

Technical Supplement

Mortality following hospitalisation for
seven clinical conditions

July 2015 – June 2018

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The conclusions in this report are those of BHI and no official endorsement by the NSW Minister for Health, the NSW Ministry of Health or any other NSW public health organisation is intended or should be inferred.

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Introduction

This Technical Supplement builds on *Spotlight on Measurement: Measuring 30-day mortality following hospitalisation, NSW, July 2012 – June 2015, 2nd edition*¹. *Spotlight on Measurement* is methods-based, and describes the development and validation processes that underpin the risk-standardised mortality ratio (RSMR). It features extensive sensitivity analyses including:

- coding of transfers between hospitals
- palliative care admissions
- the effect of different measurement periods
- varying funnel plot control limits
- assessing mortality in small hospitals
- adjusting for socioeconomic status
- exploring partner hospital performance.

This Technical Supplement presents additional sensitivity analyses undertaken in support of the release of new mortality results for the period July 2015 – June 2018. It also includes:

- cohort and outcome definitions
- inclusions and exclusions
- risk adjustment models
- attribution protocols.

This supplement is technical in nature and intended for audiences interested in the creation and analysis of health system performance information.

Excluding emergency department-only patients

In June 2017, NSW Health released a new patient admission policy stating that a patient treated in, and discharged from, an emergency department (ED) only, should not be recorded as an admitted patient.² This is to ensure compliance with national regulatory requirements.

Prior to June 2017, a small number of patients that were treated only within an ED were included in the NSW Admitted Patient Data Collection (APDC) and, therefore, in previous BHI mortality analyses.

Excluding ED-only patients may change the observed deaths of a hospital in a number of ways. The most common are via the exclusion of deaths that occur following ED-only episodes (this will result in fewer observed deaths) and the re-allocation of deaths between hospitals following transfer from an ED-only episode to an admission at another hospital (this will result in fewer observed deaths at the first hospital and more observed deaths at the second hospital).

Thus, the impact that excluding ED-only patients may have on a hospital's RSMR depends on how many ED-only patients it has and how many patients the hospital is re-allocated from ED-only episodes at another hospital. Moreover, if a hospital is large, the re-allocation of a large number of deaths (either to or from) may have little impact on their RSMR, but if a hospital is small, the re-allocation of a single death may have a substantial impact.

Sensitivity analyses were conducted to investigate the impact of excluding this small number of patients (i.e. ED-only patients) and the impact of excluding them from previous analyses (e.g. 2012–2015 cohorts) since it is not possible to include these patients in the current report (i.e. 2015–2018 cohorts).

ED-only patients represented a small proportion of total admitted patients in 2012–2015 for all clinical conditions (Table 1), but had higher unadjusted mortality rates than other patients.

Excluding ED-only patients from the cohorts was not expected to change the RSMRs substantially as they comprised only a small proportion of the cohort for each condition. However, even a small change in RSMRs could alter the status of hospitals close to the control limits.

Accordingly, RSMRs were reproduced and outliers were identified for each condition based on the new RSMRs. There was a small change in the number of outliers for all conditions across 73 hospitals (Table 2). The funnel plots are shown for chronic obstructive pulmonary disease (COPD), which had the highest percentage of hospitals change outlier status (Figures 1 and 2).

As a result, ED-only patients are not included in BHI mortality analyses from July 2015 onwards and comparison of results before and after this time should be made with caution. To support this shift in cohort definition, hospital-level profiles have a break in time series, and state-level time series graphs in the main report have been recalculated across time to exclude ED-only patients, to support the validity of comparisons over time.

Table 1

Distribution of ED-only* and other patients, NSW hospitals, July 2012 – June 2015

Condition	ED-only patients	All other patients
Acute myocardial infarction	2,248 (7%)	28,247 (93%)
Ischaemic stroke	276 (2%)	15,211 (98%)
Haemorrhagic stroke	671 (12%)	4,990 (88%)
Congestive heart failure	1,002 (4%)	26,485 (96%)
Pneumonia	2,130 (5%)	45,016 (95%)
Chronic obstructive pulmonary disease	1,061 (3%)	29,470 (97%)
Hip fracture surgery	0 (0%)	16,199 (100%)

Table 2

Effect on outliers when ED-only* patients are excluded from the cohorts, NSW public hospitals, July 2012 – June 2015 (among 73 hospitals)

Condition	Change in hospital outliers after excluding ED-only episodes
Acute myocardial infarction	One hospital was no longer higher than expected and one hospital became higher than expected. Two hospitals were no longer lower than expected and two hospitals became lower than expected
Ischaemic stroke	One hospital was no longer higher than expected and one hospital became higher than expected. Two hospitals became lower than expected
Haemorrhagic stroke	One hospital became higher than expected and one hospital became lower than expected
Congestive heart failure	Three hospitals were no longer higher than expected and one hospital became higher than expected
Pneumonia	Two hospitals were no longer higher than expected and one hospital became higher than expected
Chronic obstructive pulmonary disease	Five hospitals were no longer higher than expected. One hospital was no longer lower than expected and two hospitals became lower than expected
Hip fracture surgery	No change in hospital outliers

Note: Not all hospitals have results for all seven conditions.

* ED-only refers to ED-only patients who were seen in hospital and discharged longer or higher than expected.

Figure 1 Chronic obstructive pulmonary disease 30-day risk-standardised mortality ratio, NSW public hospitals, July 2012 – June 2015. Including ED-only* patients

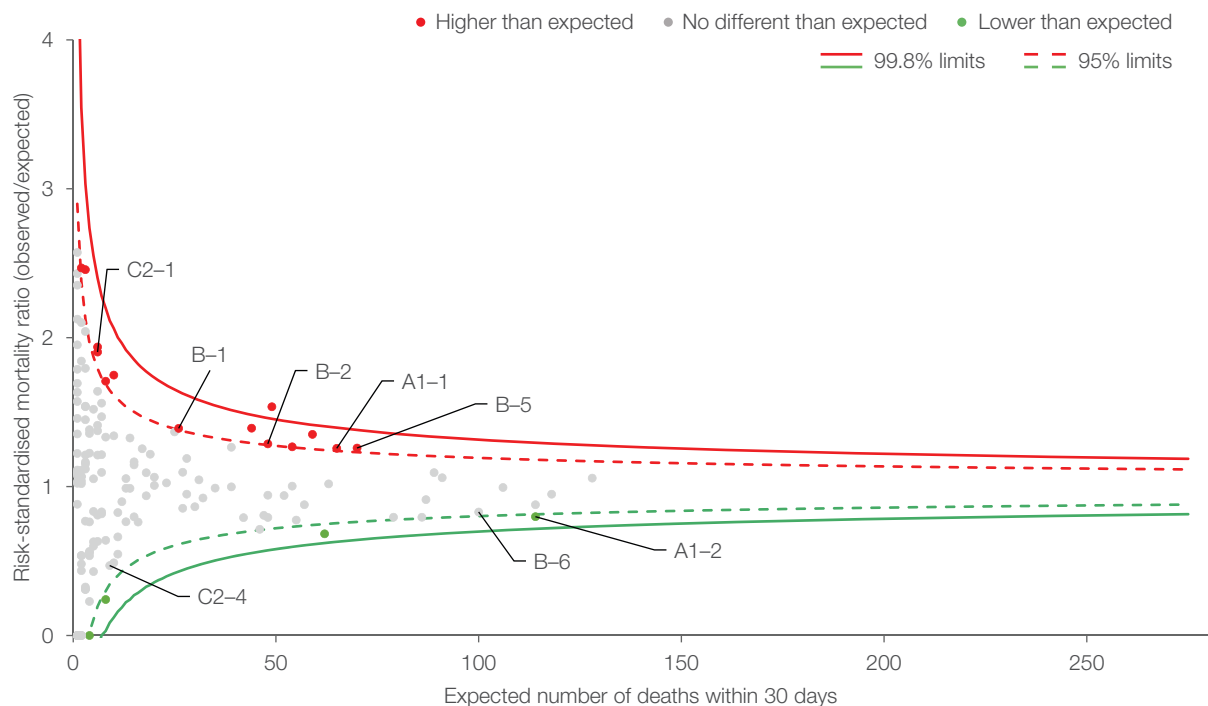
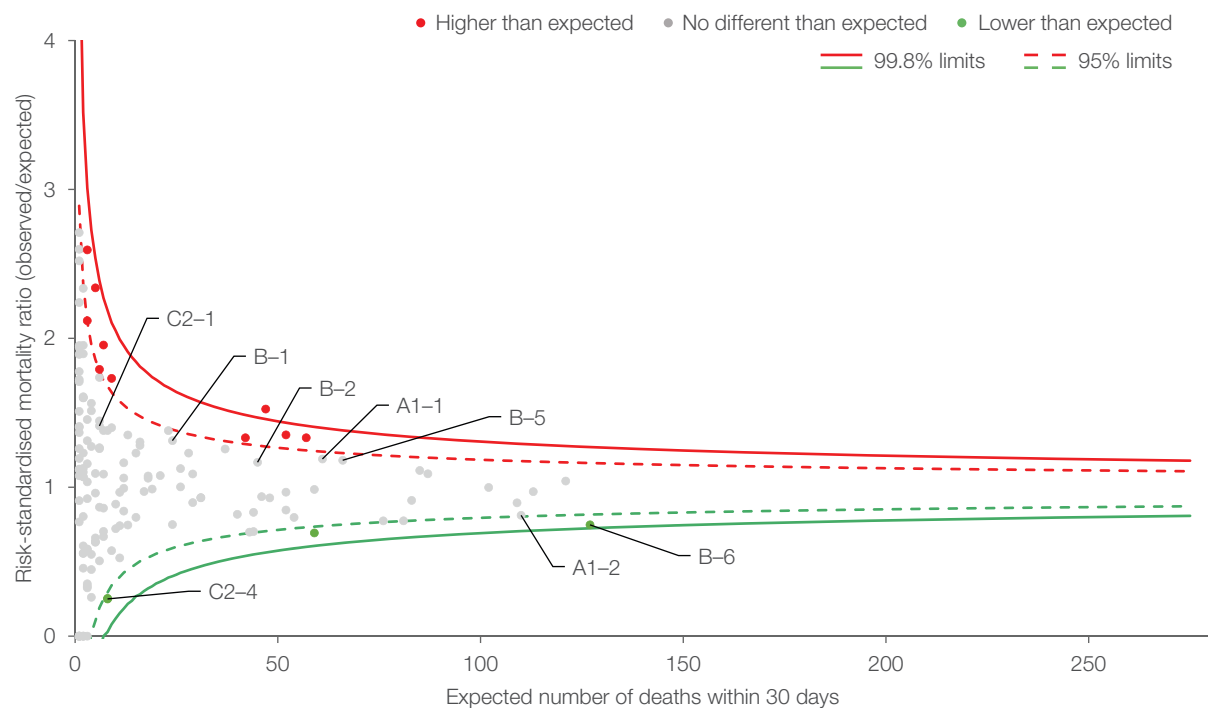


Figure 2 Chronic obstructive pulmonary disease 30-day risk-standardised mortality ratio, NSW public hospitals, July 2012 – June 2015. Excluding ED-only* patients



* ED-only refers to patients with an admitted patient record who were treated in, and discharged from, an emergency department only.

Adjusting for residence in an aged care facility

Frail patients have been shown to have an increased risk of 30-day mortality.³

However, as *frailty* is not an indexed or tabular term listed in the ICD-10-AM classification, it is difficult to accurately identify these patients using the NSW Admitted Patient Data Collection.

As a starting point, the classification 'patients that were referred from a residential aged care facility or transferred to a nursing home' was used to identify frail patients. A one-year lookback checked whether 'residence in an aged care facility' was noted in the patient's index admission and in any other admissions in that period.

A sensitivity analysis was conducted on the inclusion of 'residence in an aged care facility' in the risk adjustment models for the 2015–2018 cohorts. 'Residence in an aged care facility' was significantly associated with 30-day mortality for all seven clinical conditions ($p < 0.05$). However, there were no significant changes in the model C-statistics for any condition (Table 3). Accordingly, the predictive validity of the prediction model did not improve when 'residence in an aged care facility' was included.

RSMRs were reproduced and outliers were identified for each condition based on the new RSMRs. There was a change in outlier status for pneumonia but not for the other six conditions. The funnel plots are shown for pneumonia which, after adjusting for 'residence in an aged care facility', had one hospital that was no longer lower than expected and one hospital that became lower than expected (Figures 3 and 4). The RSMRs for these hospitals did not change substantially – they were close to the control limits and a small change was sufficient to change their status.

Given these results and the difficulty in accurately identifying frail patients in the APDC, the 2015–2018 analyses retained the standardisation approach used for 2012–2015 (i.e. 'residence in an aged care facility' not included in the risk-adjustment model).

Table 3 Odds ratios and C-statistics for residence in an aged care facility in risk adjustment models, July 2015 – June 2018

Condition	Odds ratio	C-statistic with adjustment	C-statistic without adjustment
Acute myocardial infarction	1.53	0.86	0.86
Ischaemic stroke	1.79	0.75	0.75
Haemorrhagic stroke	1.41	0.67	0.67
Congestive heart failure	1.49	0.73	0.73
Pneumonia	1.57	0.81	0.81
Chronic obstructive pulmonary disease	1.56	0.75	0.75
Hip fracture surgery	2.73	0.79	0.76

Figure 3 Pneumonia 30-day risk-standardised mortality ratio, NSW public hospitals, July 2015 – June 2018. **Without adjustment for residence in an aged care facility**

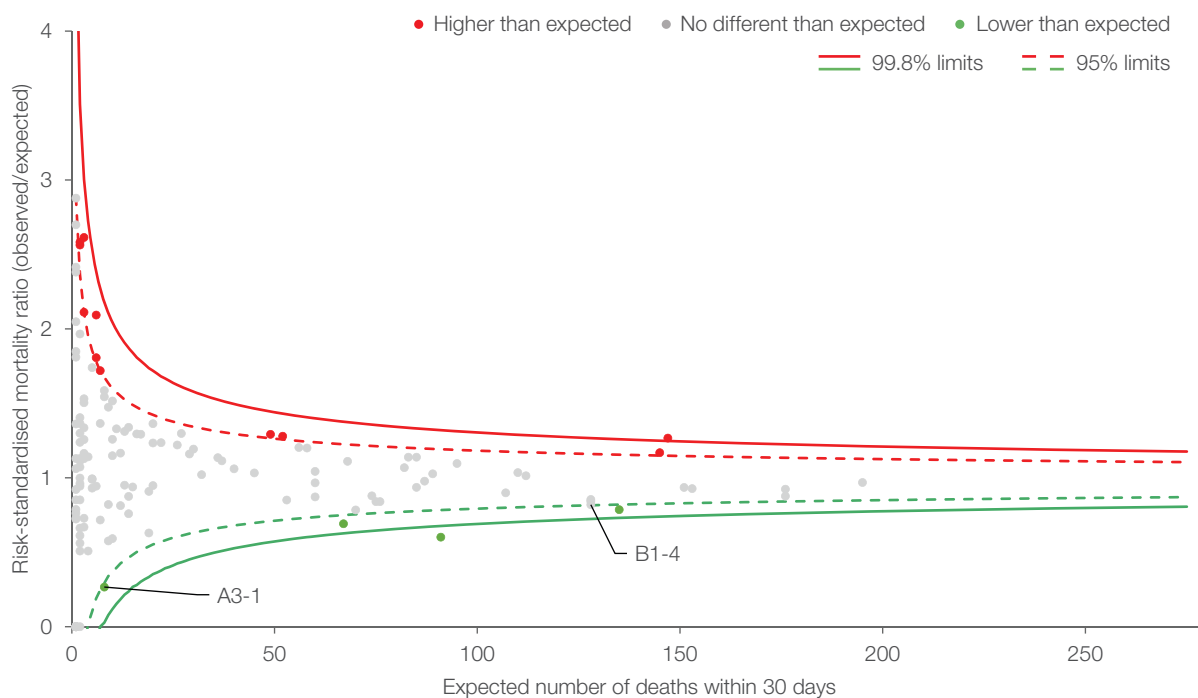
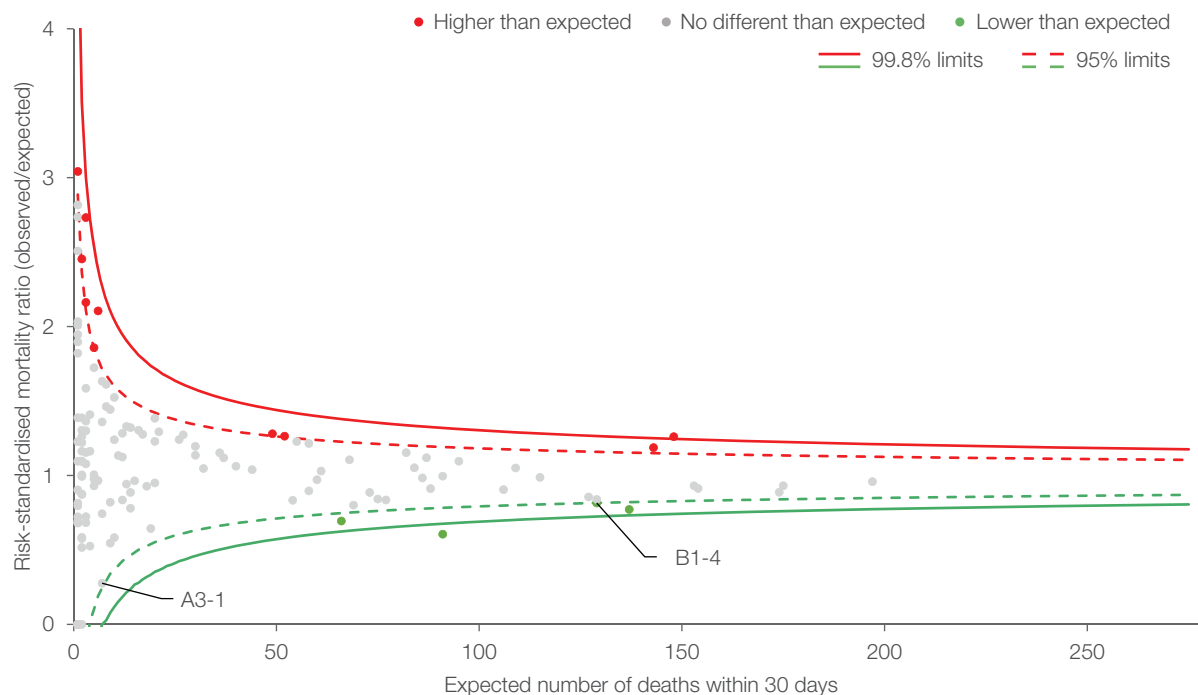


Figure 4 Pneumonia 30-day risk-standardised mortality ratio, NSW public hospitals, July 2015 – June 2018. **With adjustment for residence in an aged care facility**



Depth of secondary diagnoses and comorbidity coding

Indicators of mortality may depend on hospital coding practices, as the extent to which comorbidities are coded in the patient record may affect risk adjustment (i.e. standardisation).

Depth of coding is defined as the average number of secondary diagnoses or significant comorbidities coded for index cases. An assessment of depth of coding was conducted, comparing hospitals and changes over time.

The average number of secondary diagnoses has increased over time for all conditions but most markedly for hip fracture surgery. From July 2012 – June 2015, the average depth of coding was 9.4 diagnoses and from July 2015 – June 2018, there were 11.7 diagnoses for hip fracture surgery (Table 4).

The average number of secondary diagnoses that were predictors in the model has not increased over time (Table 5).

Table 4 Average number of any secondary diagnoses, seven conditions, NSW and hospital range, July 2012 – June 2015 and July 2015 – June 2018

Condition	July 2012 – June 2015	July 2015 – June 2018
Acute myocardial infarction	4.8 (1.3 – 7.4)	5.9 (2.7 – 10.0)
Ischaemic stroke	7.0 (3.5 – 9.4)	8.2 (4.9 – 11.2)
Haemorrhagic stroke	5.8 (4.0 – 10.0)	7.8 (5.3 – 11.4)
Congestive heart failure	6.0 (2.5 – 9.3)	8.1 (4.4 – 12.5)
Pneumonia	4.8 (1.0 – 8.8)	6.3 (1.5 – 10.6)
Chronic obstructive pulmonary disease	4.3 (1.4 – 9.1)	5.9 (2.2 – 10.7)
Hip fracture surgery	9.4 (6.4 – 12.7)	11.7 (7.4 – 16.0)

Table 5 Average number of secondary diagnoses that were predictors in the model, seven conditions, NSW and hospital range, July 2012 – June 2015 and July 2015 – June 2018

Condition	July 2012 – June 2015	July 2015 – June 2018
Acute myocardial infarction	1.2 (0.5 – 1.7)	0.9 (0.3 – 1.9)
Ischaemic stroke	0.2 (0.01 – 0.3)	0.2 (0.1 – 0.3)
Haemorrhagic stroke	0.1 (0.0 – 0.3)	0.1 (0.0 – 0.6)
Congestive heart failure	1.8 (0.7 – 2.6)	1.8 (0.9 – 2.9)
Pneumonia	0.9 (0.2 – 1.8)	0.9 (0.2 – 1.5)
Chronic obstructive pulmonary disease	0.8 (0.2 – 1.8)	0.9 (0.2 – 1.8)
Hip fracture surgery	0.6 (0.5 – 0.9)	0.6 (0.4 – 0.8)

Palliative care patients

In palliative care, the clinical intent or treatment goal is primarily quality of life for a patient with an active, progressive disease with little or no prospect of cure.⁴ It includes care provided in a palliative care unit or as part of a palliative care program, care directly under the management of a palliative care physician, or care where the primary clinical intent is palliation.⁵ Patients receiving this type of care have mortality rates that are much higher than patients admitted for acute or other types of care.

In NSW admitted patient records, episodes of palliative care are given a classification that distinguishes them from acute episodes of care. That is, patients are admitted for palliative care as part of their care journey at end of life. Before 30-day RSMRs are calculated, BHI restricts its analyses to patients who are admitted for acute care. Importantly, patients admitted for palliative care are not included in the analyses.

However, hospitals also provide acute care to patients who are on a palliative care journey (0.6% for acute myocardial infarction (AMI), 1.8% for ischaemic stroke, 4.9% for haemorrhagic stroke, 2.1% for congestive heart failure (CHF), 1.4% for pneumonia, 1.6% for COPD and 0.7% for hip fracture surgery). These patients may be discharged home from hospital, they may be transferred to a palliative care unit in a hospital setting or they may die. These acute patients are retained in the analyses and clinical conditions highly associated with a requirement for a palliative care journey, such as malignant cancers, are used to adjust the risk that patients may die within a 30-day period of admission for an acute episode of illness.

In hospitals where this pattern of admission is common, patients on a palliative care journey may comprise a substantial part of a hospital's acute patient cohort. Because these patients are disproportionately likely to die, a small number may heavily influence a hospital's RSMR (typically pushing them toward higher than expected RSMR). Moreover, because palliation is not a feature of risk-adjustment models used at BHI and internationally, hospitals may not have their expected deaths adjusted for the number or proportion of palliative patients they treat.

Palliation-related acute episodes may be identified by a secondary diagnosis code (Z51.5).⁵ Accordingly, hospitals that had a higher than expected RSMR following risk-adjustment and with a very high proportion of palliative patients relative to NSW (identified with a secondary diagnosis code of Z51.5) have been flagged with an 'interpret with caution' note in the report, *Mortality following hospitalisation for seven clinical conditions*, July 2015 – June 2018, and in the associated profiles, which contain detailed information about each hospital's patient cohorts for each of the seven clinical conditions.

Information has been provided to these hospitals to further contextualise their RSMRs.

Appendix 1:

Acute myocardial infarction indicator specification

Risk-standardised mortality ratio (RSMR) indicator specification, cohort and prediction model

The condition

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.

The indicator

The RSMR provides a fair comparison of a particular hospital's results for deaths in or out of hospital within 30 days of admission given its case mix, with an average NSW hospital with the same case mix.⁶

Data source

Data were drawn from the Hospital Performance Dataset, NSW Ministry of Health Secure Analytics for Population Health Research and Intelligence.

Record linkage was carried out by the Centre for Health Record Linkage (www.cherel.org.au).

SAS was used for the analyses.

Calculation

The ratio of the observed number of deaths (numerator) to the expected number of deaths (denominator) in or out of hospital within 30 days of admission for AMI for a given hospital.

Cohort index admissions

An index admission is the hospitalisation included in calculating RSMRs for the condition of interest. The index admissions form the cohort for assessing 30-day mortality.

Inclusions

- principal diagnosis of AMI (ICD-10-AM code I21)
- aged 15+ years, acute emergency admissions
- discharged between 1 July 2015 and 30 June 2018.

Exclusions

- discharges from NSW hospitals administered by agencies external to NSW
- patients with hospitalisations coded as 'STEMI, not specified' (ICD-10-AM code I21.9) were excluded from the base model.

Period of care and transfers

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 were 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.

For patients who had multiple periods of care for a condition, only the last period of care was considered in the analysis for that condition.

Numerator

Observed number of deaths in or out of hospital within 30 days of admission for AMI.

Denominator

Expected number of deaths at a given hospital, on the basis of an average NSW hospital's performance with the same case mix, calculated as the sum of the estimated probabilities of deaths using a NSW-level prediction model.

Attribution of index admissions and deaths

In cases of patient transfers, index admissions and deaths are attributed to the first admitting hospital within the period of care.

Development and validation of the prediction model

The NSW-level prediction model was developed using index admissions between 1 July 2015 and 30 June 2018, and using random intercept logistic regression models, taking into account patient level risk factors (age, sex and comorbidities) and clustering within hospitals.⁷

A backward modelling approach was used to build the multivariable regression model. Variables significant at the 0.20 level in the univariate analysis were considered for inclusion in the multivariable model. Only variables with a 2-sided p-value of less than 0.05 in the multivariable model were retained in the final model (Table 6).

The prediction ability of the model was assessed using C-statistics in data from other financial years (Table 7). The stability of the coefficients in other financial years was also tested (Figure 5). The clinical relevance of the variables in the final model and their direction of association with the outcome were reviewed by clinicians.

Index admissions between 1 July 2015 and 30 June 2018 were used to calculate the expected mortality for each hospital during that period.

Risk adjustment variables

The following variables were included in the development of the prediction models:

- age at index admission
- sex
- the Australian Commission on Safety and Quality in Health Care comorbidity list,⁸ with a one-year lookback period in hospital data.

The final set of risk-adjustment variables for AMI were: age, STEMI/non-STEMI status, dementia, hypotension, shock, renal failure, heart failure, dysrhythmia, malignancy, hypertension and cerebrovascular disease.

Presentation

Results are presented in a funnel plot. Hospitals with an RSMR that falls beyond the 95% and 99.8% control limits are flagged. Control limits are calculated based on a Poisson distribution.⁹

Table 6

Acute myocardial infarction prediction model for deaths in or out of hospital within 30 days, July 2015 – June 2018

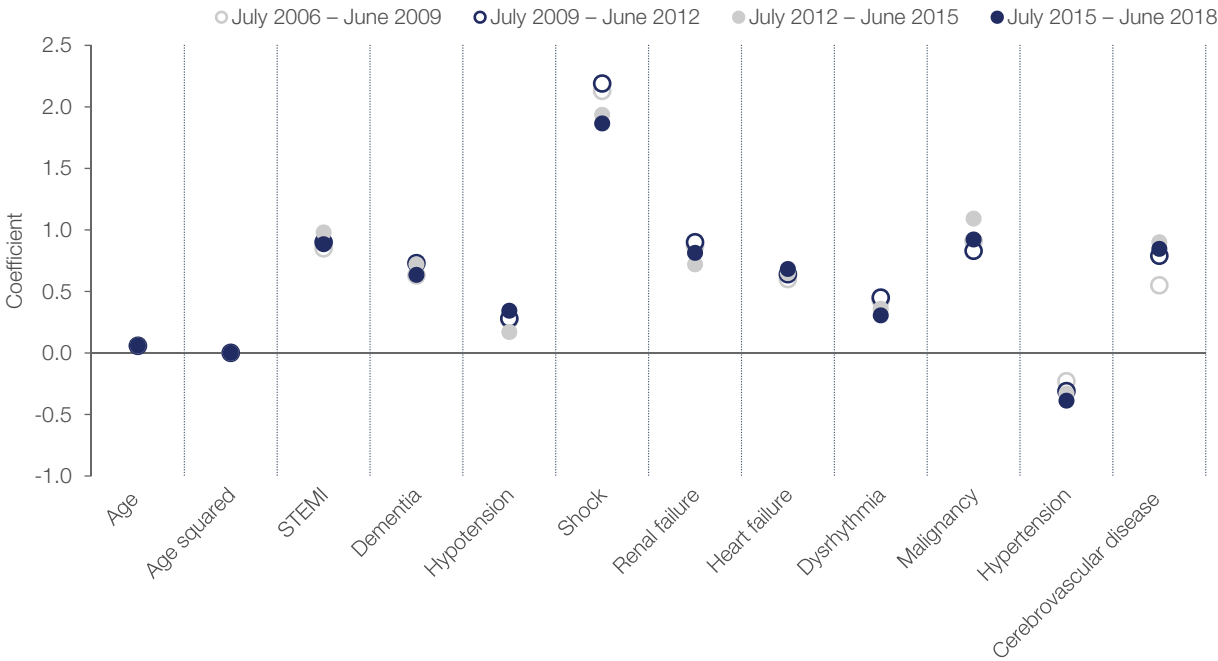
Predictors	Odds Ratio	P-value	(95% confidence interval)
Age (per year increase)	1.06	<0.0001	(1.06 – 1.07)
Age squared	1.00	<0.0001	(1.00 – 1.00)
STEMI	2.42	<0.0001	(2.14 – 2.73)
Dementia	1.89	<0.0001	(1.51 – 2.35)
Hypotension	1.41	<0.0001	(1.25 – 1.59)
Shock	6.46	<0.0001	(5.44 – 7.67)
Renal failure	2.26	<0.0001	(2.00 – 2.54)
Heart failure	1.98	<0.0001	(1.76 – 2.23)
Dysrhythmia	1.36	<0.0001	(1.21 – 1.52)
Malignancy	2.52	<0.0001	(2.04 – 3.11)
Hypertension	0.68	<0.0001	(0.60 – 0.77)
Cerebrovascular disease	2.33	<0.0001	(1.90 – 2.86)

Table 7

Acute myocardial infarction model performance (C-statistics) over different time periods

Period	C-statistic
July 2015 – June 2018	0.86
July 2012 – June 2015	0.86
July 2009 – June 2012	0.85
July 2006 – June 2009	0.84

Figure 5 Acute myocardial infarction model coefficient stability, four time periods, July 2006 – June 2018



Appendix 2:

Ischaemic stroke indicator specification

Risk-standardised mortality ratio (RSMR) indicator specification, cohort and prediction model

The condition

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.

The indicator

The RSMR provides a fair comparison of a particular hospital's results in deaths in or out of hospital within 30 days of admission given its case mix, with an average NSW hospital with the same case mix.⁶

Data source

Data were drawn from the Hospital Performance Dataset, NSW Ministry of Health Secure Analytics for Population Health Research and Intelligence.

Record linkage was carried out by the Centre for Health Record Linkage (www.cherel.org.au).

SAS was used for the analyses.

Calculation

The ratio of the observed number of deaths (numerator) to the expected number of deaths (denominator) in or out of hospital within 30 days of admission for ischaemic stroke for a given hospital.

Cohort index admissions

An index admission is the hospitalisation included in calculating RSMRs for the condition of interest. The index admissions form the cohort for assessing 30-day mortality.

Inclusions

- principal diagnosis of ischaemic stroke (ICD-10-AM code I63)
- aged 15+ years, acute emergency admissions
- discharged between 1 July 2015 and 30 June 2018.

Exclusions

- discharges from NSW hospitals administered by agencies external to NSW.

Period of care and transfers

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 were 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.

For patients who had multiple periods of care for a condition, only the last period of care was considered in the analysis for that condition.

Numerator

Observed number of deaths in or out of hospital within 30 days of admission for ischaemic stroke.

Denominator

Expected number of deaths at a given hospital, on the basis of an average NSW hospital's performance with the same case mix, calculated as the sum of the estimated probabilities of deaths using a NSW-level prediction model.

Attribution of index admissions and deaths

In cases of patient transfers, index admissions and deaths are attributed to the first admitting hospital within the period of care.

Development and validation of the prediction model

The NSW-level prediction model was developed using index admissions between 1 July 2015 and 30 June 2018, and using random intercept logistic regression models, taking into account patient level risk factors (age, sex and comorbidities) and clustering within hospitals.⁷

A backward modelling approach was used to build the multivariable regression model. Variables significant at the 0.20 level in the univariate analysis were considered for inclusion in the multivariable model. Only variables with a 2-sided p-value of less than 0.05 in the multivariable model were retained in the final model (Table 8).

The prediction ability of the model was assessed using C-statistics in data from other financial years (Table 9). The stability of the coefficients in other financial years was also tested (Figure 6). The clinical relevance of the variables in the final model and their direction of association with the outcome were reviewed by clinicians.

Index admissions between 1 July 2015 and 30 June 2018 were used to calculate the expected mortality for each hospital during that period.

Risk adjustment variables

The following variables were included in the development of the prediction models:

- age at index admission
- sex
- the Australian Commission on Safety and Quality in Health Care comorbidity list,⁸ with a one-year lookback period in hospital data.

The final set of risk-adjustment variables for ischaemic stroke were: age, sex, renal failure, heart failure and malignancy.

Presentation

Results are presented in a funnel plot. Hospitals with an RSMR that falls beyond the 95% and 99.8% control limits are flagged. Control limits are calculated based on a Poisson distribution.⁹

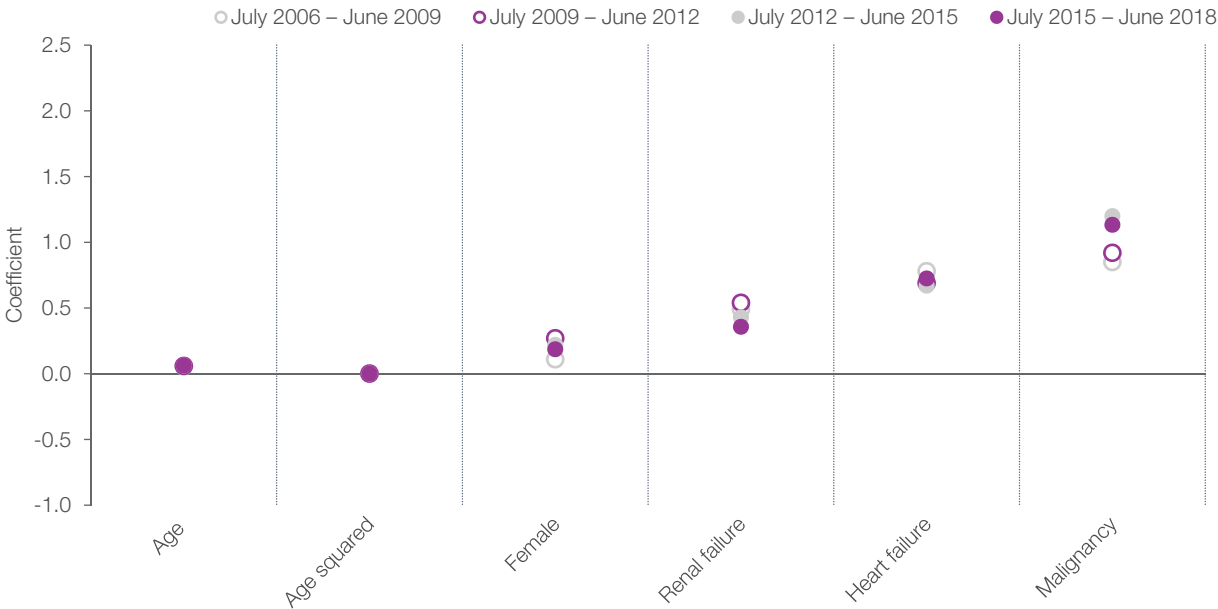
Table 8 Ischaemic stroke prediction model for deaths in or out of hospital within 30 days, July 2015 – June 2018

Predictors	Odds Ratio	P-value	(95% confidence interval)
Age (per year increase)	1.07	<0.0001	(1.06 – 1.07)
Age squared	1.00	<0.0001	(1.00 – 1.00)
Female	1.21	0.0003	(1.09 – 1.33)
Renal failure	1.43	<0.0001	(1.27 – 1.61)
Heart failure	2.06	<0.0001	(1.77 – 2.40)
Malignancy	3.11	<0.0001	(2.59 – 3.72)

Table 9 Ischaemic stroke model performance (C-statistics) over different time periods

Period	C-statistic
July 2015 – June 2018	0.75
July 2012 – June 2015	0.74
July 2009 – June 2012	0.73
July 2006 – June 2009	0.72

Figure 6 Ischaemic stroke model coefficient stability, four time periods, July 2006 – June 2018



Appendix 3:

Haemorrhagic stroke indicator specification

Risk-standardised mortality ratio (RSMR) indicator specification, cohort and prediction model

The condition

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. The severity and consequences of stroke can vary from complete recovery to severe disability or death.

The indicator

The RSMR provides a fair comparison of a particular hospital's results in deaths in or out of hospital within 30 days of admission given its case mix, with an average NSW hospital with the same case mix.⁶

Data source

Data were drawn from the Hospital Performance Dataset, NSW Ministry of Health Secure Analytics for Population Health Research and Intelligence.

Record linkage was carried out by the Centre for Health Record Linkage (www.cherel.org.au).

SAS was used for the analyses.

Calculation

The ratio of the observed number of deaths (numerator) to the expected number of deaths (denominator) in or out of hospital within 30 days of admission for haemorrhagic stroke for a given hospital.

Cohort index admissions

An index admission is the hospitalisation included in calculating RSMRs for the condition of interest. The index admissions form the cohort for assessing 30-day mortality.

Inclusions

- principal diagnosis of haemorrhagic stroke (ICD-10-AM codes I61, I62)
- aged 15+ years, acute emergency admissions
- discharged between 1 July 2015 and 30 June 2018.

Exclusions

- discharges from NSW hospitals administered by agencies external to NSW.

Period of care and transfers

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 were 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.

For patients who had multiple periods of care for a condition, only the last period of care was considered in the analysis for that condition.

Numerator

Observed number of deaths in or out of hospital within 30 days of admission for haemorrhagic stroke.

Denominator

Expected number of deaths at a given hospital, on the basis of an average NSW hospital's performance with the same case mix, calculated as the sum of the estimated probabilities of deaths using a NSW-level prediction model.

Attribution of index admissions and deaths

In cases of patient transfers, index admissions and deaths are attributed to the first admitting hospital within the period of care.

Development and validation of the prediction model

The NSW-level prediction model was developed using index admissions between 1 July 2015 and 30 June 2018, and using random intercept logistic regression models, taking into account patient level risk factors (age, sex and comorbidities) and clustering within hospitals.⁷

A backward modelling approach was used to build the multivariable regression model. Variables significant at the 0.20 level in the univariate analysis were considered for inclusion in the multivariable model. Only variables with a 2-sided p-value of less than 0.05 in the multivariable model were retained in the final model (Table 10).

The prediction ability of the model was assessed using C-statistics in data from other financial years (Table 11). The stability of the coefficients in other financial years was also tested (Figure 7). The clinical relevance of the variables in the final model and their direction of association with the outcome were reviewed by clinicians.

Index admissions between 1 July 2015 and 30 June 2018 were used to calculate the expected mortality for each hospital during that period.

Risk adjustment variables

The following variables were included in the development of the prediction models:

- age at index admission
- sex
- the Australian Commission on Safety and Quality in Health Care comorbidity list,⁸ with a one-year lookback period in hospital data.

The final set of risk-adjustment variables for haemorrhagic stroke were: age, sex, heart failure, malignancy and history of haemorrhagic stroke.

Presentation

Results are presented in a funnel plot. Hospitals with an RSMR that falls beyond the 95% and 99.8% control limits are flagged. Control limits are calculated based on a Poisson distribution.⁹

Table 10 Haemorrhagic stroke prediction model for deaths in or out of hospital within 30 days, July 2015 – June 2018

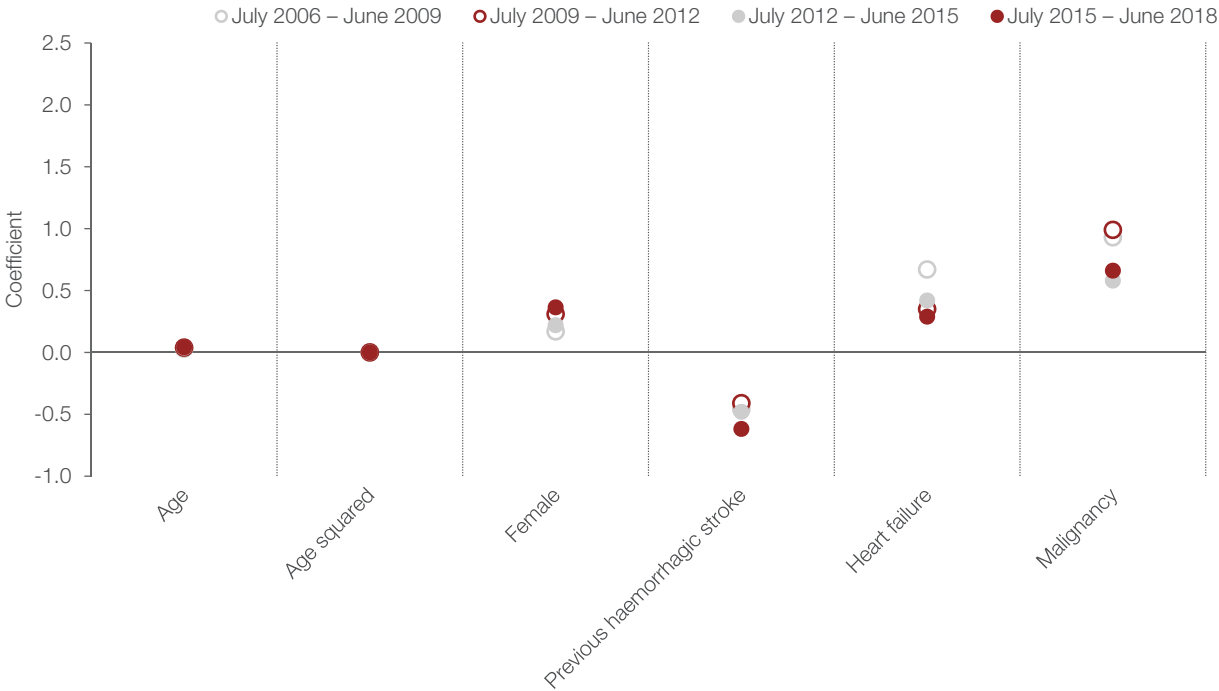
Predictors	Odds Ratio	P-value	(95% confidence interval)
Age (per year increase)	1.04	<0.0001	(1.04 – 1.05)
Age squared	1.00	0.0012	(1.00 – 1.00)
Female	1.44	<0.0001	(1.27 – 1.63)
Previous haemorrhagic stroke	0.54	<0.0001	(0.41 – 0.70)
Heart failure	1.34	0.0315	(1.03 – 1.74)
Malignancy	1.94	<0.0001	(1.54 – 2.43)

*Contiguous hospitalisation episodes for CHF are counted once; acute episodes with a principal diagnosis of CHF are considered.

Table 11 Haemorrhagic stroke model performance (C-statistics) over different time periods

Period	C-statistic
July 2015 – June 2018	0.67
July 2012 – June 2015	0.65
July 2009 – June 2012	0.66
July 2006 – June 2009	0.65

Figure 7 Haemorrhagic stroke model coefficient stability, four time periods, July 2006 – June 2018



Appendix 4:

Congestive heart failure indicator specification

Risk-standardised mortality ratio (RSMR) indicator specification, cohort and prediction model

The condition

Congestive heart failure (CHF) is a chronic condition that 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.

The indicator

The RSMR provides a fair comparison of a particular hospital's results in deaths in or out of hospital within 30 days of admission given its case mix, with an average NSW hospital with the same case mix.⁶

Data source

Data were drawn from the Hospital Performance Dataset, NSW Ministry of Health Secure Analytics for Population Health Research and Intelligence.

Record linkage was carried out by the Centre for Health Record Linkage (www.cherel.org.au).

SAS was used for the analyses.

Calculation

The ratio of the observed number of deaths (numerator) to the expected number of deaths (denominator) in or out of hospital within 30 days of admission for CHF for a given hospital.

Cohort index admissions

An index admission is the hospitalisation included in calculating RSMRs for the condition of interest. The index admissions form the cohort for assessing 30-day mortality.

Inclusions

- principal diagnosis of congestive heart failure (ICD-10-AM codes I11.0, I13.0, I13.2, I50.0, I50.1, I50.9)
- aged 45+ years, acute emergency admissions
- discharged between 1 July 2015 and 30 June 2018.

Exclusions

- discharges from NSW hospitals administered by agencies external to NSW.

Period of care and transfers

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 were 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.

For patients who had multiple periods of care for a condition, only the last period of care was considered in the analysis for that condition.

Numerator

Observed number of deaths in or out of hospital within 30 days of admission for CHF.

Denominator

Expected number of deaths at a given hospital, on the basis of an average NSW hospital's performance with the same case mix, calculated as the sum of the estimated probabilities of deaths using a NSW-level prediction model.

Attribution of index admissions and deaths

In cases of patient transfers, index admissions and deaths are attributed to the first admitting hospital within the period of care.

Development and validation of the prediction model

The NSW-level prediction model was developed using index admissions between 1 July 2015 and 30 June 2018, and using random intercept logistic regression models, taking into account patient level risk factors (age, sex and comorbidities) and clustering within hospitals.⁷

A backward modelling approach was used to build the multivariable regression model. Variables significant at the 0.20 level in the univariate analysis were considered for inclusion in the multivariable model. Only variables with a 2-sided p-value of less than 0.05 in the multivariable model were retained in the final model (Table 12).

The prediction ability of the model was assessed using C-statistics in data from other financial years (Table 13). The stability of the coefficients in other financial years was also tested (Figure 8). The clinical relevance of the variables in the final model and their direction of association with the outcome were reviewed by clinicians.

Index admissions between 1 July 2015 and 30 June 2018 were used to calculate the expected mortality for each hospital during that period.

Risk adjustment variables

The following variables were included in the development of the prediction models:

- age at index admission
- sex
- Elixhauser comorbidities,¹⁰ with a one-year lookback period in hospital data.

The final set of risk-adjustment variables for CHF were: age, valvular disease, pulmonary circulation disorders, hypertension, other neurological disorders, chronic pulmonary disease, diabetes – complicated, diabetes – uncomplicated, renal failure, liver disease, peptic ulcer disease excluding bleeding, metastatic cancer, coagulopathy, weight loss, fluid and electrolyte disorders, deficiency anaemia, dementia and number of previous acute admissions for CHF.

Presentation

Results are presented in a funnel plot. Hospitals with an RSMR that falls beyond the 95% and 99.8% control limits are flagged. Control limits are calculated based on a Poisson distribution.⁹

Table 12 Congestive heart failure prediction model for deaths in or out of hospital within 30 days, July 2015 – June 2018

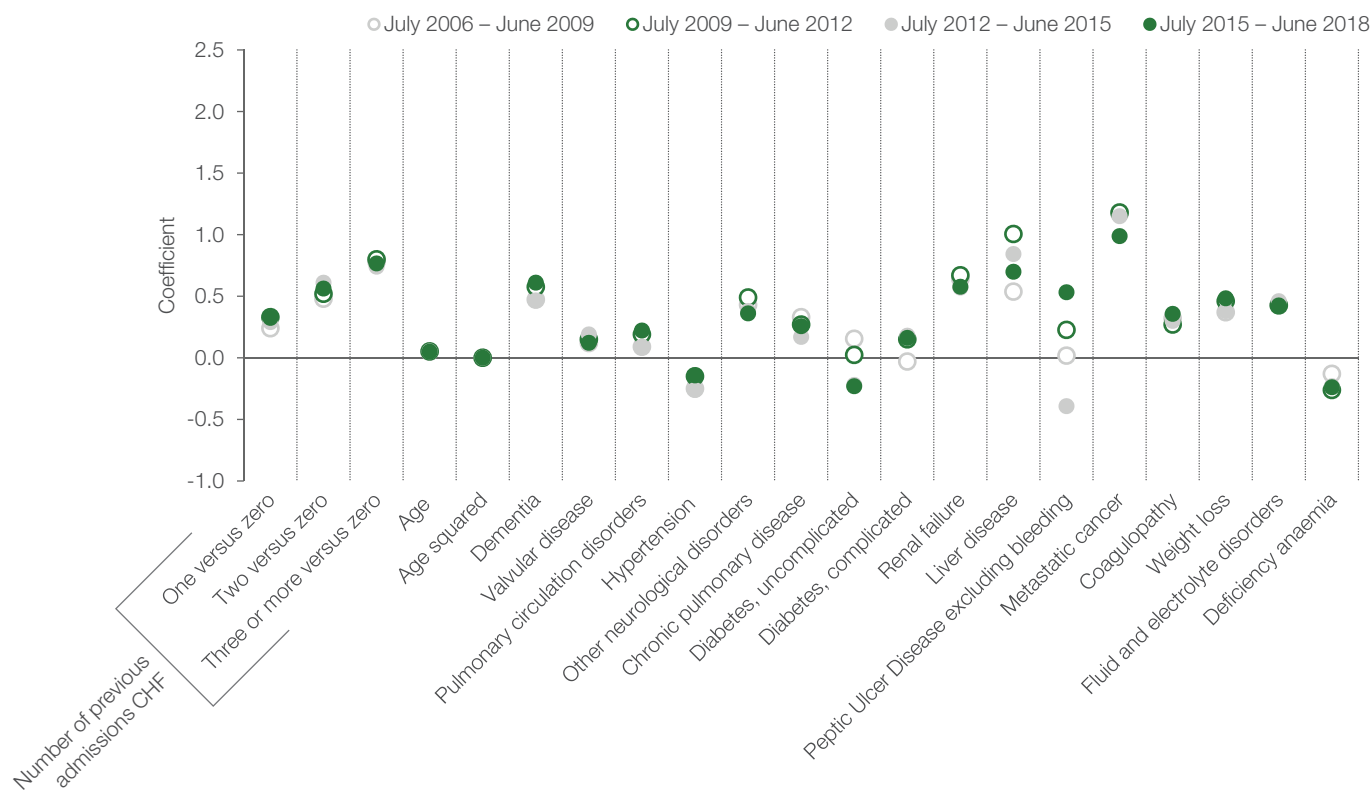
Predictors	Odds Ratio	P-value	(95% confidence interval)
Age (per year increase)	1.05	<0.0001	(1.05 – 1.06)
Age squared	1.00	<0.0001	(1.00 – 1.00)
Number of previous acute admissions CHF* (versus zero)			
One	1.38	<0.0001	(1.26 – 1.52)
Two	1.76	<0.0001	(1.53 – 2.01)
Three or more	2.15	<0.0001	(1.84 – 2.51)
Dementia	1.84	<0.0001	(1.61 – 2.11)
Valvular disease	1.13	0.0147	(1.02 – 1.25)
Pulmonary circulation disorder	1.25	<0.0001	(1.13 – 1.38)
Hypertension	0.87	0.0006	(0.80 – 0.94)
Other neurological disorders	1.43	<0.0001	(1.20 – 1.72)
Chronic pulmonary disease	1.29	<0.0001	(1.19 – 1.41)
Diabetes, uncomplicated	0.79	<0.0001	(0.71 – 0.88)
Diabetes, complicated	1.18	0.0006	(1.07 – 1.29)
Renal failure	1.78	<0.0001	(1.64 – 1.94)
Liver disease	2.01	<0.0001	(1.71 – 2.36)
Peptic Ulcer Disease excluding bleeding	1.70	0.023	(1.08 – 2.70)
Metastatic cancer	2.69	<0.0001	(2.15 – 3.36)
Coagulopathy	1.43	<0.0001	(1.28 – 1.59)
Weight loss	1.62	<0.0001	(1.47 – 1.79)
Fluid and electrolyte disorders	1.53	<0.0001	(1.41 – 1.66)
Deficiency anaemia	0.79	<0.0001	(0.71 – 0.88)

*Contiguous hospitalisation episodes for CHF are counted once; acute episodes with a principal diagnosis of CHF are considered.

Table 13 Congestive heart failure model performance (C-statistics) over different time periods

Period	C-statistic
July 2015 – June 2018	0.73
July 2012 – June 2015	0.71
July 2009 – June 2012	0.72
July 2006 – June 2009	0.71

Figure 8 Congestive heart failure model coefficient stability, four time periods, July 2006 – June 2018



Appendix 5:

Pneumonia indicator specification

Risk-standardised mortality ratio (RSMR) indicator specification, cohort and prediction model

The condition

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

The indicator

The RSMR provides a fair comparison of a particular hospital's results in deaths in or out of hospital within 30 days of admission given its case mix, with an average NSW hospital with the same case mix.⁶

Data source

Data were drawn from the Hospital Performance Dataset, NSW Ministry of Health Secure Analytics for Population Health Research and Intelligence.

Record linkage was carried out by the Centre for Health Record Linkage (www.cherel.org.au).

SAS was used for the analyses.

Calculation

The ratio of the observed number of deaths (numerator) to the expected number of deaths (denominator) in or out of hospital within 30 days of admission for pneumonia for a given hospital.

Cohort index admissions

An index admission is the hospitalisation included in calculating RSMRs for the condition of interest. The index admissions form the cohort for assessing 30-day mortality.

Inclusions

- principal diagnosis of pneumonia (ICD-10-AM codes J13, J14, J15, J16, J18)
- aged 18+ years, acute emergency admissions
- discharged between 1 July 2015 and 30 June 2018.

Exclusions

- discharges from NSW hospitals administered by agencies external to NSW.

Period of care and transfers

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 were 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.

For patients who had multiple periods of care for a condition, only the last period of care was considered in the analysis for that condition.

Numerator

Observed number of deaths in or out of hospital within 30 days of admission for pneumonia.

Denominator

Expected number of deaths at a given hospital, on the basis of an average NSW hospital's performance with the same case mix, calculated as the sum of the estimated probabilities of deaths using a NSW-level prediction model.

Attribution of index admissions and deaths

In cases of patient transfers, index admissions and deaths are attributed to the first admitting hospital within the period of care.

Development and validation of the prediction model

The NSW-level prediction model was developed using index admissions between 1 July 2015 and 30 June 2018, and using random intercept logistic regression models, taking into account patient level risk factors (age, sex and comorbidities) and clustering within hospitals.⁷

A backward modelling approach was used to build the multivariable regression model. Variables significant at the 0.20 level in the univariate analysis were considered for inclusion in the multivariable model. Only variables with a 2-sided p-value of less than 0.05 in the multivariable model were retained in the final model (Table 14).

The prediction ability of the model was assessed using C-statistics in data from other financial years (Table 15). The stability of the coefficients in other financial years was also tested (Figure 9). The clinical relevance of the variables in the final model and their direction of association with the outcome were reviewed by clinicians.

Index admissions between 1 July 2015 and 30 June 2018 were used to calculate the expected mortality for each hospital during that period.

Risk adjustment variables

The following variables were included in the development of the prediction models:

- age at index admission
- sex
- the Australian Commission on Safety and Quality in Health Care comorbidity list,⁸ with a one-year lookback period in hospital data.

The final set of risk-adjustment variables for pneumonia were: age, dementia, hypotension, shock, renal failure, other chronic obstructive pulmonary disease, heart failure, dysrhythmia, malignancy, liver disease, cerebrovascular disease and Parkinson's disease.

Presentation

Results are presented in a funnel plot. Hospitals with an RSMR that falls beyond the 95% and 99.8% control limits are flagged. Control limits are calculated based on a Poisson distribution.⁹

Table 14 **Pneumonia prediction model for deaths in or out of hospital within 30 days, July 2015 – June 2018**

Predictors	Odds Ratio	P-value	(95% confidence interval)
Age (per year increase)	1.06	<0.0001	(1.05 – 1.06)
Age squared	1.00	<0.0001	(1.00 – 1.00)
Dementia	2.38	<0.0001	(2.14 – 2.65)
Hypotension	1.28	<0.0001	(1.18 – 1.38)
Shock	2.82	<0.0001	(2.42 – 3.27)
Renal failure	1.56	<0.0001	(1.45 – 1.68)
Other COPD	1.23	<0.0001	(1.15 – 1.33)
Heart failure	1.47	<0.0001	(1.36 – 1.59)
Dysrhythmia	1.16	0.0003	(1.07 – 1.25)
Malignancy	5.09	<0.0001	(4.67 – 5.55)
Liver disease	2.26	<0.0001	(1.87 – 2.74)
Cerebrovascular disease	1.82	<0.0001	(1.57 – 2.11)
Parkinson's disease	1.28	0.0510	(1.00 – 1.64)

Table 15 **Pneumonia model performance (C-statistics) over different time periods**

Period	C-statistic
July 2015 – June 2018	0.81
July 2012 – June 2015	0.80
July 2009 – June 2012	0.82
July 2006 – June 2009	0.81

Figure 9 Pneumonia model coefficient stability, four time periods, July 2006 – June 2018



Appendix 6:

Chronic obstructive pulmonary disease indicator specification

Risk-standardised mortality ratio (RSMR) indicator specification, cohort and prediction model

The condition

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.

The indicator

The RSMR provides a fair comparison of a particular hospital's results in deaths in or out of hospital within 30 days of admission given its case mix, with an average NSW hospital with the same case mix.⁶

Data source

Data were drawn from the Hospital Performance Dataset, NSW Ministry of Health Secure Analytics for Population Health Research and Intelligence.

Record linkage was carried out by the Centre for Health Record Linkage (www.cherel.org.au).

SAS was used for the analyses.

Calculation

The ratio of the observed number of deaths (numerator) to the expected number of deaths (denominator) in or out of hospital within 30 days of admission for COPD for a given hospital.

Cohort index admissions

An index admission is the hospitalisation included in calculating RSMRs for the condition of interest. The index admissions form the cohort for assessing 30-day mortality.

Inclusions

- principal diagnosis of COPD (ICD-10-AM codes J20*, J40*, J41, J42, J43, J44, J47) (*only if accompanied by a secondary diagnosis of J41, J42, J43, J44 or J47)
- aged 45+ years, acute emergency admissions
- discharged between 1 July 2015 and 30 June 2018.

Exclusions

- discharges from NSW hospitals administered by agencies external to NSW.

Period of care and transfers

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 were 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.

For patients who had multiple periods of care for a condition, only the last period of care was considered in the analysis for that condition.

Numerator

Observed number of deaths in or out of hospital within 30 days of admission for COPD.

Denominator

Expected number of deaths at a given hospital, on the basis of an average NSW hospital's performance with the same case mix, calculated as the sum of the estimated probabilities of deaths using a NSW-level prediction model.

Attribution of index admissions and deaths

In cases of patient transfers, index admissions and deaths are attributed to the first admitting hospital within the period of care.

Development and validation of the prediction model

The NSW-level prediction model was developed using index admissions between 1 July 2015 and 30 June 2018, and using random intercept logistic regression models, taking into account patient level risk factors (age, sex and comorbidities) and clustering within hospitals.⁷

A backward modelling approach was used to build the multivariable regression model. Variables significant at the 0.20 level in the univariate analysis were considered for inclusion in the multivariable model. Only variables with a 2-sided p-value of less than 0.05 in the multivariable model were retained in the final model (Table 16).

The prediction ability of the model was assessed using C-statistics in data from other financial years (Table 17). The stability of the coefficients in other financial years was also tested (Figure 10). The clinical relevance of the variables in the final model and their direction of association with the outcome were reviewed by clinicians.

Index admissions between 1 July 2015 and 30 June 2018 to calculate the expected mortality for each hospital during that period.

Risk adjustment variables

The following variables were included in the development of the prediction models:

- age at index admission
- sex
- Elixhauser comorbidities,¹⁰ with a one-year lookback period in hospital data.

The final set of risk-adjustment variables for COPD were: age, sex, congestive heart failure, cardiac arrhythmia, pulmonary circulation disorders, other neurological disorders, diabetes – complicated, metastatic cancer, solid tumour without metastasis, coagulopathy, weight loss, fluid and electrolyte disorders, dementia and number of previous acute admissions for COPD.

Presentation

Results are presented in a funnel plot. Hospitals with an RSMR that falls beyond the 95% and 99.8% control limits are flagged. Control limits are calculated based on a Poisson distribution.⁹

Table 16

Chronic obstructive pulmonary disease prediction model for deaths in or out of hospital within 30 days, July 2015 – June 2018

Predictors	Odds Ratio	P-value	(95% confidence interval)
Age (per year increase)	1.03	<0.0001	(1.03 – 1.03)
Age squared	1.00	0.0190	(1.00 – 1.00)
Number of previous acute admissions COPD* (versus zero)			
One	1.65	<0.0001	(1.49 – 1.82)
Two	1.80	<0.0001	(1.57 – 2.06)
Three or more	2.92	<0.0001	(2.60 – 3.28)
Dementia	1.71	<0.0001	(1.43 – 2.04)
Female	0.91	0.0173	(0.84 – 0.98)
Congestive heart failure	1.48	<0.0001	(1.35 – 1.62)
Cardiac arrhythmia	1.27	<0.0001	(1.16 – 1.38)
Pulmonary circulation disorder	1.47	<0.0001	(1.29 – 1.67)
Other neurological disorders	1.26	0.0440	(1.01 – 1.58)
Diabetes, complicated	0.87	0.0139	(0.79 – 0.97)
Metastatic cancer	2.01	<0.0001	(1.59 – 2.55)
Solid tumour without metastasis	1.94	<0.0001	(1.62 – 2.32)
Coagulopathy	1.21	0.0241	(1.03 – 1.43)
Weight loss	1.98	<0.0001	(1.81 – 2.17)
Fluid and electrolyte disorders	1.53	<0.0001	(1.41 – 1.67)

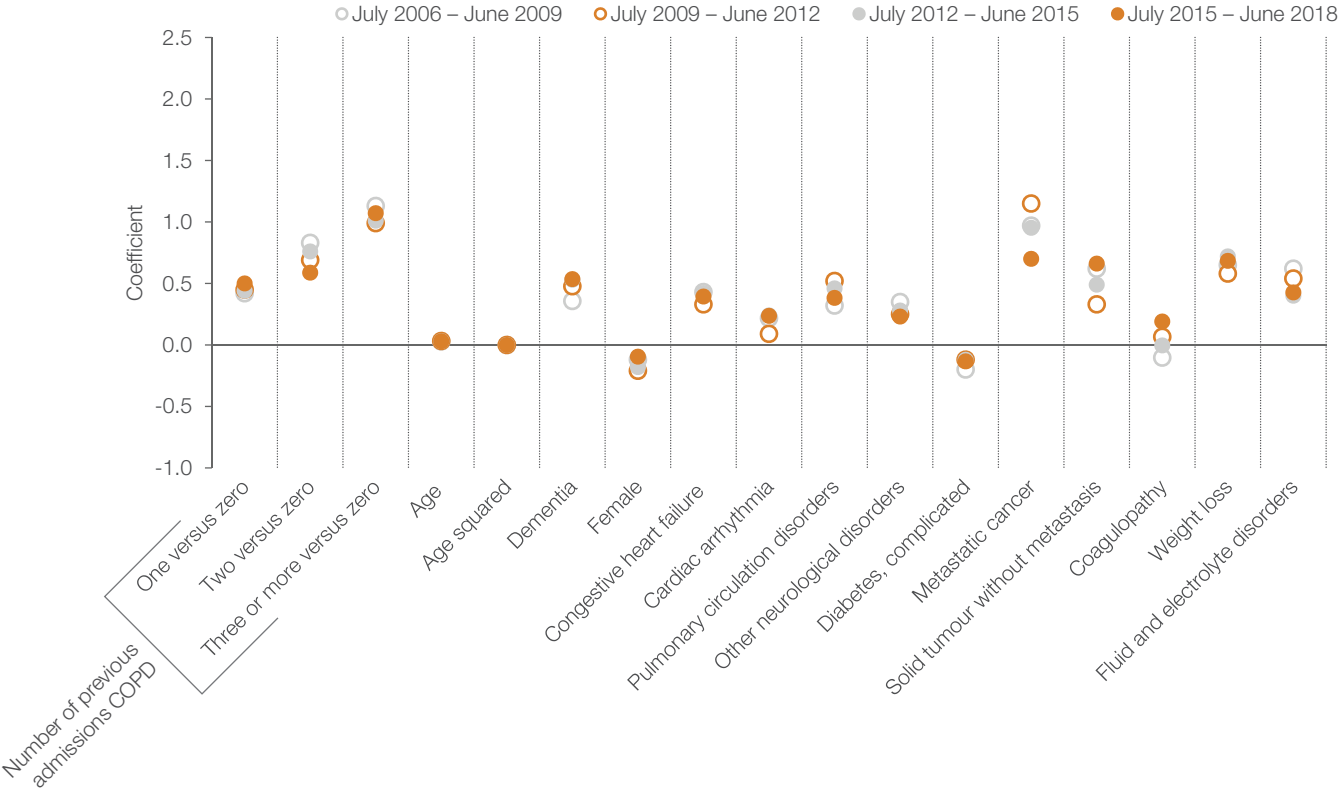
*Contiguous hospitalisation episodes for COPD are counted once; acute episodes with a principal diagnosis of COPD are considered.

Table 17

Chronic obstructive pulmonary disease model performance (C-statistics) over different time periods

Period	C-statistic
July 2015 – June 2018	0.75
July 2012 – June 2015	0.74
July 2009 – June 2012	0.74
July 2006 – June 2009	0.73

Figure 10 Chronic obstructive pulmonary disease model coefficient stability, four time periods, July 2006 – June 2018



Appendix 7:

Hip fracture surgery indicator specification

Risk-standardised mortality ratio (RSMR) indicator specification, cohort and prediction model

The condition

Hip fracture refers to a fracture of the femur (thigh bone) within five centimetres of the distal (lower) part of the lesser trochanter. Hip fractures may 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.¹¹

The indicator

The RSMR provides a fair comparison of a particular hospital's results in deaths in or out of hospital within 30 days of admission given its case mix, with an average NSW hospital with the same case mix.⁶

Data source

Data were drawn from the Hospital Performance Dataset, NSW Ministry of Health Secure Analytics for Population Health Research and Intelligence.

Record linkage was carried out by the Centre for Health Record Linkage (www.cherel.org.au).

SAS was used for the analyses.

Calculation

The ratio of the observed number of deaths (numerator) to the expected number of deaths (denominator) in or out of hospital within 30 days of admission for hip fracture surgery for a given hospital.

Cohort index admissions

An index admission is the hospitalisation included in calculating RSMRs for the condition of interest. The index admissions form the cohort for assessing 30-day mortality.

Inclusions

- principal diagnosis of hip fracture (ICD-10-AM codes S72.0, S72.1, S72.2)
- an additional diagnosis indicating the hip fracture was related to a fall (ICD-10-AM codes W00-W19, R29.6)
- a procedure code indicating that the patient was admitted for surgery (ACHI code 47519-00, 47522-00, 47528-01, 47531-00, 49315-00, 49318-00*, 49319-00*) (*only if accompanied by one of the following Australian Refined Diagnostic Related Group codes: I03A, I03B, I08A, I08B, I78A, I78B, I73A, Z63A)
- aged 50+ years, acute admissions
- discharged between 1 July 2015 and 30 June 2018.

Exclusions

- discharges from NSW hospitals administered by agencies external to NSW.

Period of care and transfers

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 were 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. For patients who had multiple periods of care for a condition, only the last period of care was considered in the analysis for that condition.

Numerator

Observed number of deaths in or out of hospital within 30 days of admission for hip fracture surgery.

Denominator

Expected number of deaths at a given hospital, on the basis of an average NSW hospital's performance with the same case mix, calculated as the sum of the estimated probabilities of deaths using a NSW-level prediction model.

Attribution of index admissions and deaths

In cases of patient transfers, index admissions and deaths are attributed to the first admitting hospital within the period of care.

Development and validation of the prediction model

The NSW-level prediction model was developed using index admissions between 1 July 2015 and 30 June 2018 and using random intercept logistic regression models, taking into account patient level risk factors (age, sex and comorbidities) and clustering within hospitals.⁷

A backward modelling approach was used to build the multivariable regression model. Variables significant at the 0.20 level in the univariate analysis were considered for inclusion in the multivariable model. Only variables with a 2-sided p-value of less than 0.05 in the multivariable model were retained in the final model (Table 18).

The prediction ability of the model was assessed using C-statistics in data from other financial years (Table 19). The stability of the coefficients in other financial years was also tested (Figure 11). The clinical relevance of the variables in the final model and their direction of association with the outcome were reviewed by clinicians.

Index admissions between 1 July 2015 and 30 June 2018 were used to calculate the expected mortality for each hospital during that period.

Risk adjustment variables

The following variables were included in the development of the prediction models:

- age at index admission
- sex
- the Australian Commission on Safety and Quality in Health Care comorbidity list,⁸ with a one-year lookback period in hospital data.

The final set of risk-adjustment variables for hip fracture surgery were: age, sex, ischaemic heart disease, dysrhythmia, respiratory infection, renal failure, heart failure, malignancy and dementia.

Presentation

Results are presented in a funnel plot. Hospitals with an RSMR that falls beyond the 95% and 99.8% control limits are flagged. Control limits are calculated based on a Poisson distribution.⁹

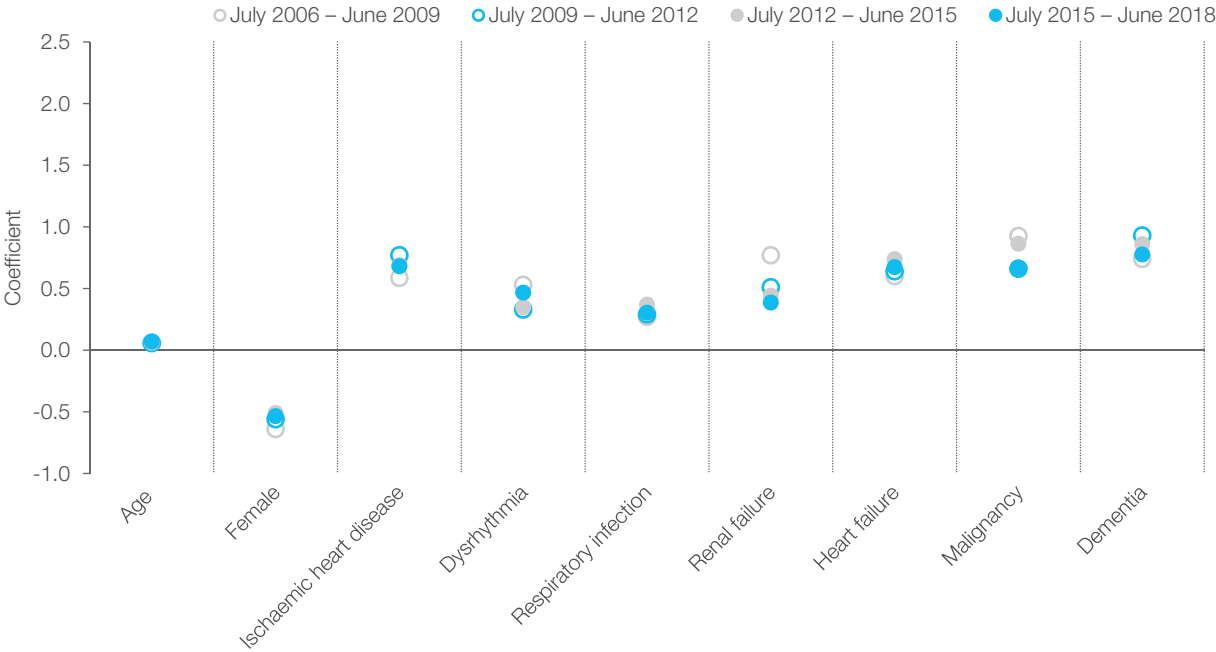
Table 18 Hip fracture surgery prediction model for deaths in or out of hospital within 30 days, July 2015 – June 2018

Predictors	Odds Ratio	P-value	(95% confidence interval)
Age (per year increase)	1.07	<0.0001	(1.06 – 1.08)
Female	0.59	<0.0001	(0.51 – 0.67)
Ischaemic heart disease	1.98	<0.0001	(1.62 – 2.41)
Respiratory infection	1.36	0.0002	(1.15 – 1.59)
Kidney failure	1.47	<0.0001	(1.27 – 1.70)
Heart failure	1.96	<0.0001	(1.64 – 2.35)
Dysrhythmia	1.60	<0.0001	(1.37 – 1.86)
Malignancy	1.95	<0.0001	(1.48 – 2.58)
Dementia	2.17	<0.0001	(1.88 – 2.51)

Table 19 Hip fracture surgery model performance (C-statistics) over different time periods

Period	C-statistic
July 2015 – June 2018	0.76
July 2012 – June 2015	0.77
July 2009 – June 2012	0.77
July 2006 – June 2009	0.78

Figure 11 Hip fracture surgery model coefficient stability, four time periods, July 2006 – June 2018



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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 healthcare system.

BHI was established in 2009 and 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 manages the NSW Patient Survey Program, gathering information from patients about their experiences and outcomes of care in public hospitals and other healthcare facilities.

BHI publishes a range of reports and information products, including interactive tools, that provide objective, accurate and meaningful information about how the health system is performing.

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 supply 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.

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