bureau of health information

The Insights Series

Exploring clinical variation in mortality

Mortality following hospitalisation, seven clinical conditions, NSW

July 2012 – June 2015

BUREAU OF HEALTH INFORMATION

Level 11, 67 Albert Avenue
Chatswood NSW 2067
Australia
Telephone: +61 2 9464 4444
Email: BHI-enq@health.nsw.gov.au
bhi.nsw.gov.au

State Health Publication Number: (BHI) 170151
ISSN: 1839-1680 (print); 2204-5511 (online)

Suggested citation:
Bureau of Health Information. *The Insights Series – Exploring clinical variation in mortality, Mortality following hospitalisation, seven clinical conditions NSW, July 2012 – June 2015.* Sydney (NSW); BHI; 2017.

Please note there is the potential for minor revisions of data in this report.
Please check the online version at **bhi.nsw.gov.au** for any amendments.

Published April 2017

Table of contents

10 key findings 1

Setting the scene 4

Exploring mortality results 12

Condition-specific results 20

- Acute myocardial infarction 21
- Ischaemic stroke 25
- Haemorrhagic stroke 29
- Congestive (chronic) heart failure 33
- Pneumonia 37
- Chronic obstructive pulmonary disease 41
- Hip fracture surgery 45

Appendices 50

References 55

Acknowledgements 56

Key findings

10 key findings

1. **At a NSW level, 30-day mortality rates have fallen for all seven conditions** – over a 15-year period, decreases ranged from 15% for haemorrhagic stroke to 41% for acute myocardial infarction.

2. **Between 2009–12 and 2012–15, mortality fell most sharply for ischaemic stroke.**

3. **In 2012–15, NSW mortality rates were lowest for acute myocardial infarction (AMI) and hip fracture surgery (7%) and highest for haemorrhagic stroke (33%).** Placing the NSW results in an international context, mortality in 2013 was relatively low for AMI and relatively high for ischaemic stroke.

4. **The percentage of deaths that occurred after discharge ranged across conditions from 24% for haemorrhagic stroke to 53% for hip fracture surgery.**

5. **There were 75 public hospitals included in the analyses and for each of the conditions, only a small number of hospitals had higher than expected mortality** – ranging from one hospital for haemorrhagic stroke to 11 hospitals for chronic obstructive pulmonary disease.

6. **There were twice as many hospital results that were higher than expected than lower than expected in 2012–15** – with 45 'higher than expected' and 20 'lower than expected' mortality results.

7. **Higher and lower than expected mortality occurred in hospitals of various sizes and geographical remoteness** – however lower than expected mortality results were more prevalent in larger (principal referral) hospitals.

8. **For two conditions, there was a pronounced increase between 2009–12 and 2012–15 in the number of hospitals with higher than expected mortality** – for chronic obstructive pulmonary disease, the increase was from four to 11 hospitals and for pneumonia, from five to nine hospitals.

9. **Two hospitals had lower than expected mortality for multiple conditions and maintained that over two time periods** – St Vincent's and Prince of Wales hospitals were both flagged as low outliers for three conditions in the 2012–15 analyses; and for two conditions mortality was lower than expected both in 2009–12 and 2012–15.

10. **Four hospitals had higher than expected mortality for multiple conditions both in 2009–12 and 2012–15** – however each one – John Hunter, Manning, Port Macquarie and Tamworth – did improve for one or more conditions in 2012–15.

Setting the scene

About this report

Background

Measures that assess how healthcare affects patient outcomes such as mortality and readmission make a crucial contribution to performance evaluation. When appropriately risk adjusted, they can point to unwarranted clinical variation.

In 2013, BHI published *30-day mortality following hospitalisation, five clinical conditions, NSW, July 2009 – June 2012*.[1] The report represented an important watershed. For the first time, information about the performance of hospitals in terms of patient deaths following admission for acute myocardial infarction (AMI), ischaemic stroke, haemorrhagic stroke, pneumonia, and hip fracture surgery was made publicly available.

Subsequent to the mortality report, BHI released an edition of its *Insights Series* on readmissions for the period July 2009 – June 2012 using a similar method.[2] This focused on the same suite of conditions plus congestive (or chronic) heart failure (CHF) and two elective surgical procedures – total hip replacement and total knee replacement. In 2016, mortality information for the July 2009 – June 2012 period was released for CHF and chronic obstructive pulmonary disease (COPD)[3].

This volume provides an update of the mortality analyses. It is based on a risk-standardised mortality ratio (RSMR) and assesses outcomes for patients who were hospitalised for one of seven different conditions during the period July 2012 – June 2015. It is published as part of a suite of reporting products that explore clinical variation in NSW public hospitals (see opposite page).

Measuring mortality

Measuring mortality is not straightforward. While death is an important and clearly defined outcome, it reflects a combination of unmodifiable patient factors as well as quality and safety factors that are amenable to change.

Assessments of unwarranted variation in mortality at a hospital level therefore make adjustments for unmodifiable patient factors. A hospital that treats older or sicker patients is not expected to have similar rates of mortality as a hospital that treats younger patients or less complex cases. Assessments should also avoid over-interpretion of small fluctuations in the number of deaths, particularly in smaller hospitals.

This report is based on an approach that takes account of unmodifiable factors – both in terms of patient case mix and volumes. The RSMR uses a statistical model, based on a condition-specific NSW patient population, to calculate for each hospital an 'expected' number of deaths within 30 days of discharge, given the characteristics of their patients. This is compared to the 'observed' number of deaths.

As with any measure, care is needed in interpretation. Each hospital's ratio is based on its particular patient cohort and so cannot be used in direct hospital comparisons. While the models perform well, some risk factors are not captured in the available data, and so adjustment is not perfect. RSMRs are best used as screening tools to indicate where further, locally-driven, assessment is needed.

The *Exploring clinical variation* suite of reports includes: an overarching synthesis and summary report; two volumes that describe variation in patient outcome measures across NSW public hospitals; tailored hospital profiles that provide detailed information about patient cohorts and outcomes; and two method-based reports that describe the analytic approach and the sensitivity analyses that informed the development and validation of the measures used to assess performance.

Exploring clinical variation – an overview

A synthesis that compares and contrasts results for mortality and readmission measures in NSW. The overview reflects outcomes of care provided to patients hospitalised for any of nine different conditions during 2012–15. It summarises performance for 79 NSW public hospitals in 2012–15 and highlights changes in performance over time.

Exploring clinical variation in readmission

A volume focused on readmission (or more precisely, on return to acute care) following discharge from an acute hospitalisation. It reports hospital-level performance using risk-standardised readmission ratios (RSRRs) for eight conditions, and features: funnel plots to display hospital results; descriptions of patient cohorts; information about when, where and why readmissions occurred; distribution of higher and lower than expected performance across hospital peer groups; historical performance; and details about the effect of statistical modelling on hospital results.

Hospital profiles

Individual hospital profiles for 79 public hospitals outline key characteristics of patients admitted for the nine conditions of interest. The profiles feature demographic details of patients, hospital case mix and how it differs from the NSW patient population, time series results, the effect of statistical modelling on results, and the distribution of higher than expected and lower than expected results across similar peer group hospitals.

Spotlight on Measurement

Two new editions of *Spotlight on Measurement*[4,5] are available. These reports are methods-based, and describe the development and validation processes that underpin the RSMR and RSRR measures. They feature cohort and outcome definitions, inclusions and exclusions, risk adjustment models, attribution protocols, and sensitivity analyses that explore issues such as variation in palliative care coding.

All reports and profiles are available at **bhi.nsw.gov.au**

Mortality – Seven conditions

The conditions included in this report range in terms of acuity, span chronic and acute care, and encompass different surgical and medical specialties.

Altogether the conditions account for about 10% of acute hospitalisations in NSW*; and about 30% of all in-hospital deaths.

Acute myocardial infarction (AMI)

- Occurs when blood supply to part of the heart is interrupted
- In July 2012 – June 2015, 30,488 patients were hospitalised for AMI
- 65% of hospitalised patients were male
- Average patient age was 70 years (39% were aged 75+ years)
- 2,108 patients died within 30 days of hospitalisation (seven deaths per 100 patients)
- 6% of male patients died; 9% of female patients died
- There were 28,105 discharges from acute care
- There were 4,534 (16%) patient returns to acute care within 30 days of discharge.

Ischaemic stroke

- Occurs when a blood vessel is blocked, depriving the brain of oxygen
- In July 2012 – June 2015, 15,475 patients were hospitalised for ischaemic stroke
- 55% of hospitalised patients were male
- Average patient age was 74 years (55% were aged 75+ years)
- 1,861 patients died within 30 days of hospitalisation (12 deaths per 100 patients)
- 9% of male patients died; 15% of female patients died
- There were 14,471 discharges from acute care
- There were 1,539 (11%) patient returns to acute care within 30 days of discharge.

Haemorrhagic stroke

- Occurs when a blood vessel in the brain develops a leak or bursts
- In July 2012 – June 2015, 5,659 patients were hospitalised for haemorrhagic stroke
- 56% of hospitalised patients were male
- Average patient age was 74 years (58% were aged 75+ years)
- 1,855 patients died within 30 days of hospitalisation (33 deaths per 100 patients)
- 29% of male patients died; 37% of female patients died
- Haemorrhagic stroke was not included in the return to acute care analyses.

Congestive (chronic) heart failure (CHF)

- Occurs when the heart is unable to pump adequately
- In July 2012 – June 2015, 27,484 patients were hospitalised for CHF
- 51% of hospitalised patients were male
- Average patient age was 80 years (73% were aged 75+ years)
- 3,793 patients died within 30 days of hospitalisation (14 deaths per 100 patients)
- 14% of male patients died; 13% of female patients died
- There were 33,450 discharges from acute care
- There were 7,602 (23%) patient returns to acute care within 30 days of discharge.

* Of acute emergency hospitalisations for persons aged 15+ years.

There are clear differences in the patient populations and outcomes across the conditions. For example, patients hospitalised for acute myocardial infarction were, on average, younger than those hospitalised for hip fracture surgery (70 and 83 years). With the exception of hip fracture surgery and chronic obstructive pulmonary disease, more than half of patients were male.

Pneumonia

- Occurs when one or both lungs are inflamed, usually due to infection
- In July 2012 – June 2015, 47,133 patients were hospitalised for pneumonia
- 52% of hospitalised patients were male
- Average patient age was 71 years (50% were aged 75+ years)
- 5,037 patients died within 30 days of hospitalisation (11 deaths per 100 patients)
- 11% of male patients died; 10% of female patients died
- There were 46,422 discharges from acute care
- There were 6,543 (14%) patient returns to acute care within 30 days of discharge.

Chronic obstructive pulmonary disease (COPD)

- Occurs when the lungs are unable to provide adequate oxygenation
- In July 2012 – June 2015, 30,525 patients were hospitalised for COPD
- 48% of hospitalised patients were male
- Average patient age was 74 years (51% were aged 75+ years)
- 3,160 patients died within 30 days of hospitalisation (10 deaths per 100 patients)
- 11% of male patients died; 9% of female patients died
- There were 47,359 discharges from acute care
- There were 10,293 (22%) patient returns to acute care within 30 days of discharge.

Hip fracture surgery

- A fracture in the upper quarter of the thigh bone (femur), treated with surgery
- In July 2012 – June 2015, 16,193 patients were hospitalised for hip fracture and had surgery
- 28% of those patients were male
- Average patient age was 83 years (82% were aged 75+ years)
- 1,093 patients died within 30 days of hospitalisation (seven deaths per 100 patients)
- 9% of male patients died; 6% of female patients died
- There were 14,581 discharges from acute care
- There were 1,485 (10%) patient returns to acute care within 30 days of discharge.

Data and methods

Data sources

Data were drawn from the NSW Admitted Patient Data Collection and NSW Registry of Births, Deaths and Marriages, and were probabilistically linked by the Centre for Health Record Linkage. Data access was via SAPHaRI, Centre for Epidemiology and Evidence, NSW Ministry of Health. SAS[6] and StataSE v12[7] were used for the analyses. Linked data were used to measure all patient deaths that occurred in the 30 days following hospitalisation, both in hospital and after discharge.

The measure

The principal indicator used in the report is a risk-standardised mortality ratio (RSMR) (Figure 1). The RSMR describes, for each hospital, the number of patient deaths in or out of hospital within 30 days of admission compared with the 'expected' number of deaths. The 'expected' number of deaths is generated by a statistical model that takes into account patient characteristics that affect the likelihood of dying following hospitalisation.

For each condition, principal diagnoses codes were used to identify patients hospitalised between 1 July 2012 and 30 June 2015. For hip fracture surgery, procedure codes and diagnosis-related group codes were also used to identify the index cohort.

Multiple acute, contiguous hospitalisations were considered as a single, acute period of care. Acute admissions on the same day of separation from another acute hospitalisation are included in the same acute period of care, regardless of the mode of separation recorded in the initial hospital. If an acute admission is coded as ending in a transfer, and there is another acute admission within one day of that transfer, the second admission is concatenated into the same period of care.

Prediction models

For each condition, NSW-level prediction models were developed using index admissions between 1 July 2009 and 30 June 2012 and using random intercept logistic regression models, taking into account patient-level risk factors (age, sex and comorbidities) and clustering within hospitals. C-statistics assess the prediction ability of the models and range from 0.66 for haemorrhagic stroke to 0.85 for acute myocardial infarction (see Appendix 1 for model variables and C-statistics). The stability of the coefficients were tested using different years of data.

Interpretation

Funnel plots are used to determine whether RSMRs reach statistical significance (see Appendix 2 for how to interpret funnel plots).

The 2013 edition of *The Insights Series* featured funnel plots with control limits set at 90% and 95%. In line with international best practice and in order to enhance specificity and limit type I errors, this report presents RSMRs in funnel plots with more stringent 95% and 99.8% control limits.

Control limits are calculated based on a Poisson distribution. Hospital results that fall outside the 95% control limits are considered to be 'special cause' outliers and results are flagged. The probability that an 'in-control' hospital would fall outside the upper 95% control limit by chance alone is, at most, one in 40.[8]

Where results are provided for multiple time periods, any historical RSMRs that fall outside the 90% control limits but within the 95% control limits are marked as 'intermediate' results.

Attribution and reporting

Outcomes were attributed to the first admitting hospital within the period of care.

NSW hospitals vary in size and in the types and complexity of clinical services they provide. For some analyses, data are stratified by peer group in terms of principal referral hospitals (peer group A), major hospitals (peer group B) and district hospitals (peer group C). Results for principal referral, major and district hospitals (peer groups A to C) with at least 50 hospitalisations for the condition of interest in the three-year study period are reported publicly. Not all hospitals have results for all conditions. Results for hospitals with <1.0 expected deaths are suppressed.

Depth of coding

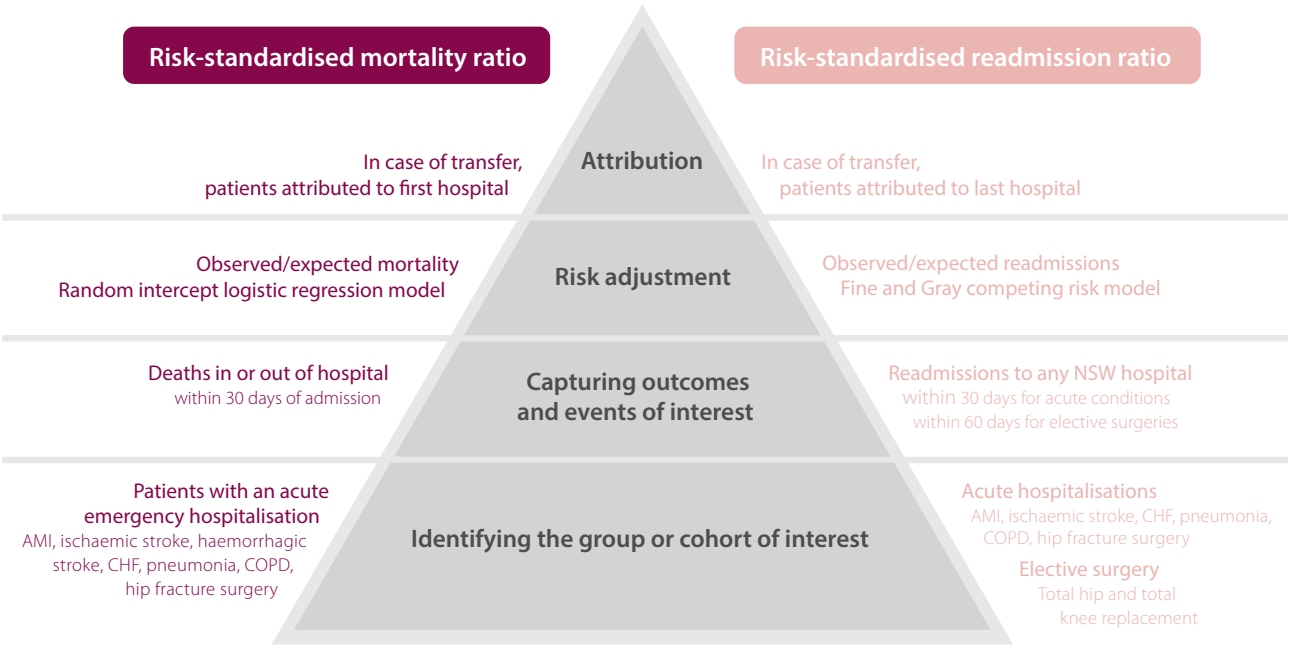
The RSMR relies on accurate coding of secondary diagnoses in patients' hospital records. Comorbidities are identified by a one-year lookback to capture all comorbidities listed in any hospitalisation in the preceding year. Depth of coding is monitored to assess differences over time and between hospitals (Appendix 3).[9]

Multiple periods of care

Among patients who had multiple hospitalisations for a condition, only the last period of care was considered in the analysis. Across the conditions, the proportion of patients who had a single period of care during July 2012 – June 2015 ranged from 66% among patients hospitalised for COPD to 97% for hip fracture surgery patients.

Details about cohort definitions, outcomes, risk adjustment models and attribution are described in *Spotlight on Measurement*.[4]

Figure 1 Risk-standardised ratios for assessing performance in mortality and readmission



Exploring mortality results

Mortality – NSW results

Between 2000 and 2015, NSW age-sex standardised mortality rates improved considerably – with decreases ranging from 15% for haemorrhagic stroke to 41% for AMI (Figure 2).

More recently, between 2009–12 and 2012–15, mortality rates generally continued to fall – most markedly for ischaemic stroke (from 13.5 to 11.9 deaths per 100 patients).

The seven conditions included in the 2012–15 mortality analyses differed in the percentage of deaths that occurred after discharge from hospital – ranging from 24% for haemorrhagic stroke to 53% for hip fracture surgery (Figure 3).

The conditions also differed in the rate and patterns of mortality over the 30-day period following hospitalisation. Unadjusted 30-day mortality rates at the NSW level ranged from seven per 100 hospitalisations for AMI and hip fracture surgery to 33 per 100 hospitalisations for haemorrhagic stroke. Mortality was particularly high in the first seven days following hospitalisation for haemorrhagic stroke (Figure 4).

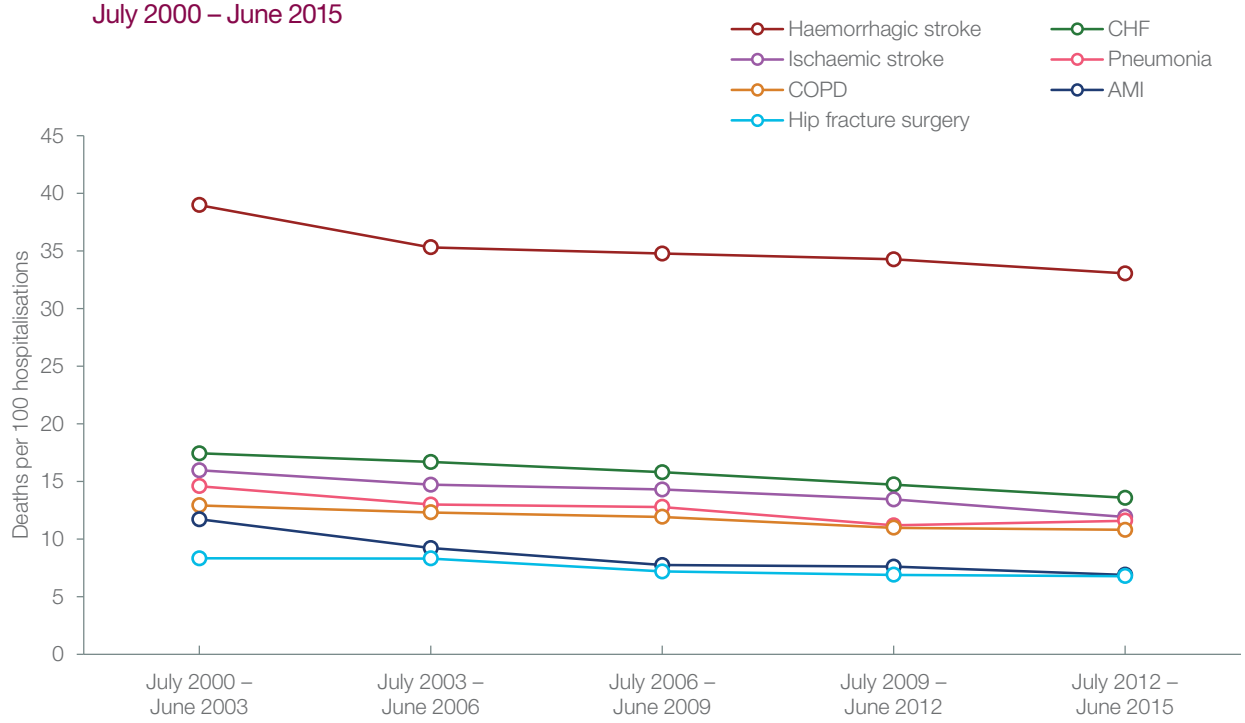
Limited data are available for benchmarking, however they suggest mortality in NSW is relatively low for AMI and relatively high for ischaemic stroke (Table 1).

Table 1 **NSW mortality rates, international context**

Conditions	NSW (July 2012 – June 2015)	Comparators
AMI	7%	7%, 8%, 8%, 8%, 9%, 9%, 14%
Ischaemic stroke	12%	8%, 8%, 10%, 10%, 10%, 11%
Haemorrhagic stroke	33%	NA
CHF	14%	7%, 12%
Pneumonia	11%	9%, 12%
COPD	10%	7%, 11%
Hip fracture surgery	7%	5%, 5%, 8%

Source: References 10–18

Figure 2 **30-day mortality, age-sex standardised rate per 100 hospitalisations, by condition, NSW, July 2000 – June 2015**



Note: Indirectly standardised using July 2009 – June 2012 NSW condition-specific hospitalisation cohorts as the standard population.

Figure 3 Percentage of deaths that occurred in hospital and after discharge, by condition, NSW, July 2012 – June 2015

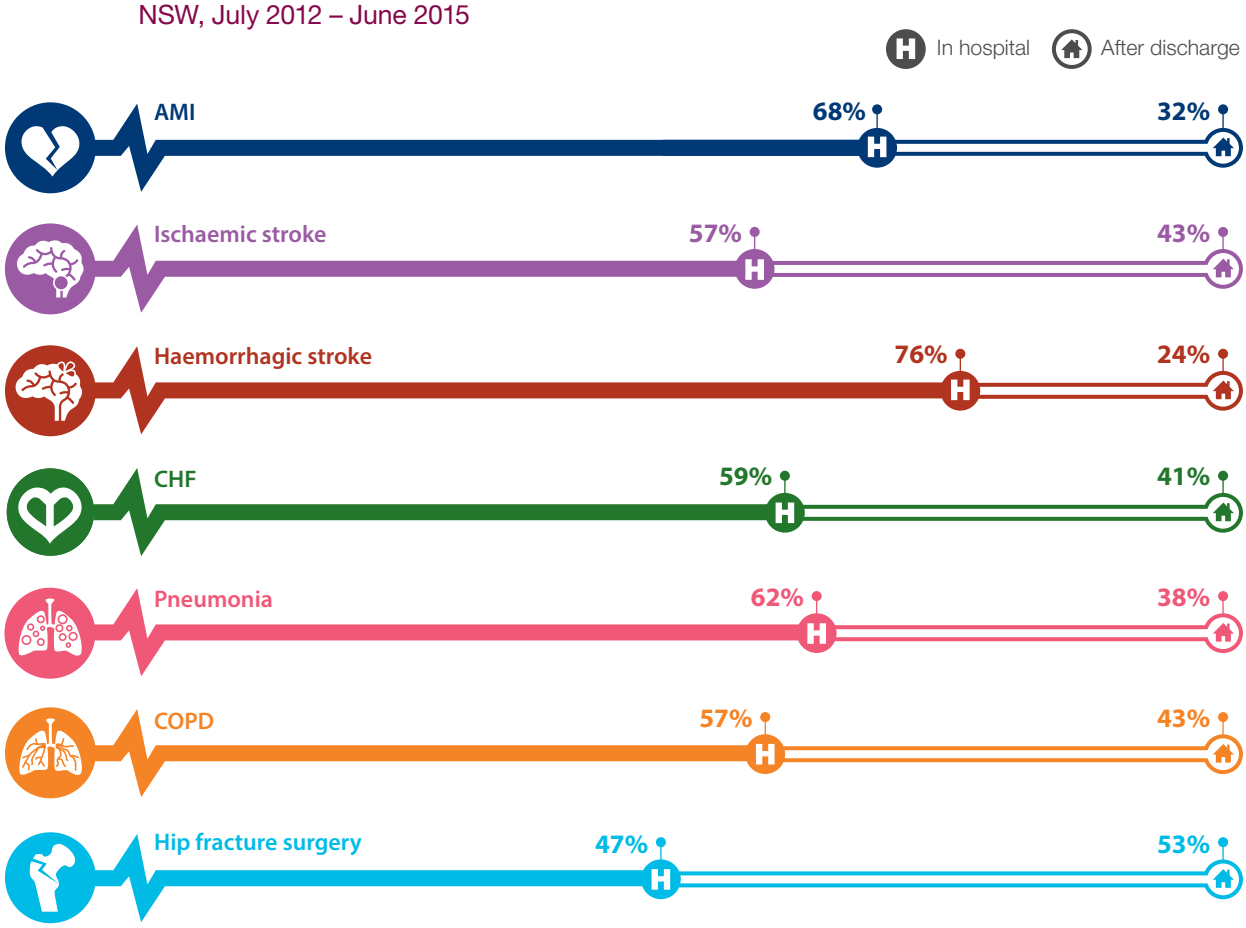
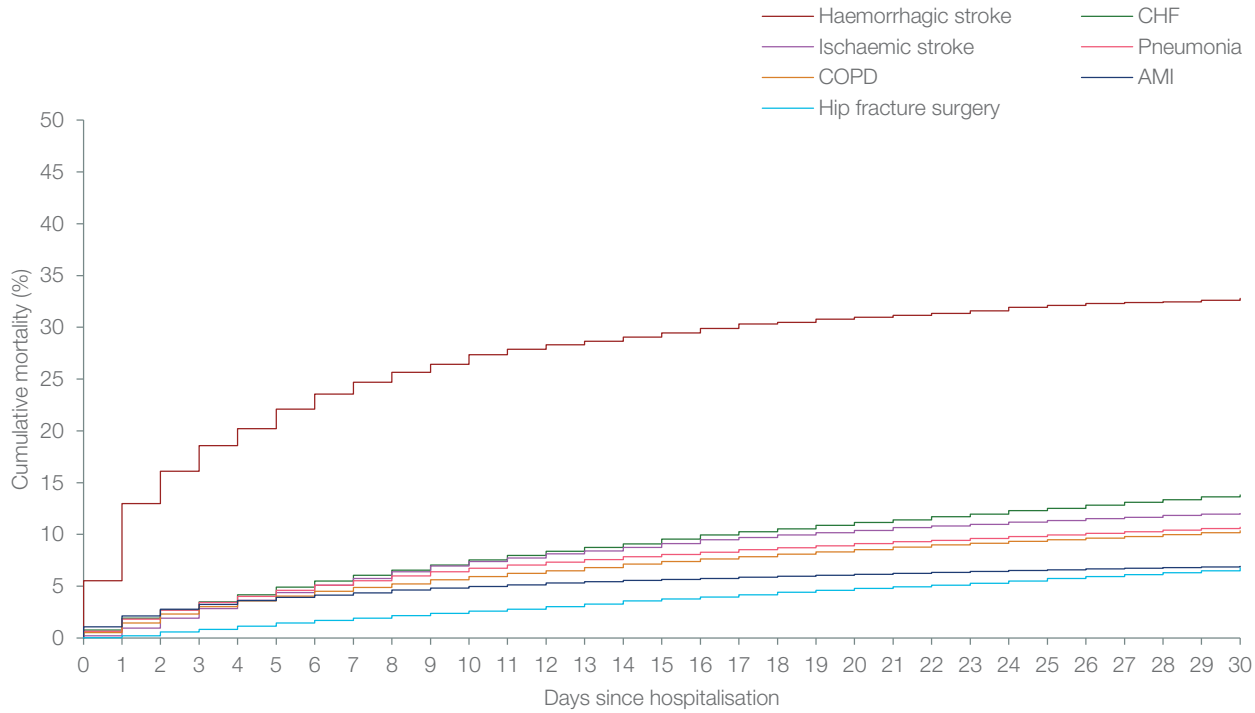


Figure 4 Cumulative mortality (%) in 30 days following hospitalisation, by condition, NSW, July 2012 – June 2015



Note: For hip fracture, data are for 30 days following surgery.

Mortality – Hospital-level results

Across the seven conditions in 2012–15, the number of hospitals* with lower than expected mortality ranged from none to six hospitals; and the number with higher than expected mortality ranged from one to 11 hospitals (Figure 5).

Within each set of analyses, the majority of hospitals had mortality results that were not significantly different than expected, once patient characteristics were taken into account – ranging from 54 hospitals (78%) for CHF to 29 hospitals (97%) for haemorrhagic stroke (Figure 6).

Across all the conditions there were 45 higher than expected and 20 lower than expected mortality results.

Between 2009–12 and 2012–15, the number of hospitals with higher than expected mortality did not change dramatically for most conditions. There were two exceptions however – for COPD, the number of hospitals with higher than expected mortality increased from four to 11 and for pneumonia, from five to nine (data not shown).

In the 2012–15 analyses, 47 hospitals had no conditions for which mortality was higher than expected. Two hospitals (Prince of Wales and St Vincent's) had lower than expected mortality for three conditions; and four hospitals (John Hunter, Manning, Port Macquarie and Tamworth) had higher than expected mortality for three conditions (Figure 7).

Figure 5 **30-day mortality results, by condition, NSW public hospitals, July 2012 – June 2015**

	AMI	Ischaemic stroke	Haemorrhagic stroke	CHF	Pneumonia	COPD	Hip fracture surgery
Higher than expected mortality	Calvary Mater Dubbo Nepean Parkes	Armidale Auburn John Hunter Shoalhaven Westmead	Gosford	Armidale Ballina Belmont Bowral Campbelltown Grafton Maclean Moruya Parkes Tamworth	Blue Mountains Gosford Inverell Manning Moruya Mudgee Port Macquarie Queanbeyan Wyong	Belmont Calvary Mater Campbelltown Casino Cowra John Hunter Manning Mudgee Port Macquarie Tamworth The Tweed	Dubbo John Hunter Manning Port Macquarie Tamworth
Lower than expected mortality	Kempsey Prince of Wales Queanbeyan	Belmont		Blacktown Concord Hornsby Prince of Wales St Vincent's	Blacktown Prince of Wales Royal North Shore Shellharbour St Vincent's Wollongong	Royal North Shore Wollongong	Concord Liverpool St Vincent's

* Hospital results are shown for principal referral, major and district hospitals (peer groups A – C only).

Figure 6 Number of public hospitals, by outlier status for 30-day mortality, by condition, NSW, July 2012 – June 2015

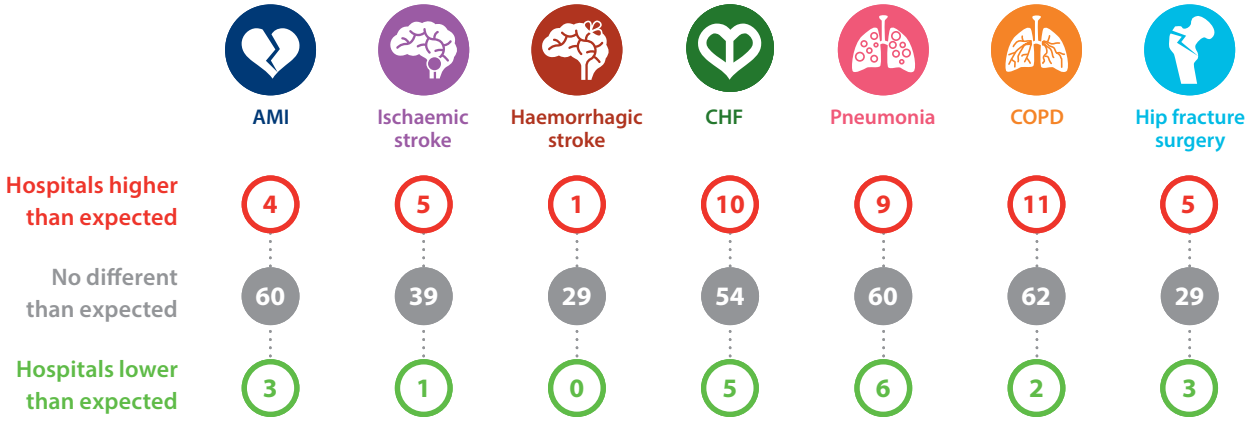


Figure 7 30-day mortality, concentration of outlier results across hospitals, NSW, July 2012 – June 2015

Among 75 referral, major and district hospitals, between July 2012 and June 2015:

Four hospitals had higher than expected mortality for three conditions

Nine hospitals had higher than expected mortality for two conditions

15 hospitals had higher than expected mortality for one condition

47 hospitals did not have higher than expected mortality for any of the seven conditions*

* Not all hospitals have results for all seven conditions.

Mortality – By peer group and changes over time

Hospital peer groups

Not every hospital had sufficient patients to be reported in the RSMR analyses (50 or more index hospitalisations). To summarise peer group findings, any RSMR reported for a hospital is considered to be a 'result'. In all peer groups, the majority of hospitals' 30-day mortality results were no different than expected – 78% of principal referral, 86% of major, and 86% of district hospitals (Figure 8).

Among principal referral hospitals, 13% of results showed lower than expected mortality and 9% higher than expected. For major hospitals, 2% of results showed lower than expected mortality and 12% higher than expected; and for district hospitals, 3% of results showed lower than expected mortality and 12% higher than expected (Figure 8).

Higher and lower than expected mortality results were found across all peer groups. There was however a greater concentration of lower than expected mortality results among principal referral hospitals (Figure 9).

Checking validity of measures

The mortality indicators have undergone extensive sensitivity testing to explore:

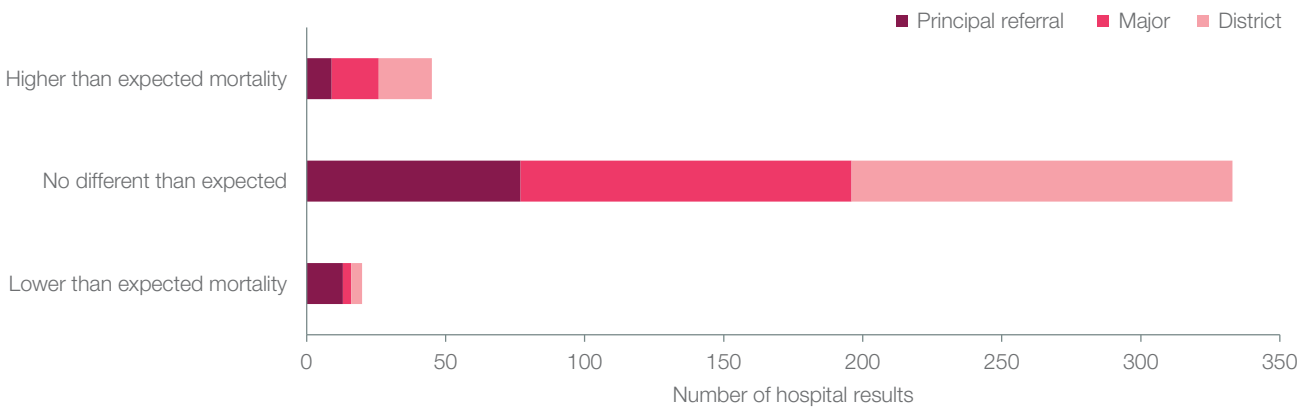
- The extent of change over time in coding of comorbidities in patients' records
- Whether palliative care codes are applied differently across the state's hospitals
- Prevalence and potential confounding of ED visits to a different hospital in the 24 hours before admission
- For hospitals that operate in partnerships, the effect of treating them as a single unit.

The results of these analyses did not identify any significant methodological limitation in the RSMR approach. For more detail, see *Spotlight on Measurement – Measuring 30-day mortality following hospitalisation, 2nd edition*.[4]

Figure 8 30-day mortality, all conditions, number and percentage of peer group results, NSW, July 2012 – June 2015

Hospital peer group	Lower than expected mortality	No different than expected mortality	Higher than expected mortality
Principal referral	13 results (13%)	77 results (78%)	9 results (9%)
Major	3 results (2%)	119 results (86%)	17 results (12%)
District	4 results (3%)	137 results (86%)	19 results (12%)

Figure 9 30-day mortality, all conditions, by hospital peer group results, NSW, July 2012 – June 2015



Changes between 2009–12 and 2012–15

Three hospitals had consistently low mortality for the same condition in both 2009–12 and 2012–15 and two of them (Prince of Wales and St Vincent's) did so for two conditions. There were eight hospitals with higher than expected mortality for the same condition across both time periods, and one of these (Tamworth) did so for three conditions (Figure 10).

For 10 hospitals, mortality improved to lower than expected – and for four of them, improvement was for two conditions (Blacktown, Concord, Royal North Shore and Wollongong). One hospital changed from higher to lower than expected mortality – Blacktown for pneumonia.

For 18 hospitals, mortality improved to no different than expected for at least one condition; and for Tamworth and Port Macquarie, the improvement was for three and two conditions, respectively (Figure 10).

Figure 10 Hospitals with changed outlier status, 30-day mortality, NSW, 2009–12 and 2012–15

Higher than expected | No different than expected | Lower than expected

09–12	12–15	AMI	Ischaemic stroke	Haemorrhagic stroke	CHF	Pneumonia	COPD	Hip fracture surgery
Higher than expected	Higher than expected		John Hunter		Bowral Tamworth	Inverell Manning Wyong	Cowra Port Macquarie Tamworth	Tamworth
No different than expected	Higher than expected	Calvary Mater Dubbo Nepean Parkes	Armidale Auburn Shoalhaven Westmead	Gosford	Armidale Ballina Belmont Campbelltown Grafton Maclean Moruya Parkes*	Blue Mountains Gosford Moruya Mudgee Port Macquarie Queanbeyan	Belmont Calvary Mater Campbelltown Casino John Hunter Manning Mudgee The Tweed	Dubbo John Hunter Manning Port Macquarie
Higher than expected	No different than expected	Cessnock Hornsby Milton Tamworth	Dubbo Lismore Nepean Tamworth	John Hunter Port Macquarie	Batemans Bay Blue Mountains Cowra Manning Mudgee Port Macquarie Tumut	Tamworth	Mt Druitt	Gosford Orange
Higher than expected	Lower than expected					Blacktown		
No different than expected	Lower than expected	Kempsey Queanbeyan*	Belmont		Blacktown Concord Hornsby St Vincent's	Prince of Wales Royal North Shore Wollongong	Royal North Shore Wollongong	Concord Liverpool
Lower than expected	Lower than expected	Prince of Wales			Prince of Wales	Shellharbour St Vincent's		St Vincent's

Note: Using 90% control limits in 2009–12, eight hospitals had higher than expected mortality: Belmont (COPD), Blacktown(COPD), Bowral (AMI), Coffs Harbour (hip fracture surgery and ischaemic stroke), Royal Prince Alfred (ischaemic stroke), St. George (AMI), Westmead (ischaemic stroke). One hospital had lower than expected mortality: Belmont (ischaemic stroke).

* <50 hospitalisations in 2009–12

Condition-specific results

Acute myocardial infarction

NSW public hospitals

An acute myocardial infarction (AMI), or heart attack, occurs when the blood supply to part of the heart is interrupted, resulting in death of heart cells. The heart muscle suffers permanent damage if blood supply is not restored quickly.

Key characteristics of people hospitalised in NSW for AMI between July 2012 and June 2015 are summarised in Figure 11.

Among hospitals that admitted at least 50 patients, unadjusted mortality rates ranged from 0.9 to 13.2 deaths per 100 patients. In order to assess hospital performance fairly, it is important to take account of case mix. Statistical techniques such as risk-standardised mortality ratios (RSMR) adjust for a range of patient-level factors – including age, sex and other illnesses – in the measurement of hospital outcomes.

The AMI funnel plot shows 30-day RSMRs for each hospital in the state. Of the 67 principal referral, major and district hospitals (peer groups A–C) that admitted 50 or more AMI patients in the three-year period, there were three (Queanbeyan, Kempsey, and Prince of Wales) with lower than expected mortality and four (Parkes, Dubbo, Calvary Mater and Nepean) with higher than expected mortality (Figure 12).

The effect of statistical modelling on hospital results for AMI mortality is summarised in Figure 13. For three hospitals – one with lower than expected mortality (Prince of Wales) and two with higher than expected mortality (Dubbo and Parkes) – RSMRs reached statistical significance only with the full risk-standardised model.

Figure 11 Acute myocardial infarction 30-day mortality in NSW: Key characteristics

In the three-year period, July 2012 – June 2015:

- 30,488 patients were hospitalised with a principal diagnosis of AMI (ICD-10-AM code I21, excluding I21.9). Of these patients, 2,101 were hospitalised for AMI two or more times. Only their last hospitalisation is considered.
- 2,108 patients died within 30 days (from any cause, in or out of hospital)
- This corresponds to an unadjusted mortality rate of seven per 100 patients.

Among the 2,108 deaths within 30 days:

- 1,337 (63%) occurred in the initial admitting hospital
- 98 (5%) occurred in another hospital, following patient transfer
- 673 (32%) occurred after discharge, outside hospital
- 325 (15%) occurred on first day of hospitalisation
- 1,330 (63%) occurred within seven days of hospitalisation.

Age, sex and comorbidity

- Patients who survived for at least 31 days following hospitalisation for AMI had an average age of 69 years (median 69); while patients who died within 30 days had an average age of 80 years (median 83)
- The average number of recorded comorbidities (with one-year lookback) was 4.8
- More males (19,826) than females (10,662) were hospitalised for AMI
- Among males, 6% died within 30 days, while among females, 9% died within 30 days
- After adjusting for age and comorbidity, sex was not significantly associated with mortality.

Figure 12 Acute myocardial infarction 30-day risk-standardised mortality ratio, NSW public hospitals, July 2012 – June 2015

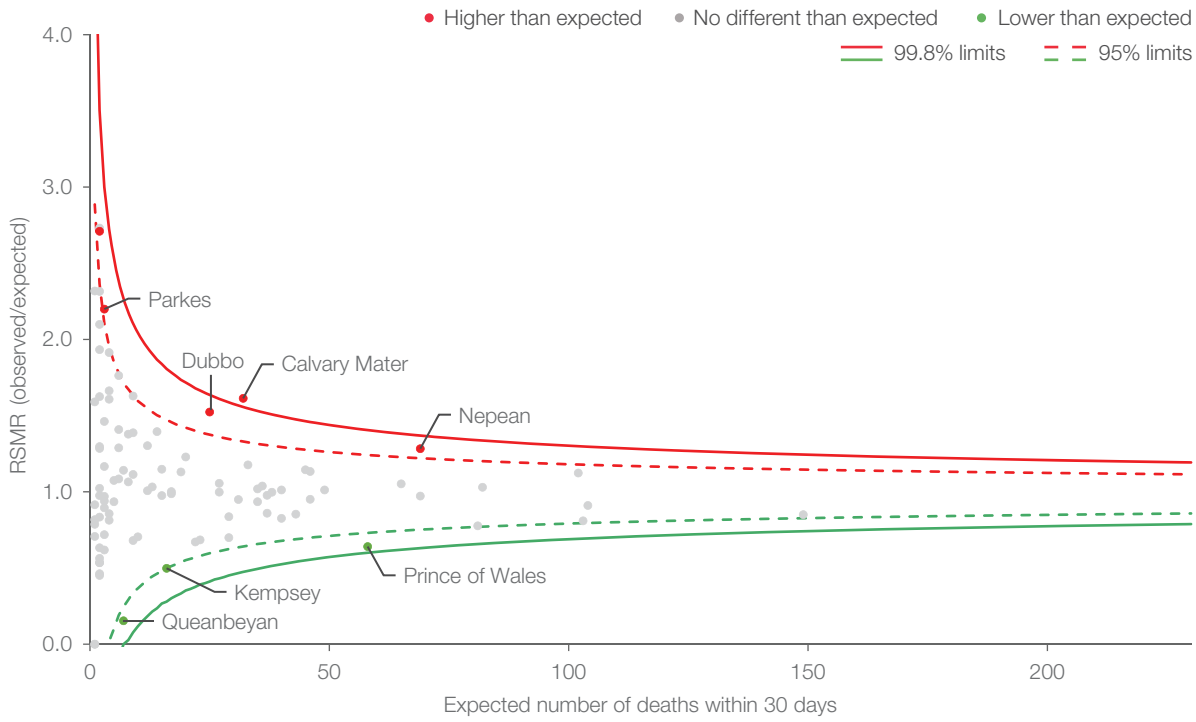
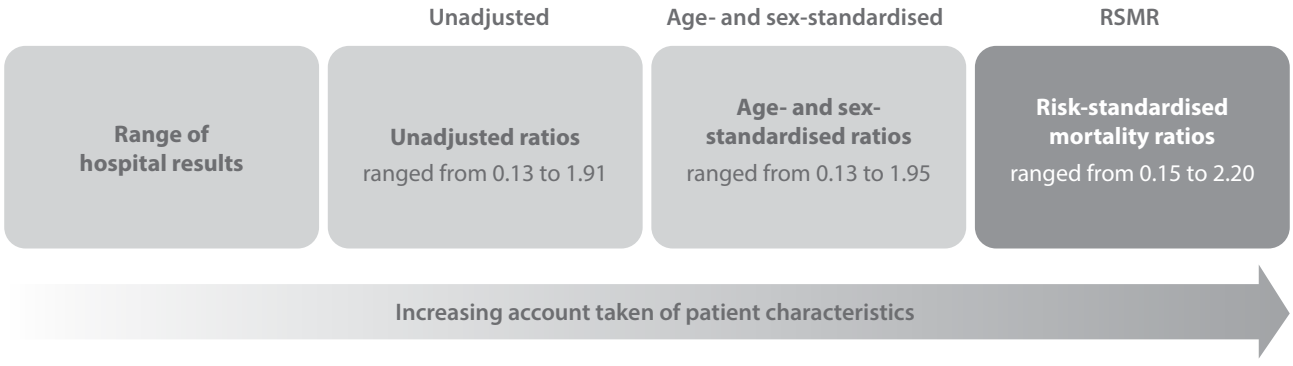


Figure 13 The effect of statistical adjustment on measures of acute myocardial infarction 30-day mortality, NSW public hospitals (peer groups A–C), July 2012–June 2015



	Lower than expected	Higher than expected
Outlier for all models	Queanbeyan	Calvary Mater
Outlier for age- and sex-standardised and risk-standardised	Kempsey	Nepean
Outlier for unadjusted and risk-standardised	-	-
Outlier for risk-standardised only	Prince of Wales	Dubbo, Parkes

Acute myocardial infarction

Exploring patterns of 30-day mortality

From a clinical and performance perspective, knowing when death occurred (in the 30 days following hospitalisation) can highlight particular elements of care and specific care processes where there are opportunities to improve.

This information is provided in hospital cumulative 30-day mortality curves. For example, compared with the NSW cumulative mortality profile, mortality among patients hospitalised at Parkes increased more sharply around day 10; while for patients at Queanbeyan, fewer deaths over the 30-day period are reflected in a much flatter curve (Figure 14).

Each hospital's cumulative mortality curve is shown in its individual profile (**bhi.nsw.gov.au**).

Across peer groups, higher and lower than expected mortality occurred in smaller district and larger principal referral hospitals (Figure 15).

In the July 2012 – June 2015 analysis, three hospitals had lower than expected mortality. One of them (Prince of Wales) also had lower than expected mortality in the immediately preceding time periods. Four hospitals had higher than expected mortality. None of these hospitals also had higher than expected mortality in the preceding time period (Figure 16).

Figure 14 Cumulative mortality, by day, acute myocardial infarction, NSW and highest and lowest RSMR hospitals, July 2012 – June 2015

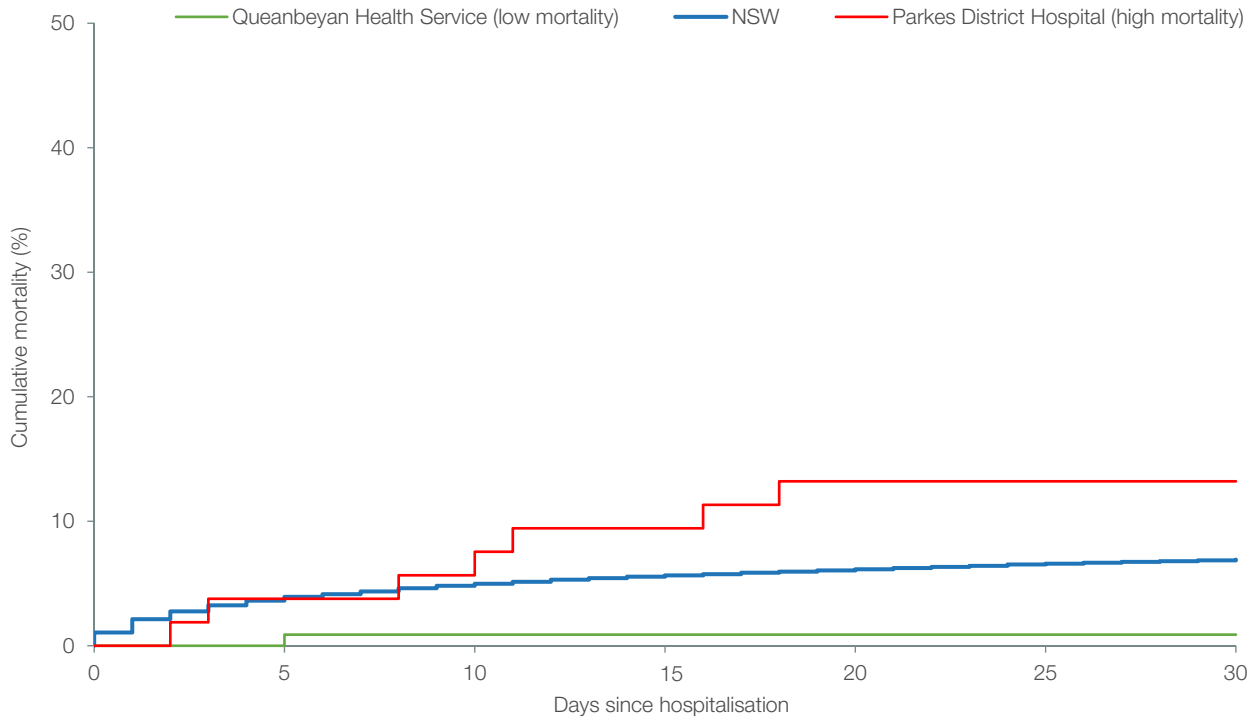


Figure 15 Acute myocardial infarction 30-day risk-standardised mortality ratio (hospitals with ≥ 50 patients), by peer group, July 2012 – June 2015

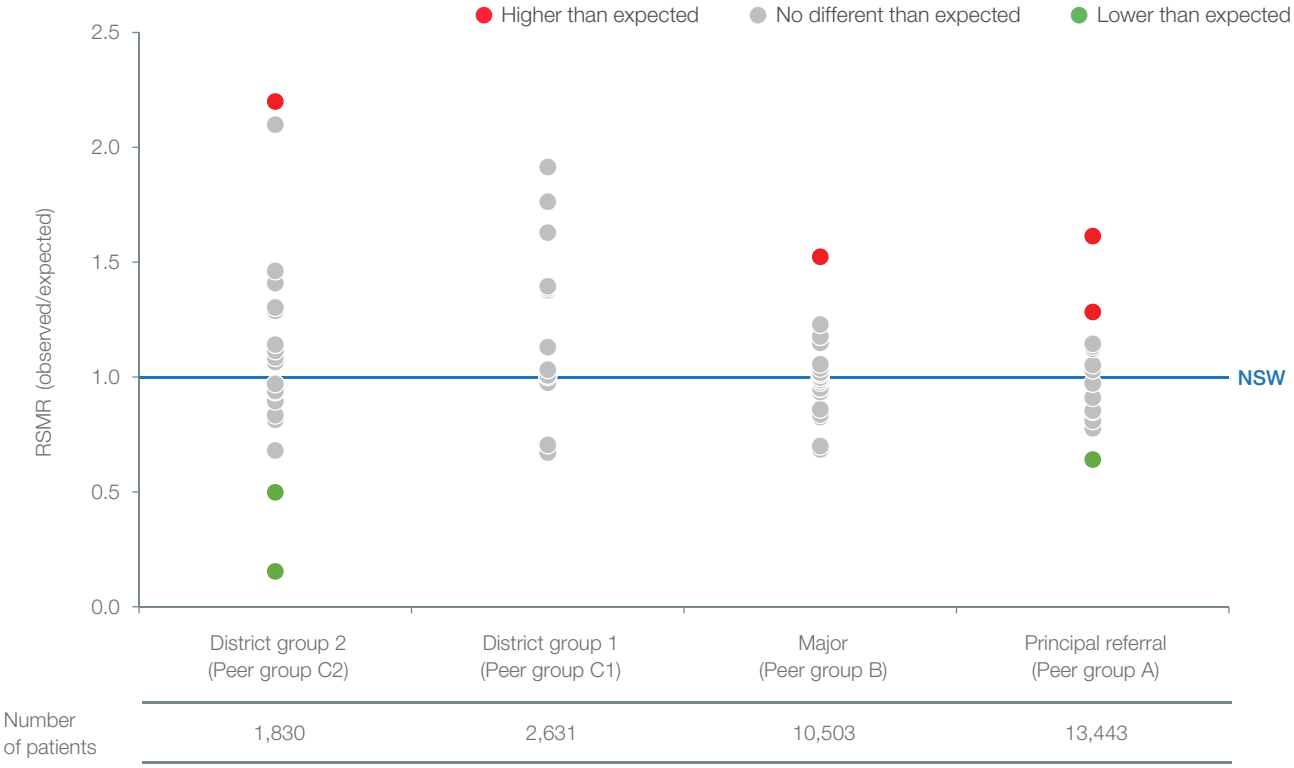
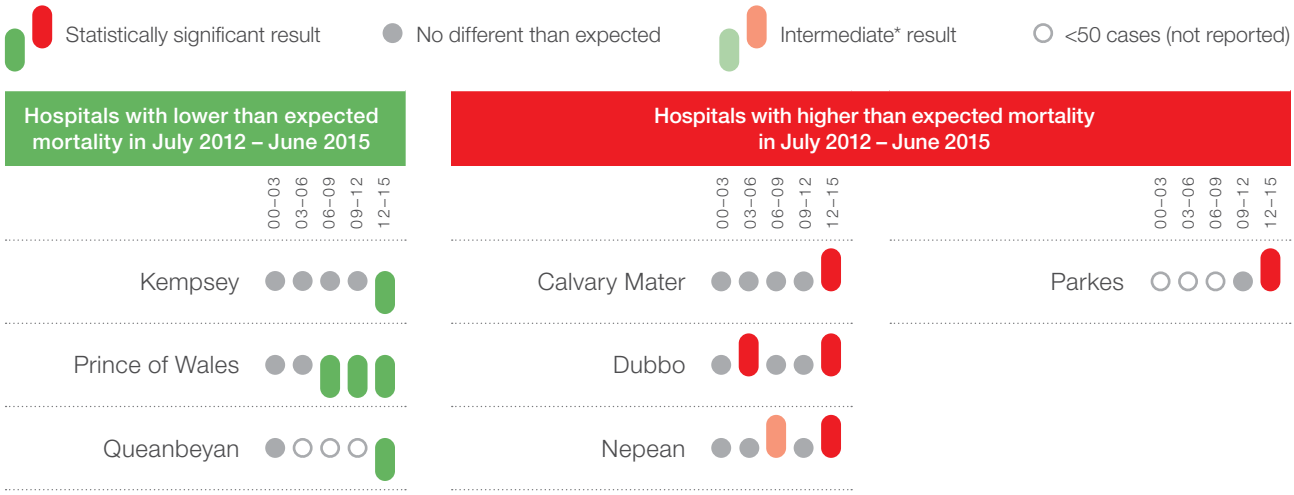


Figure 16 Acute myocardial infarction, 15-year time series results for hospitals that were outliers for the period July 2012 – June 2015



* RSMR outliers in July 2012 – June 2015 used control limits of 95% and 99.8%. Periods between July 2000 and June 2012 used control limits of 90% and 95%. Historical results that were outside the 90% control limits but did not reach significance at the 95% level are categorised as 'intermediate' results.

Ischaemic stroke

NSW public hospitals

Ischaemic stroke occurs when a blood vessel is blocked, depriving the brain of oxygen and nutrients. As a result, the area of the brain supplied or drained by the blood vessel suffers damage. The severity and consequences of stroke can vary from complete recovery to severe disability or death.

Key characteristics of people hospitalised in NSW for ischaemic stroke between July 2012 and June 2015 are summarised in Figure 17.

Among hospitals that admitted at least 50 patients, unadjusted mortality rates ranged from 4.0 to 23.9 deaths per 100 patients. In order to assess hospital performance fairly, it is important to take account of case mix. Statistical techniques such as RSMRs adjust for a range of patient-level factors – including age, sex and other illnesses – in the measurement of hospital outcomes.

The ischaemic stroke funnel plot shows 30-day RSMRs for each hospital. Of the 45 hospitals that admitted 50 or more ischaemic stroke patients in the three-year period, there was one hospital (Belmont) with lower than expected mortality and five hospitals (Armidale, Auburn, Shoalhaven, Westmead and John Hunter) with higher than expected mortality (Figure 18).

The effect of statistical modelling on hospital results for ischaemic stroke mortality is summarised in Figure 19. For four hospitals with higher than expected 30-day mortality (Armidale, John Hunter, Shoalhaven and Westmead), results reached statistical significance in all three models – unadjusted, age-sex standardised and the full risk-standardised model.

Figure 17 Ischaemic stroke 30-day mortality in NSW: Key characteristics

In the three-year period, July 2012 – June 2015:

- 15,475 patients were hospitalised with a principal diagnosis of ischaemic stroke (ICD-10-AM code I63). Of these patients, 669 were hospitalised for ischaemic stroke two or more times. Only their last hospitalisation is considered.
- 1,861 patients died within 30 days (from any cause, in or out of hospital)
- This corresponds to an unadjusted mortality rate of 12 per 100 patients.

Among the 1,861 deaths within 30 days:

- 1,038 (56%) occurred in the initial admitting hospital
- 31 (2%) occurred in another hospital, following patient transfer
- 792 (43%) occurred after discharge, outside hospital
- 31 (2%) occurred on the first day of hospitalisation
- 889 (48%) occurred within seven days of hospitalisation.

Age, sex and comorbidity

- Patients who survived for at least 31 days following hospitalisation for ischaemic stroke had an average age of 73 years (median 76); while patients who died within 30 days had an average age of 83 years (median 85)
- The average number of recorded comorbidities (with one-year lookback) was 7.0
- More males (8,469) than females (7,006) were hospitalised for ischaemic stroke
- Among males, 9% died within 30 days, while among females, 15% died within 30 days
- After adjusting for age and comorbidity, sex was significantly associated with mortality; males had a lower risk of death.

Figure 18 Ischaemic stroke 30-day risk-standardised mortality ratio, NSW public hospitals, July 2012 – June 2015

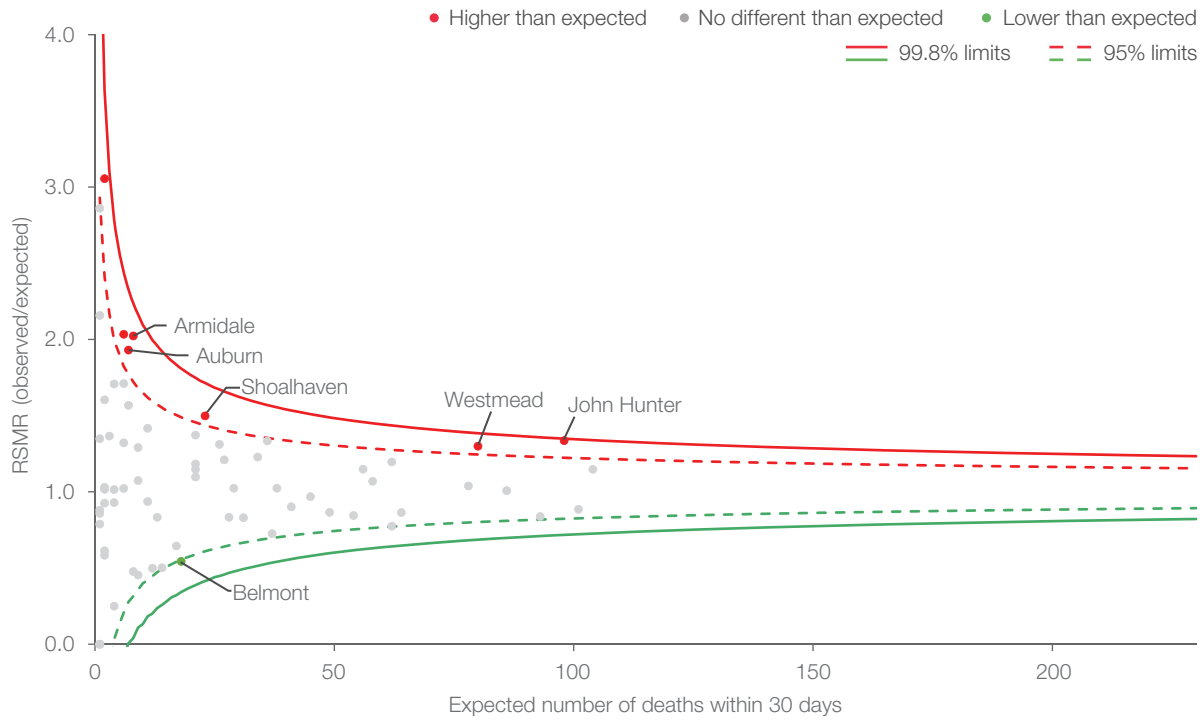


Figure 19 The effect of statistical adjustment on measures of ischaemic stroke 30-day mortality, NSW public hospitals (peer groups A–C), July 2012–June 2015

	Unadjusted	Age- and sex-standardised	RSMR
Range of hospital results	**Unadjusted ratios** ranged from 0.33 to 1.99	**Age- and sex-standardised ratios** ranged from 0.44 to 1.99	**Risk-standardised mortality ratios** ranged from 0.45 to 2.02

Increasing account taken of patient characteristics

	Lower than expected	Higher than expected
Outlier for all models	-	Armidale, John Hunter, Shoalhaven, Westmead
Outlier for age- and sex-standardised and risk-standardised	Belmont	-
Outlier for unadjusted and risk-standardised	-	Auburn
Outlier for risk-standardised only	-	-

Ischaemic stroke

Exploring patterns of 30-day mortality

From a clinical and performance perspective, knowing when death occurred (in the 30 days following hospitalisation) can highlight particular elements of care and specific care processes where there are opportunities to improve.

This information is provided in hospital cumulative 30-day mortality curves. For example, compared with the NSW cumulative mortality profile, mortality among patients hospitalised in Armidale increased rapidly in the first 15 days and then flattened out, while among patients hospitalised at Belmont, mortality remained flatter across the 30-day period (Figure 20).

Each hospital's cumulative mortality curve is shown in its individual profile (**bhi.nsw.gov.au**).

Higher than expected mortality occurred across all peer groups – in principal referral, major and district hospitals. The hospital with lower than expected mortality, Belmont, is a small district hospital (Figure 21).

Of the five hospitals with higher than expected mortality, one (John Hunter) also had higher than expected mortality in the preceding time period (Figure 22).

The hospital with lower than expected mortality (Belmont) and one with higher than expected mortality (John Hunter) are geographically close and patients are sometimes cared for across the two sites. An RSMR was calculated for the two hospital cohorts combined into a single entity. That entity had higher than expected mortality.

Figure 20 Cumulative mortality, by day, ischaemic stroke, NSW and highest and lowest RSMR, July 2012 – June 2015

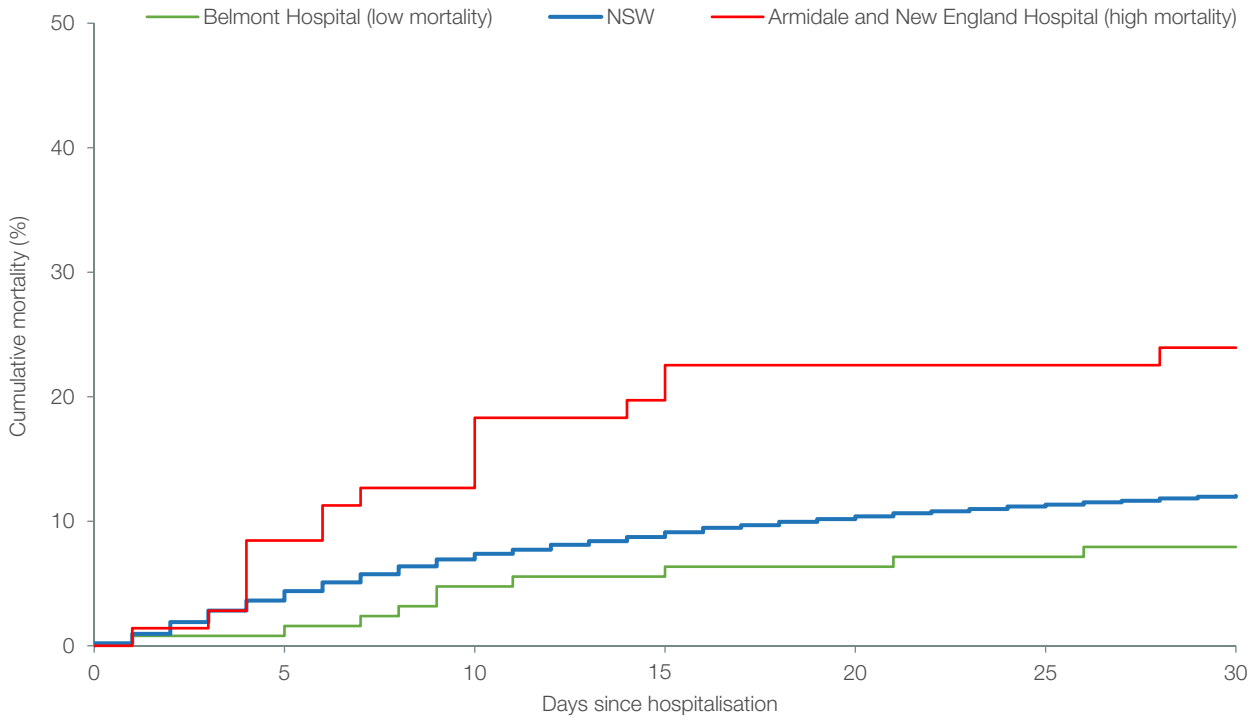


Figure 21 Ischaemic stroke 30-day risk-standardised mortality ratio (hospitals with ≥ 50 patients), by peer group, July 2012 – June 2015

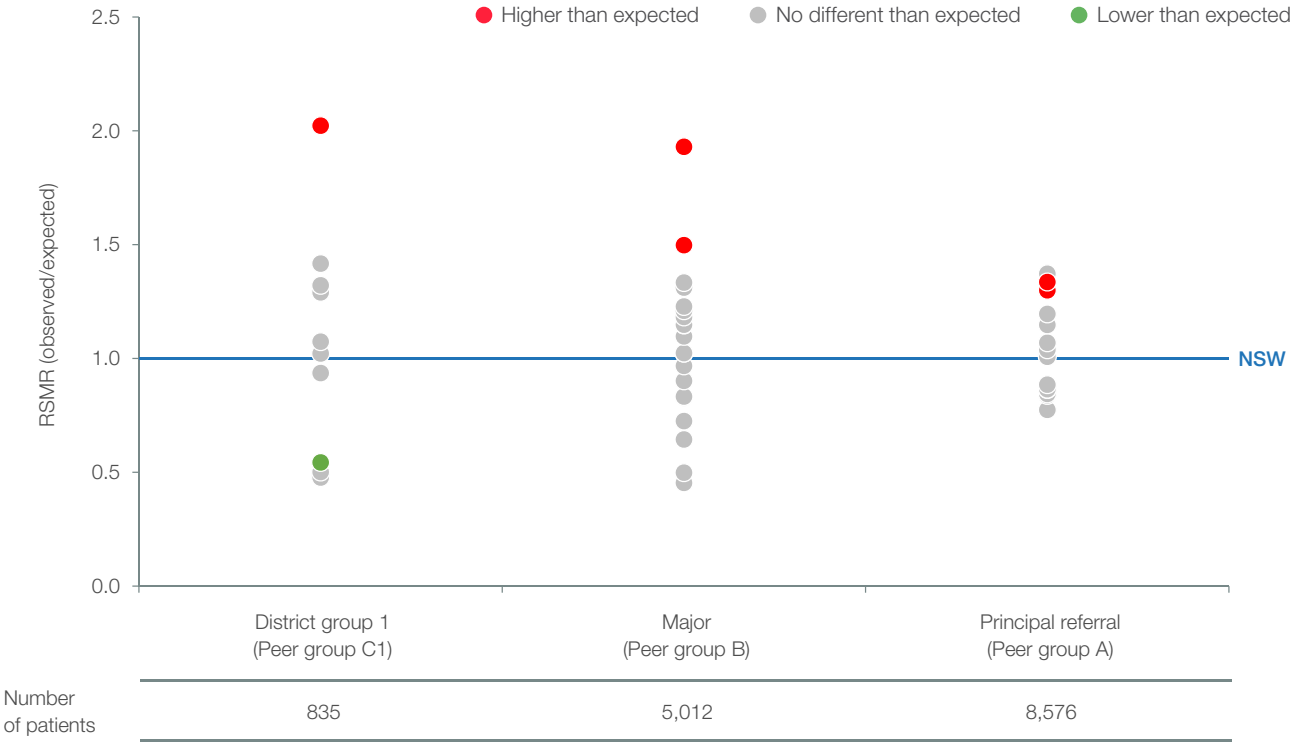


Figure 22 Ischaemic stroke, 15-year time series results for hospitals that were outliers for the period July 2012 – June 2015

* RSMR outliers in July 2012 – June 2015 used control limits of 95% and 99.8%. Periods between July 2000 and June 2012 used control limits of 90% and 95%. Historical results that were outside the 90% control limits but did not reach significance at the 95% level are categorised as 'intermediate' results.

Haemorrhagic stroke

NSW public hospitals

Haemorrhagic stroke occurs when a blood vessel, usually an artery, develops a leak or bursts. Consequently, the brain surrounding the vessel is damaged by blood or pressure. Severity and consequences of stroke vary from complete recovery, to severe disability or death.

Key characteristics of people hospitalised in NSW for haemorrhagic stroke between July 2012 and June 2015 are summarised in Figure 23.

Among hospitals that admitted at least 50 patients, unadjusted mortality rates ranged from 23.2 to 52.0 deaths per 100 patients. In order to assess hospital performance fairly, it is important to take account of case mix. Statistical techniques such as RSMRs adjust for a range of patient-level factors – including age, sex and other illnesses – in the measurement of hospital outcomes.

The haemorrhagic stroke funnel plot shows 30-day RSMRs for each hospital. Of the 30 hospitals that admitted 50 or more haemorrhagic stroke patients in the three-year period, there were no hospitals with lower than expected mortality. One hospital (Gosford) had higher than expected mortality (Figure 24).

The effect of statistical modelling on hospital results for haemorrhagic stroke mortality is summarised in Figure 25. For the hospital with higher than expected mortality (Gosford), results reached statistical significance in all three models – unadjusted, age-sex standardised and the full risk-standardised model.

Figure 23 Haemorrhagic stroke 30-day mortality in NSW: Key characteristics

In the three-year period, July 2012 – June 2015:

- 5,659 patients were hospitalised with a principal diagnosis of haemorrhagic stroke (ICD-10-AM codes I61, I62). Of these patients, 252 were hospitalised for haemorrhagic stroke two or more times. Only their last hospitalisation is considered.
- 1,855 patients died within 30 days (from any cause, in or out of hospital)
- This corresponds to an unadjusted mortality rate of 33 per 100 patients.

Among the 1,855 deaths within 30 days:

- 1,352 (73%) occurred in the initial admitting hospital
- 67 (4%) occurred in another hospital, following patient transfer
- 436 (24%) occurred after discharge, outside hospital
- 313 (17%) occurred on the first day of hospitalisation
- 1,397 (75%) occurred within seven days of hospitalisation.

Age, sex and comorbidity

- Patients who survived for at least 31 days following hospitalisation for haemorrhagic stroke had an average age of 72 years (median 75); while patients who died within 30 days had an average age of 79 years (median 82)
- The average number of recorded comorbidities (with one-year lookback) was 5.8
- More males (3,145) than females (2,514) were hospitalised for haemorrhagic stroke
- Among males, 29% died within 30 days, while among females, 37% died within 30 days
- After adjusting for age and comorbidity, sex was significantly associated with mortality; males had a lower risk of death.

Figure 24 Haemorrhagic stroke 30-day risk-standardised mortality ratio, NSW public hospitals, July 2012 – June 2015

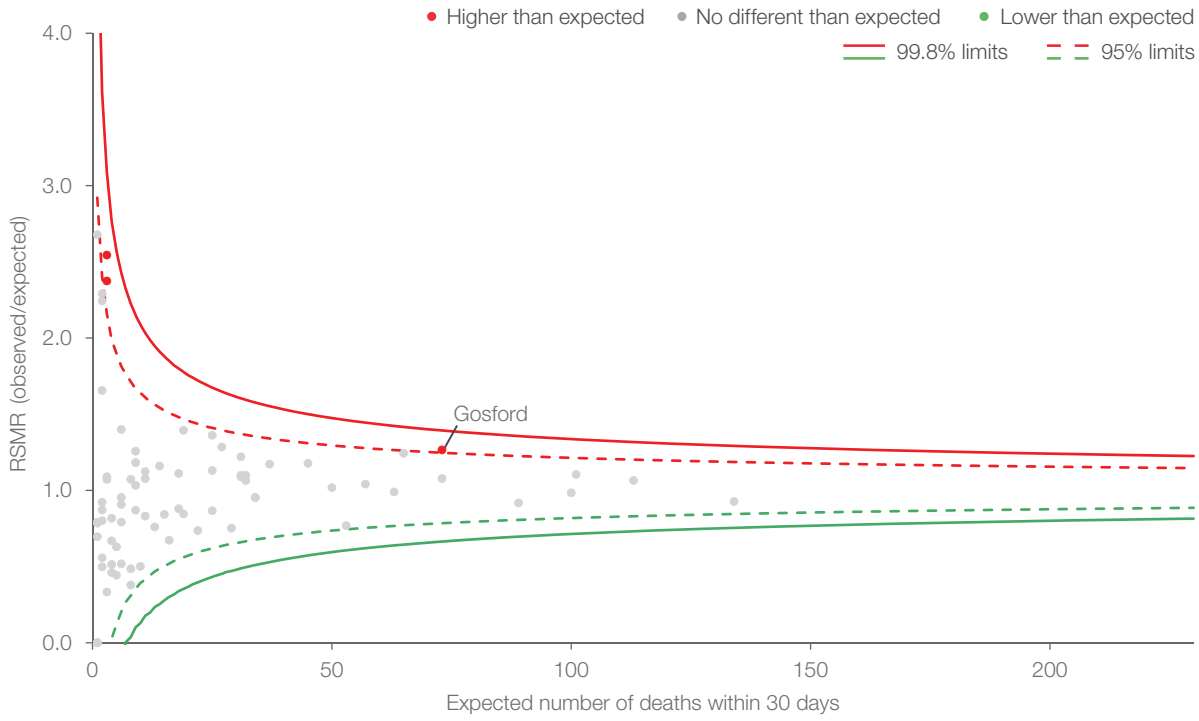


Figure 25 The effect of statistical adjustment on measures of haemorrhagic stroke 30-day mortality, NSW public hospitals (peer groups A–C), July 2012–June 2015

	Unadjusted	Age- and sex-standardised	RSMR
Range of hospital results	**Unadjusted ratios** ranged from 0.53 to 1.58	**Age- and sex-standardised ratios** ranged from 0.57 to 1.45	**Risk-standardised mortality ratios** ranged from 0.55 to 1.39

Increasing account taken of patient characteristics

	Lower than expected	Higher than expected
Outlier for all models	-	Gosford
Outlier for age- and sex-standardised and risk-standardised	-	-
Outlier for unadjusted and risk-standardised	-	-
Outlier for risk-standardised only	-	-

Haemorrhagic stroke

Exploring patterns of 30-day mortality

From a clinical and performance perspective, knowing when death occurred (in the 30 days following hospitalisation) can highlight particular elements of care and specific care processes where there are opportunities to improve.

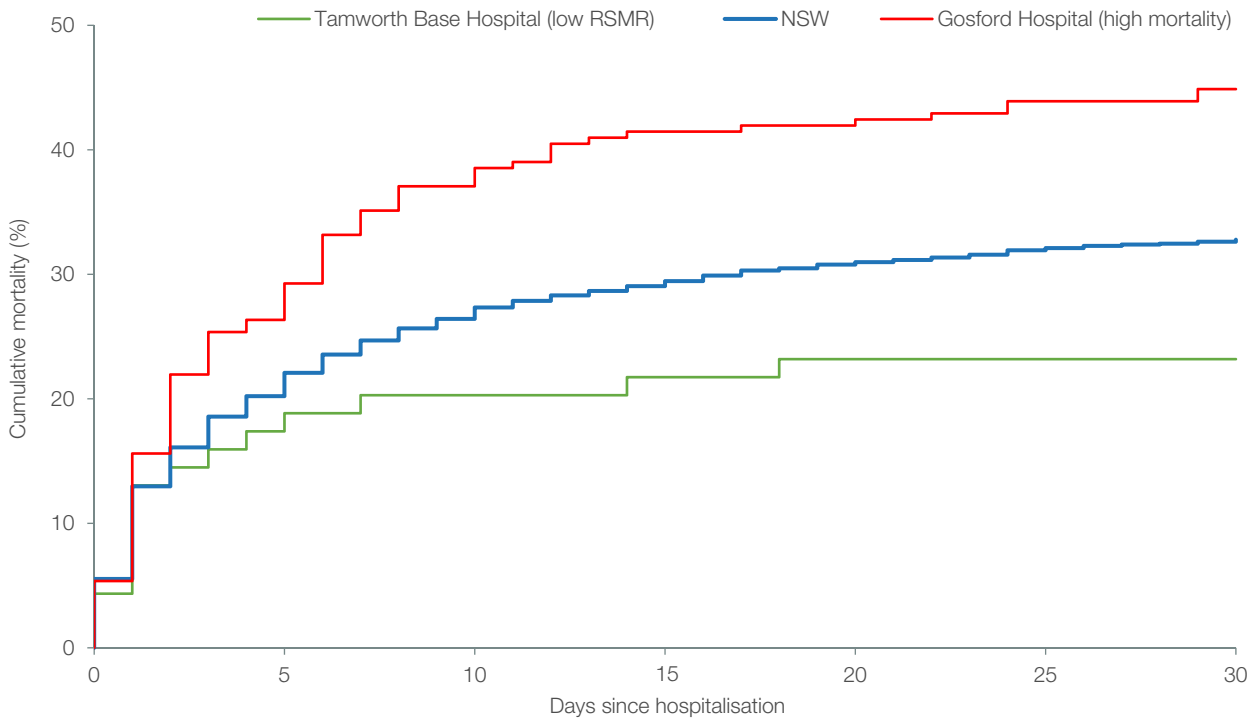
This information is provided in hospital cumulative 30-day mortality curves. For example, compared with the NSW cumulative mortality profile, mortality among Gosford Hospital patients climbed more rapidly in the initial 10 days following hospitalisation. No hospital had lower than expected mortality (Figure 26).

Each hospital's cumulative mortality curve is shown in its individual profile (**bhi.nsw.gov.au**).

Mortality varied across peer groups but the only hospital with an RSMR that reached statistical significance, Gosford, is a principal referral hospital (Figure 27).

The outlier hospital with higher than expected mortality in the July 2012 – June 2015 period (Gosford) had mortality no different than expected in the preceding period (Figure 28).

Figure 26 Cumulative mortality, by day, haemorrhagic stroke, NSW and highest and low RSMR, July 2012 – June 2015



Note: Tamworth Base Hospital did not have lower than expected mortality in 2012–15 however it did have a low RSMR and its cumulative mortality is shown for comparison purposes.

Figure 27 Haemorrhagic stroke 30-day risk-standardised mortality ratio (hospitals with ≥ 50 patients), by peer group, July 2012 – June 2015

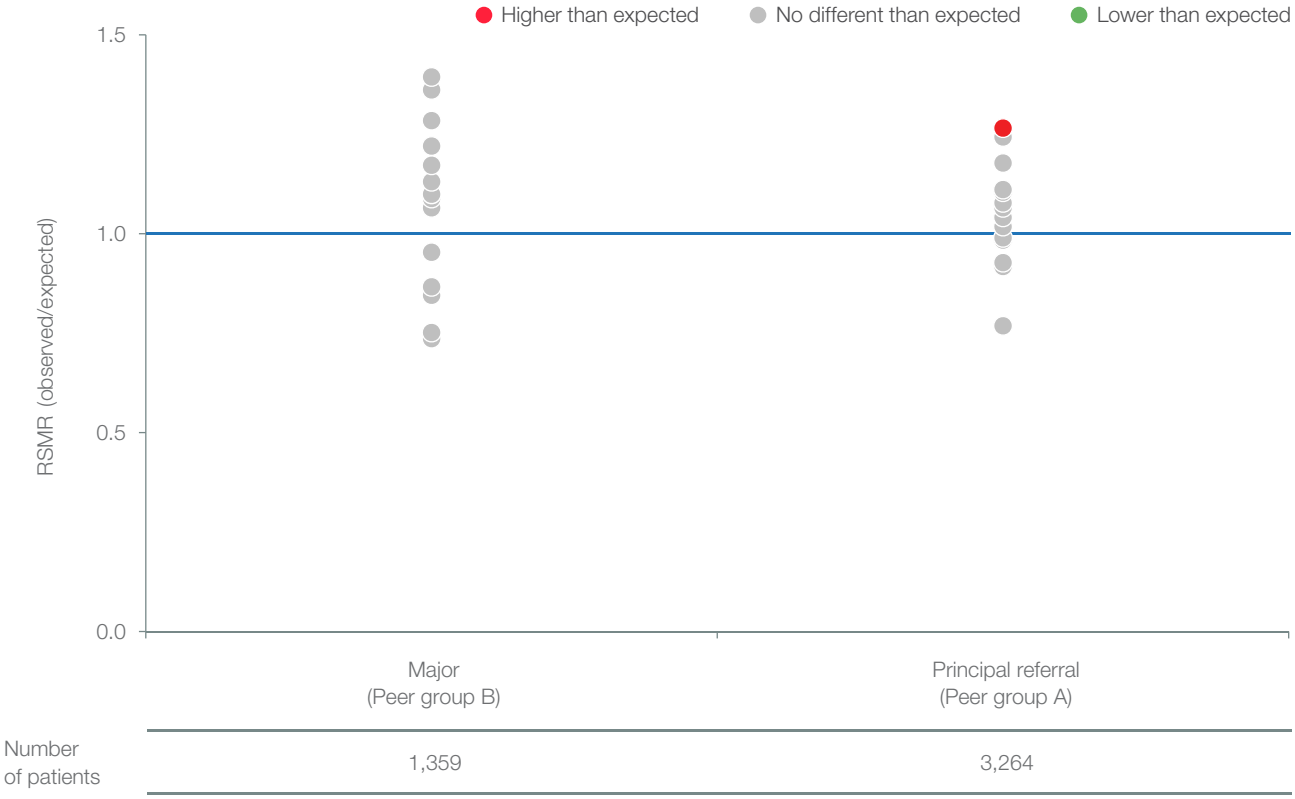
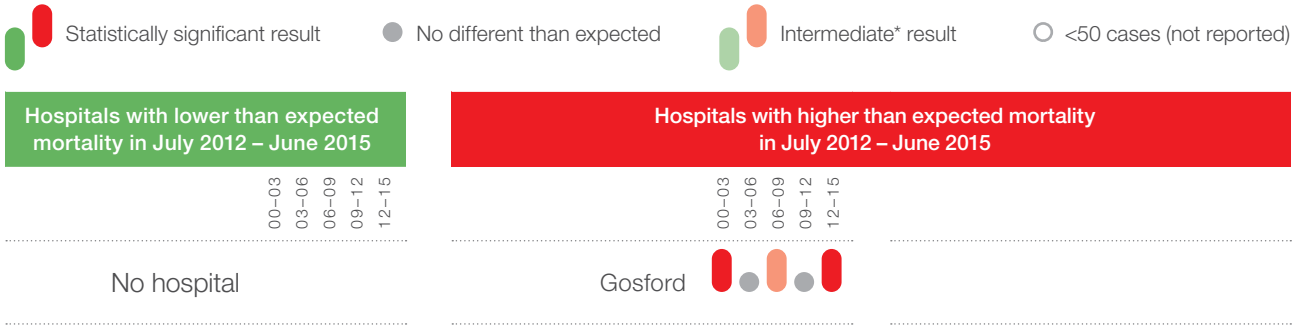


Figure 28 Haemorrhagic stroke, 15-year time series results for hospitals that were outliers for the period July 2012 – June 2015



* RSMR outliers in July 2012 – June 2015 used control limits of 95% and 99.8%. Periods between July 2000 and June 2012 used control limits of 90% and 95%. Historical results that were outside the 90% control limits but did not reach significance at the 95% level are categorised as 'intermediate' results.

Congestive heart failure

NSW public hospitals

Congestive (or chronic) heart failure (CHF) occurs when the heart is unable to keep up with the demands of, or provide adequate blood flow to, other organs. It often develops as a result of hypertension, diabetes or other coronary diseases.

Key characteristics of people hospitalised in NSW for CHF between July 2012 and June 2015 are summarised in Figure 29.

Among hospitals that admitted at least 50 patients, unadjusted mortality rates ranged from 8.3 to 26.6 deaths per 100 patients. In order to assess hospital performance fairly, it is important to take account of case mix. Statistical techniques such as RSMRs adjust for a range of patient-level factors – including age, sex and other illnesses – in the measurement of hospital outcomes.

The CHF funnel plot shows 30-day RSMRs for each hospital. Of the 69 hospitals that admitted 50 or more CHF patients in the three-year period, there were five (Hornsby, Blacktown, Concord, St Vincent's and Prince of Wales) with lower than expected mortality and 10 (Parkes, Armidale, Moruya, Maclean, Ballina, Grafton, Bowral, Tamworth, Belmont and Campbelltown) with higher than expected mortality (Figure 30).

The effect of statistical modelling on hospital results for CHF 30-day mortality is summarised in Figure 31. For two hospitals with higher than expected 30-day mortality (Belmont and Campbelltown), results reached statistical significance in all three models – unadjusted, standardised and the full risk-standardised model.

Figure 29 Congestive heart failure 30-day mortality in NSW: Key characteristics

In the three-year period, July 2012 – June 2015:

- 27,484 patients were hospitalised with a principal diagnosis of congestive heart failure (ICD-10-AM codes I11.0, I13.0, I13.2, I50.0, 150.1, 150.9). Of these patients 7,108 were hospitalised for CHF two or more times. Only their last hospitalisation is considered in the mortality analysis (however the number of previous hospitalisations is used as an adjustment variable).
- 3,793 patients died within 30 days (from any cause, in or out of hospital)
- This corresponds to an unadjusted mortality rate of 14 per 100 patients.

Among the 3,793 deaths within 30 days:

- 12,171 (57%) occurred in the initial admitting hospital
- 56 (1%) occurred in another hospital, following patient transfer
- 1,566 (41%) occurred after discharge, outside hospital
- 210 (6%) occurred on the first day of hospitalisation
- 1,666 (44%) occurred within seven days of hospitalisation.

Age, sex and comorbidity

- Patients who survived for at least 31 days following hospitalisation for CHF had an average age of 80 years (median 82); while patients who died within 30 days had an average age of 84 years (median 85)
- The average number of recorded comorbidities (with one-year lookback) was 6.0
- More males (14,124) than females (13,360) were hospitalised for CHF
- Among males, 14% died within 30 days, while among females, 13% died within 30 days
- After adjusting for age and comorbidities, sex was significantly associated with mortality; males had a higher risk of death.

Figure 30 Congestive heart failure 30-day risk-standardised mortality ratio, NSW public hospitals, July 2012 – June 2015

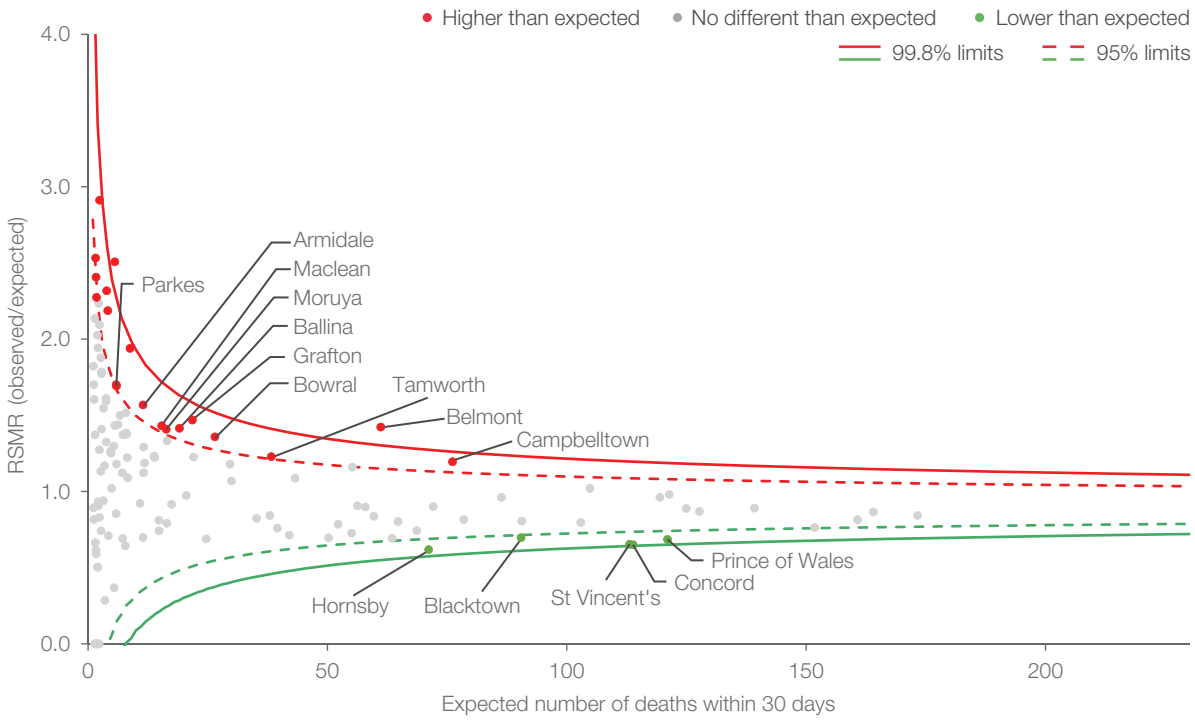
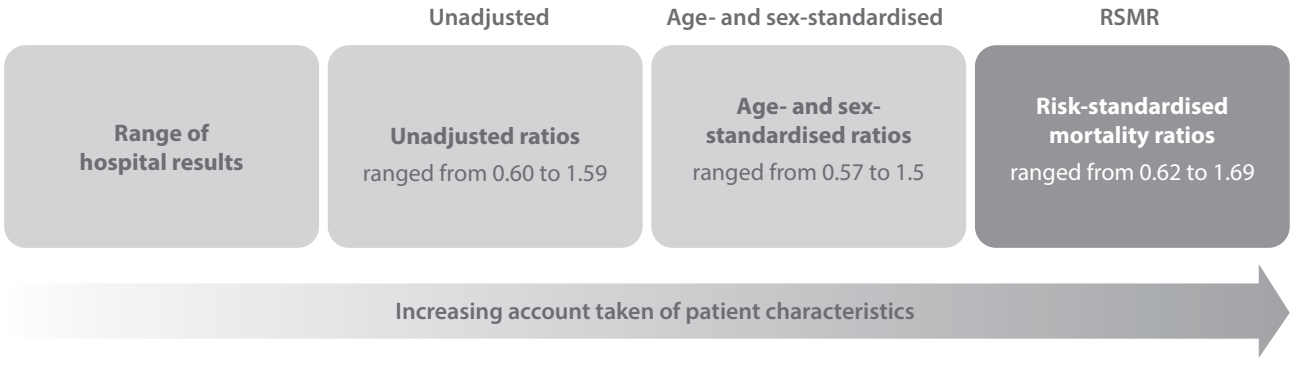


Figure 31 The effect of statistical adjustment on measures of congestive heart failure 30-day mortality, NSW public hospitals (peer groups A–C), July 2012–June 2015



	Lower than expected	Higher than expected
Outlier for all models	-	Belmont, Campbelltown
Outlier for age- and sex-standardised and risk-standardised	Hornsby, Concord	-
Outlier for unadjusted and risk-standardised	Blacktown	-
Outlier for risk-standardised only	Prince of Wales, St Vincent's	Armidale, Tamworth, Ballina, Grafton, Maclean, Moruya, Bowral, Parkes

Congestive heart failure

Exploring patterns of 30-day mortality

From a clinical and performance perspective, knowing when death occurred (in the 30 days following hospitalisation) can highlight particular elements of care and specific care processes where there are opportunities to improve.

This information is provided in hospital cumulative 30-day mortality curves. For example, compared with the NSW cumulative mortality profile, mortality among patients hospitalised in Parkes increased more rapidly in the first nine days; while among patients at Hornsby hospital it was flatter (Figure 32).

Each hospital's cumulative mortality curve is shown in its individual profile (**bhi.nsw.gov.au**).

Across peer groups, lower than expected mortality occurred in principal referral and major hospitals while higher than expected mortality occurred in major and district hospitals (Figure 33).

Among outliers in the July 2012 – June 2015 analysis, of the five hospitals with lower than expected mortality, one (Prince of Wales) also had lower than expected mortality in the preceding time period. Of the 10 hospitals with higher than expected mortality, two (Bowral and Tamworth) also had higher than expected mortality in the preceding time period (Figure 34).

Figure 32 Cumulative mortality, by day, congestive heart failure, NSW and highest and lowest RSMR, July 2012 – June 2015

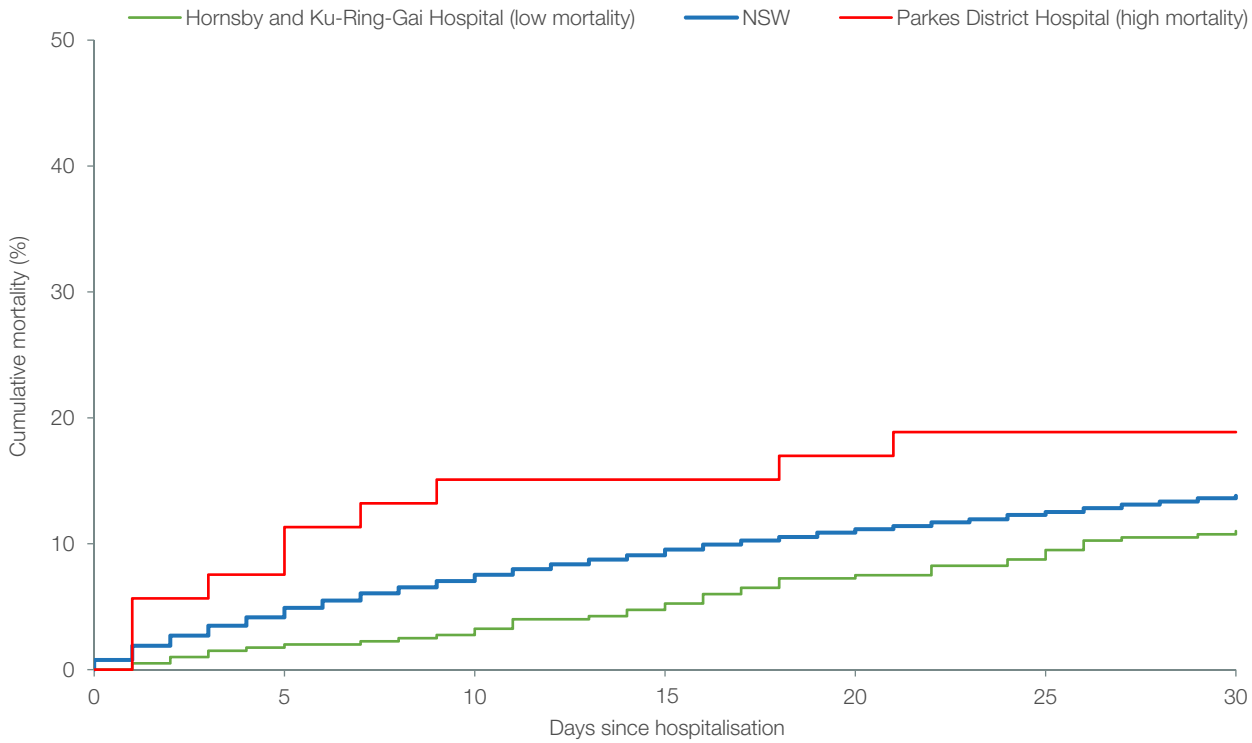


Figure 33 **Congestive heart failure 30-day risk-standardised mortality ratio (hospitals with ≥ 50 patients), by peer group, July 2012 – June 2015**

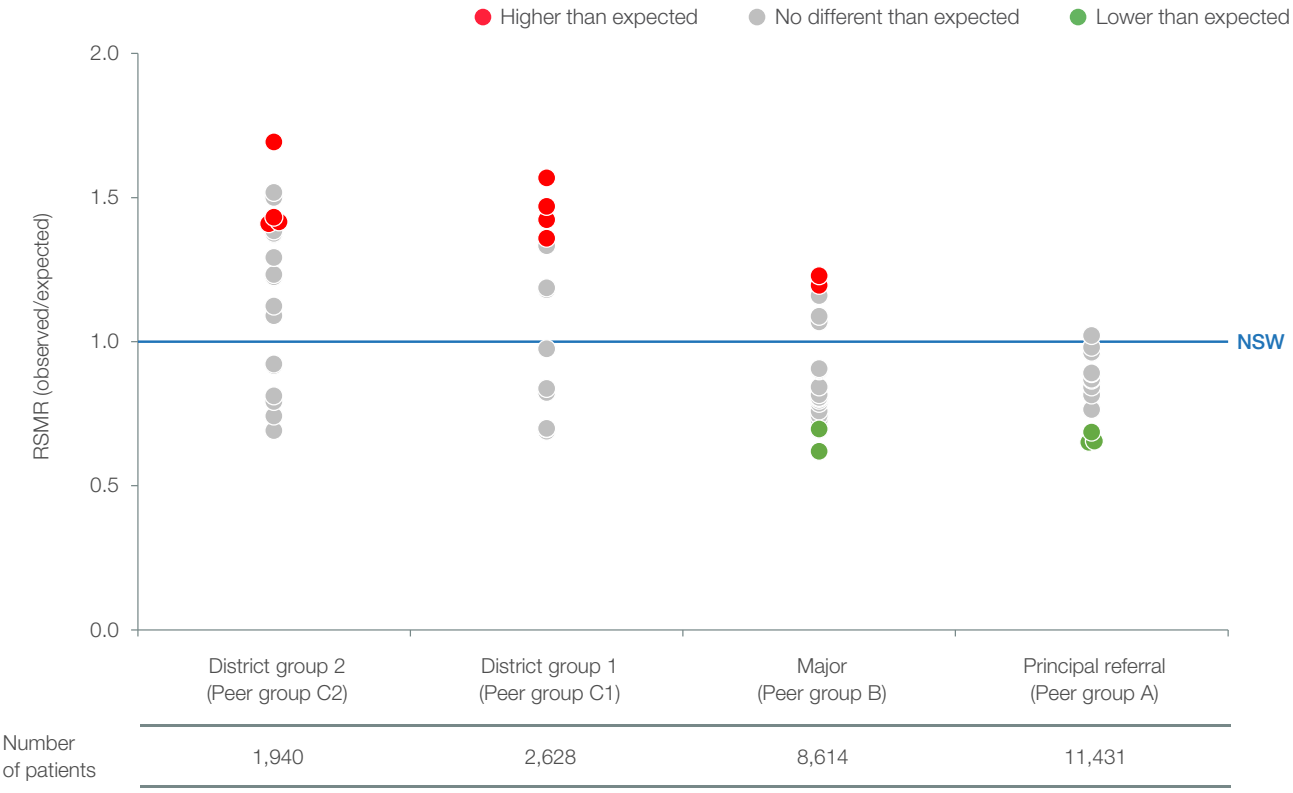
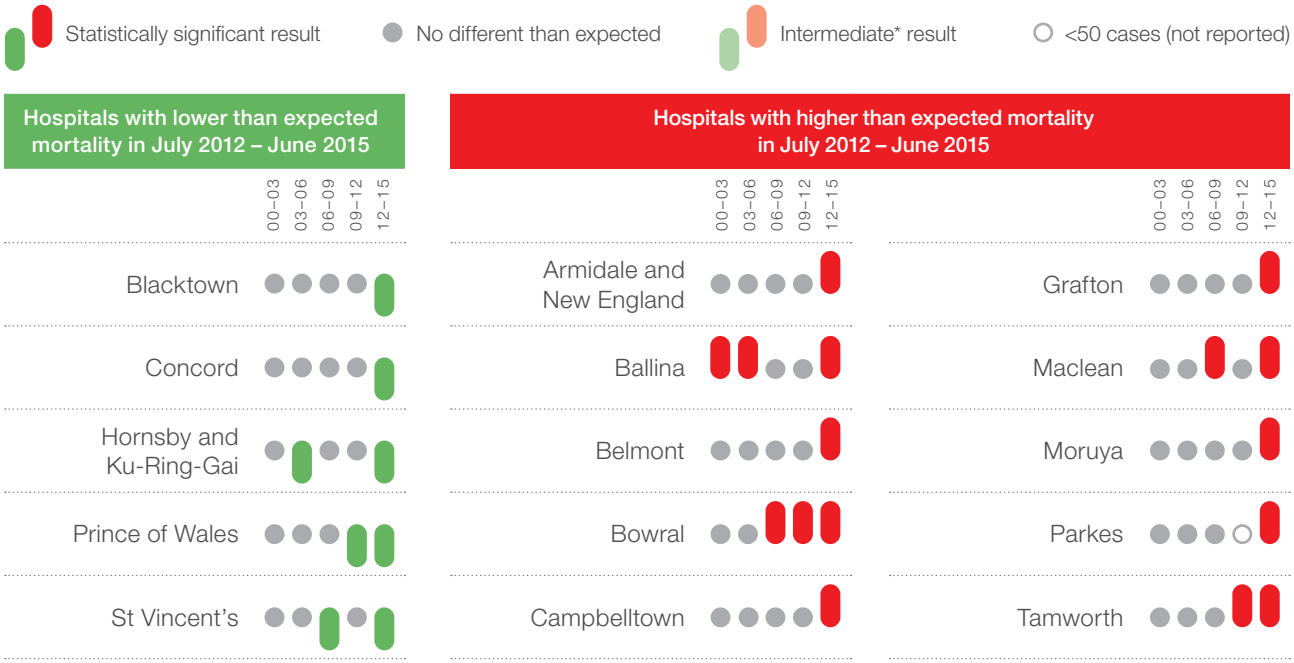


Figure 34 **Congestive heart failure, 15-year time series results for hospitals that were outliers for the period July 2012 – June 2015**



* RSMR outliers in July 2012 – June 2015 used control limits of 95% and 99.8%. Periods between July 2000 and June 2012 used control limits of 90% and 95%. Historical results that were outside the 90% control limits but did not reach significance at the 95% level are categorised as 'intermediate' results.

Pneumonia

NSW public hospitals

Pneumonia is an inflammatory condition of one or both lungs, usually due to infection. Symptoms include fever, chills, cough with sputum production, chest pain and shortness of breath.

Key characteristics of people hospitalised in NSW for pneumonia between July 2012 and June 2015 are summarised in Figure 35.

Among hospitals that admitted at least 50 patients, unadjusted mortality rates ranged from 0.0 to 16.2 deaths per 100 patients. In order to assess hospital performance fairly, it is important to take account of case mix. Statistical techniques such as RSMRs adjust for a range of patient-level factors – including age, sex and other illnesses – in the measurement of hospital outcomes.

The pneumonia funnel plot shows 30-day RSMRs for each hospital. Of the 75 hospitals that admitted 50 or more pneumonia patients in the three-year period, there were six (Shellharbour, Wollongong, Royal North Shore, Prince of Wales, St Vincent's and Blacktown) with lower than expected mortality and nine (Gosford, Wyong, Inverell, Manning, Port Macquarie, Moruya, Queanbeyan, Mudgee and Blue Mountains) with higher than expected mortality (Figure 36).

The effect of statistical modelling on hospital results for pneumonia mortality is summarised in Figure 37. For four hospitals – one with lower than expected mortality (Shellharbour) and three with higher than expected mortality (Gosford, Inverell and Manning), results reached statistical significance in all three models – unadjusted, age-sex standardised and the full risk-standardised model.

Figure 35 Pneumonia 30-day mortality in NSW: Key characteristics

In the three-year period, July 2012 – June 2015:

- 47,133 patients were hospitalised with a principal diagnosis of pneumonia (ICD-10-AM codes J13-J16, J18). Of these patients 4,487 were hospitalised for pneumonia two or more times. Only their last hospitalisation is considered.
- 5,037 patients died within 30 days (from any cause, in or out of hospital)
- This corresponds to an unadjusted mortality rate of 11 per 100 patients.

Among the 5,037 deaths within 30 days:

- 3,037 (60%) occurred in the initial admitting hospital
- 70 (1%) occurred in another hospital, following patient transfer
- 1,930 (38%) occurred after discharge, outside hospital
- 304 (6%) occurred on the first day of hospitalisation
- 2,608 (52%) occurred within seven days of hospitalisation.

Age, sex and comorbidity

- Patients who survived for at least 31 days following hospitalisation for pneumonia had an average age of 70 years (median 74); while patients who died within 30 days had an average age of 81 years (median 84)
- The average number of recorded comorbidities (with one-year lookback) was 4.8
- More males (24,586) than females (22,547) were hospitalised for pneumonia
- Among males, 11% died within 30 days, while among females, 10% died within 30 days
- After adjusting for age and comorbidity, sex was not significantly associated with mortality.

Figure 36 Pneumonia 30-day risk-standardised mortality ratio, NSW public hospitals, July 2012 – June 2015

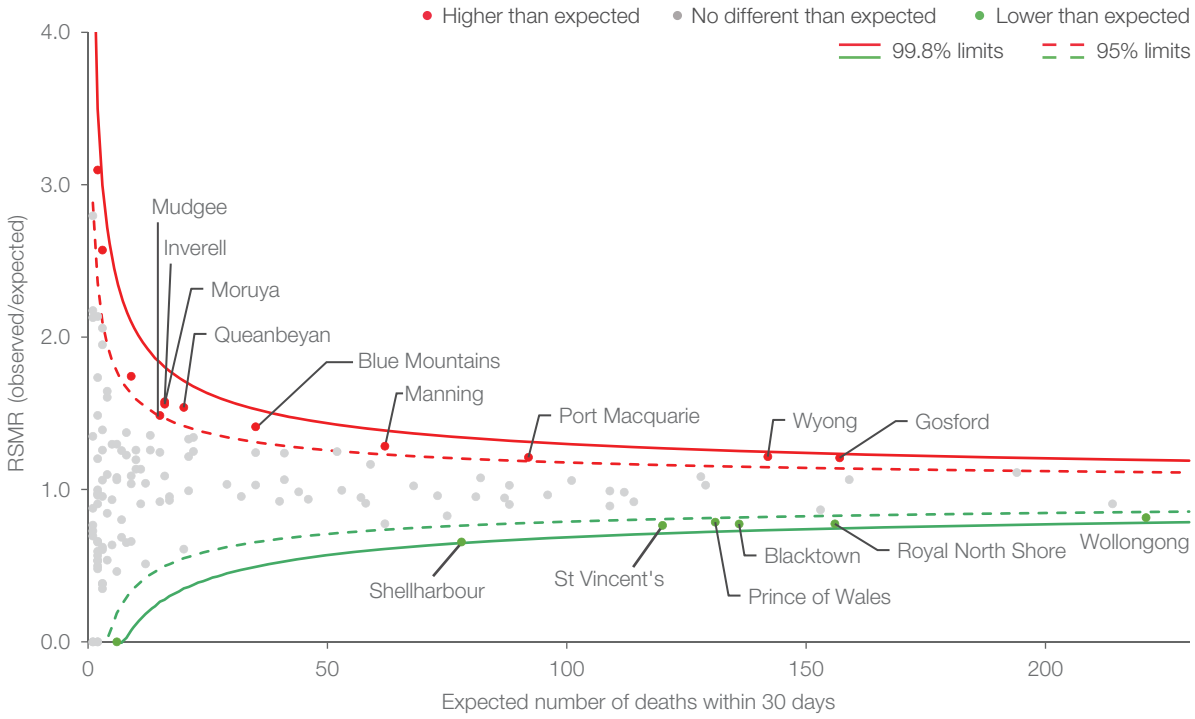


Figure 37 The effect of statistical adjustment on measures of pneumonia 30-day mortality, NSW public hospitals (peer groups A–C), July 2012–June 2015

	Unadjusted	Age- and sex-standardised	RSMR
Range of hospital results	**Unadjusted ratios** ranged from 0.30 to 1.52	**Age- and sex-standardised ratios** ranged from 0.35 to 1.62	**Risk-standardised mortality ratios** ranged from 0.46 to 1.58

Increasing account taken of patient characteristics

	Lower than expected	Higher than expected
Outlier for all models	Shellharbour	Gosford, Inverell, Manning
Outlier for age- and sex-standardised and risk-standardised	Royal North Shore	-
Outlier for unadjusted and risk-standardised	St Vincent's	Port Macquarie, Wyong
Outlier for risk-standardised only	Wollongong, Prince of Wales, Blacktown	Queanbeyan, Moruya, Blue Mountains, Mudgee

Pneumonia

Exploring patterns of 30-day mortality

From a clinical and performance perspective, knowing when death occurred (in the 30 days following hospitalisation) can highlight particular elements of care and specific care processes where there are opportunities to improve.

This information is provided in hospital cumulative mortality curves. For example, compared with the NSW cumulative mortality profile, 30-day mortality among patients hospitalised at Inverell increased more rapidly in the initial 10 days following hospitalisation, while it was much flatter among patients at Shellharbour (Figure 38).

Each hospital's cumulative mortality curve is shown in its individual profile (**bhi.nsw.gov.au**).

Across peer groups, higher and lower than expected mortality occurred in principal referral, major and district hospitals (Figure 39).

Among the six hospitals with lower than expected mortality in the July 2012 – June 2015 analysis, two (St Vincent's and Shellharbour) also had lower than expected mortality in the preceding time period. One hospital (Blacktown) had higher than expected mortality in the preceding time period. Of the nine hospitals with higher than expected mortality, three (Inverell, Manning and Wyong) also had higher than expected mortality in the preceding time period (Figure 40).

Figure 38 Cumulative mortality, by day, pneumonia, NSW and highest and lowest RSMR, July 2012 – June 2015

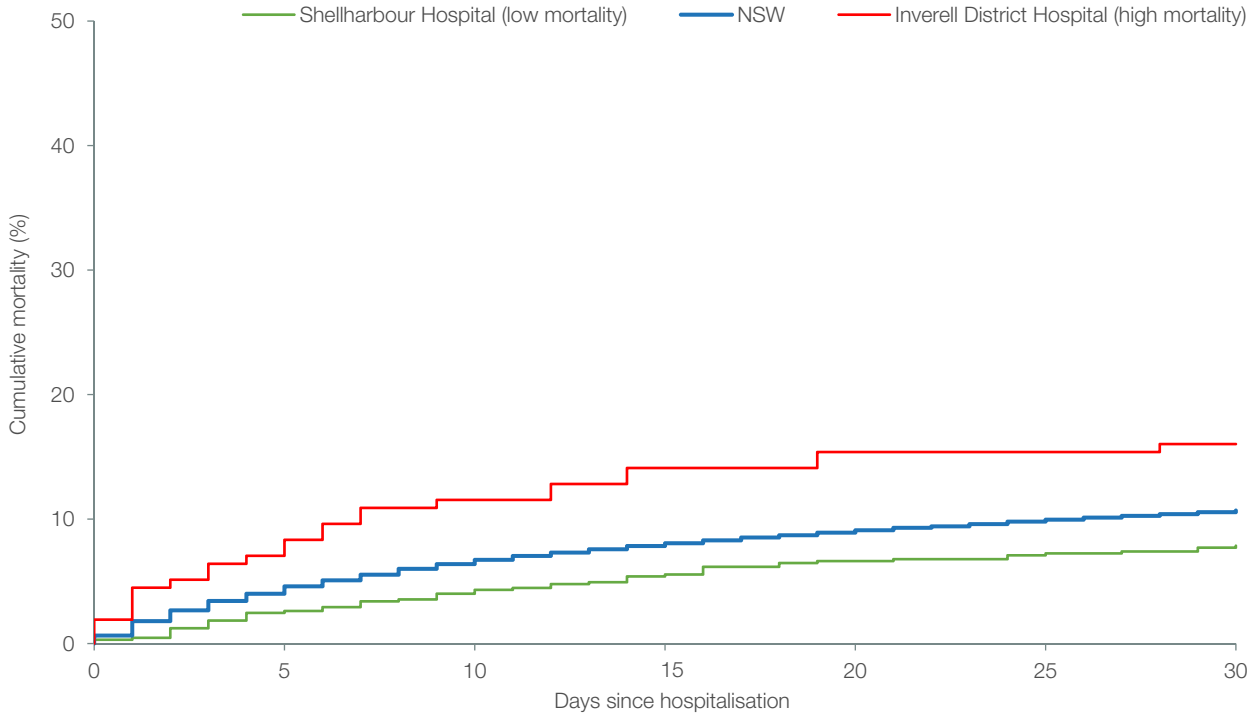


Figure 39 Pneumonia 30-day risk-standardised mortality ratio (hospitals with ≥ 50 patients), by peer group, July 2012 – June 2015

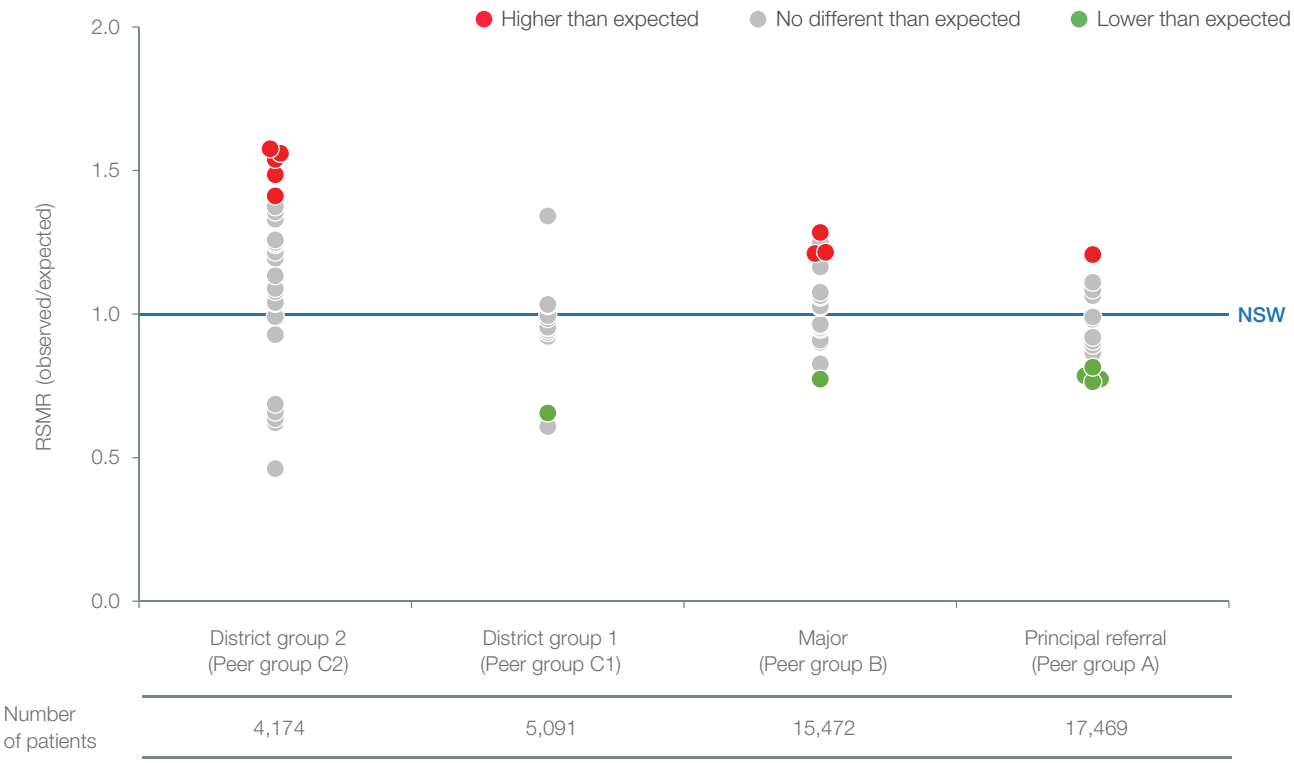
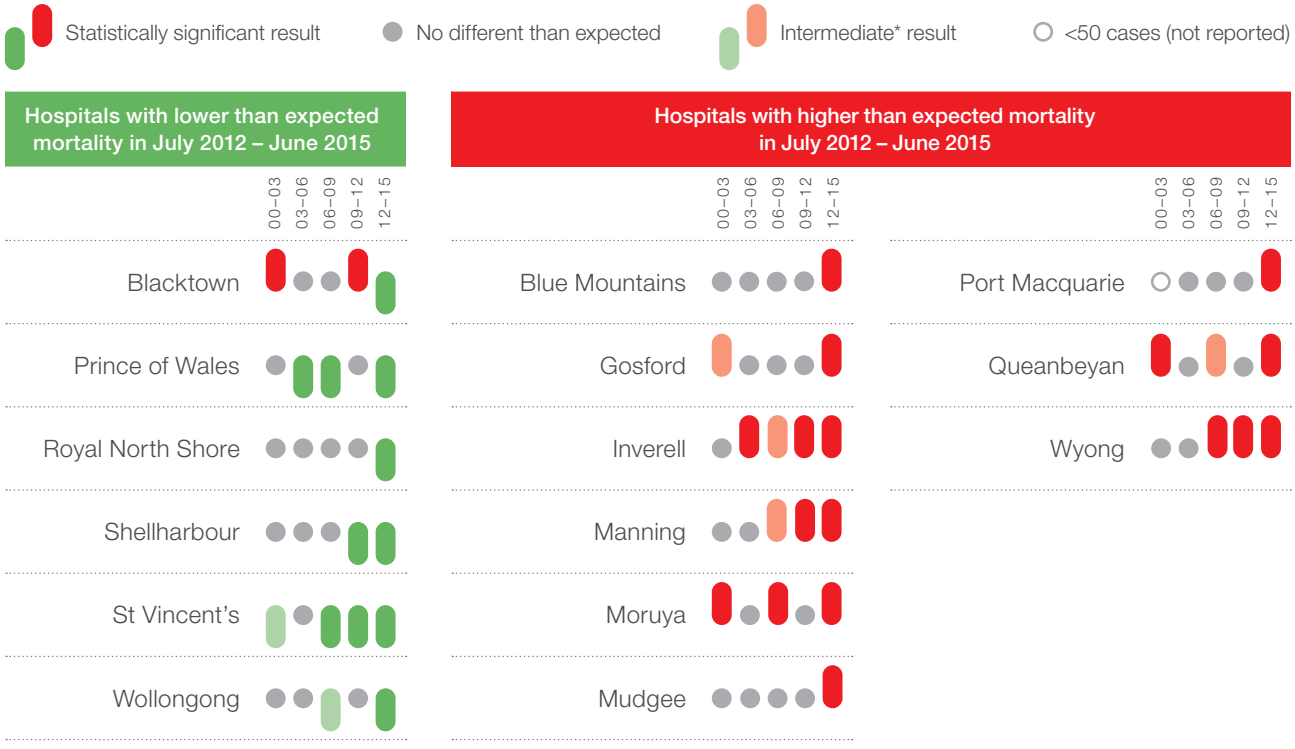


Figure 40 Pneumonia, 15-year time series results for hospitals that were outliers for the period July 2012 – June 2015



* RSMR outliers in July 2012 – June 2015 used control limits of 95% and 99.8%. Periods between July 2000 and June 2012 used control limits of 90% and 95%. Historical results that were outside the 90% control limits but did not reach significance at the 95% level are categorised as 'intermediate' results.

Chronic obstructive pulmonary disease

NSW public hospitals

Chronic obstructive pulmonary disease (COPD) is a long-term lung disease, associated with prolonged exposure to tobacco smoke. While no existing treatment can cure COPD, it can be effectively managed.

Key characteristics of people hospitalised in NSW for COPD between July 2012 and June 2015 are summarised in Figure 41.

Among hospitals that admitted at least 50 patients, unadjusted mortality rates ranged from 1.9 to 15.8 deaths per 100 patients. In order to assess hospital performance fairly, it is important to take account of case mix. Statistical techniques such as RSMRs adjust for a range of patient-level factors – including age, sex and other illnesses – in the measurement of hospital outcomes.

The COPD funnel plot shows 30-day RSMRs for each hospital. Of the 75 hospitals that admitted 50 or more COPD patients, there were two (Royal North Shore and Wollongong) with lower than expected mortality and 11 (Mudgee, Cowra, Casino, Tamworth, Port Macquarie, Belmont, Manning, Calvary Mater, The Tweed, John Hunter and Campbelltown) with higher than expected mortality (Figure 42).

The effect of statistical modelling on hospital results for COPD mortality is summarised in Figure 43. For four hospitals with higher than expected mortality (Belmont, Calvary Mater, Manning and Campbelltown), results reached statistical significance in all three models – unadjusted, age-sex standardised and the full risk-standardised model.

Figure 41 Chronic obstructive pulmonary disease 30-day mortality in NSW: Key characteristics

In the three-year period, July 2012 – June 2015:

- 30,525 patients were hospitalised with a principal diagnosis of chronic obstructive pulmonary disease (ICD-10-AM codes J20, J40-J44, J47). Of these patients, 10,312 were hospitalised for COPD two or more times. Only their last hospitalisation is considered.
- 3,160 patients died within 30 days (from any cause, in or out of hospital)
- This corresponds to an unadjusted mortality rate of 10 per 100 patients.

Among the 3,160 deaths within 30 days:

- 1,764 (56%) occurred in the initial admitting hospital
- 45 (1%) occurred in another hospital, following patient transfer
- 1,351 (43%) occurred after discharge, outside hospital
- 161 (5%) occurred on the first day of hospitalisation
- 1,489 (47%) occurred within seven days of hospitalisation.

Age, sex and comorbidity

- Patients who survived for at least 31 days following hospitalisation for COPD had an average age of 74 years (median 75); while patients who died within 30 days had an average age of 78 years (median 78)
- The average number of recorded comorbidities (with one-year lookback) was 4.3
- Similar numbers of males (15,366) and females (15,159) were hospitalised for COPD
- Among males, 11% died within 30 days, while among females, 9% died within 30 days
- After adjusting for age and comorbidity, sex was significantly associated with mortality; males had a higher risk of death.

Figure 42 Chronic obstructive pulmonary disease 30-day risk-standardised mortality ratio, NSW public hospitals, July 2012 – June 2015

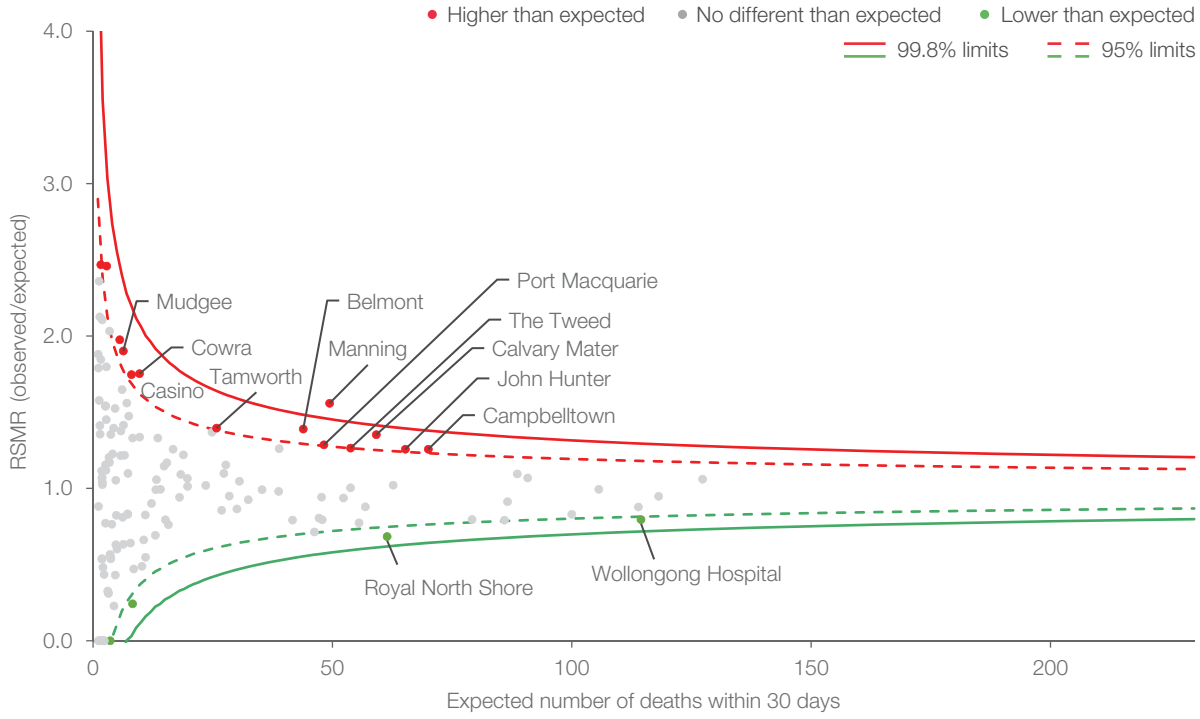


Figure 43 The effect of statistical adjustment on measures of chronic obstructive pulmonary disease 30-day mortality, NSW public hospitals (peer groups A–C), July 2012–June 2015

	Unadjusted	Age- and sex-standardised	RSMR
Range of hospital results	**Unadjusted ratios** ranged from 0.36 to 1.53	**Age- and sex-standardised ratios** ranged from 0.40 to 1.61	**Risk-standardised mortality ratios** ranged from 0.47 to 1.90

Increasing account taken of patient characteristics

	Lower than expected	Higher than expected
Outlier for all models	-	Belmont, Calvary Mater, Manning, Campbelltown
Outlier for age- and sex-standardised and risk-standardised	Royal North Shore	John Hunter
Outlier for unadjusted and risk-standardised	-	-
Outlier for risk-standardised only	Wollongong	Tamworth, Port Macquarie, Casino, The Tweed, Cowra, Mudgee

Chronic obstructive pulmonary disease

Exploring patterns of 30-day mortality

From a clinical and performance perspective, knowing when death occurred (in the 30 days following hospitalisation) can highlight particular elements of care and specific care processes where there are opportunities to improve.

This information is provided in hospital cumulative mortality curves. For example, compared with the NSW cumulative mortality profile, mortality among patients hospitalised at Mudgee was higher on the day of admission, and similar thereafter while the mortality pattern was flatter at Royal North Shore after the first week (Figure 44).

Each hospital's cumulative mortality curve is shown in its individual hospital profile (**bhi.nsw.gov.au**).

Higher than expected mortality occurred across the range of hospital peer groups. Lower than expected mortality occurred in larger principal referral hospitals only (Figure 45).

Among the two hospitals with lower than expected mortality in the July 2012 – June 2015 analysis, none had lower than expected mortality in the preceding time period. Of the 11 hospitals with higher than expected mortality, three (Cowra, Port Macquarie and Tamworth) had higher than expected mortality in the preceding time period (Figure 46).

Figure 44 Cumulative mortality, by day, chronic obstructive pulmonary disease, NSW and highest and lowest RSMR, July 2012 – June 2015

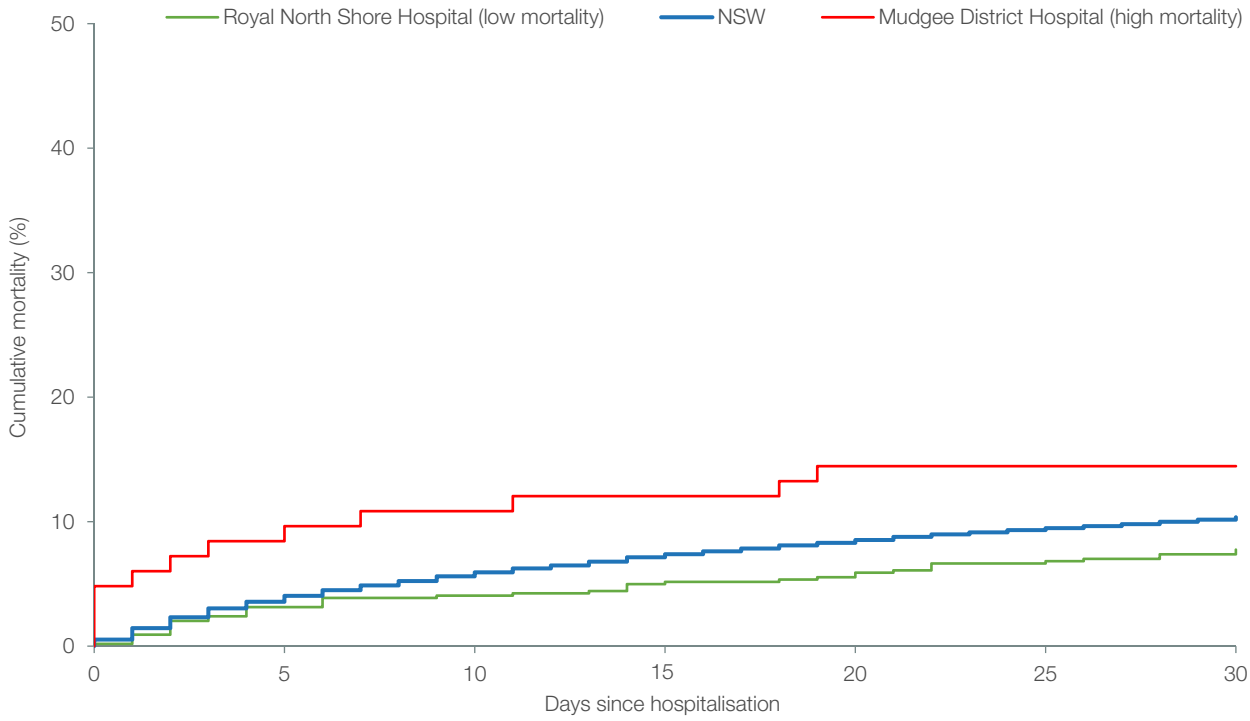


Figure 45 Chronic obstructive pulmonary disease 30-day risk-standardised mortality ratio (hospitals with ≥ 50 patients), by peer group, July 2012 – June 2015

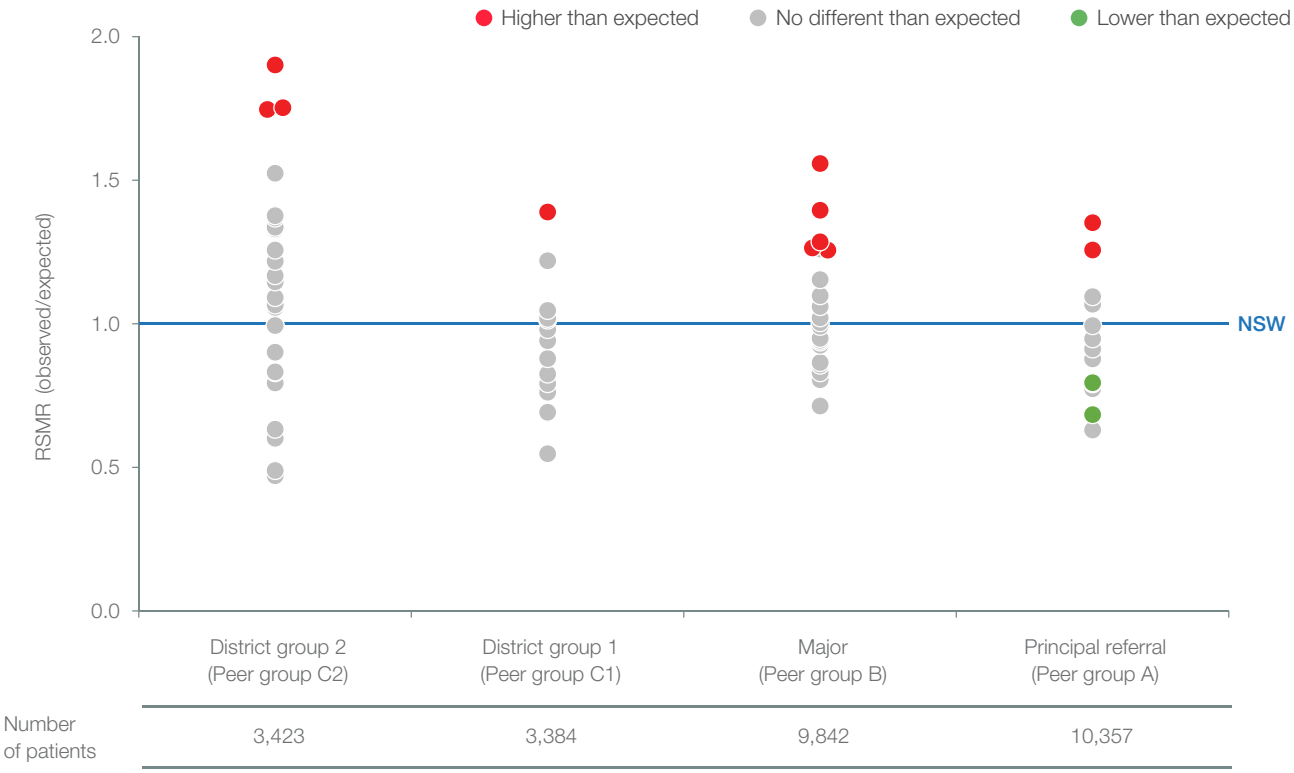
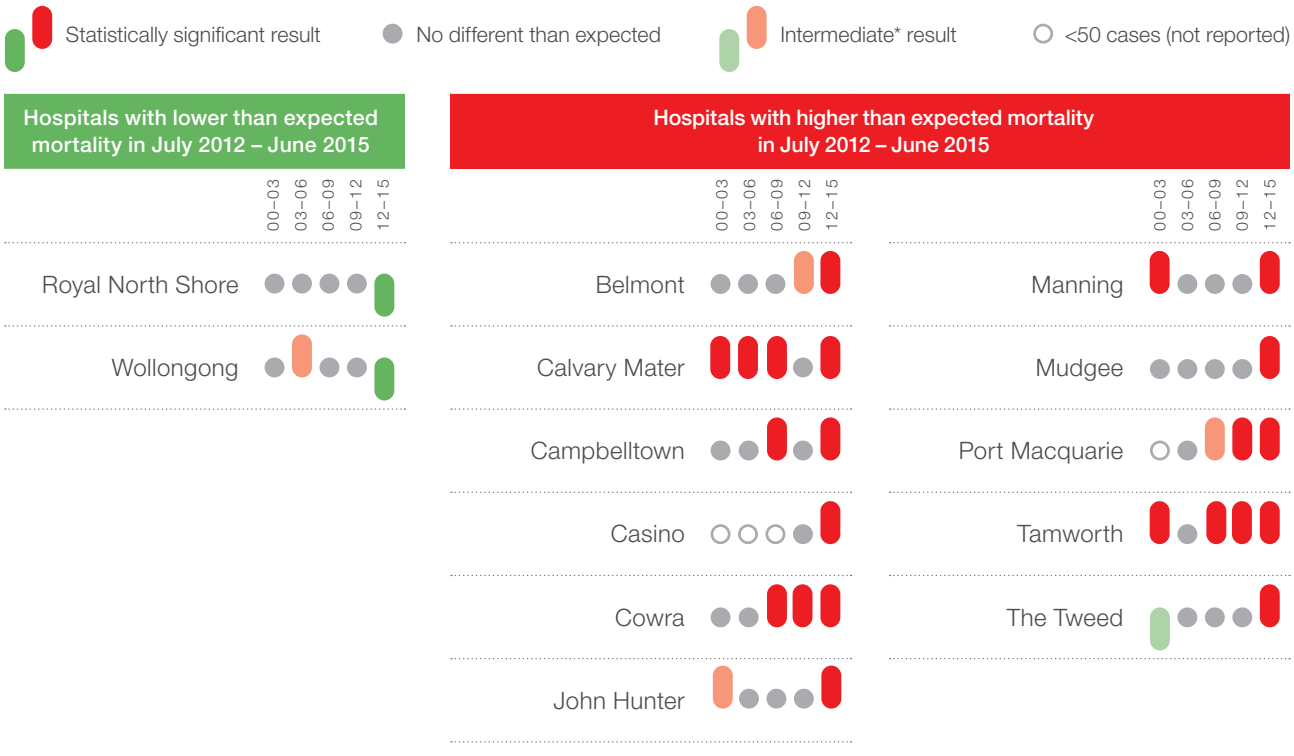


Figure 46 Chronic obstructive pulmonary disease, 15-year time series results for hospitals that were outliers for the period July 2012 – June 2015



* RSMR outliers in July 2012 – June 2015 used control limits of 95% and 99.8%. Periods between July 2000 and June 2012 used control limits of 90% and 95%. Historical results that were outside the 90% control limits but did not reach significance at the 95% level are categorised as 'intermediate' results.

Hip fracture surgery

NSW public hospitals

Hip fracture refers to fractures of the femur (thigh bone) within five centimetres of the distal (lower) part of the lesser trochanter. Hip fractures can occur at any age but are most common in elderly people. There are two main risk factors, both associated with ageing: increased risk of falling, and loss of skeletal strength from osteoporosis.

This analysis includes patients aged 50+ years and their outcomes in the 30 days following admission to the hospital that performed surgery for their hip fracture. Not all patients admitted with a hip fracture undergo surgery. During July 2012 – June 2015, of the 16,070 patients hospitalised with a hip fracture, 87% underwent surgery. This proportion ranged across hospitals from 72% in Goulburn to 95% in Dubbo (data not shown).

Key characteristics of people hospitalised in NSW for hip fracture surgery between July 2012 and June 2015 are summarised in Figure 47.

The hip fracture surgery funnel plot shows 30-day RSMRs for each hospital in NSW. Of the 37 hospitals that performed surgery on 50 or more hip fracture patients in the three year period, three (Concord, St Vincent's and Liverpool) had lower than expected mortality and five hospitals (Dubbo, Manning, Tamworth, Port Macquarie and John Hunter) had higher than expected mortality (Figure 48).

The effect of statistical modelling on hospital results is summarised in Figure 49. For four hospitals – one with lower than expected mortality (St Vincent's) and three with higher than expected mortality (John Hunter, Tamworth and Dubbo), results reached statistical significance in all three models – unadjusted, age-sex standardised and the full risk-standardised model.

Figure 47 Hip fracture surgery 30-day mortality in NSW: Key characterstics

In the three-year period, July 2012 – June 2015:

- 16,193 patients were hospitalised for hip fracture surgery (ICD-10-AM codes S72.0, S72.1, S72.2 accompanied with a fall code W00-W19 and R29.6 and treated with a surgical procedure). There were an additional 2,620 patients who were admitted with a hip fracture but did not undergo surgery.
- 1,093 patients died within 30 days (from any cause, in or out of hospital)
- This corresponds to an unadjusted mortality rate of 7 per 100 patients.

Among the 1,093 deaths within 30 days:

- 513 (47%) occurred in the initial admitting hospital
- 4 (0.4%) occurred in another hospital, following patient transfer
- 576 (53%) occurred after discharge, outside hospital
- 6 (0.5%) occurred on the first day of hospitalisation
- 310 (28%) occurred within seven days of hospitalisation.

Age, sex and comorbidity

- Patients who survived for at least 31 days following hospitalisation for hip fracture surgery had an average age of 83 years (median 84); while patients who died within 30 days had an average age of 87 years (median 89)
- The average number of recorded comorbidities (with one-year lookback) was 9.4
- Fewer males (4,514) than females (11,679) were hospitalised for hip fracture surgery
- Among males, 9% died within 30 days while among females 6% died within 30 days
- After adjusting for age and comorbidities, sex was significantly associated with mortality; males had a higher risk of death.

Figure 48 Hip fracture surgery 30-day risk-standardised mortality ratio, NSW public hospitals, July 2012 – June 2015

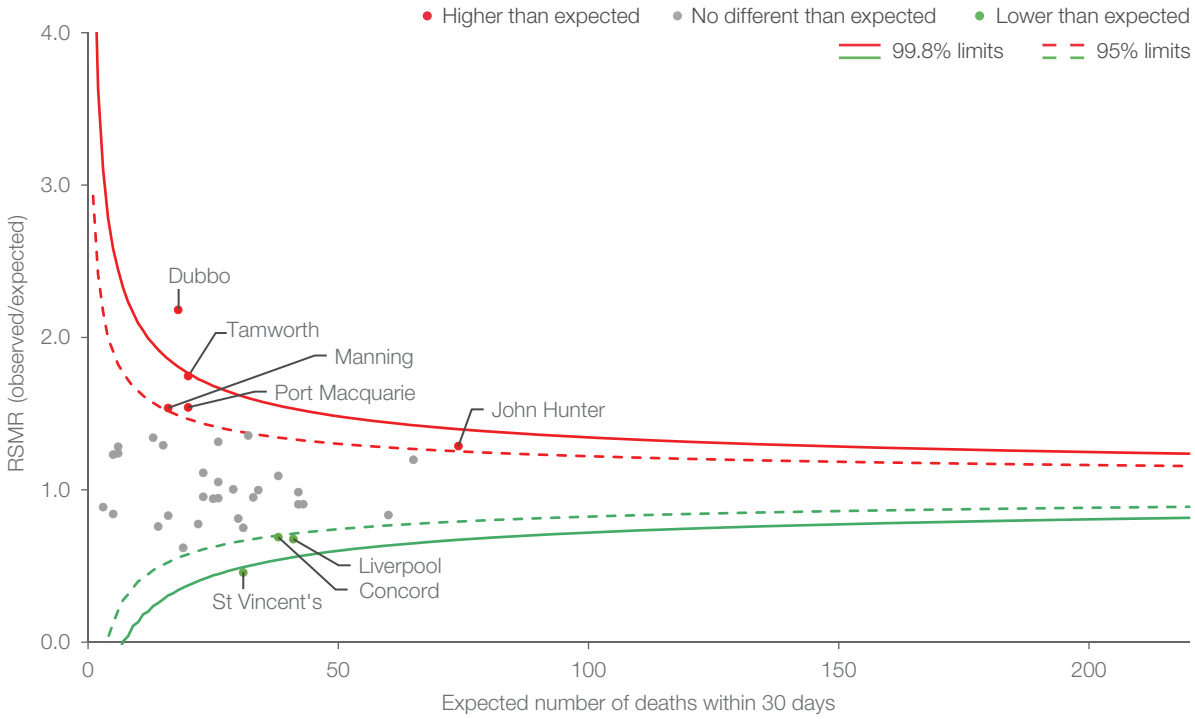


Figure 49 The effect of statistical adjustment on measures of hip fracture surgery 30-day mortality, NSW public hospitals (peer groups A–C), July 2012–June 2015

	Unadjusted	Age- and sex-standardised	RSMR
Range of hospital results	**Unadjusted ratios** ranged from 0.47 to 1.93	**Age- and sex-standardised ratios** ranged from 0.50 to 2.09	**Risk-standardised mortality ratios** ranged from 0.46 to 2.18

Increasing account taken of patient characteristics

	Lower than expected	Higher than expected
Outlier for all models	St Vincent's	John Hunter, Tamworth, Dubbo
Outlier for age- and sex-standardised and risk-standardised	-	Manning
Outlier for unadjusted and risk-standardised	Liverpool	-
Outlier for risk-standardised only	Concord	Port Macquarie

Hip fracture surgery

Exploring patterns of 30-day mortality

From a clinical and performance perspective, knowing when death occurred (in the 30 days following hospitalisation) can highlight particular elements of care and specific care processes where there are opportunities to improve.

This information is provided in hospital cumulative mortality curves. For example, compared with the NSW cumulative mortality profile, mortality among patients hospitalised at Dubbo increased more steeply in the initial 19 days and then flattened out. St Vincent's cumulative mortality curve was much flatter (Figure 50).

Each hospital's cumulative mortality curve is shown in its individual hospital profile (**bhi.nsw.gov.au**).

Across peer groups, higher and lower than expected mortality occurred in principal referral hospitals, and higher than expected mortality in major hospitals (Figure 51).

Among the three hospitals with lower than expected mortality in the July 2012 – June 2015 analysis, one (St Vincent's) had lower than expected mortality in the four preceding time periods. Of the five hospitals with higher than expected mortality, one (Tamworth) had higher than expected mortality in the preceding two time periods (Figure 52).

Figure 50 Cumulative mortality, by day, hip fracture surgery, NSW and highest and lowest RSMR, July 2012 – June 2015

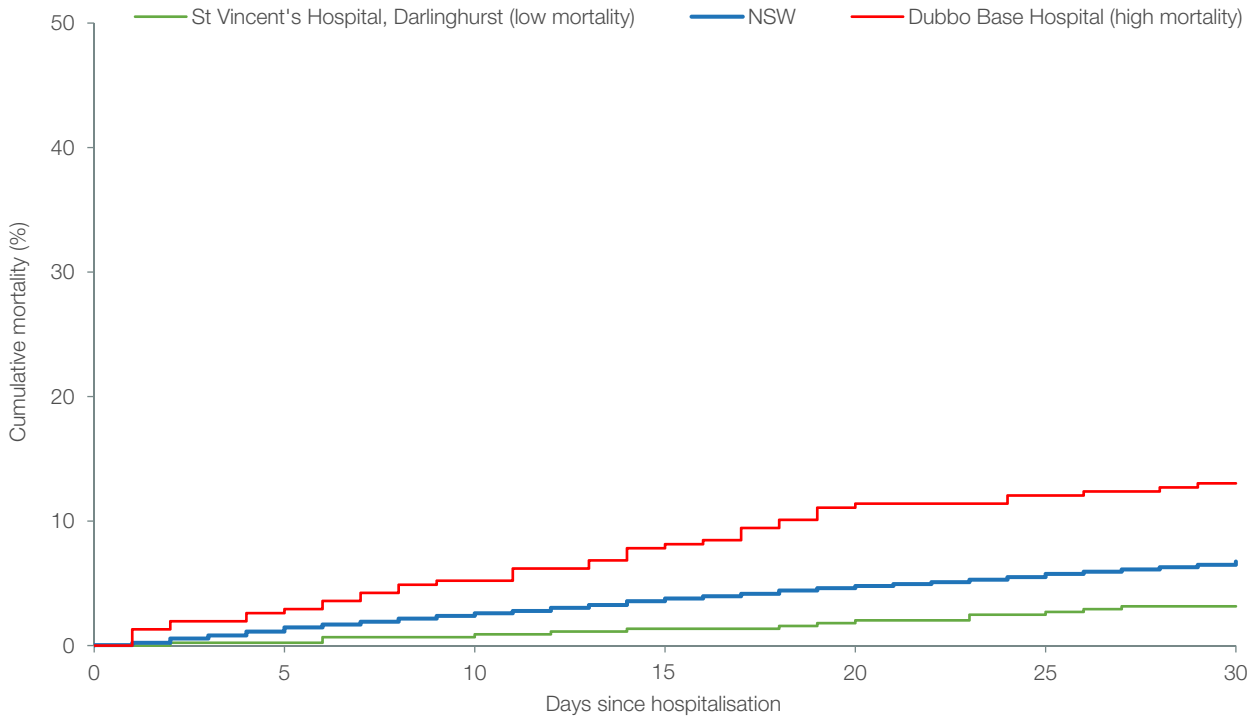


Figure 51 Hip fracture surgery 30-day risk-standardised mortality ratio (hospitals with >50 patients), by peer group, July 2012 – June 2015

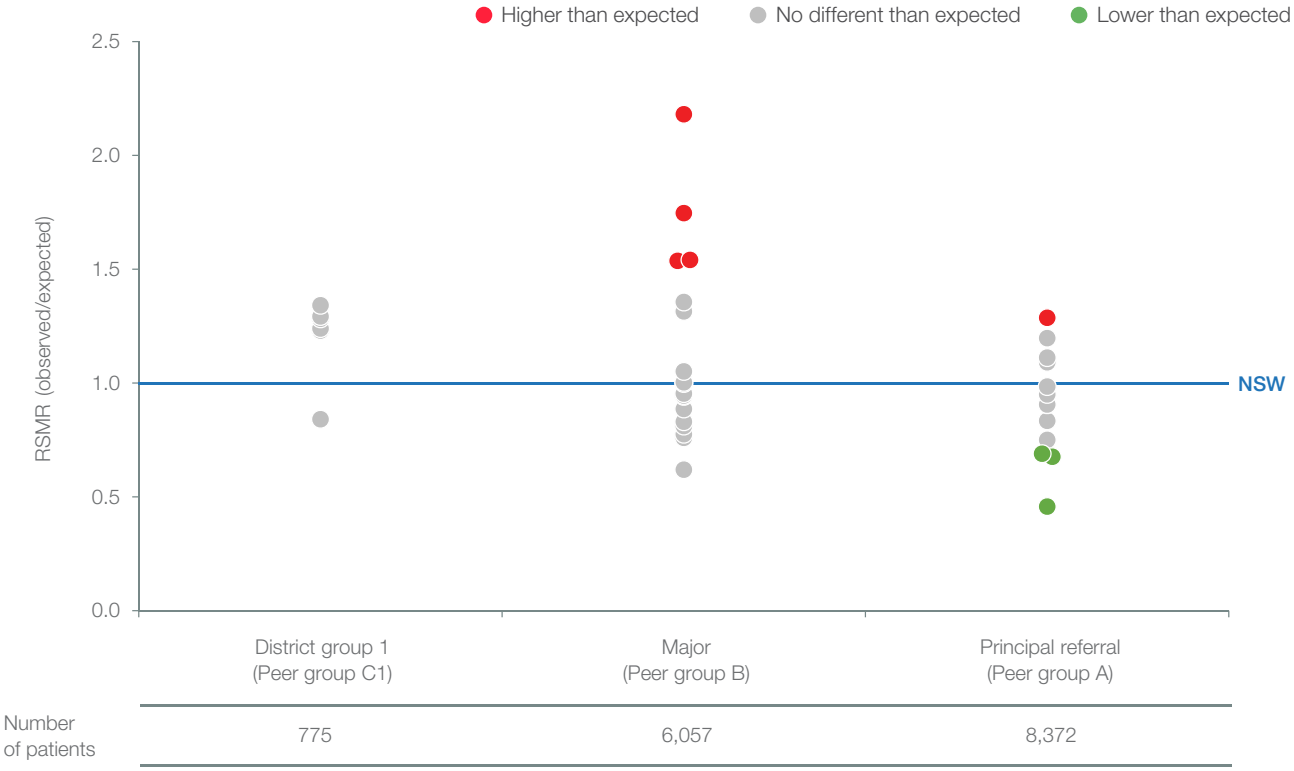
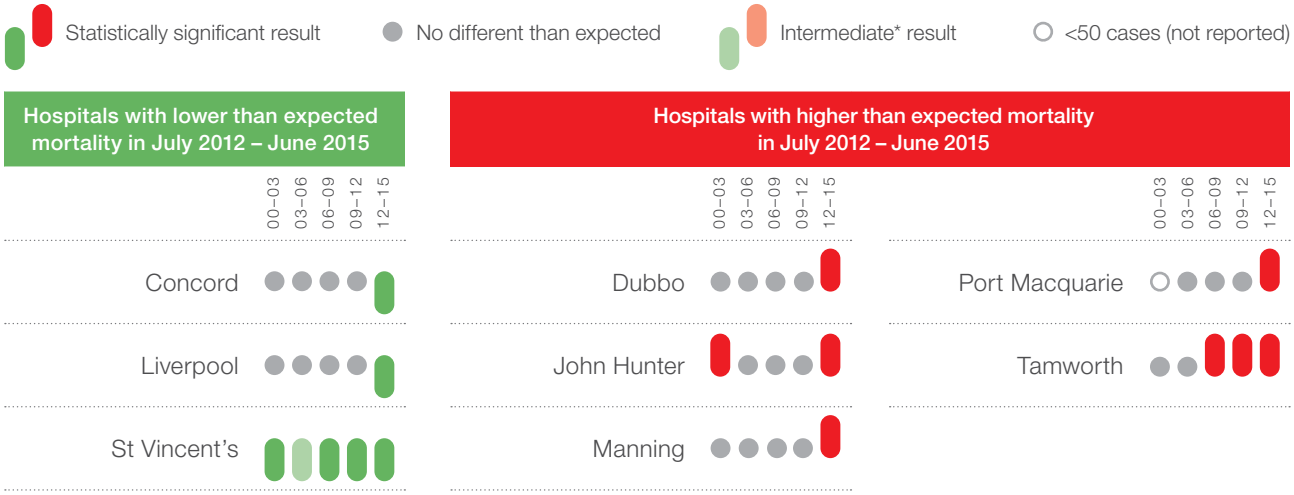


Figure 52 Hip fracture surgery, 15-year time series results for hospitals that were outliers for the period July 2012 – June 2015



* RSMR outliers in July 2012 – June 2015 used control limits of 95% and 99.8%. Periods between July 2000 and June 2012 used control limits of 90% and 95%. Historical results that were outside the 90% control limits but did not reach significance at the 95% level are categorised as 'intermediate' results.

Appendices

Appendix 1

Prediction models

For each condition included in the report, NSW-level prediction models were developed using index admissions between 1 July 2009 and 30 June 2012. Random intercept logistic regression models were built taking into account patient-level risk factors (age, sex and comorbidities) and clustering within hospitals.

The variables that were found to be significantly associated with mortality were retained in the final models and are listed in Figure 53.

C-statistics, that describe the prediction ability of the models, are also shown.

Figure 53 Final prediction models, patient factors and comorbidities and and c-statistics

Condition	Patient factors and comorbidities	C-statistic
Acute myocardial infarction*	Age, dementia, Alzheimer's disease, hypotension, shock, renal failure, heart failure, dysrhythmia, malignancy, hypertension, cerebrovascular disease	0.85
Ischaemic stroke*	Age, sex, renal failure, heart failure, malignancy	0.75
Haemorrhagic stroke*	Age, sex, heart failure, malignancy, history of previous haemorrhagic stroke	0.66
Congestive heart failure	Age, sex, valvular disease, pulmonary circulation disorders, peripheral vascular disorder, hypertension, paralysis, other neurological disorders, chronic pulmonary disease, diabetes - complicated, renal failure, liver disease, lymphoma, metastatic cancer, coagulopathy, weight loss, fluid and electrolyte disorders, deficiency anaemia, number of previous acute admissions	0.71
Pneumonia*	Age, dementia, hypotension, shock, renal failure, other chronic obstructive pulmonary disease, heart failure, dysrhythmia, malignancy, liver disease, cerebrovascular disease, Parkinson's disease	0.80
Chronic obstructive pulmonary disease	Age, sex, congestive heart failure, cardiac arrhythmia, pulmonary circulation disorders, other neurological disorders, diabetes – complicated, liver disease, lymphoma, metastatic cancer, solid tumour without metastasis, weight loss, fluid and electrolyte disorders, psychoses, number of previous acute admissions	0.74
Hip fracture surgery*	Age, sex, ischaemic heart disease, dysrhythmia, respiratory infection, renal failure, heart failure, malignancy, dementia	0.77

* Comorbidity based on Australian commission ICD codes and definitions used, dementia was added for hip fracture surgery. The ICD-10-AM code for renal failure was used.

Appendix 2

How to interpret a funnel plot

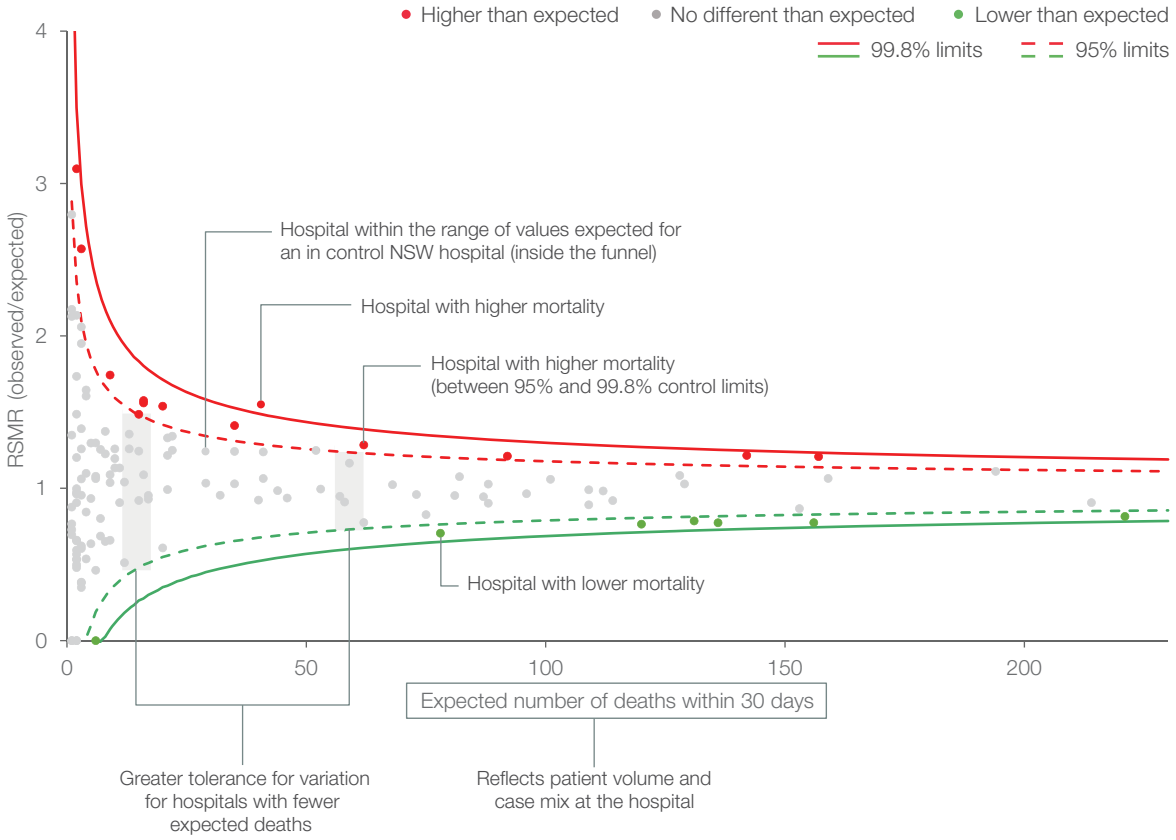
Mortality is influenced by a wide range of factors that interact in complex ways, meaning there will always be some level of variation in patient outcomes. The 'funnel' shape that gives the funnel plot its name indicates the tolerance around this variability (Figure 54).

Hospitals with fewer hospitalisations (those with a relatively low number of expected deaths, and appearing towards the left hand side of the plot) will display greater variability and may have a high or low ratio by chance. Fair assessment about performance should take this into account.

Hospitals above the upper 95% control limit of the funnel are considered to have higher than expected mortality; those below the lower 95% limit are considered to have lower than expected mortality. For hospitals outside 99.8% limits, there is greater confidence about their outlier status.

The limits quantify the level of confidence in interpreting the results. The probability that an 'in-control' hospital would fall outside the upper 95% control limit by chance alone is, at most, one in 40.

Figure 54 Annotated funnel plot



Appendix 3

The depth of comorbidity and secondary diagnoses coding

Indicators of mortality depend, to a certain extent, on hospital coding practices. An assessment of depth of coding was conducted, comparing hospitals and changes over time (Figure 55).

Depth of coding is defined as the average number of secondary diagnoses coded for index cases.

Figure 55 Average number of secondary diagnoses, seven conditions, NSW and hospital range, 2009–12 and 2012–15

Condition	Average number of secondary diagnoses (range across hospital peer groups A–C)	
	July 2009 – June 2012	July 2012 – June 2015
Acute myocardial infarction	4.3 (1.2–6.7)	4.8 (1.3–7.4)
Ischaemic stroke	6.3 (3.3–9.2)	7.0 (3.5–9.4)
Haemorrhagic stroke	5.1 (3.4–8.7)	5.8 (4.0–10.0)
Congestive heart failure	5.1 (1.6–8.2)	6.0 (1.7–9.3)
Pneumonia	3.8 (1.0–7.0)	4.8 (1.0–8.8)
Chronic obstructive pulmonary disease	3.6 (1.0–7.0)	4.3 (1.4–9.1)
Hip fracture surgery	8.5 (5.7–11.6)	9.4 (6.4–12.7)

Flag red on full adjustment model only

There were 16 hospitals with higher than expected mortality only with the full adjustment model (four in peer group B, three in peer group C1 and nine in peer group C2). Of these, five hospitals had higher than expected mortality for two conditions (Mudgee, Moruya, Parkes, Port Macquarie and Tamworth).

Of the 21 hospital results with higher than expected mortality only in the risk-adjustment model, eight were for CHF; six for COPD; four for pneumonia; two for AMI; and one for hip fracture surgery.

Flag green on full adjustment model only

There were five hospitals with lower than expected mortality only on the full adjustment model (four in peer group A and one in peer group B). Of these, one had lower than expected mortality for three conditions (Prince of Wales) and one did so for two conditions (Wollongong).

Of the eight hospital results with lower than expected mortality, three were for pneumonia; two for CHF; one for COPD; one for AMI; and one for hip fracture surgery.

References

1. Bureau of Health Information. The Insights Series: 30-day mortality following hospitalisation, five clinical conditions, NSW, July 2009 – June 2012. Sydney 2013.

2. Bureau of Health Information. The Insights Series: Return to acute care following hospitalisation, Insights into readmissions, NSW public hospitals, July 2009 – June 2012 Sydney 2015.

3. Bureau of Health Information. Healthcare in Focus 2015 – How does NSW compare? Sydney 2016.

4. Bureau of Health Information. Spotlight on Measurement: Measuring 30-day mortality following hospitalisation, NSW, July 2012 – June 2015, 2nd edition. Sydney 2017.

5. Bureau of Health Information. Spotlight on Measurement: Measuring return to acute care following discharge from hospital, NSW, July 2012 – June 2015, 2nd edition. Sydney 2017.

6. SAS Institute. The SAS System for Windows, version 12, Cary (NC). SAS Institute 2012.

7. StataCorp. 2012. Stata Statistical Software: Release 12. College Station, TX: StataCorp LP.

8. Spiegelhalter D.J. Funnel plots for comparing institutional performance. Statist. Med. 2005; 24:1185–1202

9. Bottle A., Jarman B., Aylin P. Hospital standardised mortality ratios: sensitivity analyses on the impact of coding. Health Serv Res, 2011 46(6), 1741-61.

10. OECD 2015, Health at a Glance 2015: OECD Indicators. OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/health_glance-2015-en

11. Teng T.K., Katzenellenbogen J.M., Hung J., et al. Rural–urban differentials in 30-day and 1-year mortality following first-ever heart failure hospitalisation in Western Australia: a population-based study using data linkage. BMJ Open 2014;4:e004724.

12. Suter L.G., Li S.X., Grady J.N., et al. National Patterns of Risk-Standardized Mortality and Readmission After Hospitalization for Acute Myocardial Infarction, Heart Failure, and Pneumonia: Update on Publicly Reported Outcomes Measures Based on the 2013 Release. Journal of General Internal Medicine. 2014; 29: 1333.

13. Mortensen E.M., Restrepo M.I., Anzueto A., et al. The effect of prior statin use on 30-day mortality for patients hospitalized with community-acquired pneumonia. Respiratory Research. 2005;6:82

14. Mortensen E.M., Copeland L.A., Pugh M.V., et al. Impact of statins and ACE inhibitors on mortality after COPD exacerbations. Respiratory Research. 2009; 10:45

15. Søgaard M., Madsen M., Løkke A., et al. Incidence and outcomes of patients hospitalized with COPD exacerbation with and without pneumonia. International Journal of Chronic Obstructive Pulmonary Disease. 2016;11: 455-465.

16. Nikkel L.E., Kates S.L., Schreck M., et al. Length of hospital stay after hip fracture and risk of early mortality after discharge in New York State: retrospective cohort study BMJ. 2015; 351:6246

17. Nordström P., Gustafson Y., Michaëlsson K., et al. Length of hospital stay after hip fracture and short term risk of death after discharge: a total cohort study in Sweden BMJ. 2015; 350:696

18. The National Hip Fracture Database. National Report 2014. London: Royal College of Physicians.

Acknowledgements

The Bureau of Health Information (BHI) is the main source of information for the people of NSW about the performance of their public healthcare system. A NSW board-governed organisation, BHI is led by Chairperson Professor Carol Pollock and Chief Executive Jean-Frédéric Lévesque MD, PhD.

We would like to thank our expert advisors, colleagues at the Ministry of Health, reviewers and staff who contributed to the report.

External Advisors and Reviewers

Ian Brownwood, OECD

Jacqui Close, Neuroscience Australia

Yana Gurevich, Kira Leeb, Kathleen Morris, Canadian Institute of Health Information

Isuru Ranasinghe, University of Adelaide

Professor David Spiegelhalter, University of Cambridge

Bureau of Health Information Project Team

Analytics

Huei-Yang (Tom) Chen

Julia Chessman

Bradley Drayton

Sadaf Marashi-Pour (Lead)

Research

Diana Arachi

Ariana Dobrovic

Kim Sutherland

Design

Ed Bury

Adam Myatt

Efren Sampaga

Mark Williams

Communications and Stakeholder Engagement

Rohan Lindeman

Karen Perini

Stephanie Watson

bureau of health information

About the Bureau of Health Information

The Bureau of Health Information (BHI) is a board-governed organisation that provides independent information about the performance of the NSW public healthcare system.

BHI was established in 2009 to provide system-wide support through transparent reporting.

BHI supports the accountability of the healthcare system by providing regular and detailed information to the community, government and healthcare professionals. This in turn supports quality improvement by highlighting how well the healthcare system is functioning and where there are opportunities to improve.

BHI also manages the NSW Patient Survey Program, gathering information from patients about their experiences in public hospitals and other healthcare facilities.

BHI publishes a range of reports and tools that provide relevant, accurate and impartial information about how the health system is measuring up in terms of:

- Accessibility – healthcare when and where needed
- Appropriateness – the right healthcare, the right way
- Effectiveness – making a difference for patients
- Efficiency – value for money
- Equity – health for all, healthcare that's fair
- Sustainability – caring for the future

BHI's work relies on the efforts of a wide range of healthcare, data and policy experts. All of our assessment efforts leverage the work of hospital coders, analysts, technicians and healthcare providers who gather, codify and report data. Our public reporting of performance information is enabled and enhanced by the infrastructure, expertise and stewardship provided by colleagues from NSW Health and its pillar organisations.

bhi.nsw.gov.au

0145_IS_UCV_MORTALITY