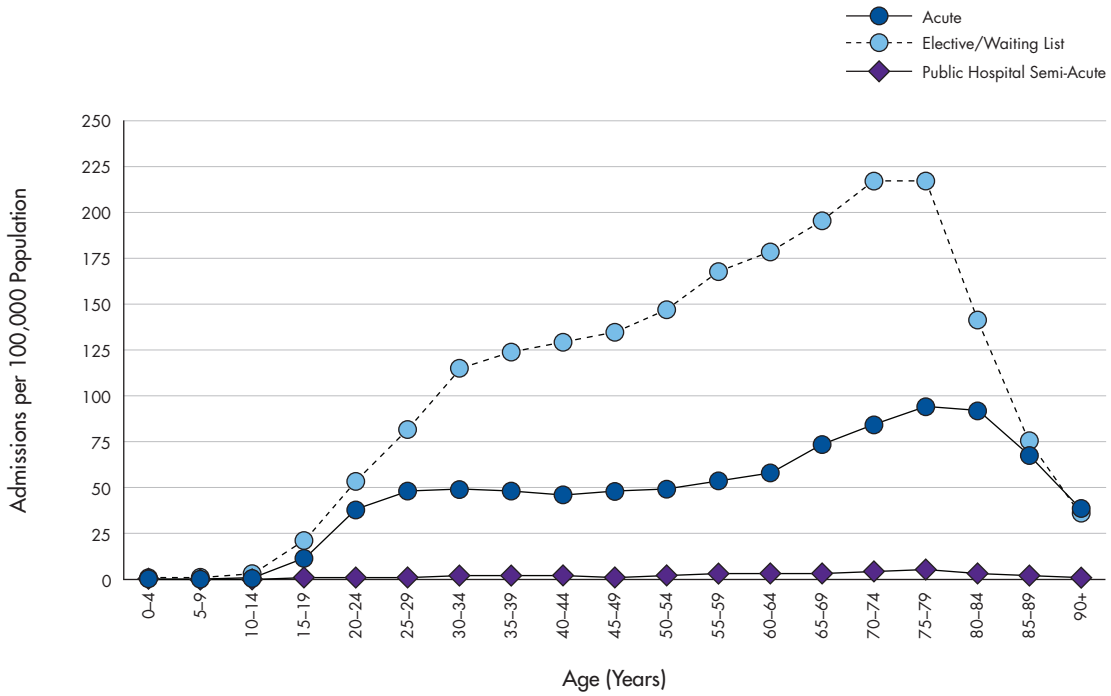


Numerator: NMDS: Hospital admissions with a cholecystectomy listed in any of the first 90 procedures.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Admissions by age and admission type

During 2007–2011, elective/waiting list admissions were infrequent in children younger than 14 years, but increased thereafter, peaking in those aged 70–79 years (Figure 15). Admission rates then declined rapidly for those in their 80s and 90s. Acute admissions were also infrequent in those aged under 14 years, but increased for those in their late teens and 20s. Rates then remained relatively static until 50 years of age, after which they increased to reach a peak at 75–79 years, before declining. Acute admission rates were lower than elective/waiting list rates for all age groups except for those aged 90+ years. These trends were largely similar to the 2006–2010 findings.

Figure 15: Hospital Admissions for Cholecystectomy by Age and Admission Type, New Zealand 2007–2011

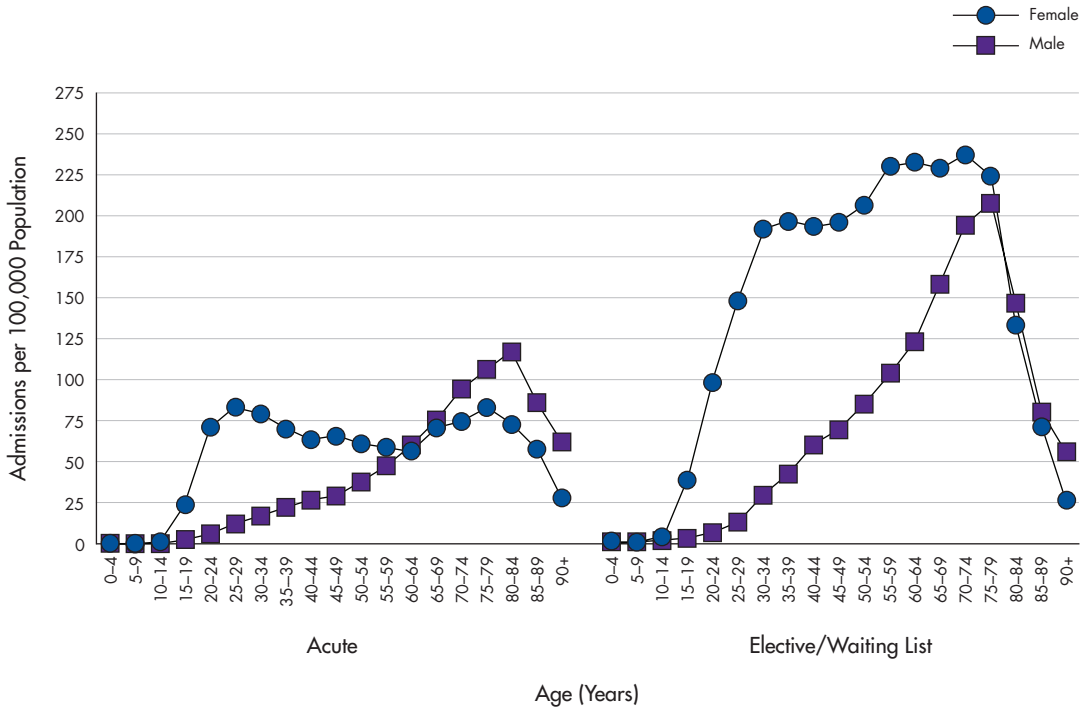


Numerator: NMDS: Hospital admissions with a cholecystectomy listed in any of the first 90 procedures.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Admissions by age, admission type and gender

When broken down by gender, admission rates for cholecystectomy were higher for females than males from the ages of 15–59 years for acute admissions, and 10–79 years for elective/waiting list admissions (Figure 16). Admission rates for males clearly peaked at 80–84 years for acute admissions and 75–79 years for elective/waiting list admissions, while female rates peaked at 25–29 years and again at 75–79 years for acute admissions, and 70–74 years for those electively admitted/drawn from the waiting list. Compared with 2006–2010, admission rates remain generally similar for acute referrals although the maximum peak around 80 years of age for males was slightly higher in 2007–2011. The peak in elective/waiting list admissions for females shows a small shift to the right compared to the 2006–2010 period, where the highest female admission rates were for those aged 60–64 years compared to 70–74 years during 2007–2011.

Figure 16: Hospital Admissions for Cholecystectomy by Age, Admission Type and Gender, New Zealand 2007–2011

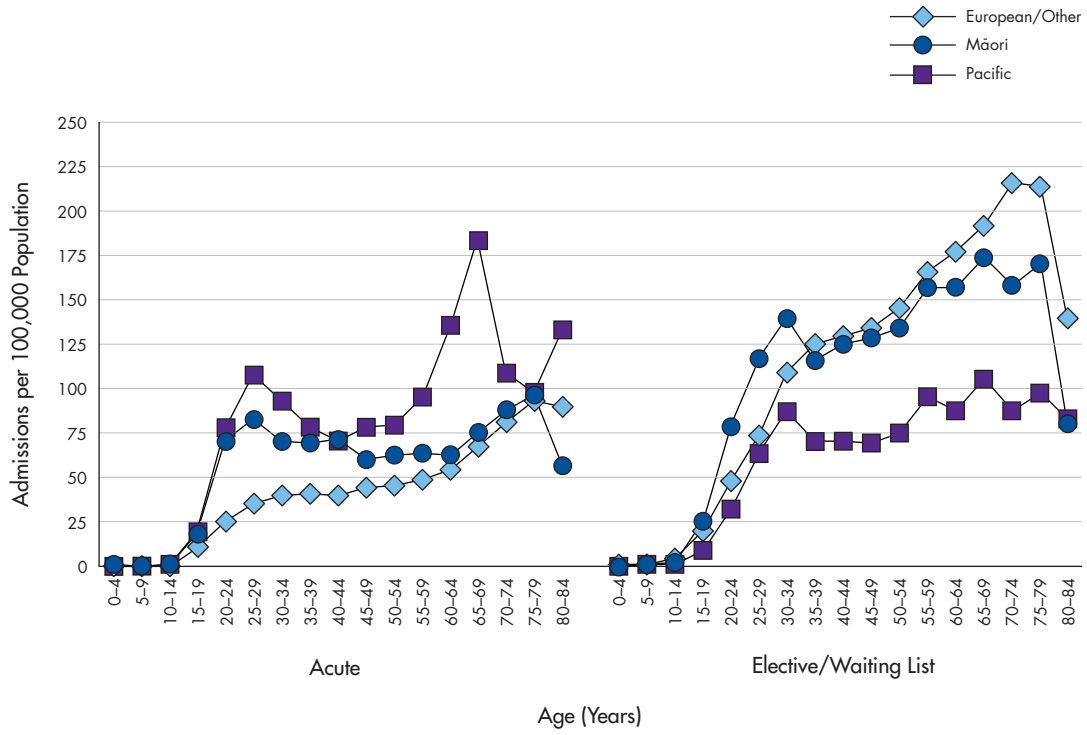


Numerator: NMDS: Hospital admissions with a cholecystectomy listed in any of the first 90 procedures.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Admissions by age, admission type and ethnicity

During 2007–2011, acute admission rates for cholecystectomy were higher for Māori and Pacific peoples than for those of European/Other ethnicity at all ages from 10 years onwards (Figure 17). Pacific peoples had the highest acute admission rates of any other group from the ages of 10–39 years and from 45 years onwards. In contrast, elective/waiting list admission rates were higher for people of European/Other ethnicity than for Māori and Pacific peoples from the age of 35 years onwards. Pacific peoples also had lower rates of elective/waiting list admissions than Māori from the ages of 10–79 years. These patterns have shown little change from the 2006–2010 period.

Figure 17: Hospital Admissions for Cholecystectomy by Age, Admission Type and Ethnicity, New Zealand 2007–2011



Numerator: NMDS: Hospital admissions with a cholecystectomy listed in any of the first 90 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.

Distribution of admissions by age and ASA score

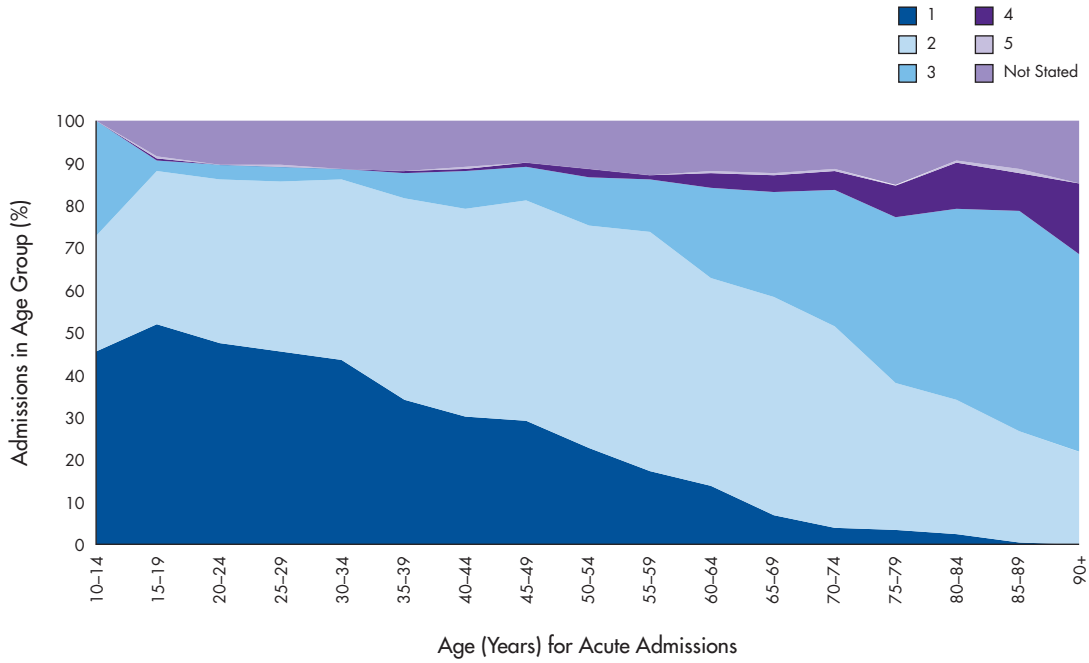
Acute admissions

During 2007–2011, the proportion of admissions for acute cholecystectomies where the first documented ASA score was 3 or more increased after 30 years of age to reach a maximum of 63.4% in the 90+ age group (Figure 18). The proportion of admissions where the ASA score was not recorded was over 10% for nearly every age group. Compared with 2006–2010, there has been little change in the distribution of ASA by age for acute admissions. The data for 10–14-year-olds shows more variation between years, possibly as a result of the smaller numbers in the dataset for this age group.

Elective/Waiting list admissions

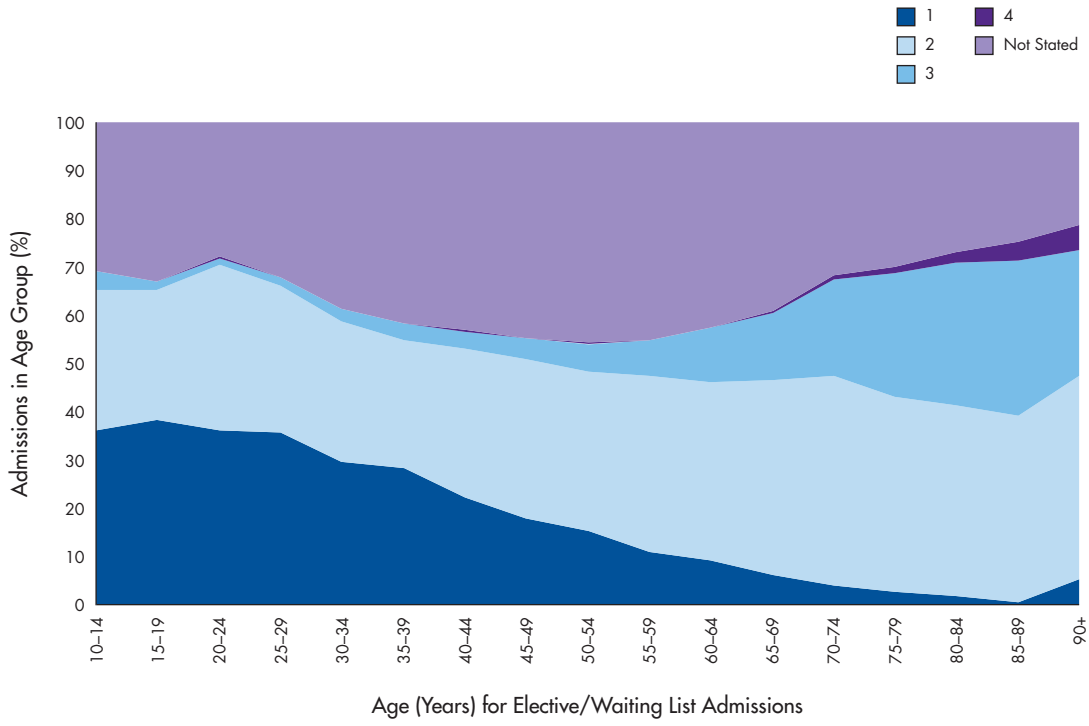
For elective/waiting list cholecystectomy admissions, ASA scores generally increased with age; however, there was a smaller proportion of people with ASA scores of 3–4 than for acute admissions in every age group (Figure 19). Note that 30–40% of cases in nearly every age group did not have their initial ASA score documented, making precise interpretation of this data difficult. These trends have shown little change since the 2006–2010 findings.

Figure 18: Acute Hospital Admissions for Cholecystectomy by Age and ASA Score, New Zealand 2007–2011



Data source: NMDS: Acute hospital admissions with a cholecystectomy listed in any of the first 90 procedures.
Small numbers precluded a valid analysis for children less than 10 years of age.

Figure 19: Elective/Waiting List Admissions for Cholecystectomy by Age and ASA Score, New Zealand 2007–2011



Data source: NMDS: Elective/Waiting list hospital admissions with a cholecystectomy listed in any of the first 90 procedures.
Small numbers precluded a valid analysis for children less than 10 years of age.

General Anaesthesia

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

Key findings

- In New Zealand during 2007–2011, following general anaesthesia on the same/next day, there were 1465 deaths. Most of these deaths occurred among acute admissions and at public hospitals.
- Cardiovascular causes were the most commonly listed underlying reason for mortality within the first day of receiving a general anaesthetic, regardless of admission type.
- All admission types showed an increase in mortality with age.
- Mortality was higher among acute admissions for every age group compared with elective/waiting list admissions. By contrast, among public hospital semi-acute admissions, mortality was higher for people aged 40–59 years in comparison with acute admissions.
- Mortality increased with ASA score for each admission type. Within each ASA category, there was a higher rate of mortality for those admitted acutely than for those admitted electively/from the waiting list or semi-acutely.
- For those admitted acutely, the risk of mortality after receiving one or more general anaesthetics was significantly higher for those aged over 65 years, those who received more than one anaesthetic during their admission, and those with a first ASA score of 3 or more. The risk of mortality was significantly lower for those aged under 45 years. These differences continued to be significant even after each variable (age, gender, ethnicity, NZDep decile and ASA score) was adjusted for the other variables in the multivariate model.
- For those admitted electively or from the waiting list, the risk of mortality after a general anaesthetic was significantly higher for those aged over 65 years, those who received more than one anaesthetic during their admission, those whose domicile was in NZDep decile 7–8, and those with a first ASA score of 3 or more. The risk of mortality was significantly lower for those aged 25–44 years. These differences were present at the multivariate level (that is, when each sociodemographic and clinical factor had been adjusted for the other factors).
- When all hospital admission types were combined, and emergency status and ASA score of the last listed general anaesthetic were considered, the risk of mortality with one or more general anaesthetics was significantly higher for those with an ASA score of 3 or more, those with more than one anaesthetic during their admission, and for procedures that were given an emergency status. These differences were observed at the multivariate level (that is, when each sociodemographic and clinical factor had been adjusted for the other factors).

All of the above results were consistent with the 2005–2009 period with the following main exceptions or additions:

- The mortality rate increased slightly to 125.5 deaths per 100,000 admissions compared with 119.1 per 100,000.
- There was a rise in the number of deaths for all types of admissions and public hospital semi-acute admissions in particular.
- The increase in public hospital semi-acute admission deaths was related to an increase in deaths due to other injuries and other cardiovascular causes. Among acute admissions there were more deaths due to gastrointestinal conditions and falls. Deaths for those admitted electively or from the waiting list rose due to cancer and other cardiovascular causes. By contrast, myocardial infarctions decreased in 2007–2011 for all admission types.

Data sources and limitations

Data in this report has been provided by the NMDS and the NMC. These databases have limitations associated with the completeness and accuracy of their information. For example, data from some privately funded procedures undertaken at private hospitals are not included in the NMDS. Both databases are reliant on the quality of the information obtained from clinical records and classification systems.

Changes over time should be interpreted with caution as a range of factors could influence the apparent increase in mortality rates. Analyses in subsequent reports will further examine this finding.

Multiple anaesthetics and admissions within a 30-day period have been analysed in the same way as in previous reports, by describing deaths per 100,000 anaesthetic events where one or more anaesthetics were performed.

Further information about data sources and methods is provided in Appendix 2.

Definition

1. Hospital admissions where one or more general anaesthetics were performed.
2. Same-day (day 0) or next-day (day 1) mortality following a general anaesthetic.

Same-/Next-day mortality following one or more general anaesthetics

Mortality following one or more general anaesthetics and hospital type

In New Zealand during 2007–2011 there were 1465 deaths on the same or next day following a general anaesthetic. Most of these deaths occurred during an acute admission 1067 (73%) and at a public hospital (99%). All of the eight deaths at private hospitals occurred among elective/waiting list admissions. Compared with 2005–2009 the same-/next-day mortality rate following an anaesthetic has increased slightly to 125.5 deaths per 100,000 admissions compared with 119.1 per 100,000. The increase between periods was proportionally largest for public hospital semi-acute admissions.

Mortality following one or more general anaesthetics by cause of death

In New Zealand during 2007–2011, for all admission types, cardiovascular causes were the most commonly listed underlying reason for mortality within the first day of receiving a general anaesthetic (Table 16). Cancers, gastrointestinal conditions and other injuries/external causes also featured prominently. Among the acute admissions in 2007–2011 there were more deaths due to gastrointestinal conditions and falls compared with 2005–2009. Major contributors to the proportionate increase in semi-acute public hospital deaths in 2007–2011 compared with 2005–2009 were more deaths due to either other injuries/external causes or other cardiovascular causes. Deaths following general anaesthesia for those admitted electively or from the waiting list rose due to cancer and other cardiovascular causes in 2007–2011 compared with 2005–2009. By contrast, myocardial infarctions decreased in 2007–2011 for all admission types.

Table 16: Same-Day or Next-Day Mortality Following Hospital Admissions with One or More General Anaesthetics by Admission Type and Main Underlying Cause of Death, New Zealand 2007–2011

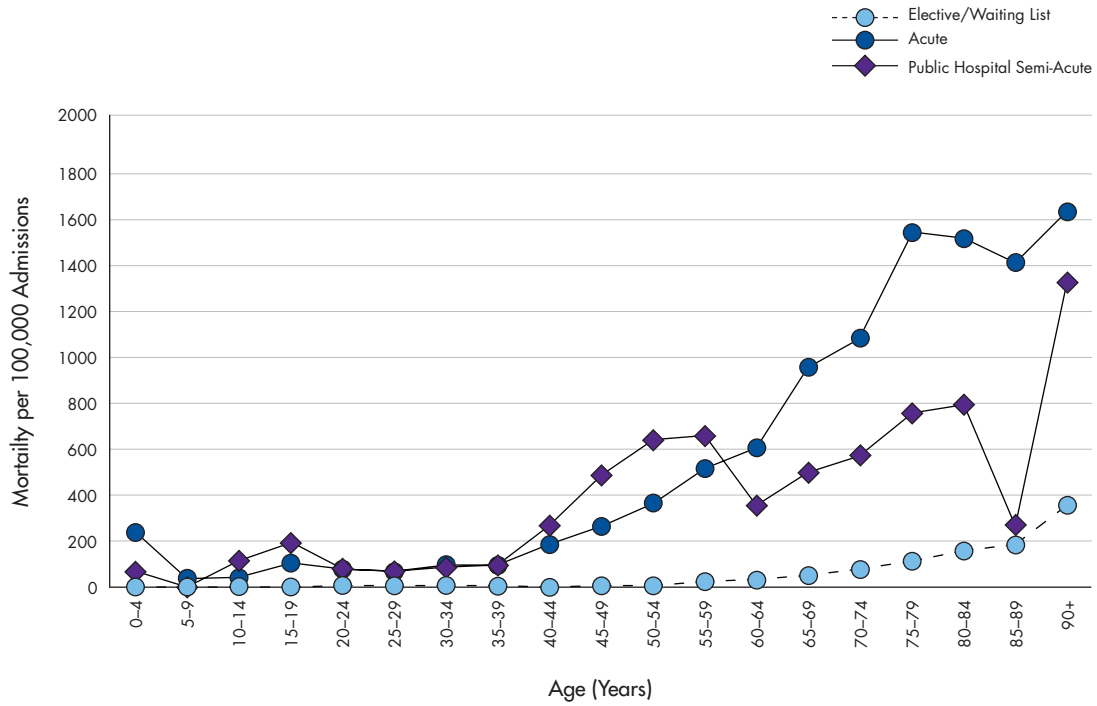
MAIN UNDERLYING CAUSE OF DEATH	Total Deaths 2007–2011	Annual Average	Deaths in Category (%)
General Anaesthetic			
Acute			
Myocardial Infarction	89	17.8	8.34
Other Ischaemic Heart Disease	71	14.2	6.65
Other Cardiovascular Causes	283	56.6	26.52
Non-Insulin Dependent Diabetes	19	3.8	1.78
Cancers	106	21.2	9.93
Emphysema and COPD	9	1.8	0.84
Other Respiratory Diseases	9	1.8	0.84
Gastrointestinal Conditions	185	37.0	17.34
Falls	66	13.2	6.19
Other Injuries/External Causes	109	21.8	10.22
Other Causes	121	24.2	11.34
Total Acute	1,067	213.4	100.00
Public Hospital Semi-Acute			
Myocardial Infarction	10	2.0	4.9
Other Ischaemic Heart Disease	20	4.0	9.8
Other Cardiovascular Causes	84	16.8	41.0
Cancers	11	2.2	5.4
Respiratory Diseases	4	0.8	2.0
Gastrointestinal Conditions	10	2.0	4.9
Falls	9	1.8	4.4
Other Injuries/External Causes	30	6.0	14.6
Other Causes	27	5.4	13.2
Total Public Hospital Semi-Acute	205	41.0	100.0
Elective/Waiting List			
Myocardial Infarction	12	2.4	6.2
Other Ischaemic Heart Disease	26	5.2	13.5
Other Cardiovascular Causes	57	11.4	29.5
Cancers	56	11.2	29.0
Gastrointestinal Conditions	16	3.2	8.3
Other Causes	26	5.2	13.5
Total Elective/Waiting List	193	38.6	100.0
Grand Total	1,465	293.0	100.0

Data source: NMDS: Same day (day 0) or next day (day 1) deaths following a general anaesthetic (as recorded in the NMDS).
COPD: Chronic obstructive pulmonary disease.

Mortality following one or more general anaesthetics by age

In New Zealand during 2007–2011, mortality following general anaesthesia on the same/next day increased with increasing age for all admission types, although a small peak in mortality is evident for those aged 0–4 years in the acute category (Figure 20). Acute admissions had higher mortality rates in every age group compared with those admitted electively/from the waiting list. However, mortality rates for people aged 40–59 years were higher among public hospital semi-acute admissions in comparison with acute admissions. Higher death rates among those semi-acute admissions aged 40–59 years was not present in the 2005–2009 period. Mortality rates were lower in 2007–2011 among semi-acute admissions aged over 90 years and acute admissions aged 70–89 years but were otherwise very similar.

Figure 20: Same-Day or Next-Day Mortality Following Hospital Admissions with One or More General Anaesthetics by Age and Admission Type, New Zealand 2007–2011

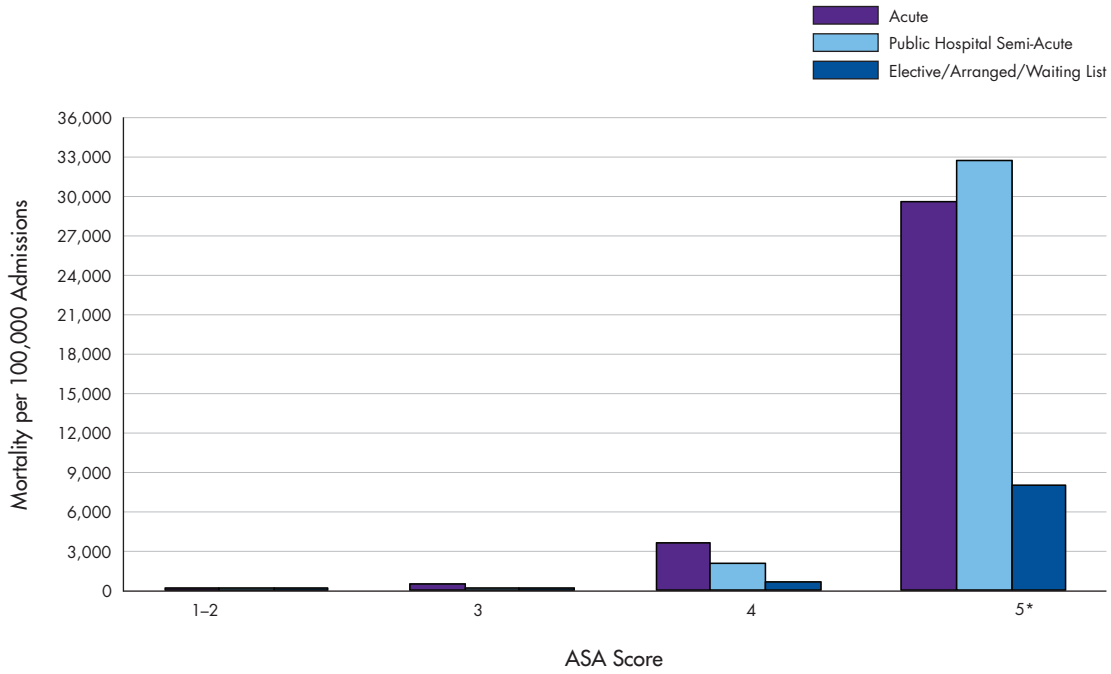


Numerator: NMC: Same-day (day 0) or next-day (day 1) deaths following a general anaesthetic.
Denominator: NMDSL: Hospital admissions with one or more general anaesthetics listed in the first 90 procedures.

Mortality following one or more general anaesthetics by ASA score

Same- or next-day mortality following general anaesthesia increased with ASA score for each admission type during 2007–2011 (Figure 21). Within ASA categories 1–4, and most evident for those admissions with an ASA score of 3–4, there was a higher rate of mortality for those admitted acutely than for those admitted electively/from the waiting list or semi-acutely. Among those patients admitted with an ASA 5 score there were high mortality rates, especially for public hospital semi-acute admissions. Note that the sample sizes were small for elective/waiting list admissions with ASA scores of 5 (<3 deaths) and may represent an error. Death rates among people with ASA 5 scores were higher in 2007–2011 but otherwise these results are similar to those from 2005–2009.

Figure 21: Same-Day or Next-Day Mortality Following Hospital Admissions with One or More General Anaesthetics by Admission Type and ASA Score, New Zealand 2007–2011



Numerator: NMC: Same-day (day 0) or next-day (day 1) deaths following a general anaesthetic.
Denominator: NMDS: Hospital admissions with one or more general anaesthetics listed in the first 90 procedures.
ASA score is first listed ASA score per admission.
* Care should be taken when interpreting ASA 5 scores for elective/waiting list and semi-acute admissions, as each are based on <3 deaths.

Mortality following one or more general anaesthetics by sociodemographic factors, number of anaesthetics and ASA score

Acute admissions

During 2007–2011, same- or next-day mortality following an acute hospital admission with one or more general anaesthetics was significantly higher for those age groups over 65 years (vs. 45–64 years), those who received more than one anaesthetic during their admission, and those with a first ASA score of 3 or more (Table 17). The risk of mortality was significantly lower for those groups aged under 45 years (vs. 45–64 years) and those who were not of European ethnicity. With the exception of ethnicity, the differences for each of these variables remained statistically significant even after the other sociodemographic and clinical factors in the multivariate model (age, gender, ethnicity, NZDep decile and ASA score) were adjusted for. The differences in mortality rates for those of Māori, Pacific or Asian/MELAA/Other ethnicities compared to Europeans failed to reach statistical significance after the other variables were accounted for.

Compared with 2005–2009, the multivariate regression suggests that there is no longer a significantly higher risk of mortality for those of Māori or Asian/MELAA/Other ethnicities (vs. European ethnicity). Similarly, the statistical difference in mortality shown for those living in more deprived (decile 9–10 compared with decile 1–2) areas in 2005–2009 was not significant during 2007–2011.

Elective/Waiting list admissions

Same- or next-day mortality after an elective/waiting list hospital admission with a general anaesthetic during 2007–2011 was significantly higher for those groups aged over 65 years (vs. 45–64 years), those who received more than one anaesthetic during their admission, those in NZDep decile 7–8, and those with a first ASA score of 3 or more (vs. ASA score 1–2) (Table 18). The risk of mortality was significantly lower for those aged 25–44 years (vs. 45–64 years). These differences persisted even after the other sociodemographic and clinical factors (age, gender, ethnicity, NZDep decile and ASA score) were adjusted for in the multivariate model. Differences in mortality between males and females, and those living in

NZDep decile 5–6 and 9–10 compared to decile 1–2 areas were only significant at the univariate level, and failed to reach significance when the model was adjusted for other factors.

Compared with 2005–2009, there was no significant difference in NZDep decile 9–10 at the multivariate level in 2007–2011. Otherwise the results in both the univariate and multivariate analyses were consistent between the two periods.

Last ASA score and emergency status for all admissions combined

During 2007–2011, when the emergency status and ASA score of the last listed general anaesthetic were considered, same- or next-day mortality following any admission type with one or more general anaesthetics was significantly higher for those with an ASA score of 3 or more (vs. ASA score 1–2), those with more than one anaesthetic during their admission, and those procedures that were given an emergency status (Table 20). While the magnitude of these risks was reduced in the multivariate model (that is, when each factor was adjusted for the other factors), the risk of mortality was still significantly different to the reference categories for each variable. These trends have not changed when compared with the 2005–2009 period.

Table 17: Same-Day or Next-Day Mortality Following Acute Admissions with One or More General Anaesthetics by Age Group, Gender, Number of Anaesthetics, ASA Score, Ethnicity and NZ Deprivation Index Decile, New Zealand 2007–2011

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
General Anaesthetic									
Acute									
Age Group	0–24 Years	106	104,078	101.8	0.10	0.24*	0.19–0.31	0.43*	0.34–0.55
	25–44 Years	80	76,443	104.7	0.10	0.25*	0.19–0.32	0.43*	0.33–0.57
	45–64 Years	233	55,748	418.0	0.42	1.00		1.00	
	65–79 Years	365	31,785	1,148.3	1.15	2.77*	2.35–3.26	1.67*	1.40–2.00
	80+ Years	283	19,325	1,464.4	1.46	3.54*	2.98–4.22	1.94*	1.59–2.36
Gender	Male	584	153,018	381.7	0.38	1.00		1.00	
	Female	483	134,361	359.5	0.36	0.94	0.84–1.06	0.97	0.85–1.10
Number of Anaesthetics	1	838	265,781	315.3	0.32	1.00		1.00	
	2+	229	20,531	1115.4	1.12	3.54*	3.06–4.09	1.92*	1.63–2.26
First ASA Score	1–2	47	187,144	25.1	0.03	1.00		1.00	
	3	169	36,039	468.9	0.47	18.74*	13.56–25.89	9.07*	6.44–12.77
	4	390	10,672	3,654.4	3.65	150.84*	111.40–204.26	65.7*	47.49–90.90
	5	191	647	29,520.9	29.52	H	H	H	H
	Not Stated	262	52,863	495.6	0.50	19.81*	14.52–27.02	16.29*	11.84–22.41
Ethnicity	European	748	184,805	404.8	0.40	1.00		1.00	
	Māori	158	52,322	302.0	0.30	0.75*	0.63–0.89	1.25	1.00–1.52
	Pacific	76	25,629	296.5	0.30	0.73*	0.58–0.93	1.23	0.94–1.61
	Asian/ MELAA/ Other	55	20,306	270.9	0.27	0.67*	0.51–0.88	1.06	0.79–1.43
NZ Deprivation Index Decile	Decile 1–2	130	42,209	308.0	0.31	1.00		1.00	
	Decile 3–4	132	43,446	303.8	0.30	0.99	0.77–1.26	0.91	0.71–1.18
	Decile 5–6	199	53,390	372.7	0.37	1.21	0.97–1.51	1.09	0.87–1.38
	Decile 7–8	281	65,998	425.8	0.43	1.38	1.12–1.70	1.18	0.95–1.47
	Decile 9–10	309	79,205	390.1	0.39	1.27	1.03–1.56	1.24	0.99–1.56

Numerator: NMC: Same-day (day 0) or next-day (day 1) deaths following a general anaesthetic.
Denominator: NMDS: Hospital admissions with one or more general anaesthetics listed in any of the first 90 procedures.
ASA score is first listed ASA score per admission.
* Significantly different from reference category.
Caution should be used in interpreting ORs where mortality exceeds 10% (see Appendix 2 for details).
H: Odds ratios suppressed due to high mortality rates.
CI: Confidence interval.
MELAA: Middle Eastern/Latin American/African.
OR: Odds ratio.

Table 18: Same-Day or Next-Day Mortality Following Elective/Waiting List Admissions with One or More General Anaesthetics by Age Group, Gender, Number of Anaesthetics, ASA Score, Ethnicity and NZ Deprivation Index Decile, New Zealand 2007–2011

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
General Anaesthetic									
Elective/Waiting List									
Age Group	0–24 Years	3	224,912	1.3	0.00	0.08*	0.02–0.25	0.10*	0.03–0.32
	25–44 Years	5	173,524	2.9	0.00	0.17*	0.07–0.42	0.18*	0.07–0.51
	45–64 Years	42	240,728	17.4	0.02	1.00		1.00	
	65–79 Years	93	123,146	75.5	0.08	4.33*	3.01–6.24	2.95*	1.99–4.37
	80+ Years	50	28,961	172.6	0.17	9.91*	6.58–14.94	5.40*	3.43–8.50
Gender	Male	107	369,402	29.0	0.03	1.00		1.00	
	Female	86	421,866	20.4	0.02	0.70*	0.53–0.94	0.96	0.72–1.29
Number of Anaesthetics	1	93	785,405	11.8	0.01	1.00		1.00	
	2+	100	5,673	1,762.7	1.76	148.87*	112.11–197.67	60.70*	44.21–83.34
First ASA Score	1–2	31	373,260	8.3	0.01	1.00		1.00	
	3	71	65,111	109.0	0.11	13.14*	8.62–20.04	3.44*	2.21–5.35
	4	37	5,514	671.0	0.67	81.33*	50.43–131.18	11.64*	6.94–19.54
	5	<3	25	s	s	s	s	s	s
	Not Stated	52	347,351	15.0	0.02	1.80*	1.16–2.81	2.48*	1.57–3.91
Ethnicity	European	152	579,638	26.2	0.03	1.00		1.00	
	Māori	21	95,244	22.0	0.02	0.84	0.53–1.33	1.46	0.89–2.39
	Pacific	8	35,417	22.6	0.02	0.86	0.42–1.75	1.31	0.59–2.95
	Asian/ MELAA/ Other	9	48,978	18.4	0.02	0.70	0.36–1.37	1.53	0.77–3.03
NZ Deprivation Index Decile	Decile 1–2	20	145,231	13.8	0.01	1.00		1.00	
	Decile 3–4	27	142,035	19.0	0.02	1.38	0.77–2.46	1.22	0.67–2.23
	Decile 5–6	39	160,667	24.3	0.02	1.76*	1.03–3.02	1.46	0.84–2.55
	Decile 7–8	62	180,433	34.4	0.03	2.50*	1.51–4.13	1.89*	1.12–3.19
	Decile 9–10	44	160,978	27.3	0.03	1.99*	1.17–3.37	1.52	0.87–2.67

Numerator: NMC: Same-day (day 0) or next-day (day 1) deaths following a general anaesthetic.
Denominator: NMDS: Elective/Waiting list hospital admissions with one or more general anaesthetics listed in any of the first 90 procedures.
ASA score is first listed ASA score per admission.
* Significantly different from reference category.
CI: Confidence interval.
MELAA: Middle Eastern/Latin American/African.
OR: Odds ratio.

Table 19: Same-Day or Next-Day Mortality Following Hospital Admissions with One or More General Anaesthetic by Age Group, Gender, Number of Anaesthetics, Last Documented ASA Score and Emergency Status, New Zealand 2007–2011

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
General Anaesthetic									
Acute, Publicly Funded Semi-Acute and Elective/Waiting List Combined									
Age Group	0–24 Years	141	366,107	38.5	0.04	0.34*	0.28–0.42	0.57*	0.46–0.70
	25–44 Years	114	276,001	41.3	0.04	0.37*	0.30–0.46	0.52*	0.42–0.66
	45–64 Years	348	310,464	112.1	0.11	1.00		1.00	
	65–79 Years	510	163,944	311.1	0.31	2.78*	2.43–3.19	1.70*	1.47–1.98
	80+ Years	352	51,107	688.8	0.69	6.18*	5.33–7.17	2.41*	2.03–2.85
Gender	Male	786	557,775	140.9	0.14	1.00		1.00	
	Female	679	609,845	111.3	0.11	0.79*	0.71–0.88	0.95	0.85–1.06
Number of Anaesthetics	1	1,086	1,138,216	95.4	0.10	1.00		1.00	
	2+	379	29,407	1,288.8	1.29	13.67*	12.16–15.38	3.41*	2.96–3.93
Last ASA Score	1–2	44	608,587	7.2	0.01	1.00		1.00	
	3	157	111,863	140.4	0.14	19.47*	14.40–26.33	9.71*	7.12–13.25
	4	396	18,659	2,122.3	2.12	303.23*	228.85–401.78	90.21*	67.05–121.38
	5	234	783	29,885.1	29.89	H	H	H	H
	Not Stated	292	427,645	68.3	0.07	10.18*	7.66–13.53	12.95*	9.68–17.32
Emergency Status	Non-Emergency/ Not Stated	712	1,022,766	69.6	0.07	1.00		1.00	
	Emergency Procedure	753	144,857	519.8	0.52	7.50*	6.77–8.31	3.60*	3.11–4.17

Numerator: NMC: Same-day (day 0) or next-day (day 1) deaths following a general anaesthetic.
Denominator: NMDS: Hospital admissions with one or more general anaesthetics listed in any of the first 90 procedures.
ASA score is last documented ASA score per admission.
* Significantly different from reference category.
Caution should be used in interpreting ORs where mortality exceeds 10% (see Appendix 2 for details).
H: Odds ratios suppressed due to high mortality rates.
CI: Confidence interval.
MELAA: Middle Eastern/Latin American/African.
OR: Odds ratio.

Background: hospital admissions with one or more general anaesthetics

Admissions with one or more general anaesthetics by admission type

In New Zealand during 2007–2011, the majority of admissions with one or more general anaesthetics were elective/drawn from the waiting list (67.8%) followed by acute admissions (24.6%). Semi-acute admissions (occurring within seven days of referral) were the least common admission type (7.6%) (Table 20). Admissions to private hospitals accounted for 39.4% of the elective/waiting list admissions. Acute admissions to private hospitals were rare. Compared with 2005–2009, the 2007–2011 data showed an increase in the number of acute admissions while elective/waiting list admissions and public hospital semi-acute admissions declined slightly.

Table 20: Hospital Admissions with One or More General Anaesthetics by Admission Type, New Zealand 2007–2011

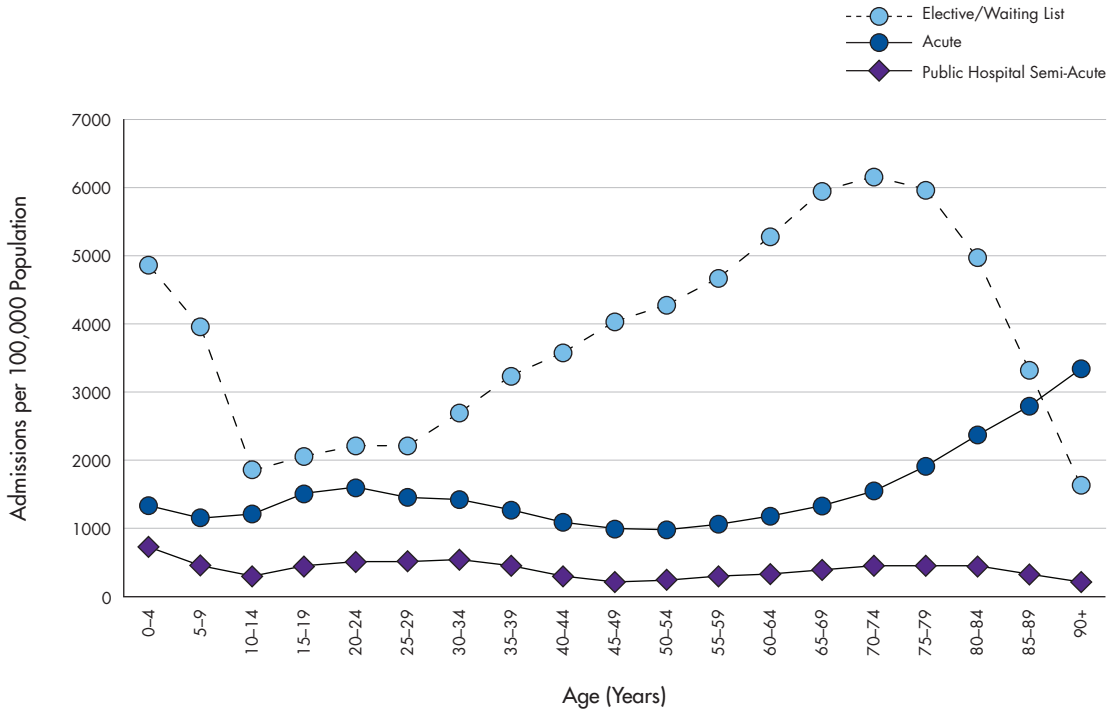
ADMISSION TYPE	Total Admission Events 2007–2011	Annual Average	Admissions (%)
One or More General Anaesthetics			
Acute	287,379	57,476	24.6
Public Hospital Semi-Acute	88,923	17,785	7.6
Elective/Waiting List	791,271 (312,144 or 39.4% at private hospitals)	158,254	67.8
Total	1,167,573	233,515	100.0

Data source: NMDS: Hospital admissions with one or more general anaesthetics listed in any of the first 90 procedures.

Admissions with one or more general anaesthetics by admission type and age

During 2007–2011, elective/waiting list admissions with one or more general anaesthetics were highest in young people aged 0–4 years, and declined rapidly until age 10–14 years (Figure 22). After this age, admission rates began to increase again, peaking overall at 70–74 years before declining in the older age groups. Acute admission rates increased slightly during the teenage years up to the 20–24-year age group, after which rates declined. After age 50–54, acute admissions increased again, reaching their highest level in those aged 90+ years. These trends are similar to previous findings for 2005–2009.

Figure 22: Hospital Admissions with One or More General Anaesthetics by Age and Admission Type, New Zealand 2007–2011



Numerator: NMDS: Hospital admissions with one or more general anaesthetics listed in any of the first 90 procedures.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Admissions with one or more general anaesthetics by age, admission type and gender

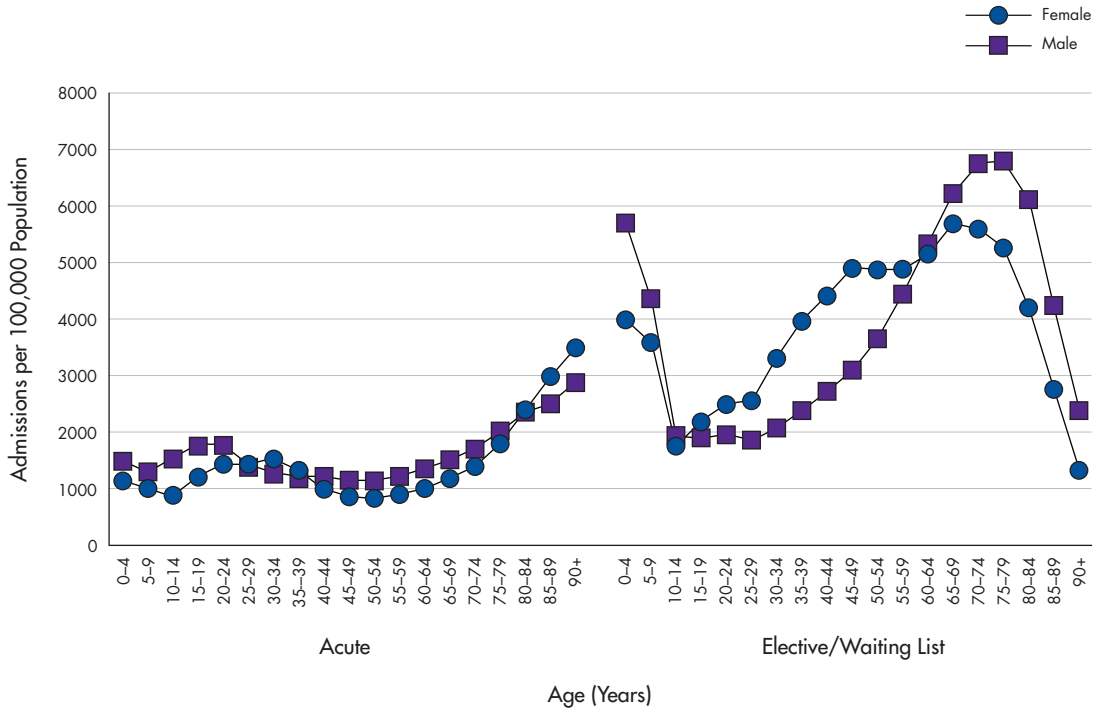
Acute admissions

In New Zealand during 2007–2011, acute admission rates for males with one or more general anaesthetics decreased during childhood, with rates reaching their low point at 5–9 years, before increasing to a small peak in the late teens and early 20s (Figure 23). After this age, male acute admissions declined to another low point in their 40s and 50s, before increasing again with age up to 90+ years. For females, the trends were similar but with the initial low point shifted to the right, and then increasing to a small peak in their 20s and 30s. After the age of 50, female acute admission rates increase with age more quickly than for males. These trends are very similar to the acute admission results for 2005–2009.

Elective/Waiting list admissions

Elective/Waiting list admissions in children and young people were highest in those aged 0–4 years, with rates then declining rapidly to a low point at age 10–14. Rates then increased to a maximum at approximately 70 years, before declining once more. Admission rates were higher for males than females aged 0–14 years, and over 60. Compared with 2005–2009, the 2007–2011 results suggest there has been a slight decline in elective/waiting list admission rates in some of the older age groups for both genders.

Figure 23: Hospital Admissions with One or More General Anaesthetics by Age, Admission Type and Gender, New Zealand 2007–2011

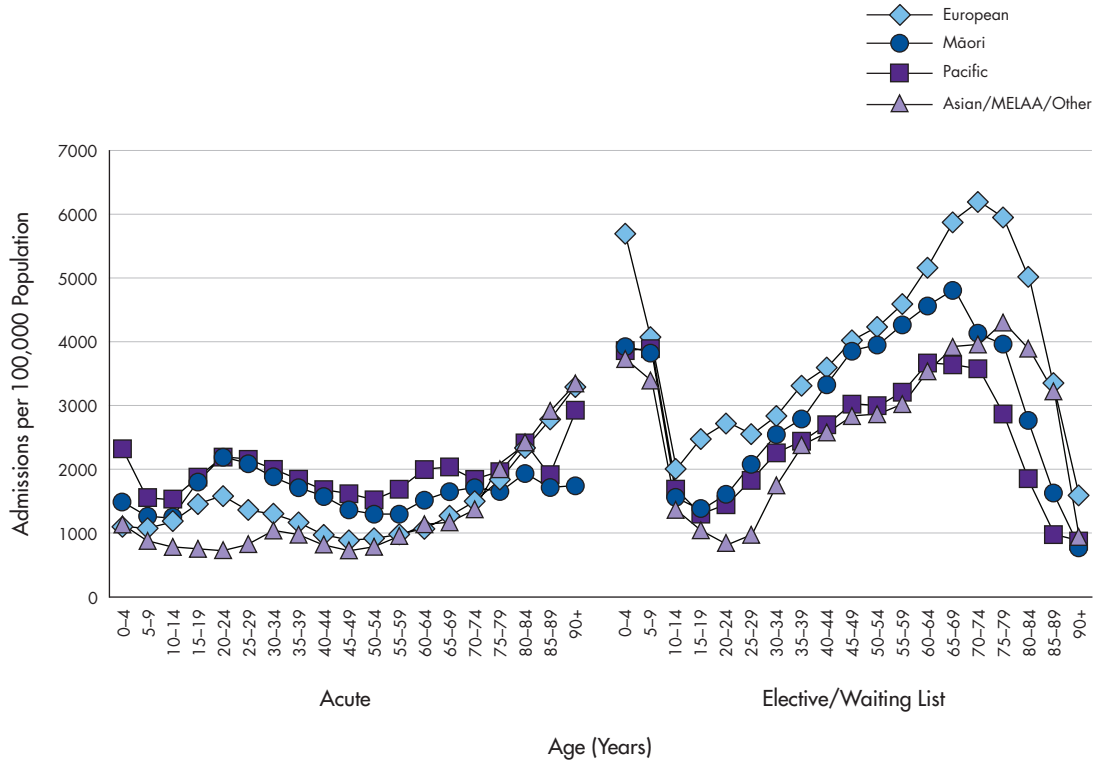


Numerator: NMDS: Hospital admissions with one or more general anaesthetics listed in any of the first 90 procedures.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Admissions with one or more general anaesthetics by age, admission type and ethnicity

Acute admission rates during 2007–2011 where one or more general anaesthetics were administered were higher for Māori and Pacific peoples than for people of European or Asian ethnicity up until 75 years of age (Figure 24). After this, ethnic differences are less consistent. Elective/Waiting list admission rates with general anaesthesia were higher for people of European ethnicity in every age group. Trends are generally consistent with the findings from 2005–2009; however, there has been a slight decrease in elective/waiting list admissions for European people of 70–74 years, down from 6548 per 100,000 Europeans in 2005–2009, to 6198 per 100,000 during 2007–2011.

Figure 24: Hospital Admissions with One or More General Anaesthetics by Age, Admission Type and Ethnicity, New Zealand 2007–2011



Numerator: NMDS: Hospital admissions with one or more general anaesthetics listed in any of the first 90 procedures.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007). Ethnicity is level 1 Prioritised.

Proportion of admissions with one or more general anaesthetics by age and ASA score

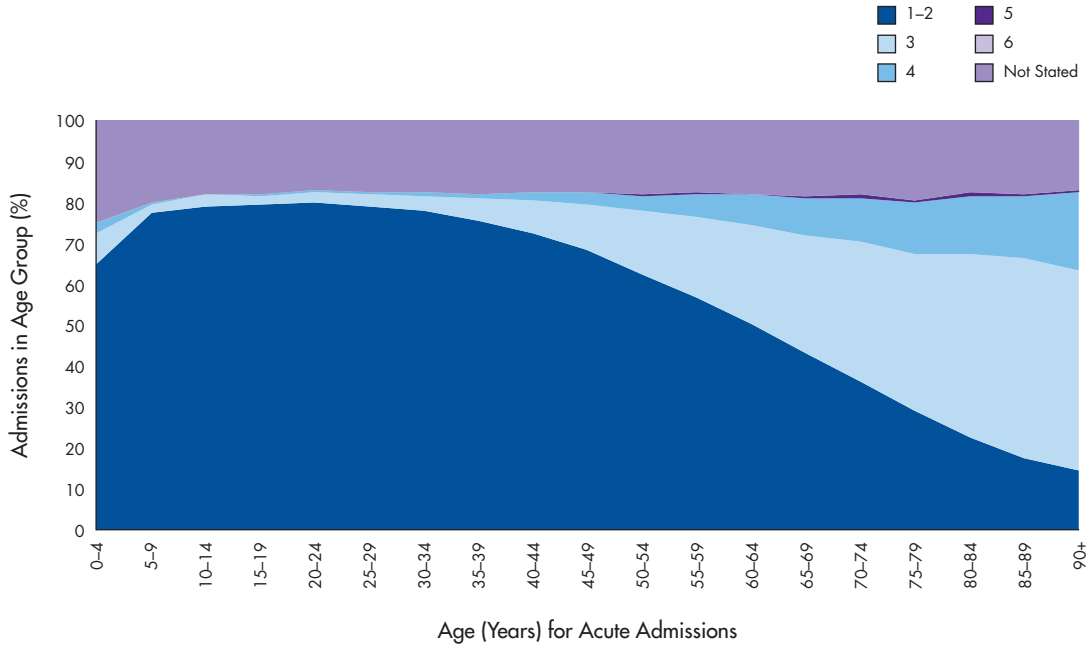
Acute admissions

The proportion of acute hospital admissions with one or more general anaesthetics, where the first documented ASA score was 3 or higher, increased progressively after the age of 30 years (Figure 25). At 90+ years, 48.3% of acute admissions with general anaesthesia had an ASA score of 3, while 19.2% had an ASA score of 4. In all age categories, at least 17% of cases did not have an ASA score stated. Compared with 2005–2009, the results are similar, although the proportion of cases not stated has improved in every age group, especially for those aged 0–4 years where undocumented ASA cases decreased from 31.5% in 2005–2009 to 24.9% in 2007–2011.

Elective/Waiting list admissions

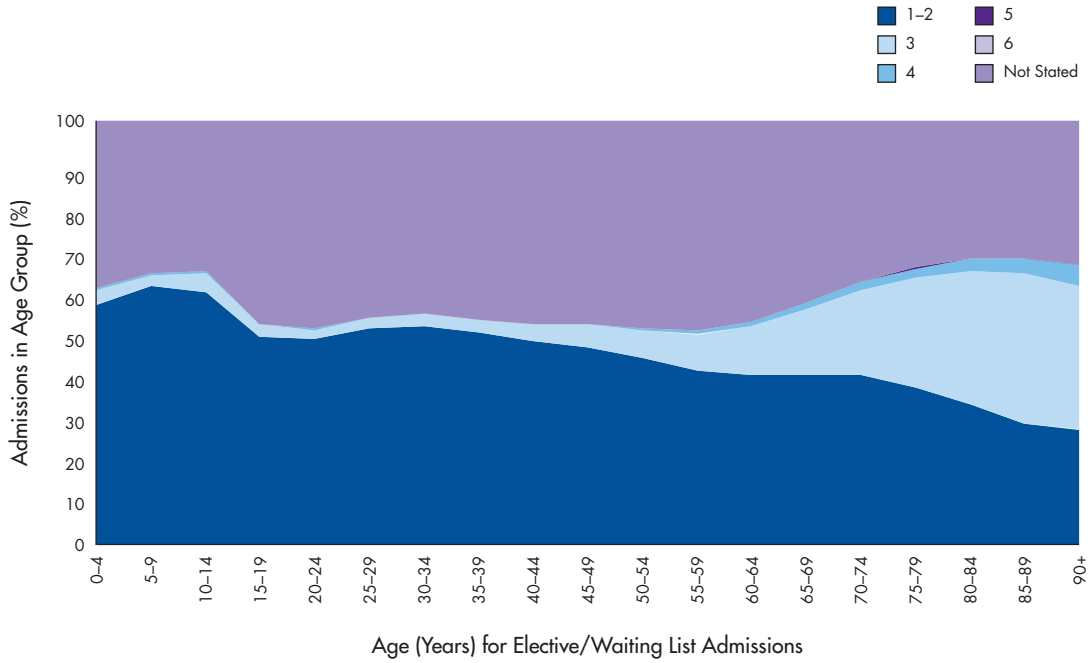
Similar patterns were observed for elective/waiting list admissions, although the proportion of admissions with an ASA score of 4 was less than for acute admissions (Figure 26). Additionally, the proportion of undocumented ASA cases is far higher than acute admissions, with at least 32% not stated for all age groups, making the interpretation of this data more difficult. These trends are similar to the 2005–2009 findings; however, the proportion of cases with ASA scores not documented has improved across all age groups, especially for children and those 85 years or more.

Figure 25: Proportion of Acute Hospital Admissions with One or More General Anaesthetics by Age and ASA Score, New Zealand 2007–2011



Data source: NMDS: Acute admissions with one or more general anaesthesia in any of the first 90 procedures. ASA score is first listed ASA score per admission.

Figure 26: Proportion of Elective/Waiting List Hospital Admissions with One or More General Anaesthetics by Age and ASA Score, New Zealand 2007–2011



Data source: NMDS: Elective/Waiting list admissions with one or more general anaesthesia in any of the first 90 procedures. ASA score is first listed ASA score per admission.

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/waiting list 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.

While those having general or neuraxial anaesthesia could be considered an indicator of overall procedural mortality there are a number of procedures in the Committee's remit that do not receive either type of anaesthetic (such as cataract removal), or are conducted in outpatient settings, which are still considered to be a surgical procedure.

Key findings

In New Zealand during 2007–2011, findings for those admissions that were given a first ASA score of 1 or 2, were admitted electively/from the waiting list, and who received a general anaesthetic or neuraxial block during their admission were as follows:

- There were 249 deaths and mortality was highest on the second day after the initial general anaesthetic or neuraxial block, although deaths occurred right up to the cut-off point for this analysis (day 30 after the initial anaesthetic).
- Malignant/Other neoplasms were the most frequently listed cause of death for those over 25 years of age.
- Cumulative mortality reached 62.9 deaths per 100,000 initial anaesthetics.
- When analysed by age group, mortality rates increased progressively after 50 years, reaching the highest rate at 90+ years. Mortality counts in each age group, however, were highest at age 80–84 years.
- Mortality in the first 30 days was significantly higher for males than females, and for those over 25 years of age. These differences persisted, even when the risk from other sociodemographic factors (age, gender, ethnicity, and NZDep decile) was adjusted for.
- When clinical factors were included in the regression models, the risk of mortality was significantly higher for those given a last ASA score of 3–4, those undergoing emergency procedures, and those receiving two or more anaesthetics during their admission. These differences continued to be significant at the multivariate level (that is, after each of the variables were adjusted for each other).

These findings were all consistent with those noted for the 2006–2010 period with the exception that cumulative mortality has slightly reduced from 68.8 deaths per 100,000 initial anaesthetics in 2006–2010 to 62.9 deaths per 100,000 in 2007–2011.

Data sources and limitations

Data in this report have been provided by the NMDS and the NMC. These databases have limitations associated with the completeness and accuracy of their information. For example, data from some privately funded procedures undertaken at private hospitals are not included in the NMDS. Both databases are reliant on the quality of the information obtained from clinical records and classification systems.

Changes over time should be interpreted with caution as a range of factors could influence the apparent improvement in mortality rates. Analyses in subsequent reports will further examine this finding.

The NMDS does not include data about non-admitted patients. These patients are more likely to be lower risk (ASA 1–2) and their procedures both elective and less complex. Data related to outpatient events are recorded in the National Non-Admitted Patients Collection (NNPAC). However NNPAC data does not include information about procedures and their ASA score and therefore they have been omitted.

Multiple anaesthetics and admissions within a 30-day period have been analysed in the same way as in previous reports.

Further information about data sources and methods is provided in Appendix 2.

Definition

1. Elective or waiting list hospital 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.

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

Mortality by type of hospital and cause of death

In New Zealand during 2007–2011, among people given a first ASA score of 1 or 2 who were admitted electively/from the waiting list, and who received a general anaesthetic or neuraxial block during their admission, there was a total of 249 deaths within 30 days. The majority of these deaths occurred following an anaesthetic or neuraxial block and elective procedure at a public hospital (239). The cumulative five-year mortality rate at public hospitals was 70.5 per 100,000 (0.07%) admissions, which was higher than the corresponding rate at private hospitals (17.5 per 100,000 admissions or 0.02%).

In New Zealand during 2007–2011, malignant/other neoplasms were the most frequently listed cause of death for those over 25 years of age who were given a first ASA score of 1 or 2, were admitted electively/from the waiting list, and who received a general anaesthetic or neuraxial block during their admission (Table 21). Myocardial infarctions/Other ischaemic heart disease and other cardiovascular causes were also leading causes of mortality in those aged over 45 years, while gastrointestinal diseases caused a relatively high number of deaths in the 80+ age group. Compared with 2006–2010, mortality counts were similar in the younger age groups, there were fewer deaths among people aged 65–79 years and slightly more in the oldest age group. The common causes of mortality were largely the same as in the previous report for 2006–2010.

Table 21: Thirty-Day Mortality Following Elective/Waiting List Admissions with a First ASA Score of 1 or 2 by Age Group and Cause, New Zealand 2007–2011

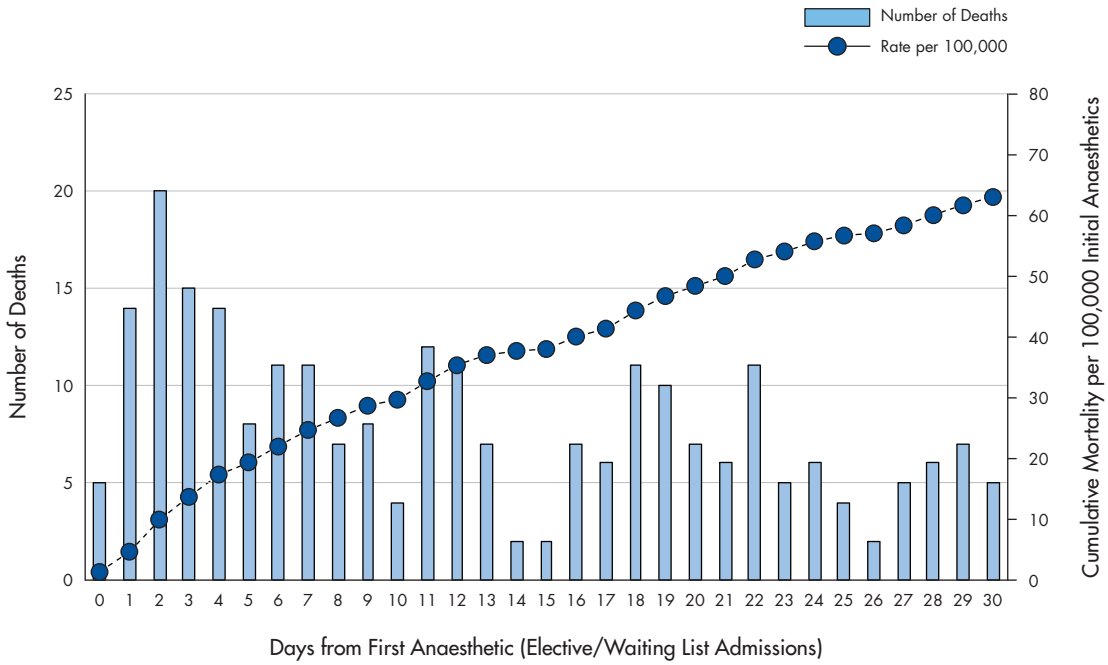
MAIN UNDERLYING CAUSE OF DEATH	Number: Total 2007–2011	Number: Annual Average	Deaths in Age Group (%)
0–24 Years			
Injuries/External Causes	<3	s	s
Malignant/Other Neoplasms	<3	s	s
Other Causes	6	1.2	60.0
Total 0–24 Years	10	2.0	100.0
25–44 Years			
Malignant/Other Neoplasms	7	1.4	43.8
Other Causes	9	1.8	56.3
Total 25–44 Years	16	3.2	100.0
45–64 Years			
Malignant/Other Neoplasms	25	5.0	43.9
Myocardial Infarction/Other Ischaemic Heart Disease	8	1.6	14.0
Other Cardiovascular Causes	4	0.8	7.0
Respiratory Diseases	3	0.6	5.3
Other Causes	17	3.4	29.8
Total 45–64 Years	57	11.4	100.0
65–79 Years			
Malignant/Other Neoplasms	39	7.8	45.9
Myocardial Infarction/Other Ischaemic Heart Disease	16	3.2	18.8
Other Cardiovascular Causes	12	2.4	14.1
Injuries/External Causes	3	0.6	3.5
Gastrointestinal Diseases	3	0.6	3.5
Other Causes	12	2.4	14.1
Total 65–79 Years	85	17.0	100.0
80+ Years			
Malignant/Other Neoplasms	35	7.0	43.2
Myocardial Infarction/Other Ischaemic Heart Disease	10	2.0	12.3
Other Cardiovascular Causes	9	1.8	11.1
Gastrointestinal Diseases	10	2.0	12.3
Respiratory Diseases	6	1.2	7.4
Other Causes	11	2.2	13.6
Total 80+ Years	81	16.2	100.0
Grand Total	249	49.8	

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

In 2007–2011, during the first 30 days following an initial general anaesthetic or neuraxial block in those admitted electively or from the waiting list with an ASA score of 1 or 2, mortality was highest on the second day after surgery, although deaths occurred with varying numbers right up until day 30 following the initial anaesthetic (Figure 27). Cumulative mortality at day 30 reached 62.9 deaths per 100,000 initial anaesthetics, or 0.06%. This rate is lower than in 2006–2010, where cumulative mortality was 68.8 per 100,000 initial anaesthetics during the first 30 days following a procedure.

Figure 27: Thirty-Day Mortality in Elective/Waiting List Admissions with a First ASA Score of 1 or 2 by Day from First Anaesthetic, New Zealand 2007–2011

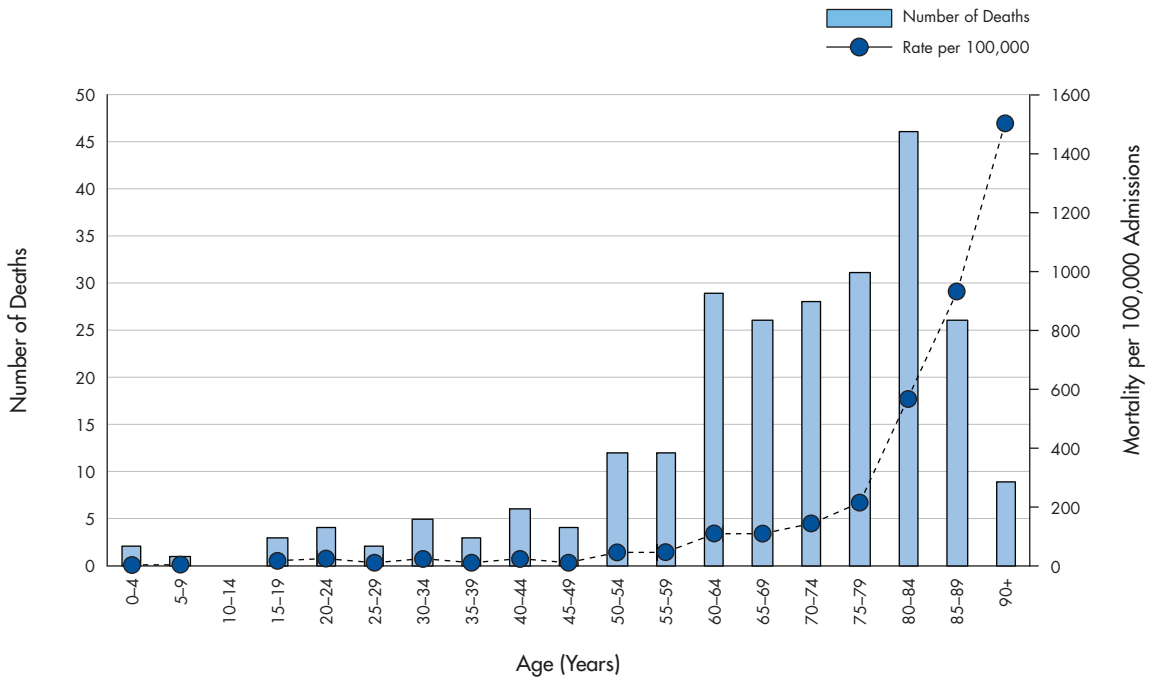


Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block in those admitted electively or from the waiting list with a first ASA score of 1 or 2.
Denominator: NMDS: Elective/Waiting list admissions in those with a first ASA score of 1 or 2 and either a general anaesthetic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

Mortality by age

Mortality in the first 30 days following an initial general anaesthetic or neuraxial block on those with an ASA score of 1 or 2 during 2007–2011 was relatively infrequent under the age of 50 years (Figure 28). Rates of mortality increased progressively after 50 years, reaching the highest rate at 90+ years. The number of deaths in each age group also generally increased after the age of 50 years; however, mortality counts were highest at age 80–84 years. These trends are similar to the 2006–2010 period. Compared with the preceding period the number of deaths among those aged 70–79 has decreased in 2007–2011.

Figure 28: Thirty-Day Mortality in Elective/Waiting List Admissions with a First ASA Score of 1 or 2 by Age, New Zealand 2007–2011



Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block in those admitted electively or from the waiting list with a first ASA score of 1 or 2.
Denominator: NMDS: Elective/Waiting list admissions 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 2007–2011, 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 than females, and for every age group over 25 years of age (compared to 0–24 years) (Table 22). These differences persisted, even when the risk was adjusted for other sociodemographic factors (age, gender, ethnicity and NZDep decile). While, at the univariate level, mortality was significantly lower for people not of European ethnicity, these differences did not remain statistically significant in the multivariate model. Compared with 2006–2010, the findings were generally similar but with the older data there was no statistical significance associated with the higher odds ratio for mortality recorded in those aged 25–44 years. By contrast, with decile 7–8 admissions the increase in the odds ratio for mortality observed for the univariate and multivariate analyses was not statistically significant with the 2007–2011 data, unlike 2006–2010.

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 or 2), those undergoing emergency procedures and those receiving two or more anaesthetics during their admission (Table 23). When adjusted for the other factors in the multivariate model, each of these factors continued to show a significant difference. These results are fully consistent with the findings from 2006–2010.

Table 22: Thirty-Day Mortality Following Elective/Waiting List Admissions with a First ASA Score of 1 or 2 by Age Group, Gender, Ethnicity and NZ Deprivation Index Decile, New Zealand 2007–2011

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/Waiting List									
Age Group	0–24 Years	10	125,969	7.9	0.01	1.00		1.00	
	25–44 Years	16	90,685	17.6	0.02	2.22*	1.01–4.90	2.50*	1.12–5.58
	45–64 Years	57	110,060	51.8	0.05	6.53*	3.33–12.78	7.32*	3.70–14.45
	65–79 Years	85	57,797	147.1	0.15	18.55*	9.63–35.73	20.94*	10.72–40.91
	80+ Years	81	11,471	706.1	0.71	89.58*	46.43–172.83	100.52*	50.97–198.22
Gender	Female	101	222,691	45.4	0.05	1.00		1.00	
	Male	148	173,290	85.4	0.09	1.88*	1.46–2.43	1.75*	1.35–2.27
Ethnicity	European	207	281,365	73.6	0.07	1.00		1.00	
	Māori	23	58,583	39.3	0.04	0.53*	0.35–0.82	1.40	0.88–2.22
	Pacific	6	21,852	27.5	0.03	0.37*	0.17–0.84	1.06	0.46–2.43
	Asian/ MELAA/ Other	8	28,104	28.5	0.03	0.39*	0.19–0.78	0.76	0.38–1.56
NZ Deprivation Index Decile	Decile 1–2	35	61,290	57.1	0.06	1.00		1.00	
	Decile 3–4	32	69,273	46.2	0.05	0.81	0.50–1.31	0.78	0.48–1.28
	Decile 5–6	57	81,255	70.1	0.07	1.23	0.81–1.87	1.18	0.77–1.82
	Decile 7–8	73	92,732	78.7	0.08	1.38	0.92–2.06	1.33	0.88–2.01
	Decile 9–10	52	90,947	57.2	0.06	1.00	0.65–1.54	1.24	0.79–1.94

Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block in those admitted electively or from the waiting list with a first ASA score of 1 or 2.
Denominator: NMDS: Elective/Waiting list admissions 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.
CI: Confidence interval.
MELAA: Middle Eastern/Latin American/African.
OR: Odds ratio.

Table 23: Thirty-Day Mortality Following Elective/Waiting List 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 2007–2011

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/Waiting List									
Age Group	0–24 Years	10	125,969	7.9	0.01	1.00		1.00	
	25–44 Years	16	90,685	17.6	0.02	2.22*	1.01–4.90	2.41*	1.08–5.39
	45–64 Years	57	110,060	51.8	0.05	6.53*	3.33–12.78	6.19*	3.13–12.24
	65–79 Years	85	57,797	147.1	0.15	18.55*	9.63–35.73	14.23*	7.24–27.97
	80+ Years	81	11,471	706.1	0.71	89.58*	46.43–172.83	63.57*	31.96–126.43
Gender	Female	101	222,691	45.4	0.05	1.00		1.00	
	Male	148	173,290	85.4	0.09	1.88*	1.46–2.43	1.77*	1.36–2.30
Ethnicity	European	207	281,365	73.6	0.07	1.00		1.00	
	Māori	23	58,583	39.3	0.04	0.53*	0.35–0.82	1.35	0.85–2.14
	Pacific	6	21,852	27.5	0.03	0.37*	0.17–0.84	0.90	0.39–2.09
	Asian/ MELAA/ Other	8	28,104	28.5	0.03	0.39*	0.19–0.78	0.75	0.37–1.53
NZ Deprivation Index Decile	Decile 1–2	35	61,290	57.1	0.06	1.00		1.00	
	Decile 3–4	32	69,273	46.2	0.05	0.81	0.50–1.31	0.74	0.44–1.22
	Decile 5–6	57	81,255	70.1	0.07	1.23	0.81–1.87	1.19	0.77–1.85
	Decile 7–8	73	92,732	78.7	0.08	1.38	0.92–2.06	1.35	0.89–2.06
	Decile 9–10	52	90,947	57.2	0.06	1.00	0.65–1.54	1.22	0.77–1.92
ASA Score of Last Anaesthetic	1–2	197	394,758	49.9	0.05	1.00		1.00	
	3	16	523	3,059.3	3.06	5.77*	5.57–5.97	5.08*	2.53–10.20
	4	17	148	11,486.5	11.49	796.05*	789.44–802.71	14.45*	6.98–29.92
	5	4	10	40,000.0	40.00	s	s	s	s
	Not Stated	15	543	2,762.4	2.76	4.85*	4.67–5.03	10.52*	5.70–19.42
Emergency Status of Last Anaesthetic	Non-Emergency/ Not Stated	209	391,389	53.4	0.05	1.00		1.00	
	Emergency	40	4,593	870.9	0.87	16.44*	11.71–23.09	2.98*	1.75–5.06
Number of Anaesthetics	1	154	376,894	40.9	0.04	1.00		1.00	
	2+	95	19,088	497.7	0.50	12.25*	9.47–15.81	3.33*	2.35–4.71

Numerator: NMC: Deaths occurring within 30 days of a general anaesthetic or neuraxial block in those admitted electively or from the waiting list with a first ASA score of 1 or 2.
Denominator: NMDS: Elective/Waiting list admissions in those with a first ASA score of 1 or 2 and either a general anaesthetic or a neuraxial block.
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 2 for details).
* Significantly different from reference category.
CI: Confidence interval.
MELAA: Middle Eastern/Latin American/African.
OR: Odds ratio.

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

Admissions by age and hospital type

In New Zealand during 2007–2011 the largest number of elective/waiting list admissions occurred among people with a first ASA score of 1 or 2 who were aged less than 25 years (Table 24). Overall 14% of these admissions occurred at private hospitals; people aged 45–64 had the highest percentage of admissions to private facilities (17%) and those aged over 80 years had the lowest (9%).

Table 24: Elective/Waiting List Admissions for Those with a First ASA Score of 1 or 2 by Hospital Type and Age Group, New Zealand 2007–2011

AGE GROUP	Number of Admissions 2007–2011 Public Hospitals	Number of Admissions 2007–2011 Private Hospitals	Total Number of Admissions 2007–2011
0–24	109,019	16,950	125,969
25–44	77,119	13,566	90,685
45–64	91,850	18,210	110,060
65–79	50,436	7,361	57,797
80+	10,477	994	11,471
Totals	338,901	57,081	395,982

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

Admissions by age and primary procedure

In New Zealand during 2007–2011, dental procedures, grommets and tonsillectomy +/– adenoidectomy were the leading reasons for elective/waiting list admissions in people aged under 25 years with a first ASA score of 1 or 2, while laparoscopic sterilisation, cholecystectomy, and dilation and curettage of the uterus were the leading reasons for those people aged 25–44 years (Table 25). When compared with 2006–2010, the total number of procedures has increased in all age groups. The three most common procedures were the same for the youngest age group. Among those people aged 25–44 years, laparoscopic sterilisation was again the most common procedure but fewer hysterectomy procedures were undertaken in 2007–2011.

Table 25: Elective/Waiting List 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 2007–2011

PRIMARY PROCEDURE	Number: Total 2007–2011	Number: Annual Average	Admissions in Age Group (%)
0–24 Years			
Dental Procedures	23,859	4,772	18.94
Grommets	18,551	3,710	14.73
Tonsillectomy +/- Adenoidectomy	16,345	3,269	12.98
Removal of Screw, Pin, Wire, Plate, Rod or Nail	4,150	830	3.29
Inguinal Hernia Repair	2,874	575	2.28
Adenoidectomy without Tonsillectomy	2,191	438	1.74
Myringoplasty with Associated Procedures	2,115	423	1.68
Orchidopexy	1,553	311	1.23
Male Circumcision	1,537	307	1.22
Laparoscopy	1,106	221	0.88
Excision/Incision of Pilonidal Sinus or Cyst	1,063	213	0.84
Other Procedures	50,625	10,125	40.19
Total 0–24 years	125,969	25,194	100.00
25–44 Years			
Laparoscopic Sterilisation	3,989	798	4.40
Cholecystectomy: Laparoscopic and Open	3,692	738	4.07
Dilation and Curettage of Uterus	3,623	725	4.00
Elective Lower Segment Caesarean Section	3,436	687	3.79
Diagnostic Hysteroscopy	2,565	513	2.83
Removal of Screw, Pin, Wire, Plate, Rod or Nail	2,251	450	2.48
Procedures on the Cervix	2,244	449	2.47
Septoplasty	2,055	411	2.27
Arthroscopic Meniscectomy of Knee	1,801	360	1.99
Laparoscopy	1,772	354	1.95
Hysterectomy: Abdominal and Vaginal	1,577	315	1.74
Other Procedures	61,680	12,336	68.02
Total 25–44 Years	90,685	18,137	100.00

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

Table 26: Elective/Waiting List 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 2007–2011

PRIMARY PROCEDURE	Number: Total 2007–2011	Number: Annual Average	Admissions in Age Group (%)
45–64 Years			
Hip Arthroplasty Including Revisions	5,278	1,056	4.80
Dilation and Curettage of Uterus	4,133	827	3.76
Excision of Lesion of Breast Including Re-Excisions	3,811	762	3.46
Cholecystectomy: Laparoscopic and Open	3,749	750	3.41
Knee Arthroplasty Including Revisions	3,684	737	3.35
Hysterectomy: Abdominal and Vaginal	3,418	684	3.11
Arthroscopic Meniscectomy of Knee	3,392	678	3.08
Diagnostic Hysteroscopy	2,813	563	2.56
Inguinal Hernia Repair	2,566	513	2.33
Mastectomy	2,181	436	1.98
Other Procedures	75,035	15,007	68.18
Total 45–64 Years	110,060	22,012	100.00
45–64 Years			
Knee Arthroplasty Including Revisions	6,378	1,276	11.04
Hip Arthroplasty Including Revisions	5,826	1,165	10.08
Inguinal Hernia Repair	2,428	486	4.20
Transurethral Resection of Prostate	2,085	417	3.61
Cholecystectomy: Laparoscopic and Open	1,794	359	3.10
Excision of Lesion of Breast Including Re-Excisions	1,103	221	1.91
Hysterectomy: Abdominal and Vaginal	1,043	209	1.80
Mastectomy	973	195	1.68
Arthroscopic Meniscectomy of Knee	823	165	1.42
Dilation and Curettage of Uterus	630	126	1.09
Other Procedures	34,714	6,943	60.06
Total 65–79 Years	57,797	11,559	100.00
80+ Years			
Hip Arthroplasty Including Revisions	1,193	239	10.40
Knee Arthroplasty Including Revisions	1,097	219	9.56
Excision of Lesions of Skin and Subcutaneous Tissue	896	179	7.81
Endoscopic Resection/Destruction of Bladder Lesion or Tissue	633	127	5.52
Transurethral Resection of Prostate	617	123	5.38
Inguinal Hernia Repair	497	99	4.33
Mastectomy	307	61	2.68
Cholecystectomy: Laparoscopic and Open	287	57	2.50
Right Hemicolectomy with Anastomosis	265	53	2.31
Cataract Surgery	155	31	1.35
Other Procedures	5,527	1,105	48.18
Total 80+ Years	11,471	2,294	100.00

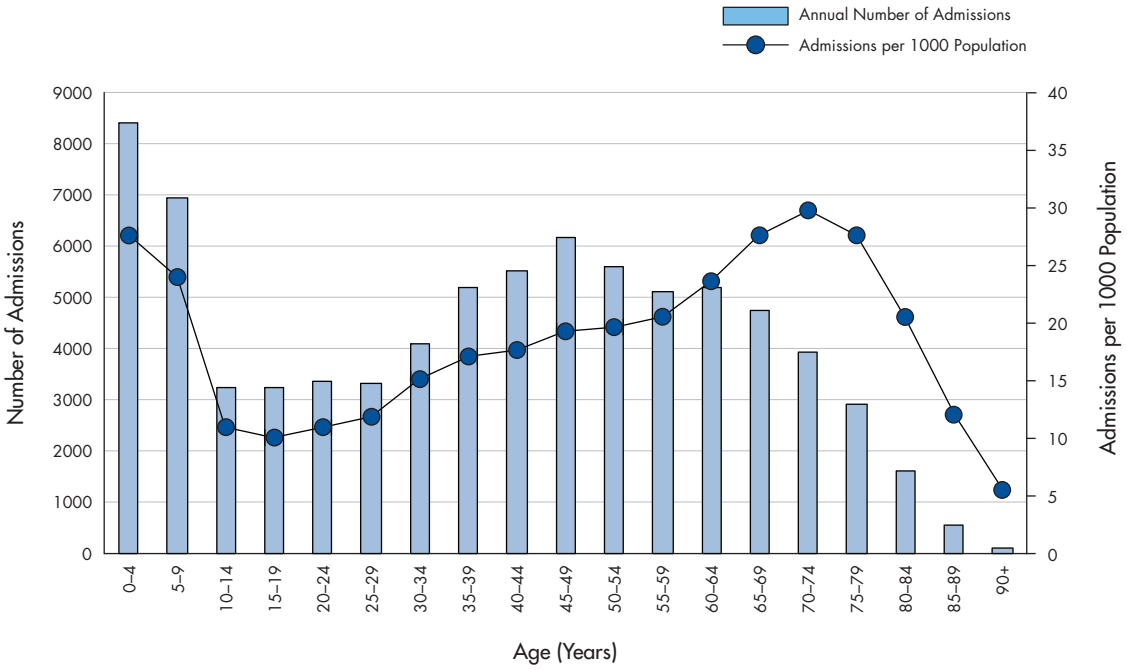
Data source: NMDS: Elective/Waiting list admissions in those with a first ASA score of 1 or 2 and either a general anaesthetic or a neuraxial block.

Hip and knee arthroplasty procedures were common for all three age groups aged over 44 years (Table 26). This was similar to 2006–2010. Other common procedures were dilation and curettage of the uterus, inguinal hernia repair and the excision of skin lesions for the 45–64, 65–79 and 80+ age groups respectively. This pattern was also evident in the 2006–2010 report.

Admissions by age

During 2007–2011, the highest annual numbers of admissions in those with an ASA score of 1 or 2 were for those aged 0–4 years, followed by those aged 5–9 years (Figure 29). Admission counts then decreased and remained low for those aged 10–29 years, before increasing again to reach a peak at 45–49 years. After 50 years, admission numbers decreased with age. Because of the underlying age structure of the New Zealand population, admission rates per 100,000 people in each age group reached a maximum at 70–74 years. These trends have not changed since the 2006–2010 findings from the previous report.

Figure 29: Elective/Waiting List Admissions in Those with a First ASA Score of 1 or 2 by Age, New Zealand 2007–2011

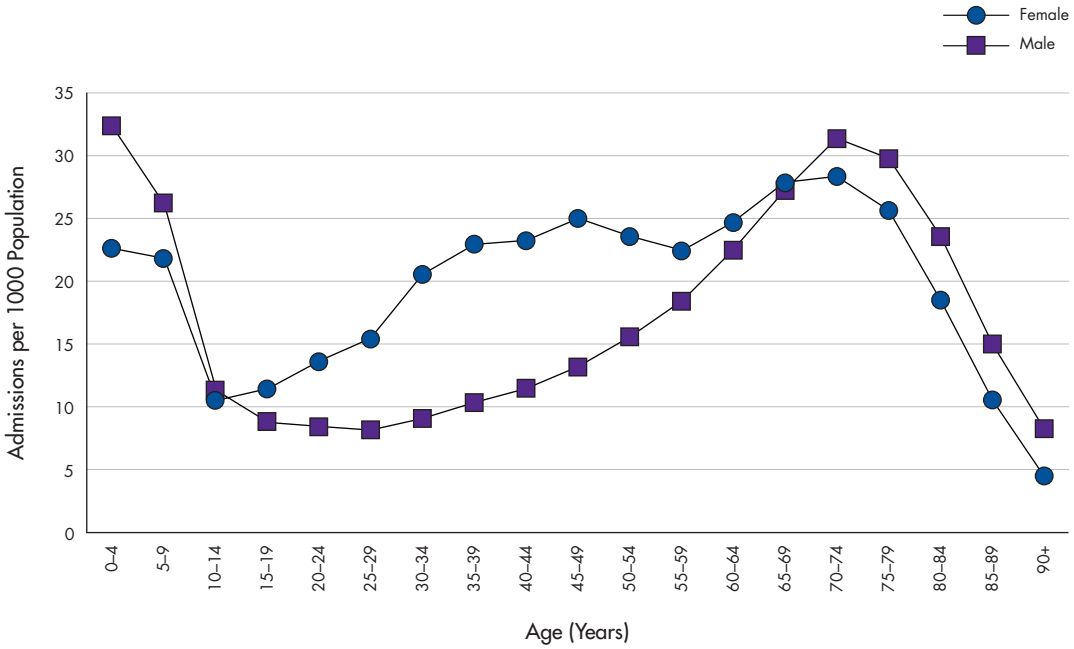


Numerator: Elective/Waiting list admissions in those with a first ASA score of 1 or 2 and either a general anaesthetic or a neuraxial block.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Admissions by age and gender

Elective/Waiting list admissions during 2007–2011 for those with a first ASA score of 1 or 2 were higher for males than females under the age of 10 years (Figure 30). After this age, rates then increased at a faster rate for females, resulting in a higher proportion of female admissions for those aged 15–69 years. From the age of 70 years onwards, males again showed higher rates of admissions than females. Both genders showed an initial peak in admissions at age 0–4 years, with a secondary peak occurring later on at 70–74 years. These results are very similar to those for the 2006–2010 period.

Figure 30: Elective/Waiting List Admissions in Those with a First ASA Score of 1 or 2 by Age and Gender, New Zealand 2007–2011

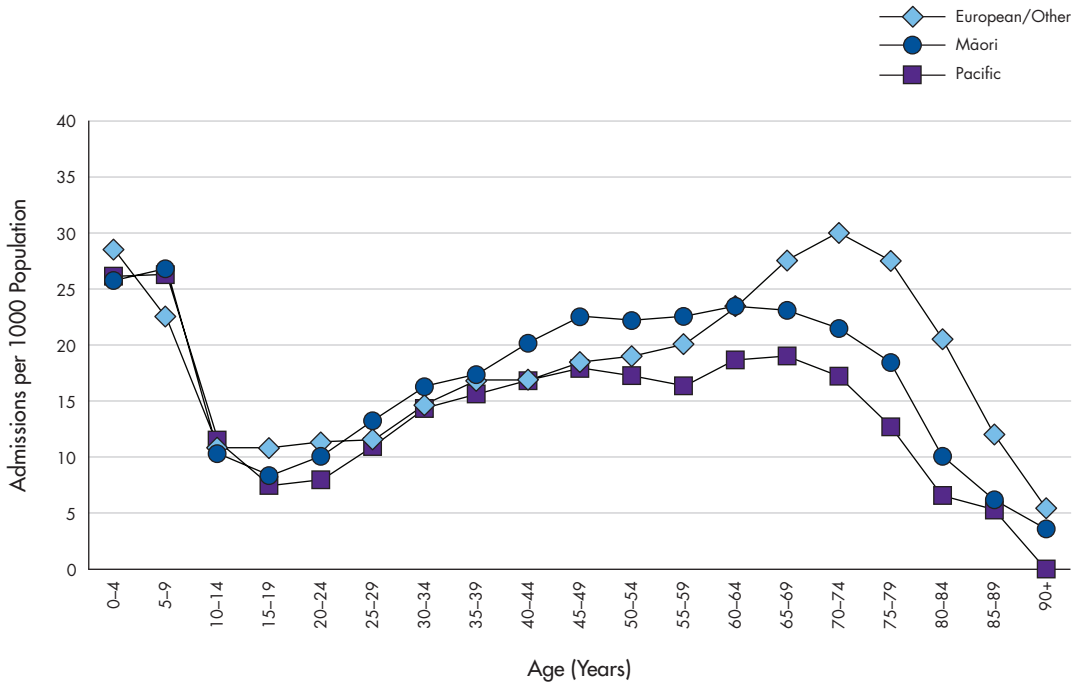


Numerator: NMDS: Elective/Waiting list admissions in those with a first ASA score of 1 or 2 and either a general anaesthetic or a neuraxial block.
Denominator: Statistics New Zealand: Estimated Resident Population (projected from 2007).

Admissions by age and ethnicity

During 2007–2011, for those aged of 0–14 years, there were no consistent differences in elective/waiting list admission rates for different ethnic groups with a first ASA score of 1 or 2 (Figure 31). From the age of 15 onwards, people of Māori ethnicity had higher admission rates than Pacific peoples. European/Other ethnic groups had higher admission rates than both Māori and Pacific peoples from the age of 65 years onwards, peaking at 70–74 years. Admission rates for Māori and Pacific peoples reached their highest point at age 5–9 years. These results are very similar to those from the 2006–2010 period.

Figure 31: Elective/Waiting List Admissions in Those with a First ASA Score of 1 or 2 by Age and Ethnicity, New Zealand 2007–2011



Numerator: NMDS: Elective/Waiting list 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.

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 anaesthetic that was either associated with, or attributed to, a pulmonary embolus.

An increasing number of admissions either associated with or attributed to pulmonary embolism is of concern; however, this finding may be due to a number of factors. One important possibility is that more cases of pulmonary embolism are now being identified due to an increased awareness of the problem and better diagnostic tools. Many district health boards (DHBs) have invested recently in better equipment with a higher capacity to identify cases of pulmonary embolism and the use of these more sophisticated scanners has markedly increased. At one DHB the number of scans has doubled over the 2007–2011 period.

Key findings

In New Zealand during 2007–2011, in relation to hospital admissions in which death occurred within the first 30 days following a general anaesthetic or neuraxial block, the following were key findings:

For pulmonary embolism-associated admissions:

- There were 276 deaths and the overall cumulative mortality for the 30-day period was 21.8 deaths per 100,000 initial anaesthetics.
- Most (68%) involved an acute admission to a public hospital and cumulative mortality among acute admissions was 61.7 deaths per 100,000 initial anaesthetics.
- Cumulative mortality reached 8.7 deaths per 100,000 initial anaesthetics for elective/waiting list admissions.
- Mortality following acute admissions was highest on the same or next day following anaesthesia.
- Mortality following elective/waiting list admissions was highest on the first and second days following anaesthesia.
- Mortality rates were significantly higher for those admitted acutely (vs. elective/waiting list admissions), those aged 25 years and over (vs. 0–24 years) and those with ASA scores of 3–5 (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.
- When the analysis was confined to only those with a pulmonary embolism-associated admission, mortality was significantly higher for those admitted acutely (vs. elective/waiting list admissions), those aged 80+ years (vs. 0–24 years) and those with ASA scores of 3–5 (vs. ASA score 1–2).

For pulmonary embolism-attributed admissions:

- There were 136 deaths and the overall cumulative mortality for the 30-day period was 10.7 deaths per 100,000 initial anaesthetics.
- Mortality rates were significantly higher for those admitted acutely (vs. elective/waiting list admissions), those aged 45 years and over (vs. 0–24 years) and those with ASA scores of 3–5 (vs. ASA score 1–2). These differences persisted, even when the risk was adjusted for other sociodemographic (age, gender, ethnicity, NZDep) and clinical (ASA score, admission type) factors.

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

- Malignant/Other neoplasms were the most frequently listed main underlying cause of death regardless of the admission type.
- Mortality rose with age and was relatively infrequent in those aged under 25 years but rates rose thereafter, with the highest rates evident for those aged over 80 years. In most age groups, mortality was higher for acute admissions compared with the other types of admissions.
- Mortality was more common in those admissions that had an ASA score of 4. In general, there was a stepwise increase in mortality with rising ASA score.

These findings were consistent with the 2006–2010 period with the following exceptions or additions:

- Cumulative mortality rates were higher in the 2007–2011 period for both acute and elective/waiting list admissions, up from the previously recorded 54.5 deaths and 7.6 deaths per 100,000 initial anaesthetics.
- The number of pulmonary embolism-attributed deaths has increased, especially among acute admissions and people aged over 44 years.

Data sources and limitations

Data in this report have been provided by the NMDS and the NMC. These databases have limitations associated with the completeness and accuracy of their information. For example, data from some privately funded procedures undertaken at private hospitals are not included in the NMDS. Both databases are reliant on the quality of the information obtained from clinical records and classification systems.

Changes over time should be interpreted with caution as a range of factors could influence the apparent increase in mortality rates. Analyses in subsequent reports will further examine this finding.

Multiple anaesthetics and admissions within a 30-day period have been analysed in the same way as in previous reports.

Further information about data sources and methods is provided in Appendix 2.

Definitions

In this analysis, hospital admissions occurring during 2007–2011 were included if a general anaesthetic or neuraxial block were listed in any of the procedure codes. The date of the first anaesthetic for each of the 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 admissions 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.

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).

Pulmonary embolus-associated and attributed mortality

Pulmonary embolus-associated mortality by admission and hospital type

In New Zealand during 2007–2011, there were 276 admissions with pulmonary embolus-associated mortality. Most (68%) involved an acute hospital admission to a public hospital. Among the 72 deaths related to an elective/waiting list admission 12 involved an admission to a private hospital. The overall cumulative mortality over the 30-day period was 21.8 deaths per 100,000 initial anaesthetics during 2007–2011.

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

In New Zealand during 2007–2011, malignant/other neoplasms and falls were the most frequently listed main underlying causes of death in those meeting the criteria for a pulmonary embolus-associated death (that is, death within 30 days of the first anaesthetic for a pulmonary embolus-associated admission) who were admitted acutely (Table 27). Similarly, malignant/other neoplasms were the most common main underlying cause of death for elective/waiting list admissions that met the criteria above. These causes were the same as the findings for the 2006–2010 period.

Table 27: Pulmonary Embolus-Associated Mortality by Main Underlying Cause of Death and Admission Type, New Zealand 2007–2011

MAIN UNDERLYING CAUSE OF DEATH	Total Deaths 2007–2011	Annual Average	Deaths in Category (%)
Pulmonary Embolus-Associated Mortality			
Acute			
Falls	48	9.6	25.4
Other Injuries/External Causes	8	1.6	4.2
Malignant/Other Neoplasms	53	10.6	28.0
Myocardial Infarction/Other Ischaemic Heart Disease	18	3.6	9.5
Pulmonary Embolism	9	1.8	4.8
Other Cardiovascular Causes	16	3.2	8.5
Gastrointestinal Diseases	14	2.8	7.4
Respiratory Diseases	7	1.4	3.7
Other Causes	16	3.2	8.5
Total Acute Admissions	189	37.8	100.0
Public Hospital Semi-Acute			
Malignant/Other Neoplasms	7	1.4	46.7
Pulmonary Embolism	<3	s	s
Other Causes	6	1.2	40.0
Total Public Hospital Semi-Acute	15	3.0	100.0
Elective/Waiting List			
Malignant/Other Neoplasms	31	6.2	43.1
Myocardial Infarction/Other Ischaemic Heart Disease	6	1.2	8.3
Other Cardiovascular Causes	8	1.6	11.1
Other Causes	27	5.4	37.5
Total Elective/Waiting List	72	14.4	100.0

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

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

During 2007–2011, 136 deaths were attributed to pulmonary embolism (that is, deaths within 30 days of a general anaesthetic or neuraxial block and where a pulmonary embolus was listed as the main or contributory cause of death in the NMC). Most deaths occurred among acute admissions (68%) and were related to admissions to public hospitals (130 or 96%). Among the pulmonary embolism-attributed deaths, malignant/other neoplasms were the most common main underlying cause of death for those admitted acutely or as elective/waiting list admissions (Table 28). Compared to 2006–2010, the most common causes have not changed; however, total deaths have increased for all admission types, especially acute admissions where 93 deaths were reported during 2007–2011 compared to only 45 acute deaths during 2006–2010.

Table 28: Pulmonary Embolus-Attributed Mortality by Main Underlying Cause of Death and Admission Type, New Zealand 2007–2011

MAIN UNDERLYING CAUSE OF DEATH	Total Deaths 2007–2011	Annual Average	Deaths in Category (%)
Pulmonary Embolus-Attributed Mortality			
Acute			
Falls	24	4.8	25.8
Malignant/Other Neoplasms	28	5.6	30.1
Pulmonary Embolism	8	1.6	8.6
Other Causes	33	6.6	35.5
Total Acute Admissions	93	18.6	100.0
Public Hospital Semi-Acute			
All Causes	6	1.2	100.0
Total Public Hospital Semi-Acute	6	1.2	100.0
Elective/Waiting List			
Malignant/Other Neoplasms	15	3.0	40.5
Cardiovascular Causes	5	1.0	13.5
Other Causes	17	3.4	45.9
Total Elective/Waiting List	37	7.4	100.0

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

Mortality by day from first anaesthetic

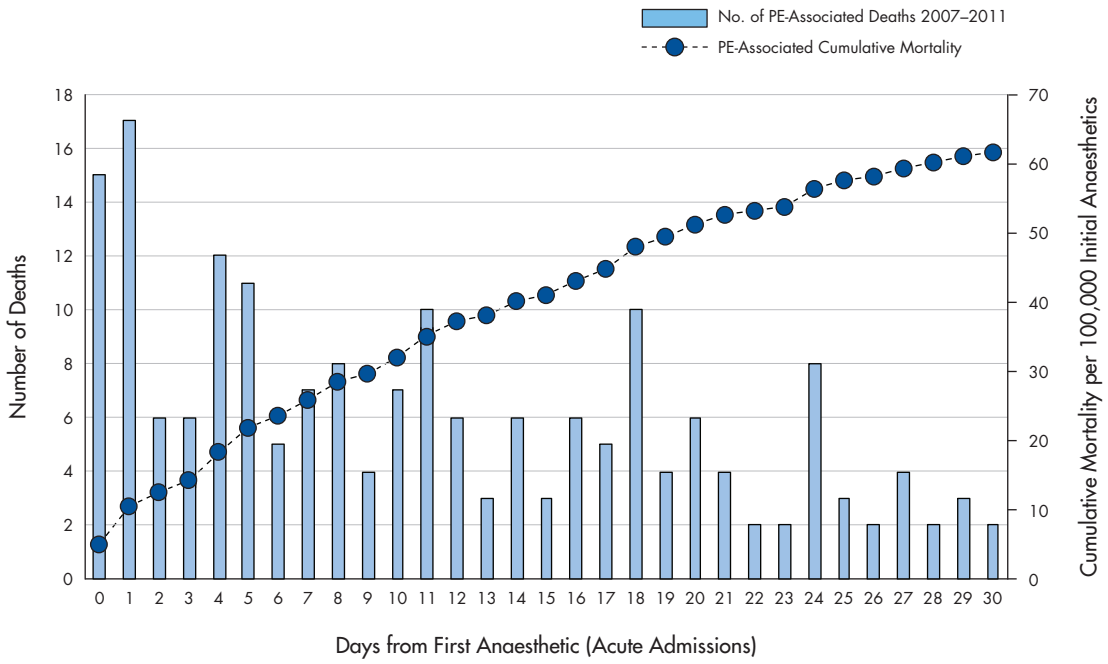
Acute admissions

Pulmonary embolus-associated mortality in those admitted acutely during 2007–2011 was highest on the day a general anaesthetic or neuraxial block was administered, or day 0, and the day after the anaesthetic, or day 1 (Figure 32). A second, smaller spike in mortality occurred on days 4 and 5; however, deaths continued to occur sporadically right up until day 30. Cumulative mortality over the 30-day period reached 61.7 deaths per 100,000 initial anaesthetics during 2007–2011, which was an increase compared to the 2006–2010 period where 54.5 deaths occurred per 100,000 initial anaesthetics.

Elective/Waiting list admissions

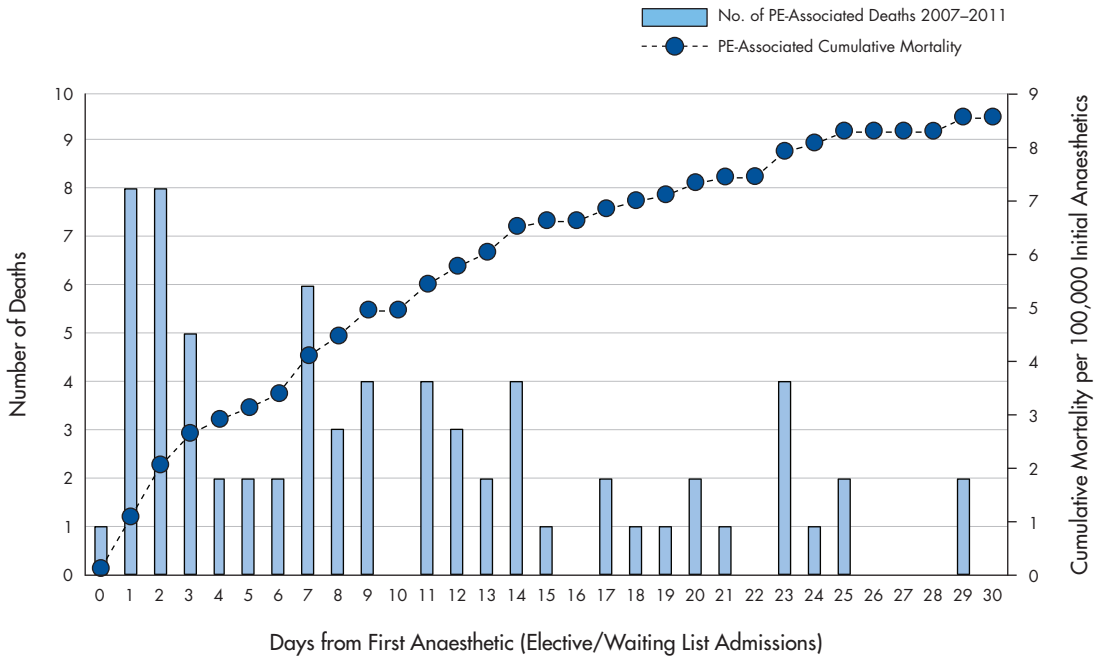
Mortality following elective/waiting list admissions associated with a pulmonary embolus was highest on the first and second days following a general anaesthetic or neuraxial block during 2007–2011 (Figure 33). Cumulative mortality reached 8.7 deaths per 100,000 initial anaesthetics, which was higher than 2006–2010, where cumulative mortality was 7.6 deaths per 100,000 initial anaesthetics. Compared with 2006–2010, the timing of deaths associated with a pulmonary embolism was generally very similar.

Figure 32: Pulmonary Embolus-Associated Mortality in Acute Admissions by Day from First Anaesthetic, New Zealand 2007–2011



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.
PE: Pulmonary embolus.

Figure 33: Pulmonary Embolus-Associated Mortality in Elective/Waiting List Admissions by Day from First Anaesthetic, New Zealand 2007–2011



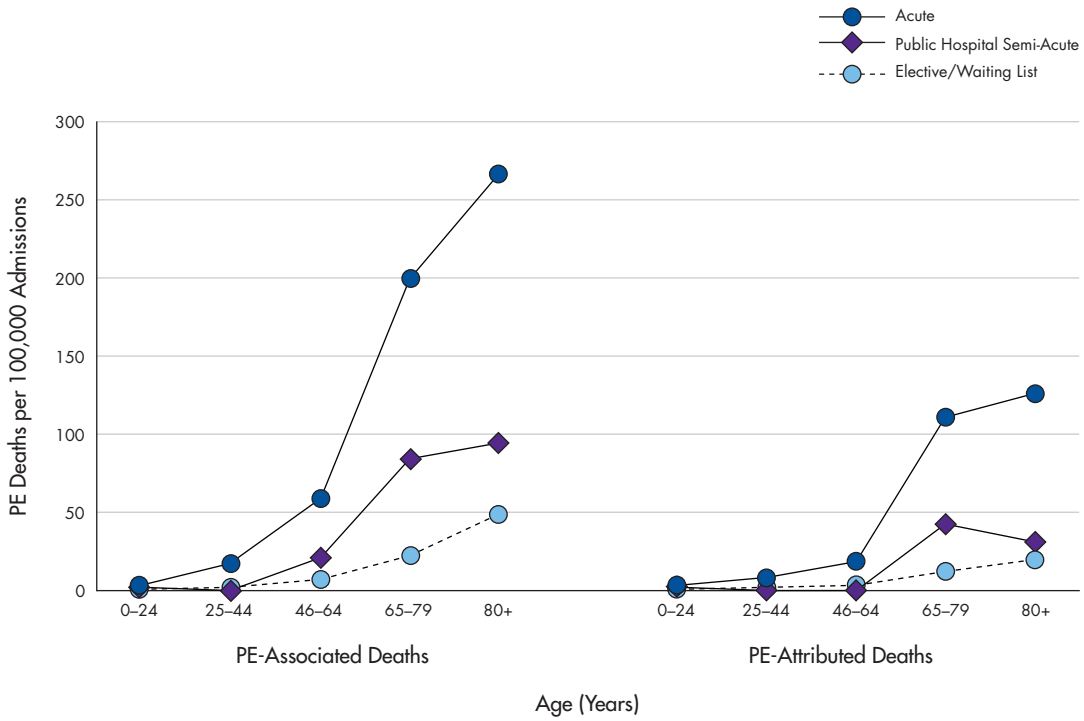
Numerator: NMC: Pulmonary embolus-associated deaths within 30 days of first anaesthetic of an elective/waiting list index admission.
Denominator: NMDS: All elective/waiting list admissions with a general anaesthetic or neuraxial block.
PE: Pulmonary embolus.

Mortality by age

Pulmonary embolus-associated mortality during 2007–2011 was relatively infrequent in those aged under 25 years but rose rapidly thereafter, with the highest rates evident for those aged over 79 years (Figure 34). In most age groups, mortality was higher for acute, which was higher than public hospital semi-acute, which was higher than for elective/waiting list admissions. Likewise, pulmonary embolus-attributed mortality increased with increasing age for acute and elective/waiting list admissions, while patterns for public hospital semi-acute admissions were less clear, possibly as a result of small numbers. When compared with 2006–2010 data, overall patterns for the 2007–2011 data were very similar; however, mortality rates were higher with the later data, particularly among people aged over 44 years.

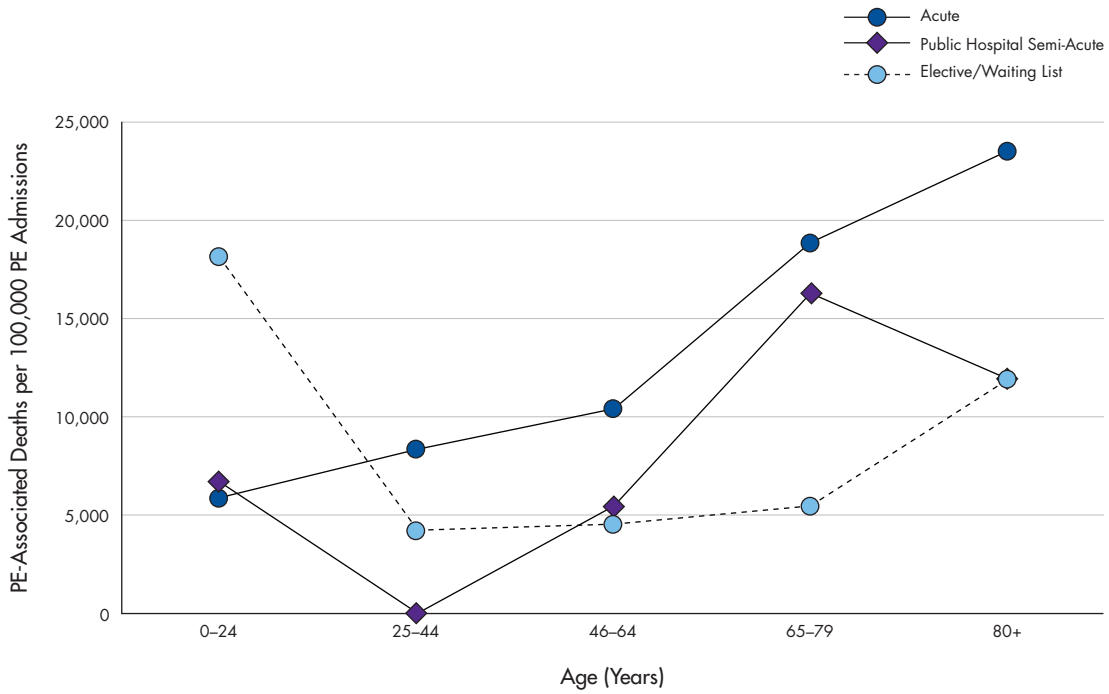
When the analysis was confined only to those with a pulmonary embolus-associated admission, 30-day mortality rates were much higher than when all admissions with a general anaesthetic or neuraxial block were included in the denominator (Figure 35). Mortality rates for acute admissions increased with age. This trend was not as clear among the other admission types although it should be noted that among semi-acute admissions in particular, the number of deaths in four age categories was three or less. These data were similar to those from 2006–2010 in relation to acute admissions. The mortality rate among those aged 80+ years who were admitted acutely and who experienced a pulmonary embolus was again approximately 24%. However, the recent data also suggest that mortality among young people (aged 0–24 years) admitted electively or from the waiting list and who experienced a pulmonary embolus was also relatively high (18%). However, this result also, at least in part, reflects the effect of small numbers for both the numerator and denominator.

Figure 34: Pulmonary Embolus-Associated and Attributed Mortality by Age and Admission Type, New Zealand 2007–2011



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

Figure 35: Thirty-Day Mortality in Pulmonary Embolus-Associated Admissions by Age and Admission Type, New Zealand 2007–2011

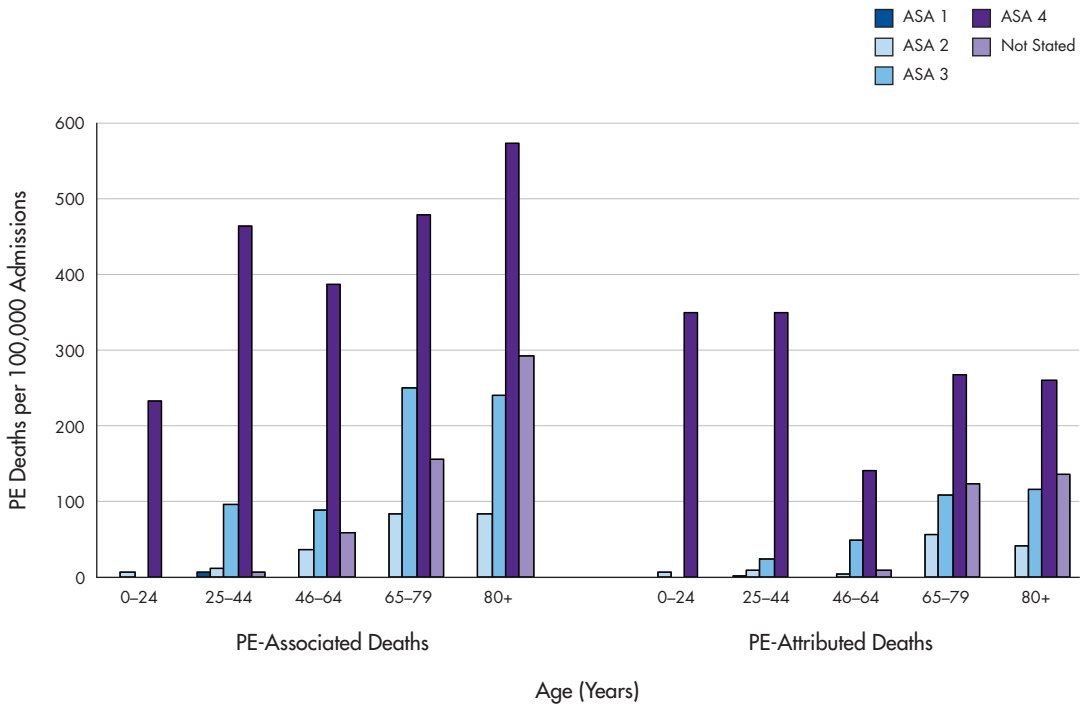


Numerator: NMC: Pulmonary embolus-associated deaths within 30 days of first anaesthetic of index admission.
Denominator: NMDS: All pulmonary embolus-associated hospital admissions.
PE: Pulmonary embolus.

Mortality by age, admission type and ASA score

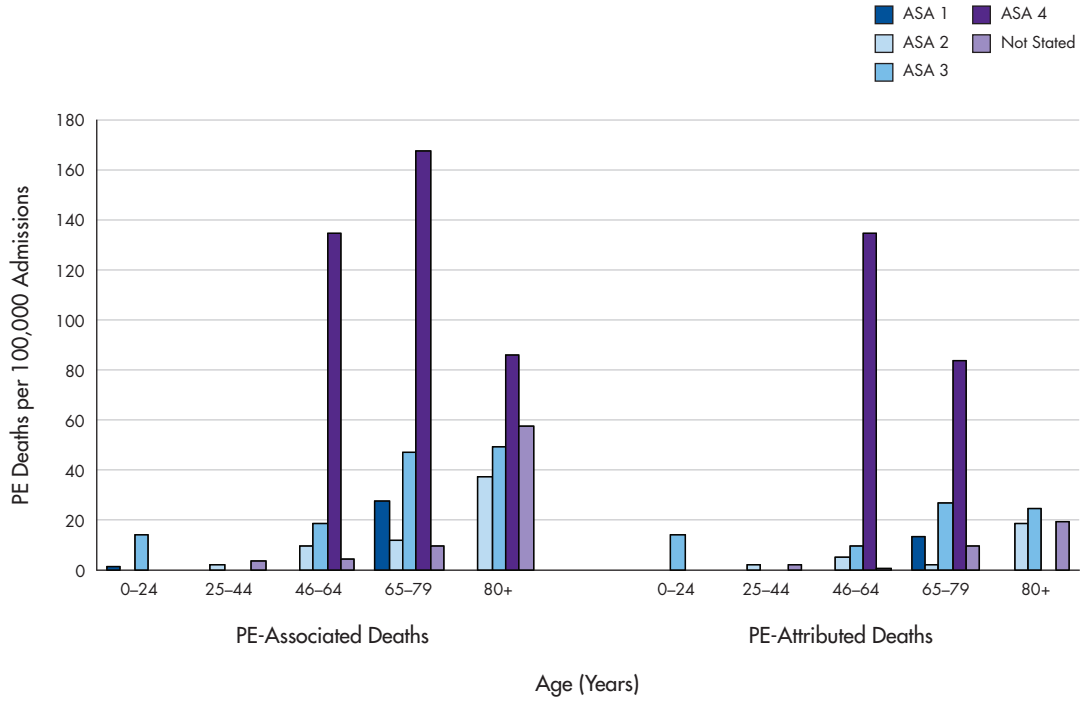
Pulmonary embolus-associated and attributed mortality during 2007–2011 was more common in those admissions that were either acute or who had an ASA score of 4. In general, there was a stepwise increase in mortality with rising ASA score; however, there were exceptions, some of which may be due to small numbers. Among elective/waiting list admissions, mortality below 45 years of age was uncommon. These patterns were very similar for the 2006–2010 data. Pulmonary embolism-attributed mortality rates among acute admissions aged over 64 years were higher in 2007–2011. Pulmonary embolism-associated death rates among acute admissions with an ASA score of 4 were higher for the two oldest age groups but lower among younger people in 2007–2011.

Figure 36: Pulmonary Embolus-Associated and Attributed Mortality in Acute Admissions by Age and ASA Score, New Zealand 2007–2011



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

Figure 37: Pulmonary Embolus-Associated and Attributed Mortality in Elective/Waiting List Admissions by Age and ASA Score, New Zealand 2007–2011



Numerator: NMC: Pulmonary embolus-associated or attributed deaths within 30 days of first anaesthetic of elective/waiting list index admissions.
Denominator: NMDS: Elective/Waiting list admissions with a general anaesthetic or neuraxial block.
PE: Pulmonary embolus.

Mortality by sociodemographic and clinical factors

Pulmonary embolism-associated mortality: During 2007–2011, pulmonary embolism-associated mortality rates were significantly higher for those admitted acutely (vs. elective/waiting list admissions), those aged 25 years and over (vs. 0–24 years) and those with ASA scores of 3–5 (vs. ASA score 1–2) (Table 29). These differences persisted even when the risk was adjusted for other sociodemographic (age, gender, ethnicity, NZDep) 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 NZDep decile. These results were entirely consistent with 2006–2010.

When the analysis was confined to only those with a pulmonary embolism-associated admission, mortality was significantly higher for those admitted acutely (vs. elective/waiting list admissions), those aged 80+ years (vs. 0–24 years) and those with ASA scores of 3–5 (vs. ASA score 1–2) (Table 30). This result was consistent with 2006–2010, although in 2007–2011 admissions for the most deprived areas were not significantly higher in the multivariate model.

Pulmonary embolism-attributed mortality: In New Zealand during 2007–2011, pulmonary embolus-attributed mortality rates were significantly higher for those admitted acutely (vs. elective/waiting list admissions), those aged 45 years and over (vs. 0–24 years) and those with ASA scores of 3–5 (vs. ASA score 1–2) (Table 31). These differences persisted, even when the risk was adjusted for other sociodemographic (age, gender, ethnicity, NZDep) and clinical (ASA score, admission type) factors. While at the univariate level, mortality was significantly lower for Māori and Asian/MELAA/Other peoples (vs. European peoples) and NZDep decile 3–4 (vs. NZDep 1–2), these differences did not remain statistically significant in the multivariate model. These results were generally similar to those observed in the 2006–2010 data.

Table 29: Pulmonary Embolus-Associated Mortality by Admission Type, Age Group, Gender, First ASA Score, Ethnicity and NZ Deprivation Index Decile, New Zealand 2007–2011

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/ Waiting List	72	831,591	8.7	0.01	1.00		1.00	
	Public Hospital Semi-Acute	15	130,156	11.5	0.01	1.33	0.76–2.32	1.36*	1.16–1.61
	Acute	189	306,564	61.7	0.06	7.12*	5.43–9.35	2.71*	2.48–2.95
Age Group	0–24 Years	6	374,558	1.6	0.00	1.00		1.00	
	25–44 Years	18	321,073	5.6	0.01	3.50*	1.39–8.81	3.52*	1.39–8.87
	45–64 Years	55	322,992	17.0	0.02	10.63*	4.58–24.68	9.19*	3.91–21.59
	65–79 Years	109	185,850	58.6	0.06	36.61*	20.55–32.68	23.17*	9.96–53.92
	80+ Years	88	63,890	137.7	0.14	86.05*	37.64–196.72	26.26*	11.06–62.36
Gender	Female	141	684,749	20.6	0.02	1.00		1.00	
	Male	135	583,611	23.1	0.02	1.12	0.89–1.42	1.00	0.79–1.28
First ASA Score	1–2	52	672,828	7.7	0.01	1.00		1.00	
	3	102	129,978	78.5	0.08	10.16*	7.28–14.19	2.71*	1.86–3.95
	4	66	21,016	314.0	0.31	40.76*	28.33–58.64	6.99*	4.61–10.62
	5	3	753	398.4	0.40	51.75*	16.13–166.07	14.26*	5.57–36.49
	Not Stated	53	443,698	11.9	0.01	1.55*	1.05–2.27	1.31	0.87–1.98
Ethnicity	European	236	894,875	26.4	0.03	1.00		1.00	
	Māori	17	176,187	9.6	0.01	0.37*	0.22–0.60	0.64	0.38–1.07
	Pacific	10	74,027	13.5	0.01	0.51*	0.27–0.96	0.81	0.42–1.57
	Asian/ MELAA/ Other	7	84,311	8.3	0.01	0.32*	0.15–0.67	0.55	0.26–1.18
NZ Deprivation Index Decile	Decile 1–2	38	216,988	17.5	0.02	1.00		1.00	
	Decile 3–4	45	227,234	19.8	0.02	1.13	0.73–1.74	1.08	0.70–1.68
	Decile 5–6	59	256,873	23.0	0.02	1.31	0.87–1.97	1.10	0.73–1.67
	Decile 7–8	67	282,996	23.7	0.02	1.35	0.91–2.01	1.15	0.77–1.72
	Decile 9–10	66	278,539	23.7	0.02	1.35	0.91–2.02	1.37	0.90–2.07

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.
CI: Confidence interval.
GA: General anaesthetic.
MELAA: Middle Eastern/Latin American/African.
OR: Odds ratio.
PE: Pulmonary embolus.

Table 30: 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 2007–2011

VARIABLE	CATEGORY	No. PE-Associated Deaths	No. PE-Associated Admissions	Rate per 100,000 Admissions	Rate per 100 PE Admissions (%)	Univariate OR	95% CI	Multivariate OR	95% CI
Pulmonary Embolus-Associated Mortality in Pulmonary Embolus-Associated Admissions									
Admission Type	Elective/ Waiting List	72	1,209	5,955.3	5.96	1.00		1.00	
	Public Hospital Semi-Acute	15	171	8,771.9	8.77	1.33	0.76–2.32	1.31	0.71–2.39
	Acute	189	1,208	15,645.7	15.65	7.12*	5.43–9.35	2.28*	1.67–3.11
Age Group	0–24 Years	6	77	7,792.2	7.79	1.00		1.00	
	25–44 Years	18	290	6,206.9	6.21	0.78	0.30–2.05	0.98	0.37–2.61
	45–64 Years	55	777	7,078.5	7.08	0.90	0.38–2.17	1.14	0.46–2.85
	65–79 Years	109	985	11,066.0	11.07	1.47	0.63–3.78	1.98	0.80–4.89
	80+ Years	88	459	19,172.1	19.17	H	H	H	H
Gender	Female	141	1,353	10,421.3	10.42	1.00		1.00	
	Male	135	1,235	10,931.2	10.93	1.06	0.82–1.35	1.10	0.84–1.43
First ASA Score	1–2	52	911	5,708.0	5.71	1.00		1.00	
	3	102	760	13,421.1	13.42	2.56*	1.81–3.63	1.72*	1.19–2.49
	4	66	272	24,264.7	24.26	H	H	H	H
	5	3	8	37,500.0	37.50	H	H	H	H
	Not Stated	53	637	8,320.3	8.32	1.50*	1.01–2.23	1.24	0.82–1.87
Ethnicity	European	236	2,171	10,870.6	10.87	1.00		1.00	
	Māori	17	205	8,292.7	8.29	0.74	0.44–1.24	0.89	0.51–1.56
	Pacific	10	71	14,084.5	14.08	1.35	0.68–2.66	1.44	0.70–2.97
	Asian/ MELAA/ Other	7	78	8,974.4	8.97	0.81	0.37–1.78	1.04	0.45–2.37
NZ Deprivation Index Decile	Decile 1–2	38	414	9,178.7	9.18	1.00		1.00	
	Decile 3–4	45	493	9,127.8	9.13	0.99	0.63–1.56	0.94	0.59–1.51
	Decile 5–6	59	542	10,885.6	10.89	1.21	0.79–1.86	1.12	0.71–1.76
	Decile 7–8	67	643	10,419.9	10.42	1.15	0.76–1.75	1.07	0.69–1.65
	Decile 9–10	66	478	13,807.5	13.81	1.59*	1.04–2.42	1.55	0.98–2.45

Numerator: NMC: Pulmonary embolus-associated deaths within 30 days of first anaesthetic of index admissions.
Denominator: NMDS: All pulmonary embolus-associated admissions.
Caution should be observed when interpreting ORs where mortality exceeds 10% (see Appendix 2 for details).
* Significantly different from reference category
H: Odds ratios suppressed due to high mortality rates.
CI: Confidence interval.
OR: Odds ratio.
MELAA: Middle Eastern/Latin American/African.
PE: Pulmonary embolus.

Table 31: Pulmonary Embolus-Attributed Mortality by Admission Type, Age Group, Gender, First ASA Score, Ethnicity and NZ Deprivation Index Decile, New Zealand 2007–2011

VARIABLE	CATEGORY	No. PE-Attributed Deaths	No. Admissions with GA or Neuraxial Block	Rate per 100,000 Admissions	Rate per 100 PE Admissions (%)	Univariate OR	95% CI	Multivariate OR	95% CI
Pulmonary Embolus-Attributed Mortality									
Admission Type	Elective/ Waiting List	37	831,591	4.4	0.00	1.00		1.00	
	Public Hospital Semi-Acute	6	130,156	4.6	0.00	1.04	0.44–2.46	1.38	0.57–3.01
	Acute	93	306,564	30.3	0.03	6.82*	4.66–9.99	5.20*	3.42–7.89
Age Group	0–24 Years	6	374,558	1.6	0.00	1.00		1.00	
	25–44 Years	10	321,073	3.1	0.00	1.94	0.71–5.35	1.92	0.70–5.31
	45–64 Years	20	322,992	6.2	0.01	3.87*	1.55–9.63	3.16*	1.25–8.03
	65–79 Years	60	185,850	32.3	0.03	20.16*	8.71–46.66	11.22*	4.65–27.08
	80+ Years	40	63,890	62.6	0.06	39.11*	16.58–92.24	10.22*	4.05–25.83
Gender	Female	69	684,749	10.1	0.01	1.00		1.00	
	Male	67	583,611	11.5	0.01	1.14	0.81–1.60	0.98	0.69–1.38
First ASA Score	1–2	25	672,828	3.7	0.00	1.00		1.00	
	3	48	129,978	36.9	0.04	9.94*	6.13–16.12	3.47*	2.04–5.88
	4	35	21,016	166.5	0.17	44.89*	26.87–75.02	10.13*	5.71–17.96
	5	<3	753	s	s	s	s	s	s
	Not Stated	26	443,698	5.9	0.01	1.58	0.91–2.73	1.74	0.99–3.06
Ethnicity	European	118	894,875	13.2	0.01	1.00		1.00	
	Māori	7	176,187	4.0	0.00	0.30*	0.14–0.65	0.50	0.23–1.12
	Pacific	4	74,027	5.4	0.01	0.41	0.15–1.11	0.63	0.22–1.75
	Asian/ MELAA/ Other	4	84,311	4.7	0.00	0.36*	0.13–0.98	0.61	0.22–1.66
NZ Deprivation Index Decile	Decile 1–2	15	216,988	6.9	0.01	1.00		1.00	
	Decile 3–4	30	227,234	13.2	0.01	1.91*	1.03–3.55	1.79	0.96–3.32
	Decile 5–6	31	256,873	12.1	0.01	1.75	0.94–3.23	1.36	0.73–2.55
	Decile 7–8	30	282,996	10.6	0.01	1.53	0.83–2.85	1.30	0.70–2.42
	Decile 9–10	30	278,539	10.8	0.01	1.56	0.84–2.90	1.61	0.86–3.04

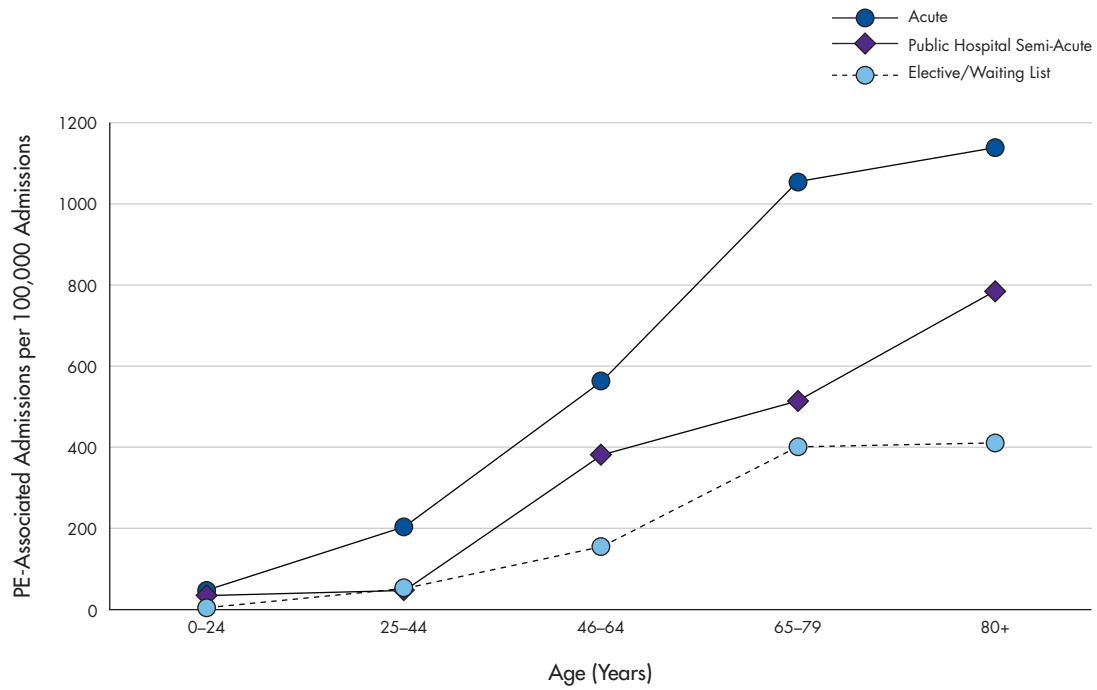
Numerator: NMC: Pulmonary embolus-attributed deaths within 30 days of first anaesthetic of index admissions.
Denominator: NMDS: All admissions with a general anaesthetic or neuraxial block.
s: Rates suppressed due to small numbers.
* Significantly different from reference category.
CI: Confidence interval.
GA: General anaesthetic.
MELAA: Middle Eastern/Latin American/African.
OR: Odds ratio.
PE: Pulmonary embolus.

Background: pulmonary embolus-associated hospital admissions

Admissions by age and admission type

In New Zealand during 2007–2011, pulmonary embolus-associated hospital admissions were infrequent in young people (aged less than 25 years), but increased thereafter for all types of admissions, particularly acute admissions. People aged over 80 years had the highest rates of pulmonary embolus-associated hospital admissions regardless of admission type. These findings are the same as those observed with the 2006–2010 data. Again pulmonary embolus-associated hospital admissions were highest for acute hospital admissions and lowest for elective/waiting list admissions. The rate of pulmonary embolus-associated hospital admissions was higher for acute admissions and public hospital semi-acute admissions in 2007–2011 compared with 2006–2010.

Figure 38: Pulmonary Embolus-Associated Hospital Admissions by Age and Admission Type, New Zealand 2007–2011



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.
PE: Pulmonary embolus.

Admissions by primary procedure

During 2007–2011, 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 (Table 32). Knee and hip arthroplasties were also the procedures most commonly undertaken during elective/waiting list admissions associated with pulmonary emboli. These findings were identical to those observed in 2006–2010.

Table 32: Pulmonary Embolus-Associated Hospital Admissions by Admission Type and Primary Procedure, New Zealand 2007–2011

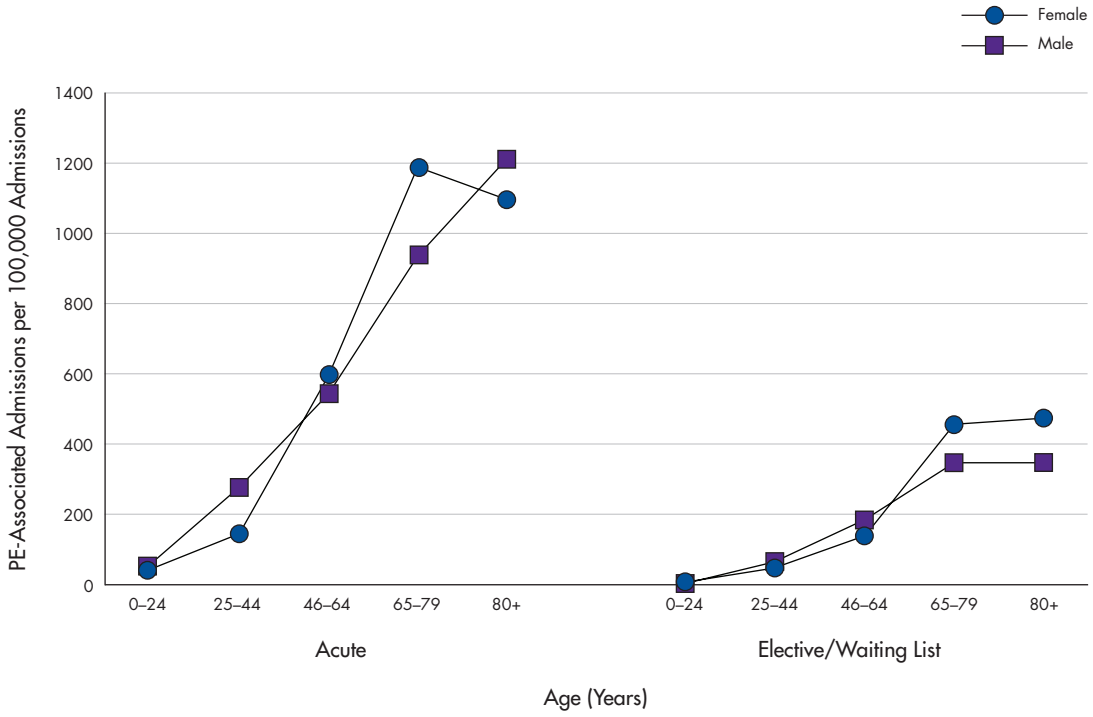
PRIMARY PROCEDURE	Total Admission Events 2007–2011	Annual Average	Admissions (%)
Pulmonary Embolus-Associated Admissions			
Acute			
Procedures on Fracture of Femur	162	32.4	13.4
Hemiarthroplasty of Femur	85	17.0	7.0
Hip Arthroplasty (Including Revisions)	40	8.0	3.3
Open Reduction of Fracture of Ankle	29	5.8	2.4
Open Reduction Fracture of Tibia	33	6.6	2.7
Closed Reduction Fracture of Tibia	14	2.8	1.2
Right Hemicolectomy	21	4.2	1.7
Resection of Small Intestine	26	5.2	2.2
Division of Abdominal Adhesions	23	4.6	1.9
Appendicectomy (Including Laparoscopic)	23	4.6	1.9
Other Procedures	753	150.4	62.3
Total Acute Admissions	1,209	241.6	100.0
Public Hospital Semi-Acute			
Insertion of Implantable Vascular Infusion Device	12	2.4	7.0
Coronary Artery Bypass	8	1.6	4.7
Procedures on Fracture of Femur	8	1.6	4.7
Hip Arthroplasty (Including Revisions)	8	1.6	4.7
Other Procedures	135	27.0	78.9
Total Public Hospital Semi-Acute	171	34.2	100.0
Elective/Waiting List			
Knee Arthroplasty (Including Revisions)	358	71.6	29.6
Hip Arthroplasty (Including Revisions)	151	30.2	12.5
Hysterectomy	46	9.2	3.8
Mastectomy	22	4.4	1.8
Prostatectomy	21	4.2	1.7
Cholecystectomy (Open and Laparoscopic)	16	3.2	1.3
Interruption of Sapheno-Femoral Junction Varicose Veins	15	3.0	1.2
Total Excision of Bladder	15	3.0	1.2
Other Procedures	564	112.8	46.7
Total Elective/Waiting List	1,208	241.6	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

There was no consistent difference between males and females for pulmonary embolus-associated hospital admissions during 2007–2011 in relation to acute admissions. This is similar to 2006–2010. Rates of pulmonary embolus-associated admissions in relation to acute admissions were higher for both genders among these older age groups when compared with the earlier data. Among elective/waiting list admissions the pattern and rate of pulmonary embolus-associated hospital admissions was similar for both the 2007–2011 and 2006–2010 data – females had a higher rate than males with older age.

Figure 39: Pulmonary Embolus-Associated Hospital Admissions by Age, Admission Type and Gender, New Zealand 2007–2011

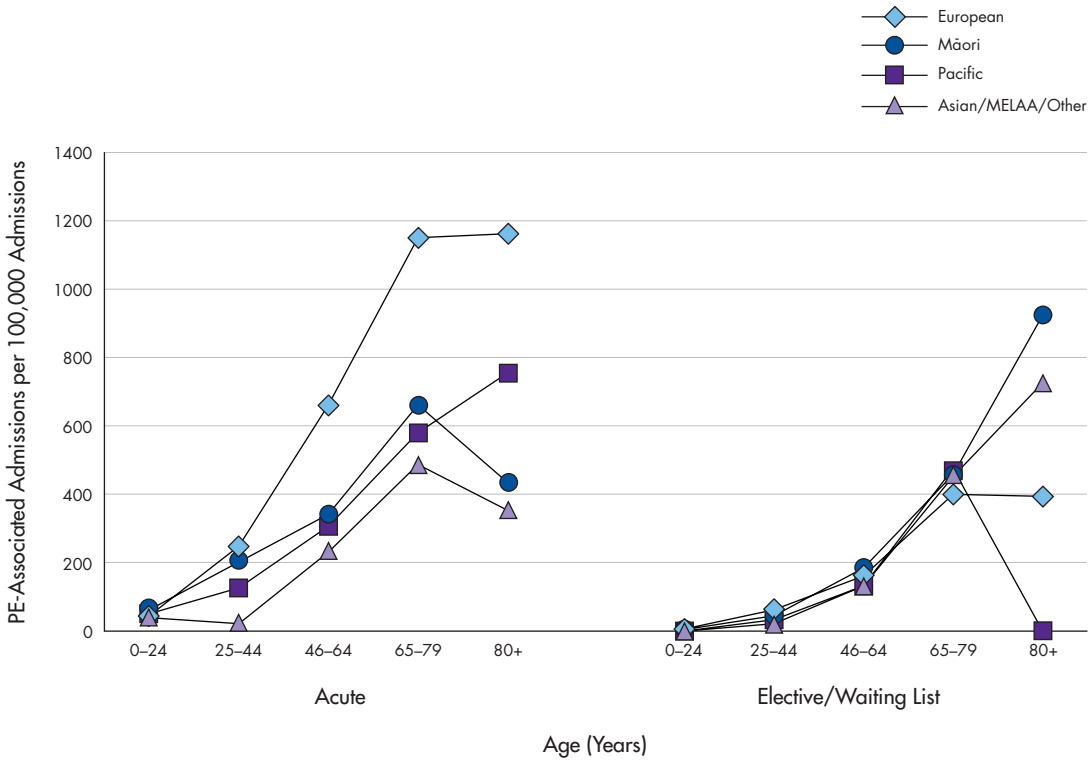


Numerator: NMDS: All admissions meeting the criteria for a pulmonary embolus-associated admission as outlined above.
Denominator: NMDS: All admissions with a general anaesthetic or neuraxial block. Note: Obstetric-related PE excluded.
PE: Pulmonary embolus.

Admissions by age, admission type and ethnicity

Pulmonary embolus-associated admissions were infrequent among young people of all ethnic groups during 2007–2011. Among European ethnicities, rates for acute admissions increased with increasing age, especially among people over 44 years of age. Compared with 2006–2010 the same pattern was evident but rates had further increased for European ethnicities among the elderly. For elective/waiting list admissions, ethnic differences were less evident. Small numbers often mean that caution is needed when interpreting these rates for Māori, Pacific or Asian/MELAA/Other ethnicities.

Figure 40: Pulmonary Embolus-Associated Hospital Admissions by Age, Admission Type and Ethnicity, New Zealand 2007–2011

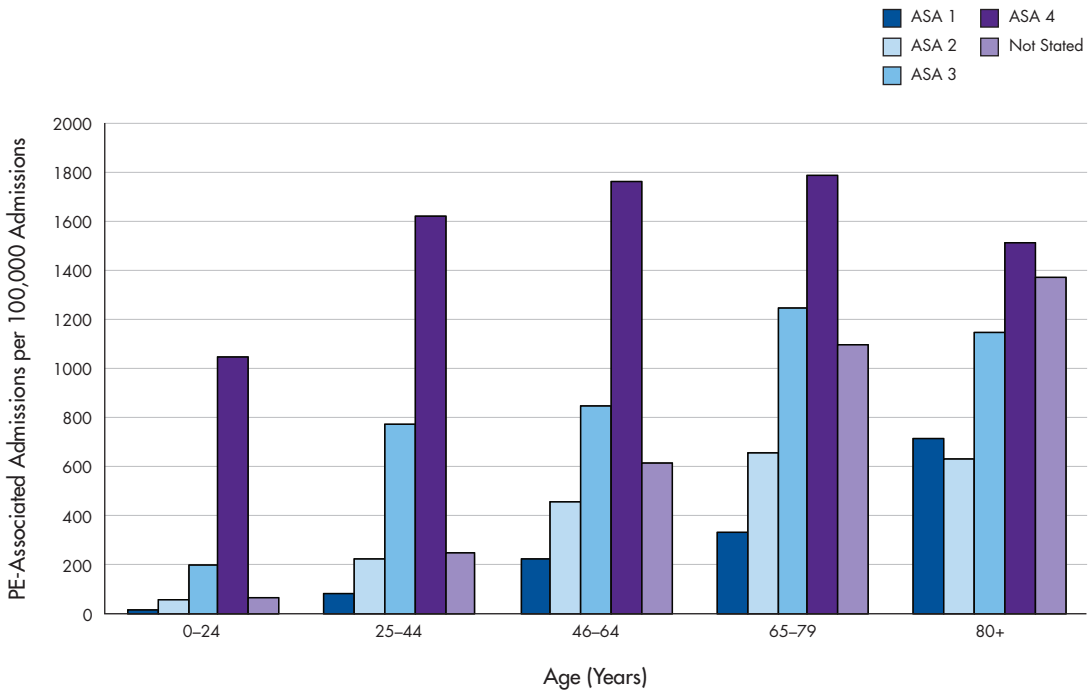


Numerator: NMDS: All admissions meeting the criteria for a pulmonary embolus-associated admission as outlined above.
Denominator: NMDS: All admissions with a general anaesthetic or neuraxial block.
Ethnicity is Level 1 Prioritised. Care should be taken when interpreting rates for Māori, Pacific and Asian/MELAA/Other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

Admissions by age, admission type and ASA score

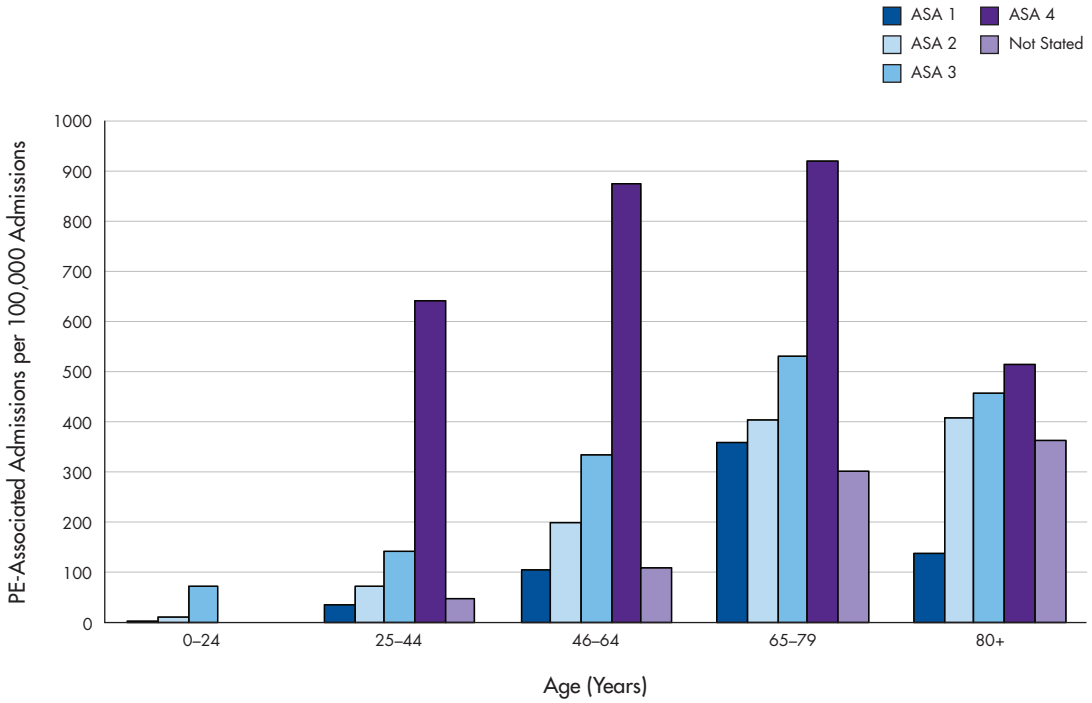
During 2007–2011, acute pulmonary embolus-associated admissions increased with increasing ASA score for both acute admissions in all age groups except the elderly (those aged over 80 years). For those aged 80+, rates were similar for those with scores of ASA 1 and 2 but then increased with increasing ASA thereafter. With the exception of people aged 0–24 years, similar patterns were seen for elective/waiting list admissions, although in each ASA category, admission rates for elective/waiting list admissions were lower than for acute admissions. In all ages and admission types, rates were highest for ASA 4 (small numbers precluded a valid analysis of ASA 5). These patterns were identical to those evident with the 2006–2010 data.

Figure 41: Pulmonary Embolus-Associated Acute Admissions by Age and First ASA Score, New Zealand 2007–2011



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.
PE: Pulmonary embolus.

Figure 42: Pulmonary Embolus-Associated Elective/Waiting List Admissions by Age and First ASA Score, New Zealand 2007–2011



Numerator: NMDS: All elective/waiting list admissions meeting the criteria for a pulmonary embolus-associated admission as outlined above.
Denominator: NMDS: All elective/waiting list admissions with a general anaesthetic or neuraxial block. ASA 5 excluded.
PE: Pulmonary embolus.

Pulmonary embolus-associated admissions by sociodemographic and clinical factors

Pulmonary embolus-associated admissions during 2007–2011 were significantly higher for those admitted semi-acutely or acutely in a public hospital (vs. elective/waiting list admissions), those over the age of 25 years (vs. those aged 0–24 years), and those with an ASA score of 3 or more (compared to an ASA score of 1–2) (Table 33). These differences persisted, even when the risk was adjusted for other sociodemographic (age, gender, ethnicity, NZDep) and clinical (ASA score, admission type) factors. In contrast, admission rates were significantly lower for Māori, Pacific and Asian/MELAA/Other ethnicities (vs. European ethnicities). Differences between NZDep decile 1–2 and 7–8 did not continue to be significant once the other factors in the multivariate model were accounted for. Compared to 2006–2010, there were no notable differences with the 2007–2011 results.

Table 33: Pulmonary Embolus-Associated Hospital Admissions by Admission Type, Age Group, Gender, First ASA Score, Ethnicity and NZ Deprivation Index Decile, New Zealand 2007–2011

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/ Waiting List	1,209	831,591	145.4	0.15	1.00		1.00	
	Public Hospital Semi-Acute	171	130,156	131.4	0.13	0.90	0.77–1.06	1.36*	1.16–1.61
	Acute	1,208	306,564	394.0	0.39	2.72*	2.51–2.94	2.71*	2.48–2.95
Age Group	0–24 Years	77	374,558	20.6	0.02	1.00		1.00	
	25–44 Years	290	321,073	90.3	0.09	4.40*	3.42–5.65	4.31*	3.34–5.56
	45–64 Years	777	322,992	240.6	0.24	11.73*	9.28–14.82	11.51*	9.07–14.61
	65–79 Years	985	185,850	530.0	0.53	25.91*	20.55–32.68	21.15*	16.65–26.88
	80+ Years	459	63,890	718.4	0.72	35.19*	27.64–44.80	18.19*	4.10–23.46
Gender	Female	2,343	684,749	342.2	0.34	1.00		1.00	1.00
	Male	2,230	583,611	382.1	0.38	1.07	0.99–1.16	0.98	0.91–1.07
First ASA Score	1–2	911	672,828	135.4	0.14	1.00		1.00	1.00
	3	760	129,978	584.7	0.58	4.34*	3.94–4.78	1.87*	1.68–2.08
	4	272	21,016	1,294.3	1.29	9.67*	8.44–11.08	3.10*	2.67–3.60
	5	8	753	1,062.4	1.06	7.92*	3.93–15.94	2.27*	1.12–4.59
	Not Stated	637	443,698	143.6	0.14	1.06	0.96–1.17	1.05	0.94–1.16
Ethnicity	European	2,171	894,875	242.6	0.24	1.00		1.00	
	Māori	205	176,187	116.4	0.12	0.48*	0.42–0.55	0.82*	0.71–0.96
	Pacific	71	74,027	95.9	0.10	0.40*	0.31–0.50	0.65*	0.51–0.83
	Asian/ MELAA/ Other	78	84,311	92.5	0.09	0.38*	0.30–0.48	0.57*	0.45–0.71
NZ Deprivation Index Decile	Decile 1–2	414	216,988	190.8	0.19	1.00		1.00	
	Decile 3–4	493	227,234	217.0	0.22	1.14	0.99–1.30	1.10	0.96–1.25
	Decile 5–6	542	256,873	211.0	0.21	1.11	0.97–1.26	1.00	0.88–1.14
	Decile 7–8	643	282,996	227.2	0.23	1.19*	1.05–1.35	1.09	0.96–1.23
	Decile 9–10	478	278,539	171.6	0.17	0.90	0.79–1.03	0.97	0.84–1.11

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 to reference category.
CI: Confidence interval.
GA: General anaesthetic.
MELAA: Middle Eastern/Latin American/African.
OR: Odds ratio.
PE: Pulmonary embolus.

Appendices

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

Table 34: Thirty-Day Mortality Rates in New Zealand Resident Population

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

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

Based on Statistics New Zealand Life Tables 2009–11.

Appendix 2: Methods

The data sources and methods employed in this report are consistent with those used for previous reports unless otherwise stated.

Data sources

Hospital admission data were obtained from the NMDS and compared with Estimated Resident Population counts from Statistics New Zealand (projected from 2007). Mortality rates were sourced from NMC data and compared to NMDS admissions counts.

In relation to specific chapters the following data were obtained:

- **Colorectal Resection**

  Hospital admissions with a colorectal resection listed in the first 90 procedure codes (ICD-10-AM ACHI Blocks, Version 3: 913, 934, 935, 936) were obtained from the NMDS.

- **Cholecystectomy**

  Hospital admissions with a cholecystectomy listed in the first 90 procedure codes (ICD-10-AM ACHI Procedure Codes, Version 3: 3044300, 3044500, 3044600, 3044800, 3044900, 3045401, 3045500). In a small proportion of cases (n=289), other more complex procedures were undertaken at the same time as the cholecystectomy (for example, liver resections). In such cases where a cholecystectomy was performed as part of a more complex procedure, the risk of mortality is likely to have been significantly higher than if a cholecystectomy was either the main or the only procedure undertaken at the time of the operation. These admissions were not included in the analyses. Mortality rates of those who died following a cholecystectomy were sourced from NMC data (with cases being selected from the cohort of those undergoing cholecystectomy, as identified in the NMDS) and compared to NMDS admissions where a cholecystectomy was listed in any of the first 90 procedure codes.

- **General Anaesthesia**

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

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

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

- **Pulmonary Embolus-Associated and Attributed Mortality**

  — *Pulmonary embolism admissions*

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

— *Pulmonary 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

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

Colorectal resection and patients under 45 years of age

The colorectal resection chapter focuses on hospital admissions for colorectal resection among people aged over 45 years. Relatively few younger people undergo this procedure.

Laparoscopic and open colorectal resection procedures

For the period 2007–2011 the NMDS does not include separate procedure codes for laparoscopic and open colorectal resection procedures. However, these data are available in the NMDS from 2012 and will be reported in future reports.

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

Private and public hospital admissions

The NMDS contains near-complete information on all publicly funded inpatient events occurring in public hospitals. In contrast, private hospital events include a mix of publicly funded and privately funded cases. DHB-funded events occurring in private hospitals are usually reported to the NMDS by the DHB contracting the treatment, and thus are mostly complete in the dataset. 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 Accident Compensation Corporation (ACC) funded events, or publicly funded

long-stay geriatric cases. Thus, in this report it must be remembered that the data presented 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).

Readmissions

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

Multiple anaesthetics and readmissions for the 'General Anaesthesia' chapter

While in the majority of cases only one general anaesthetic was performed per hospital admission, in 2.5% of admissions, two or more general anaesthetics were performed, with the maximum number of general anaesthetics performed during any one admission being 43. Further, in a number of cases, two or more anaesthetics were performed within a day of the death, resulting in both anaesthetic events being eligible for inclusion in the numerator. Finally, in a number of cases, two separate hospital admission events occurred within a day of each other, with both admission events including a general anaesthetic which occurred within a day of the death. As a result of these complexities, mortality rates have been calculated per 100,000 admission events where one or more anaesthetics were performed, rather than per 100,000 anaesthetics (that is, the denominator is the number of admission events rather than the number of anaesthetics). Where two eligible admissions occurred within a day of the death, both admission events have been counted in the denominator (number of hospital admissions) but the death has only been counted once, in the most recent admission event prior to the death.

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

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

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

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

New Zealand Deprivation Index decile (NZDep)

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

ASA and emergency suffixes

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

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

Emergency	**Modifier Description**
0	Procedure being performed as an emergency
9	Non-emergency or not known

Unless otherwise specified, the ASA status referred to throughout this report is the ASA status derived from the first anaesthesia code for each admission event (with the order of procedure codes being determined by the diagnosis sequence variable within the NMDS). In the case of multiple anaesthetics, it is likely that this first ASA status reflects most closely the ASA status of the patient at the time of admission. However, in Tables 19 and 23 the ASA status and emergency status of the last listed anaesthesia code has been used, in order to better reflect the factors associated with the last anaesthetic prior to death (with the order of procedure codes again being determined by the diagnosis sequence in the NMDS).

Odds ratios versus rate ratios

A limitation of logistic regression is that 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). When 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, this bias can be substantial (Szklo and Nieto 2004). Thus in this report, as with previous reports, 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 may overestimate the rate ratio and hence the magnitude of any association seen.

Appendix 3: Previous Report Recommendations and Progress

Below is a summary of progress made against the two previous reports of the Committee.

Table 35: Progress Summary of Second Report Recommendations

RECOMMENDATIONS OF SECOND REPORT (MARCH 2013)	PROGRESS TO DATE (MARCH 2014)
All patients should be formally assessed preoperatively for risk of venous thromboembolism and appropriate thromboprophylaxis implemented, taking into account the individual risk/benefit profile.	Raising the profile of venous thromboembolism risk will be part of the Health Quality & Safety Commission's *Open for better care* campaign.
All health care professionals should participate actively in the World Health Organization Surgical Safety Checklist, including the question on thromboprophylaxis.	The Perioperative Harm Advisory Group of the Commission is actively promoting the use of the checklist to improve teamwork and communication.
To assist informed consent, information should be available for patients concerning the risk of dying within 30 days of any procedure that has significant risk of mortality.	Reports of this Committee (reporting mortality on a five-year rolling basis starting from 2006) will shape the development of informed consent resources for patients. This will be developed in conjunction with the Consumer Engagement team of the Commission. Data from the reports have been used in clinical teaching.
Non-operative care pathways should be developed and used when surgical procedures are deemed inappropriate because of excessive risk.	This has been raised with the Royal Australasian College of Surgeons and the Australian and New Zealand College of Anaesthetists and is supported.
Case studies are developed to highlight current good practice or recommend practice change.	The inaugural workshop of the Committee used case studies in highlighting good practice and areas for practice improvements. A similar scenario will be developed for the June 2014 workshop.
Psychosocial issues contributing to mortality following procedures require further investigation.	There is potential to collaborate with the Suicide Mortality Review Trial.
Given the relative mortality of acute (1.0%) and elective (0.16%) cholecystectomy, further research is conducted into the management of acute cholecystitis.	Preliminary analysis has been completed and a summary is included in this report. Further analysis will be reported at the second workshop of the Committee in June 2014.
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.	This will be a focus of the 2015 report.
There is a continuing focus on ASA 1 and 2 elective surgery mortality (as, for these patients, a positive outcome was anticipated).	Preliminary analysis has been completed and a summary is included in this report. Further analysis will be reported at the second workshop of the Committee in June 2014.

Table 36: Progress Summary of Inaugural Report Recommendations

RECOMMENDATIONS OF INAUGURAL REPORT (FEBRUARY 2012)	PROGRESS TO DATE (MARCH 2014)
A whole-of-system perioperative mortality review process is developed which builds on the NMDS and the NMC. This would include the accurate and systematic recording of patient and procedure details from all health care facilities and practitioners.	An integrated form has been developed to collect data across all health care facilities.
Key components The enhancement and standardisation of existing data collections and current mortality review processes to ensure a uniform, efficient and meaningful national methodology.	The system developed first identifies clinically important groups of procedures for investigation and uses ACHI codes to select these procedures and reviews 30-day mortality using the NMDS and NMC. Other methodologies were investigated resulting in a number of lessons learned: • Selection of cases based on the presence of surgical sub-specialty 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. • 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 nearly 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 has been completed.
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 remains under review. The Health Quality & Safety 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 which are 'without known cause' or deaths which 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.
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.
Secure national data storage hosted by, and under the guardianship of, the Health Quality & Safety Commission.	All data is either stored or handled at an 'In Confidence' level of security.
The ability to carry out whole-of-system and focused (sub-group) analysis of both qualitative and quantitative data.	This has been developed on a quantitative level and is being investigated at a qualitative level.
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.	Endoscopy Working Group established. Form being developed to enable national, regional and local reporting.

The ability to generate evidence-based, peer-reviewed recommendations for reinforcing current 'good practice' or system improvements leading to practice change.	As methodologies for data collection and analysis are developed, the Committee will be able to formulate more specific recommendations.
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.
Work with the National Health Board to ensure that the NMDS and NMC collections are enhanced and standardised by: • ensuring that the ASA score is recorded for all procedures • separately identifying existing conditions from those acquired during that admission • ensuring that the immediate cause of death can be identified from the data collections.	The National Health Board and mortality review committees have worked together to improve data capture. This remains an iterative process as data collection and reporting systems are further developed.
Submission of data to the NMDS is mandatory for all health care facilities.	Following sector consultation, this recommendation has been well received by both the public and private sectors.

Appendix 4: Committee Progress 2010–2014

Table 37: Committee Progress, 2010–2014

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

List of Abbreviations

ACC	Accident Compensation Corporation
ACHI	Australian Classification of Health Interventions
ASA	American Society of Anesthesiologists
CI	Confidence interval
DHB	District Health Board
GA	General anaesthetic
NHI	National Health Index
NMC	National Mortality Collection
NMDS	National Minimum Dataset
NNPAC	National Non-Admitted Patient Collection
NZDep	New Zealand Deprivation Index
MELAA	Middle Eastern/Latin American/African
OR	Odds ratio
PE	Pulmonary embolism
POMRC	Perioperative Mortality Review Committee
WHO	World Health Organization

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