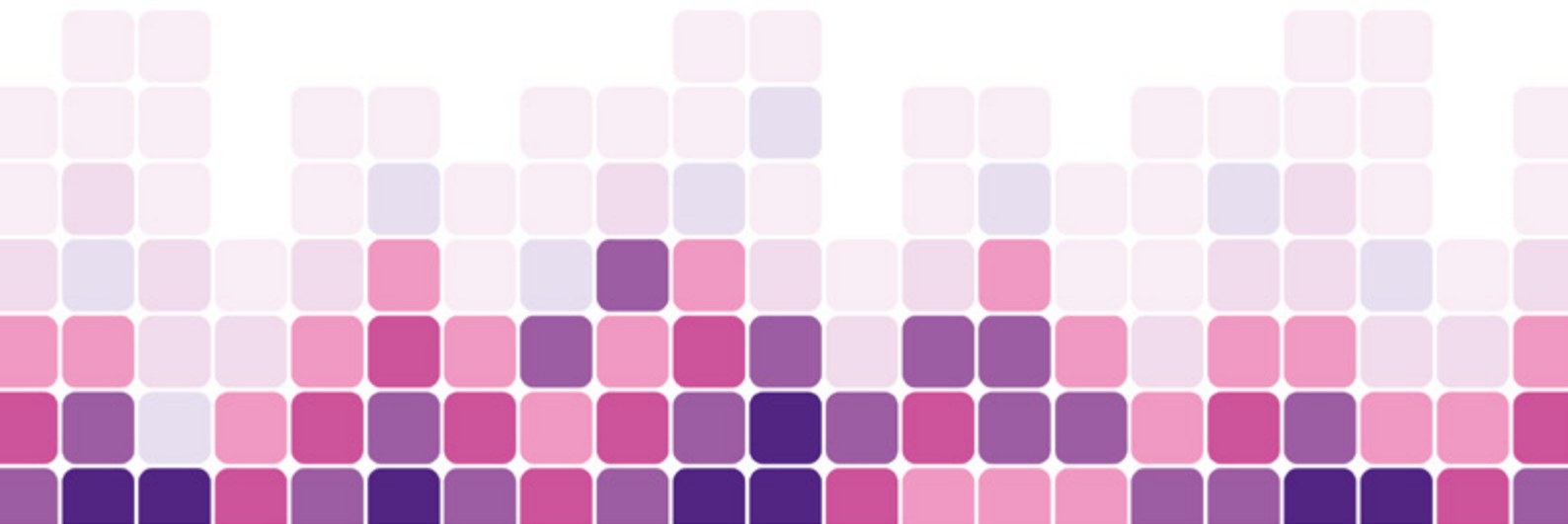


Spotlight on measurement

30-day mortality following hospitalisation,
five clinical conditions, NSW,
July 2009 – June 2012

Acute myocardial infarction, ischaemic stroke,
haemorrhagic stroke, pneumonia and hip fracture surgery

December 2013



Summary

Mortality is an important outcome – one that resonates with patients, clinicians, managers and policy-makers.

Mortality is influenced by many factors that go beyond quality of care, however it remains important to measure mortality in any comprehensive assessment of healthcare system performance.

Mortality for many conditions is decreasing - a reflection of better access to more effective healthcare, as well as changes in wider determinants of health and wellbeing such as nutrition, education and standards of living.

Many deaths are unavoidable, and may even be an expected outcome in some circumstances, however variation in mortality across healthcare facilities is sometimes a reflection of unwarranted clinical variation. In many jurisdictions, risk-standardised mortality ratios (RSMRs) are used to assess the presence of such variation and target further investigation to identify quality or performance issues.

RSMRs have been assessed across multiple jurisdictions for their utility in performance measurement and reporting efforts. This report summarises the findings of these assessments, within the NSW context.

RSMRs can be tailored to fit with local context. Decisions about the cohort of patients included in the assessment, such as hospital attribution, risk adjustment approaches, control limits and reporting formats are all adaptable to local circumstances, without compromising the measure's validity.

This document outlines the analytic work that informed these decisions in the NSW context. In brief, decisions were:

- The unit of analysis is patients (rather than hospitalisations or episodes of care)
- The outcome is the number of deaths from any cause, in or out of hospital, within 30 days of the first day of hospitalisation
- The number of deaths is interpreted in light of the expected number of deaths, calculated from a regression model
- Periods of continuous care are combined into a single 'period of care' if the diagnosis does not change and the transfer within or between hospitals occurs on the same day
- Attribution of the outcome is to the first hospital where patients were hospitalised in multiple facilities in their last 'period of care'
- The comorbidity set, defined by the Australian Commission for Safety and Quality in Health Care is used as a basis for building risk adjustment models for each condition
- Outlier hospitals are identified using the funnel plot method, with control limits of 90% and 95%
- To complement RSMRs, descriptive data on mortality within 30 days provide context and insight: survival curves; percentage of deaths on day of admission, within the first seven days following admission and after discharge.

Introduction

Across healthcare systems internationally, there is a growing imperative to measure and report on mortality.¹⁻⁶

In many ways the ultimate outcome, death, is a unique and clearly defined event that has resonance with the public, patients, clinicians, managers and policy-makers. Mortality data have a role in a range of health service objectives and are able to make significant contributions to evaluating performance; providing accountability; targeting and guiding improvement efforts; and informing research and knowledge generation.⁷⁻¹¹

Mortality is however an outcome that can be influenced by various factors not under the control of clinicians and health systems. Mortality measures therefore require sophisticated adjustments to make them fair measures.

This edition of *Spotlight on Measurement* describes the development and evaluation of statistical methods in preparation for public reporting of 30-day mortality in NSW.

This document provides details of the development process undertaken for all five clinical conditions, using acute myocardial infarction (AMI) as an example. Detailed results for the development of the other condition's risk-standardised mortality ratios (RSMRs), and relevant sensitivity analyses are available upon request.

The complete indicator specifications for the Bureau of Health Information's RSMRs are provided in available at www.bhi.gov.au.

How to measure variation in mortality?

There is substantial variation across jurisdictions in how hospital mortality is measured and reported. Hospital-standardised mortality ratios (HSMRs) are commonly used. They are also commonly criticised (see [box](#)). Increasingly there has been a move away from the more general HSMR to condition specific indicators, such as RSMRs.

Why these five conditions?

For the first time, hospital-level mortality data are to be reported publicly in NSW. Five clinical conditions were selected to be the focus of the Bureau of Health Information (BHI) indicator development process: acute myocardial infarction, ischaemic stroke, haemorrhagic stroke, pneumonia and hip fracture surgery.

These conditions were selected because:

- a) established and validated approaches currently used in other jurisdictions internationally were suitable for adaptation to the NSW context ^{1,2,5,6,12}
- b) together these conditions provide insights into a range of different aspects of healthcare - spanning timely delivery of life-saving interventions, surgical services, various care types from acute to rehabilitation, differences in acuity and prognosis.

Table 1 outlines an assessment of RSMRs, using criteria defined by the US Agency for Healthcare Research and Quality.¹³

Comparing HSMRs and RSMRs

Hospital standardised mortality ratios (HSMRs) such as those published by the UK's Dr Foster organisation, are often used as part of performance assessment efforts.

Similar to the RSMRs featured in this report, HSMRs are indicators that measure whether the mortality rate at a hospital is higher or lower than expected.

However HSMRs differ from RSMRs in a number of important ways:

1. HSMRs are very broad in scope, including diseases responsible for the top 80% of deaths in hospital. This means that attribution to specific clinical processes is difficult and actionability is often hard to define. RSMRs on the other hand, are focused on particular conditions, providing more meaningful information for managers and clinicians.
2. HSMRs generally only capture in-hospital mortality. Recent research has shown the importance of including post-discharge deaths in assessing performance.¹⁴
3. HSMRs are generally based on counts of single 'episodes' or hospitalisations, meaning that a patient can be counted multiple times. RSMRs on the other hand are based on counts of patients.

There are ongoing concerns about the ability of HSMRs to appropriately risk adjust for factors affecting the likelihood of death given their broad scope.^{15,16} HSMRs have however been successful in galvanising action to improve care in many countries around the world.^{17,18}

Table 1: 30-day risk-standardised mortality ratios (RSMR) – international experience and application to NSW

Construct	International experience	Bureau experience
Face validity	The measures focus on major causes of morbidity and mortality. Understanding variation in mortality provides opportunities to improve. Disease specific measures are seen as being clinically relevant.	The five conditions reported are responsible for around 20% of all deaths in NSW hospitals and relate to different aspects of healthcare including acute emergency care, surgical care, specialised care, rehabilitation and community-based services.
Reliability	RSMRs can be used to identify, with good statistical confidence, hospitals where the probability of dying is appreciably different from the average. This method takes into account the fact that mortality rates will vary between hospitals and between time periods depending on the volume of cases.	Methods from peer reviewed publications and international experience were used to create NSW RSMRs. The use of multilevel models to calculate expected deaths and funnel plots to identify outliers, capitalise on international experience and avoids the creation of misleading league tables.
Sensitivity	This measure is recognised to minimise what is called type II error or false negative results (i.e. failing to identify a difference that really exists). Internationally, RSMR error probabilities have been quantified as being “low” for AMI and hip fracture and “acceptable” for stroke. ²	Control limits for identifying outlier hospitals have been set at 90% and 95% (approximating 1.6 and 2 standard deviations) in line with international experience ¹⁴ clinical recommendations. This increases sensitivity and reduces the risk of type II errors (false negatives).
Specificity	The level of type I error related to false positive results (a difference that does not really exists) has been quantified as acceptable for RSMRs in other jurisdictions. ²	A low level of type 1 error (false positives) is acceptable. The control limits were set at 90% and 95% to minimise missing hospital results that require further assessment and also minimise flagging hospitals not truly different from expected.
Fairness / bias	Relying on administrative data, questions arise about whether data quality and risk adjustment are adequate to mitigate any case-mix bias in hospital comparisons. In other jurisdictions, the level of bias in 30-day risk standardised mortality ratios has been found to be acceptable. ²	Different risk adjustment approaches were assessed. Selective spot audits of hospital coding practices for stroke and AMI have not revealed any systematic or widespread anomalies or shortcomings in coding. Analysis of depth of coding found little variation between hospitals in the average counts of secondary diagnoses recorded.
Actionability	The use of condition-specific RSMRs has been associated with evidence of catalysing improvement. ⁶	The 30-day mortality ratio is supplemented by data on patient population profiles, survival times and survival proportions, which provide additional actionable information to clinicians and hospitals.
Application	RSMRs are in widespread use, and can be adapted to fit with local circumstances.	Drawing on clinical advice, small adaptations have been made to the RSMR methods. This makes the RSMRs appropriate in the NSW context. All adaptations were subject to sensitivity analyses.

Defining cohorts: who to include in the analysis

The development of the RSMRs for the NSW context required a number of key decisions about the patients to include in the study cohort. These included:

- Identification of patients with the conditions
- Designation of transferred patients and patients admitted multiple times to avoid double counting
- Identification of patients who died including consideration of place (in or out of hospital), cause (all cause or disease specific cause) and time (from admission or discharge) to death.

Cohort and unit of analysis

Patients defined as the level of analysis

Mortality indicators can be constructed using episodes (hospitalisations) or patients as the unit of analysis. Patient-based indicators are preferred as they better reflect performance and outcomes.^{2, 6, 8} Patient-based indicators rely on the availability of linked data. NSW has the privilege of linked patient data made available through the Centre for Health Record Linkage (CHeReL).

Cohort identified by discharge coding

Patients were identified using records of hospital discharge between July 2000 and June 2012 collected by the NSW Ministry of Health (SAPHaRI, Centre for Epidemiology and Evidence). ICD-10-AM codes entered as the principal diagnosis in the patient record were used to identify the cohort for each of the condition-specific RSMRs. The bulk of analysis considered the most recent three year period between 1 July 2009 and 30 June 2012. Temporal trends and the statistical stability of the estimates used the full 12 year span, in three-year time periods.

Periods of care constructed

For the purposes of this analysis, contiguous episodes of care separated only by a transfer within or between hospitals, are combined into a single 'period of care'. If a patient had multiple periods of care for the condition of interest in a three year time period, only their last period of care is used to calculate a hospital's RSMR.

The number of patients hospitalised multiple times in the period between July 2009 and June 2012 was less than 9% for all conditions. (Table 2)

Table 2: Number of patients with multiple hospitalisations during June 2009 –July 2012 by clinical condition

	AMI	Ischaemic stroke	Haemorrhagic stroke	Pneumonia	Hip fracture surgery
Number of hospitalisations					
1	26,877 (92%)	13,458 (95%)	5,319 (94%)	40,076 (91%)	15,322 (97%)
2	2,001 (7%)	687(5%)	324 (6%)	3,333 (8%)	509 (3%)
3 or more	345 (1%)	60(<1%)	38 (1%)	652 (1%)	5 (<1%)

A patient may be included in multiple RSMRs if they were hospitalised for multiple conditions in a three year period.

A flow chart describing the AMI patient cohort is shown in [Figure 1](#). Those for the other conditions are shown in [Appendices 2-5](#).

Outcome

30-days from admission

RSMRs use counts of deaths from all causes within 30-days of an index admission* date, including deaths following transfer to another hospital, as well as deaths outside of hospital altogether.

Include deaths in and out of hospital

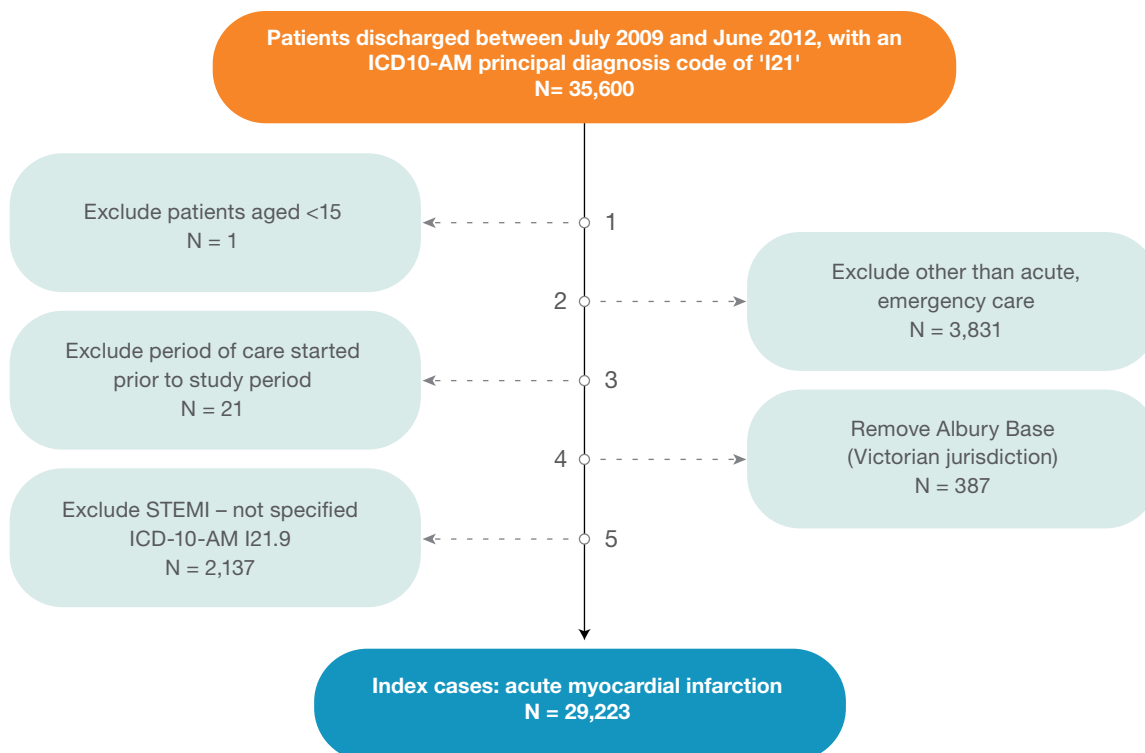
Using linked data provides a comprehensive picture of 30-day mortality. Deaths that occur in the presenting hospital, those following transfer to another hospital, and those that occur outside a hospital after discharge are all identified.

Research evidence shows that including deaths after discharge provides additional insights into quality and performance – reflecting discharge practices as well as community support and post-hospital care.¹⁸

Analysis uses 'fact of death' i.e. the cause of death is not captured

The use of fact of death data is a pragmatic one. It allows for more timely reporting as there is a shorter time lag between the date of death and release of fact of death information.

Figure 1: Acute myocardial infarction patient cohort



(*) Index admission is defined as patient initially admitted with the relevant principal diagnosis, in the last period of care.

Attribution

Patient and outcomes attributed to first admitting hospital

Attribution becomes an important issue in cases where patients are transferred between different hospitals during their period of care. Patients are our unit of analysis, and should not be counted against all hospitals in which they stayed.

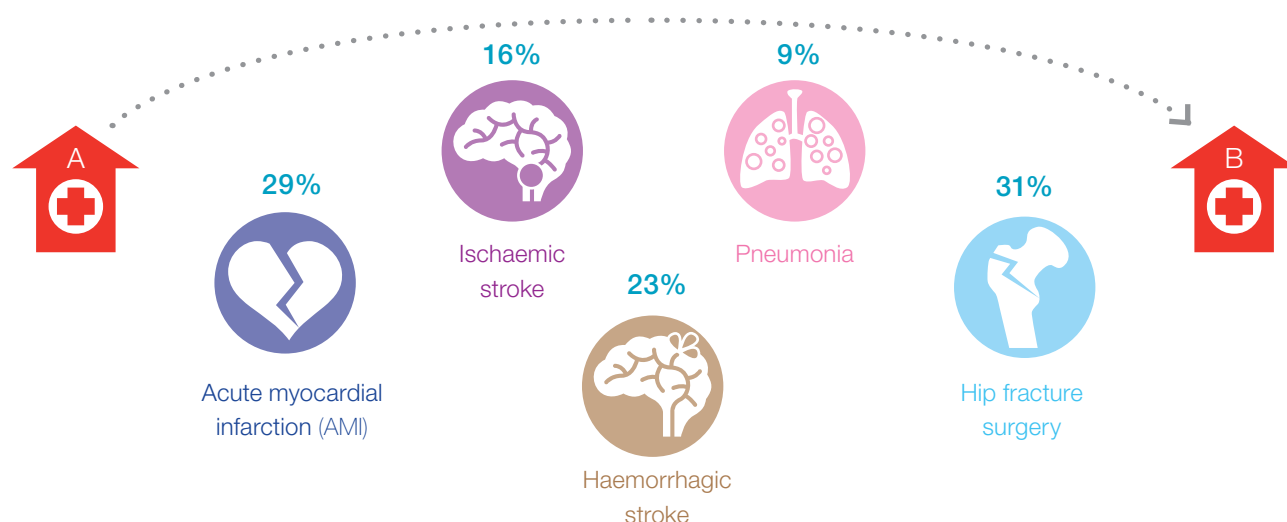
The question of which facility they are counted against or 'attributed to' is a decision that should be made carefully (for a simplified explanation see [Page 9](#))

Attribution is an interpretive problem, rather than a purely methodological one. For all of the conditions included in our report the first few hours and days of treatment are crucial to survival. It is widely recognized that the first steps taken to care for patients including emergency transportation, emergency care and first day of admission are strong determinants of mortality.

For each condition, the implications of attributing transferred patients to the 'first' or 'last' hospital they were admitted to were assessed. Attributing to the first hospital generally resulted in smaller hospitals recording a lower mortality rate; and had little impact on larger hospital results. Conceptually, attributing to first hospital is preferred because it captures the extent to which acutely unwell patients are stabilised and transferred to specialist facilities in order to receive appropriate care.

The percentage of patients transferred to another hospital varied across the five conditions. ([Figure 2](#))

Figure 2: Patients transferred as a proportion of index cases, NSW, July 2009 – June 2012.



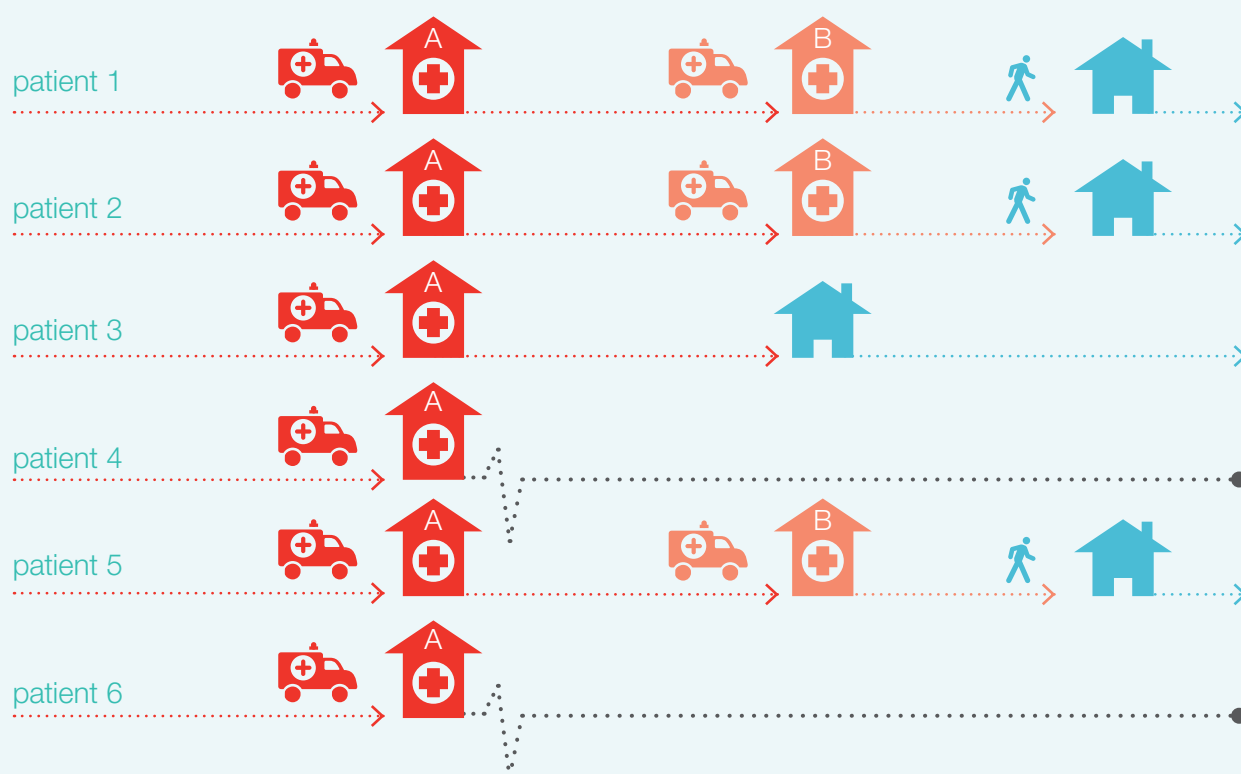
The transfers and attribution issue – a simplified example

Hospital A admits six AMI patients in a period of one month. Of those six patients, three are transferred to another hospital shortly after admission. Of the patients who remained in Hospital A, two died within 30 days. Of the patients who were transferred, none died within 30-days.

The effect of attribution on Hospital A's results are as follows:

- If we use 'last hospital attribution', Hospital A was the final hospital for three patients, of whom two died – a crude mortality rate of 67 deaths per 100 hospitalisations
- If we use 'first hospital attribution', Hospital A was the initial hospital for six patients, of whom two died – a crude mortality rate of 33 deaths per 100 hospitalisations.

The impact of the attribution decision is determined by the proportion of patients who are transferred. The effects of the decision in the case of the July 2009 - June 2011 data are shown below.



Modelling and interpretation

Statistical modelling is a well established analytic approach with a number of advantages. It allows reporting on hospitals with relatively few patients; allows comparisons of expected and actual results for each facility; and in conjunction with funnel plots, identifies outliers.

Random intercept logistic regression model

In line with international best practice, a random intercept logistic regression model using state-level data was developed for each condition.¹ This approach estimates the association of comorbidities and other patient factors with the likelihood of death in the population of patients who received hospital care in NSW between July 2009 and June 2012. The expected number of deaths for each hospital is then calculated, by summing the probabilities of death, estimated from the model, of the patients attributed to the hospital.

The model adjusts for patient level risk factors with the fixed effect parameter estimates and accounts for the clustering of patients within hospitals with the hospital-level random intercepts. Only patient characteristics significantly associated with 30-day mortality ($p < 0.05$) were retained in the final model. The clinical relevance of the variables in the final model and the direction of association with the outcome were reviewed by clinicians. We evaluated three different ways of calculating indicators of mortality from the random intercept logistic regression model.¹⁹ The impact of different approaches on hospital results is illustrated in [Table 3](#).

Approach 1 compares the odds of mortality for patients in a specific hospital to their odds of mortality in an average hospital. This approach results in an odds ratio rather a mortality ratio (odds ratio).

Approach 2 takes the total number of observed deaths in a specific hospital, divided by the expected number of deaths had those patients been treated at an average NSW hospital, estimated using the final risk adjustment model. It compares the performance of a specific hospital for a given patient case mix with an average hospital for the same patient case mix (observed / expected).

Approach 3 stabilises Approach 2 by replacing the observed number of deaths with a prediction of the observed number of deaths estimated from the NSW level risk adjustment model, in order to reduce the effect of chance in the observed variation (predicted / expected).

It should be noted that the comparisons described in these approaches are relative to the hospital's own case mix. Therefore it is not appropriate to compare hospitals with each other, as no two hospitals have the same patient volume and case mix.

Approach two selected

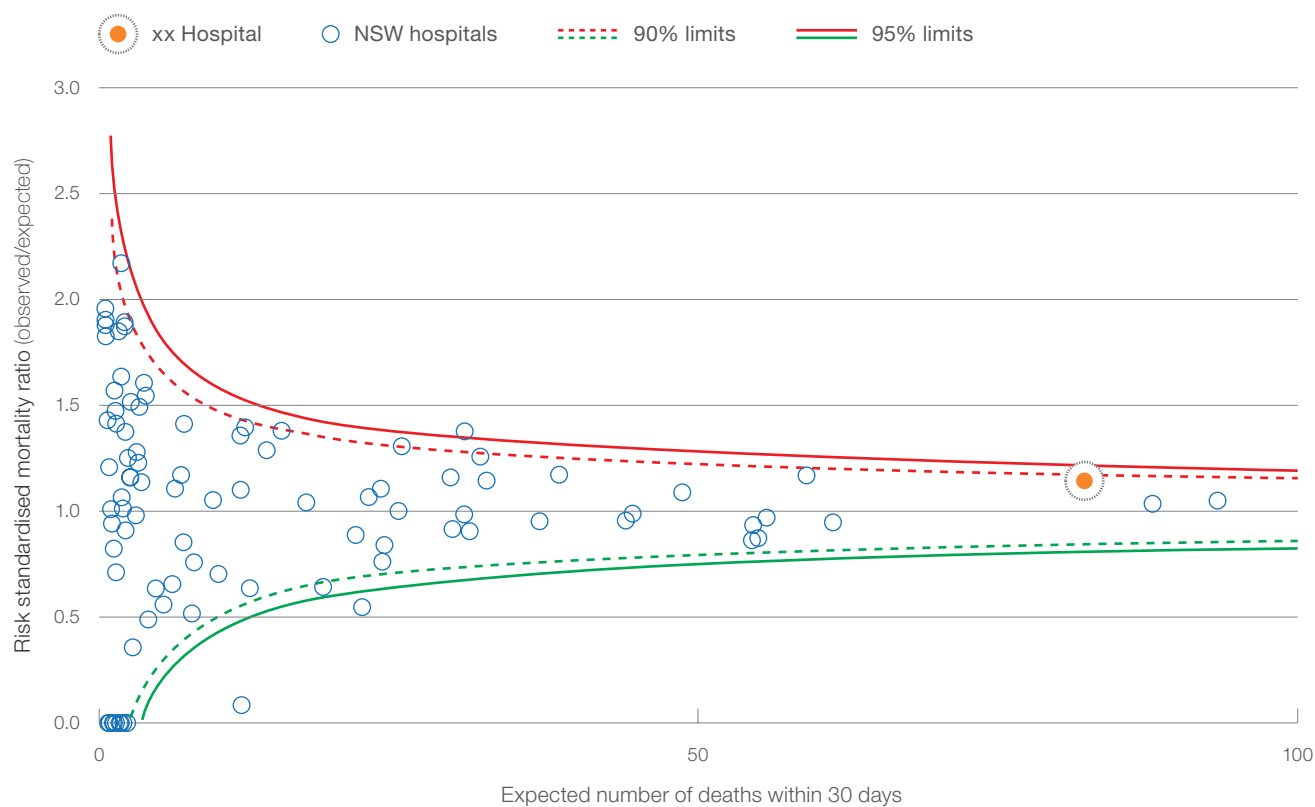
Following evaluation of the three different methods for calculating standardised mortality ratios, **Approach 2** was selected as the method that optimised the relationship between stability and sensitivity, it is also amendable to the use of funnel plots.

The objective of the indicator is to identify opportunities to improve care at a hospital level and so sensitivity was prioritised. Control limits for funnel plots were therefore set at 1.6 and 2 SD (90% and 95%) – in line with those set by England's Care Quality Commission²⁰ ([Figure 3](#)).

Table 3: The effect of different approaches on calculating the risk of mortality

Mortality level		Approach		
		1 (odds ratio)	2 (observed/ expected ratio)	3 (predicted/ expected ratio)
Peer group (see appendix 6)				
A	higher mortality	1.20	1.21	1.14
A	expected mortality	0.92	0.91	0.94
A	lower mortality	0.68	0.60	0.76
B	higher mortality	1.22	1.31	1.16
B	expected mortality	1.10	1.11	1.06
B	lower mortality	0.94	0.88	0.95
C	higher mortality	1.15	1.83	1.11
C	expected mortality	0.99	0.98	0.99
C	lower mortality	0.90	0.55	0.91

Figure 3: Funnel plot : interpreting RSMRs



Risk adjustment

Robust risk adjustment is needed if fair comparisons are to be made and therefore crucial for metrics to be accepted. Age, sex and comorbidities are known risk factors in mortality.

There are different methods available to adjust for comorbidities, including generic approaches such as Charlson or Elixhauser indices, or disease specific comorbidity adjustments, such as those developed by the agency for Safety and Quality in Health Care (ACSQHC) in its in-hospital mortality indicator development processes.²¹

ACSQHC comorbidity approach as base line

We explored using three comorbidity adjustment approaches (Charlson, ACSQHC and Elixhauser) – focusing on two of these (ACSQHC and Elixhauser) as starting points for the process of fitting random intercept logistic regression models for the five conditions.

The C statistic (area under the Receiver Operating Characteristics (ROC)) is a measure of the discriminant ability of a logistic regression model. Models are typically considered reasonable when the C-statistic is higher than 0.7 and strong when C exceeds 0.8.²²

The predictive models were built with three years of data, July 2009 – June 2012 and then validated on data from three previous time periods (July 2000 - June 2003; July 2003 - June 2006, July 2006 - June 2009). [Figure 5](#) shows the stability of the coefficients estimated for the AMI-specific risk-adjustment model across those periods using the ACSQHC comorbidity set.

The statistical analyses indicate that risk adjustment based on the ACSQHC's set of comorbidities performed best in random intercept logistic regression modelling of 30-day mortality following admission with an AMI.

(Note: the Commission's variables were determined using separation data and predicting in-hospital mortality). Across all five conditions, the ACSQHC comorbidity set was not significantly outperformed by any of the other approaches (see [Table 5](#)). Therefore, for simplicity, consistency and for concordance with other Australian jurisdictions, the Commissions comorbidity set were used (with some minor alternations) for all five clinical conditions.

The full list of variables included in the AMI model is shown in [Table 4](#). Those for other conditions are available in the performance profiles.

One year look back

Using a 'lookback period' to determine a patient's comorbidities may also improve prediction.²³ The lookback information includes comorbidities identified from admissions to any NSW hospital for any reason during the twelve months prior to and including the index admission. Model C-statistics and Akaike's information criterion (AIC) were similar for index comorbidity and one year lookback (e.g. C-statistic for ischaemic stroke was 0.738 for index and to 0.741 for one-year lookback).

Five year lookbacks were not as predictive of 30-day mortality, particularly for AMI (C-statistic for one year 0.851 and for five-year 0.849). For consistency across the clinical conditions and with international practice, we adopted a look back period of one year from the index admission date to identify patient comorbidities.

Table 4: The full list of variables included in the model and the associated odds ratios

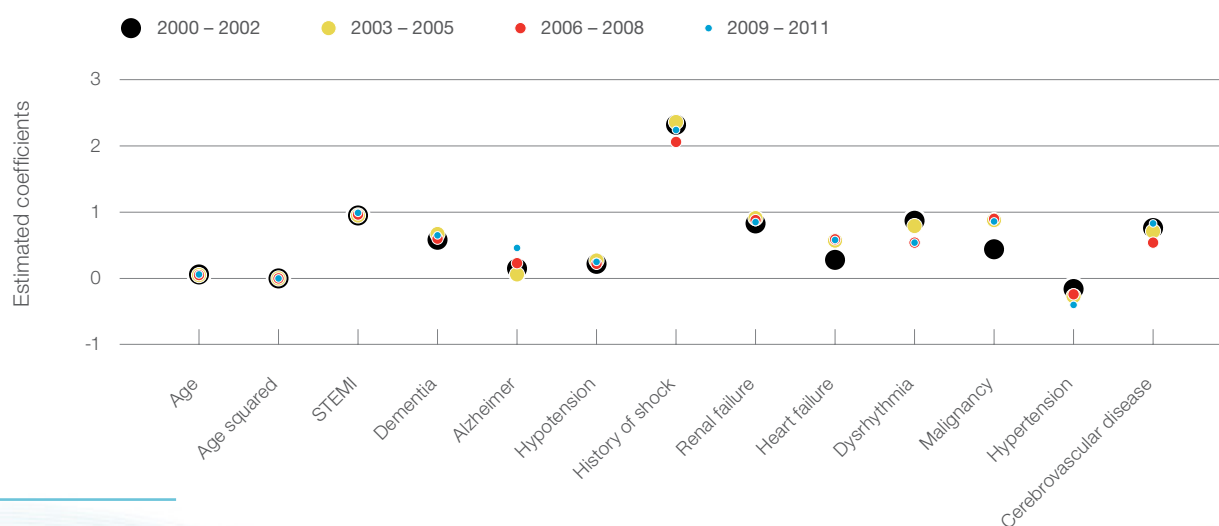
Variables	Coefficient	Odds Ratio	P>z	(95% Confidence Interval)
Age (centred)	0.06	1.06	<0.001	(1.05 - 1.06)
Age (squared)	0.00	1.00	<0.001	(1.00 - 1.00)
STEMI#	0.99	2.69	<0.001	(2.42 - 3.00)
Dementia	0.65	1.91	<0.001	(1.59 - 2.30)
Alzheimer's disease	0.46	1.59	0.03	(1.04 - 2.42)
Hypotension	0.25	1.29	<0.001	(1.14 - 1.45)
Shock	2.24	9.40	<0.001	(7.80 - 11.34)
Renal failure	0.85	2.34	<0.001	(2.08 - 2.62)
Heart failure	0.58	1.78	<0.001	(1.60 - 1.99)
Dysrhythmia	0.54	1.71	<0.001	(1.54 - 1.90)
Malignancy	0.86	2.35	<0.001	(1.91 - 2.89)
Hypertension	-0.40	0.67	<0.001	(0.61 - 0.74)
Cerebrovascular disease	0.83	2.29	<0.001	(1.90 - 2.75)

The high odds ratio of those hospitalisations that were classified neither as STEMI or non-STEMI prompted, after clinical advice, the removal of this group from our cohort and separate analyses of the AMI – unspecified patient group – see p 16.

Table 5: Validity analysis 2000-2011 financial years

C-statistic (ACSQHC comorbidities with one year look back)		
Financial years	ROC (c-statistics)	
Main model 2009-2011 financial years	0.8514	
	Using the estimated coefficients in 2009-2011	Using the recalibrated coefficients
Validation		
2006-2008 financial years	0.8309	0.8347
2003-2005 financial years	0.8413	0.8495
2000-2002 financial years	0.8360	0.8458

Figure 5: Stability of the coefficients (2000-2011 financial years)



An analysis of the median number of secondary diagnoses recorded by peer group, local health district and hospital indicated that there is a modest trend towards less secondary diagnosis recording as the hospital gets smaller.

Table 6 gives the results for episodes between July 2009 and June 2012 for all acute episodes in NSW hospitals, and episodes for patients identified in the cohorts for each of the five conditions.

Table 6: Depth of coding number of secondary diagnoses recorded by peer group level hospitals

	Mean	Median (q1-q3)
All acute episodes		
New South Wales	1.6	1 (0 - 3)
Principal referral hospitals	1.8	1 (0 - 3)
Major hospitals (metro and non-metro)	1.8	1 (0 - 3)
District hospitals	1.5	1 (0 - 3)
AMI		
New South Wales	4.0	4 (2 - 5)
Principal referral hospitals	4.8	4 (2 - 6)
Major hospitals (metro and non-metro)	3.7	3 (2 - 5)
District hospitals	2.8	2 (1 - 4)
Ischaemic stroke		
New South Wales	5.9	5 (3 - 8)
Principal referral hospitals	6.3	5 (3 - 8)
Major hospitals (metro and non-metro)	5.5	5 (2 - 7)
District hospitals	4.6	4 (2 - 6)
Haemorrhagic stroke		
New South Wales	4.6	3 (2 - 6)
Principal referral hospitals	5.3	4 (2 - 7)
Major hospitals (metro and non-metro)	3.9	3 (2 - 5)
District hospitals	3.4	3 (1 - 5)
Pneumonia		
New South Wales	3.5	2 (1 - 5)
Principal referral hospitals	4.4	3 (1 - 6)
Major hospitals (metro and non-metro)	3.6	3 (1 - 5)
District hospitals	2.5	2 (1 - 4)
Hip fracture surgery		
New South Wales	5.0	4 (2 - 7)
Principal referral hospitals	5.4	4 (2 - 7)
Major hospitals (metro and non-metro)	4.5	4 (2 - 6)
District hospitals	4.3	4 (2 - 6)

Case study: Insights into STEMI unspecified

Risk-standardised mortality ratios (RSMRs) form the basis of the hospital level reporting. RSMRs are used because they allow for a range of patient level factors that affect the likelihood of dying to be taken into account. Expected outcomes for each hospital reflect how old or how sick the patients they see are. The number of deaths recorded is compared to these expectations – allowing for fair assessments.

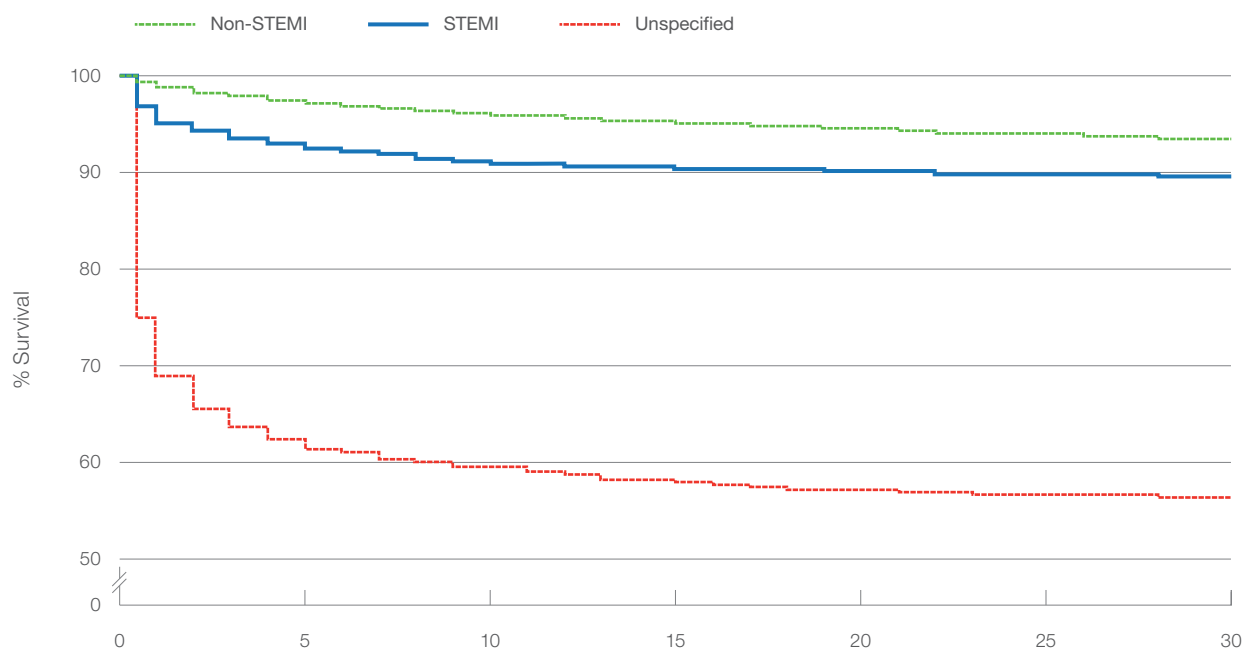
For AMI, one important patient level factor that influences the likelihood of dying is whether the AMI is a STEMI or non-STEMI. STEMI are associated with higher mortality at 30 days (OR = 2.69).²⁴ This means that for fair evaluations, the proportion of STEMI patients a hospital sees should be taken into account when determining its expected mortality. However, while most AMIs

are noted in the medical record as being either STEMI or non-STEMI, around 7% of all AMIs are not classified as either STEMI or non-STEMI. These diagnoses are termed AMI - unspecified.

Investigation of outcomes in the non-specified group revealed some striking patterns. Most notably, the 30-day mortality rate for this group of patients is 49 deaths per 100 patients (Figure 6). Of the patients who died within 30 days, 57% died on the first day of hospitalisation (Table 7).

Over time there has been a steady drop in the proportion of AMIs coded as AMI - unspecified.

Figure 6: Survival curves for AMI sub-categories: STEMI, non-STEMI and Unspecified, NSW July 2009 – June 2011



At a hospital level, the proportion of patients classified as AMI - unspecified ranged from 0 to 100%. The proportion of AMI patients who were recorded as AMI - unspecified versus the total number of AMI patients hospitalised, reveals that large hospitals record around 2-10% of patients as AMI – unspecified, while in smaller hospitals there are far more non-specific AMI diagnoses (Figure 7).

This finding implies that the AMI – unspecified group is heterogeneous with a mix of critically unwell patients likely to die; and patients for whom diagnostic records are patchy.

This is important for the calculation of RSMRs because of the high mortality rates in the AMI – unspecified group. If we include the AMI – unspecified patients in the RSMR modelling, these critically unwell patients have a spurious

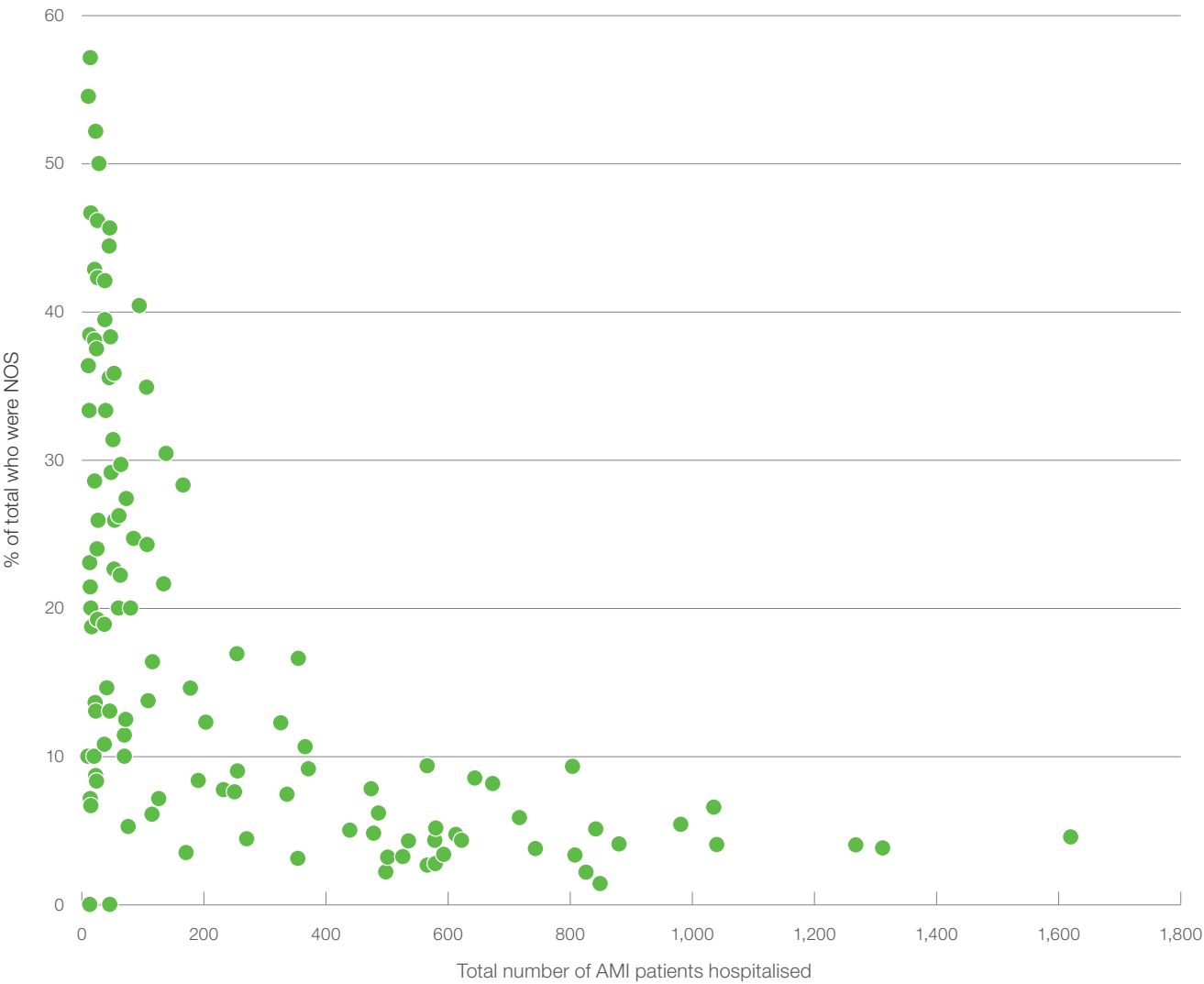
effect on the expected mortality in the smaller hospitals where AMI – unspecified is more likely to be a result of diagnostic and or coding deficiencies – potentially providing a misleading picture of performance.

As a result of these findings, the RSMRs reported in *The Insights Series: 30-day mortality following hospitalisation, five clinical conditions, NSW July 2009 – June 2012* exclude AMI – unspecified patients from the analysis.

Table 7: Mortality among AMI sub-categories: STEMI, non-STEMI and unspecified, NSW July 2009 – June 2011

	30-day mortality rate	% deaths that occurred on day 1
STEMI	10%	5%
Non-STEMI	6%	26%
STEMI - not specified	49%	57%

Figure 7: Percentage of AMI - unspecified vs total number of AMI patients, July 2009 - June 2012



Conclusion

The Bureau of Health Information's 30-day Risk-Standardised Mortality Ratio (RSMR) indicator for five clinical conditions (acute myocardial infarction; ischaemic stroke; haemorrhagic stroke; pneumonia; hip fracture surgery) highlights outlier hospitals in the state. Published in the report *Insights into care: 30-day mortality following hospitalisation, five clinical conditions, NSW, July 2009 – June 2012*, the RSMR draws on a linked databases going back 12 years and merges information from hospital records and death registries. It calculates a ratio of expected to observed deaths in the 30-days following admission to the first presenting hospitals during the last episode of illness for the selected conditions.^(a) We believe that this measure provides a strong assessment of mortality and has many advantages:

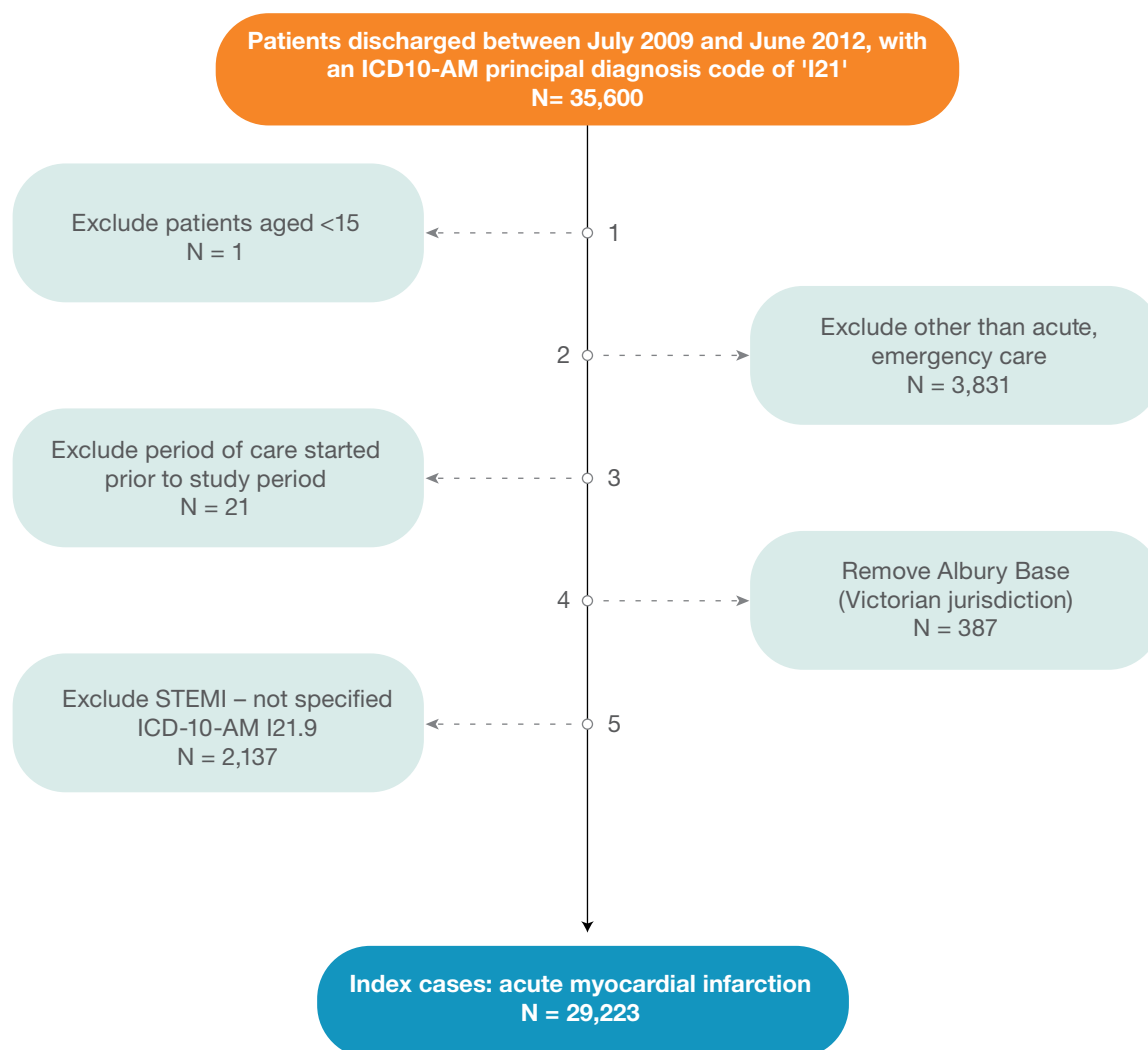
- It takes a patient perspective to assess mortality following initial presentation to hospital, avoiding the biases related to multiple hospitalisations and transfers
- It captures mortality that occur both within the hospital as well as following discharge, therefore potentially relates to both the short-term as well as the longer-term consequences of care provision within the hospital, during discharge and following their hospitalisation
- It attributes outcomes to the first presenting hospital, avoiding the bias generated by the fact that patients that are transferred to secondary or tertiary institutions tend to be patients that were healthy enough to withstand transfer
- It provides increased capacity to identify comorbidities in medical records, benefitting from a look back period, compared to measures using the comorbidities recorded at the time of a single hospitalisation
- It supports longitudinal assessment of mortality ratios to show trends in time
- It is amenable to secondary analyses to assess associations between mortality and specific clinical characteristics (STEMI vs non-STEMI acute myocardial infarction), **structural and organisational attributes** (presence of a cardiac catheterization laboratories or stroke units) and **time-dependent analyses** (deaths on day of admission vs deaths occurring on latter days).

(a) Bureau of Health Information. *Spotlight on measurement: 30-day mortality following hospitalisation, NSW, July 2009 – June 2012*. 2013. BHI; Sydney

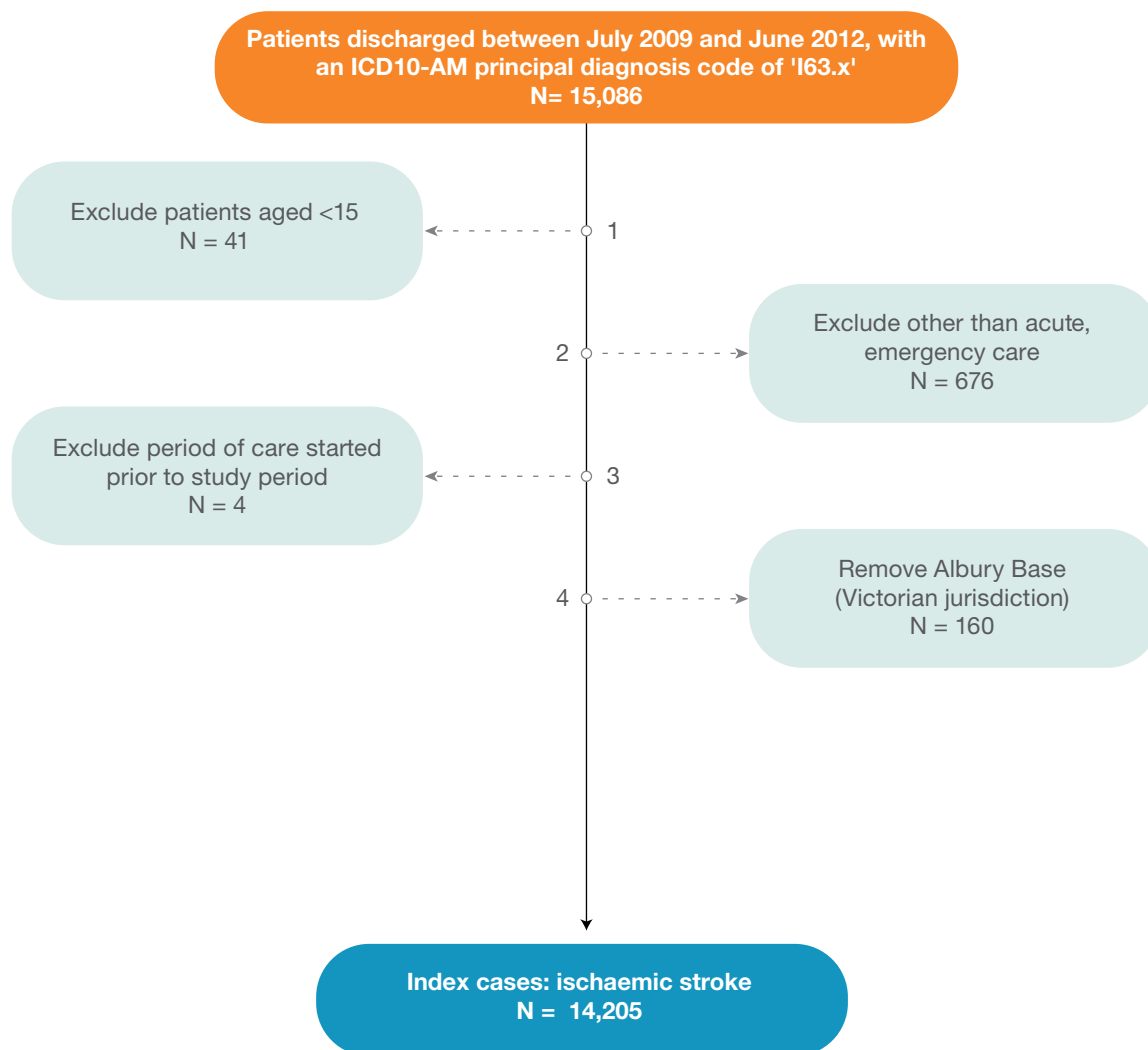
As with any indicator, it also has limitations that relate to the quality of the information available, the appropriateness of the risk-adjustment method, the capacity to capture exceptional organisational circumstances as well as taking into account the complex nature of health systems. The measure provides a fair assessment of hospitals, controlling for the types of patients they treat and allowing for differing thresholds to identify outliers given the volume of cases they see. RSMRs however are not designed to compare hospitals. Similar mortality levels might be higher than expected in one hospital and fall within the control limits for another, given their differing sizes.

In addition, RSMRs are not to be used as measure of the number of avoidable deaths. While it is known that variation in clinical care can affect the likelihood of survival for acute conditions and that a proportion of deaths are attributable to suboptimal care, RSMRs do not distinguish between deaths that are avoidable or those that are a reflection of the natural course of illness. Not every death is avoidable, not every survival is desirable. Other measures, such as clinical audit and review panels, are designed to assess the avoidability of specific cases.

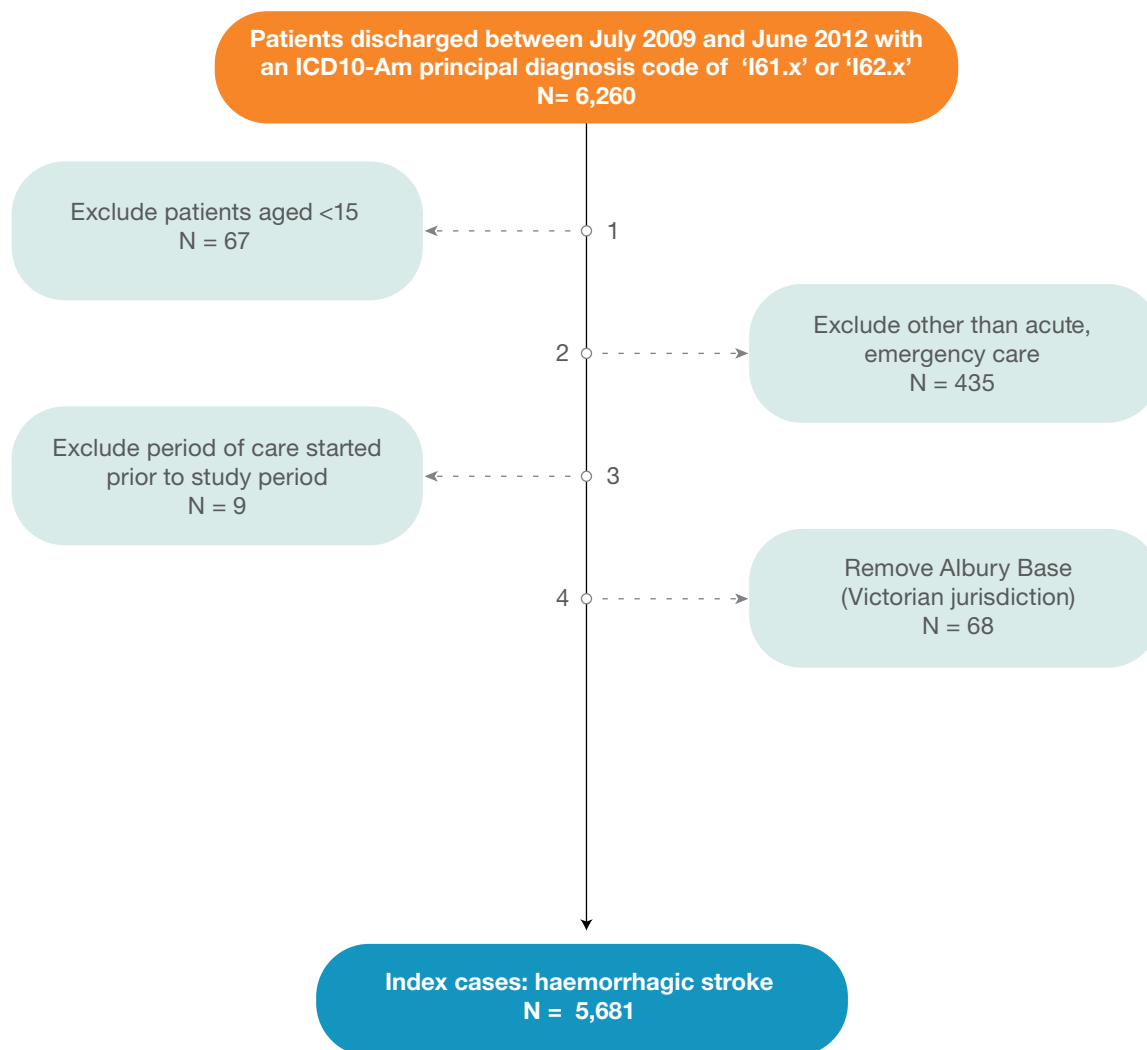
Appendix 1: Acute myocardial infarction



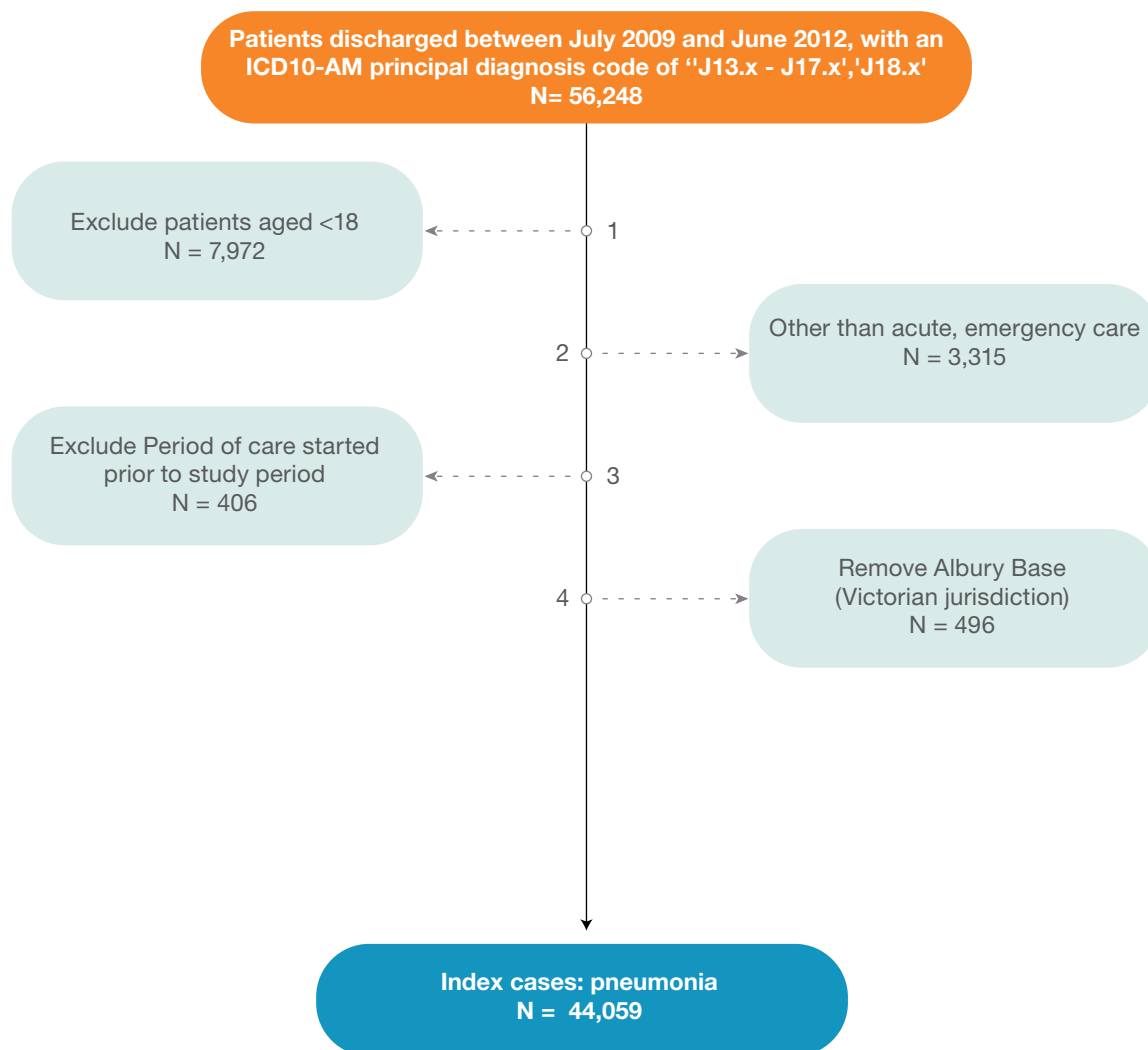
Appendix 2: Ischaemic stroke



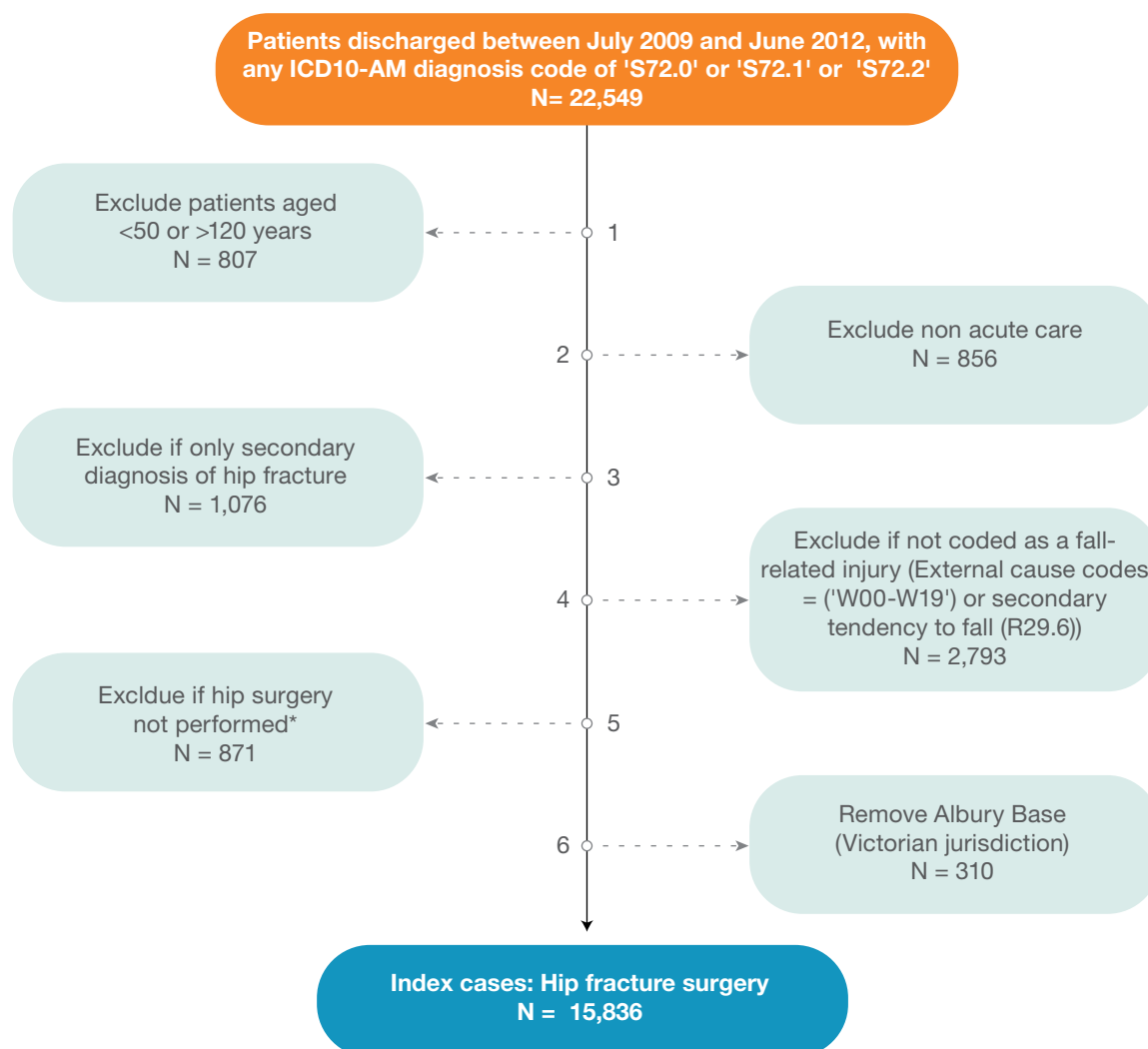
Appendix 3: Haemorrhagic stroke



Appendix 4: Pneumonia



Appendix 5: Hip fracture surgery



(*) Surgical procedure codes used for inclusion in the cohort were those recommended by the Australian Commission on Safety and Quality in Health Care (mbs_ep codes '47519-00', '47522-00', '47528-01', '47531-00', '49315-00') and additional procedure codes recommended by NSW Agency for Clinical Innovation's surgical network ('49318-00', '49319-00')

Appendix 6: peer groups

Peer groups

NSW hospitals vary in size and the types and complexity of clinical services that they provide. It is important to compare similar or like hospitals. To do this, the Bureau uses a NSW Health classification system called '*peer group*'. The hospital peer groups included in this report are:

Group	Name	Description
A	Principal referral	Very large hospitals providing a broad range of services, including specialised units at a state or national level (for this report, ungrouped tertiary hospitals are included in this group).
BM/BNM	Major	Large metropolitan (BM) and non-metropolitan (BNM) hospitals.
C1	District group 1	Medium sized hospitals treating between 5,000–10,000 patients annually.
C2	District group 2	Smaller hospitals, typically in rural locations.

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About the Bureau

The Bureau of Health Information provides the community, healthcare professionals and the NSW Parliament with timely, accurate and comparable information on the performance of the NSW public health system in ways that enhance the system's accountability and inform efforts to increase its beneficial impact on the health and wellbeing of the people of NSW.

The Bureau is an independent, board-governed statutory health corporation. The conclusions in this report are those of the Bureau and no official endorsement by the NSW Minister for Health, the NSW Ministry of Health or any other NSW statutory health corporation is intended or should be inferred.

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