MELBOURNE HEALTH

THE UNIVERSITY OF MELBOURNE

MELBOURNE EPICENTRE

Hospital Mortality Indicator (HMI) Review APPENDICES

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PREPARED BY

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APPENDIX 1 – Critical appraisal tools

Methodology Checklist 3: Cohort studies

SIGN

Study identification (*Include author, title, year of publication, journal title, pages*)		
Guideline topic:	Key Question No:	Reviewer:

Before completing this checklist, consider:

1. Is the paper really a cohort study? If in doubt, check the study design algorithm available from SIGN and make sure you have the correct checklist.
2. Is the paper relevant to key question? Analyse using PICO (Patient or Population Intervention Comparison Outcome). IF NO REJECT (give reason below). IF YES complete the checklist.

Reason for rejection: 1. Paper not relevant to key question ☐ 2. Other reason ☐ (please specify):

Please note that a retrospective study (ie a database or chart study) cannot be rated higher than +.

SECTION 1: INTERNAL VALIDITY

In a well conducted cohort study:		***Does this study do it?***
1.1	The study addresses an appropriate and clearly focused question.	Yes □ No □ Can't say □
SELECTION OF SUBJECTS		
1.2	The two groups being studied are selected from source populations that are comparable in all respects other than the factor under investigation.	Yes □ No □ Can't say □ Does not apply □
1.3	The study indicates how many of the people asked to take part did so, in each of the groups being studied.	Yes □ No □ Does not apply □
1.4	The likelihood that some eligible subjects might have the outcome at the time of enrolment is assessed and taken into account in the analysis.	Yes □ No □ Can't say □ Does not apply □
1.5	What percentage of individuals or clusters recruited into each arm of the study dropped out before the study was completed.	
1.6	Comparison is made between full participants and those lost to follow up, by exposure status.	Yes □ No □ Can't say □ Does not apply □

ASSESSMENT		
1.7	The outcomes are clearly defined.	Yes □ No □ Can't say □
1.8	The assessment of outcome is made blind to exposure status. If the study is retrospective this may not be applicable.	Yes □ No □ Can't say □ Does not apply □
1.9	Where blinding was not possible, there is some recognition that knowledge of exposure status could have influenced the assessment of outcome.	Yes □ No □ Can't say □ □
1.10	The method of assessment of exposure is reliable.	Yes □ No □ Can't say □
1.11	Evidence from other sources is used to demonstrate that the method of outcome assessment is valid and reliable.	Yes □ No □ Can't say □ Does not apply□
1.12	Exposure level or prognostic factor is assessed more than once.	Yes □ No □ Can't say □ Does not apply □
CONFOUNDING		
1.13	The main potential confounders are identified and taken into account in the design and analysis.	Yes □ No □ Can't say □
STATISTICAL ANALYSIS		
1.14	Have confidence intervals been provided?	Yes □ No □
SECTION 2: OVERALL ASSESSMENT OF THE STUDY		
2.1	How well was the study done to minimise the risk of bias or confounding?	High quality (++) □ Acceptable (+) □ Unacceptable – reject 0
2.2	Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, how strong do you think the association between exposure and outcome is?	
2.3	Are the results of this study directly applicable to the patient group targeted in this guideline?	Yes □ No □
2.4	**Notes.** Summarise the authors conclusions. Add any comments on your own assessment of the study, and the extent to which it answers your question and mention any areas of uncertainty raised above.	

Checklist for appraising articles for Question 3. Risk prediction models

Q3. What risk adjustment models and statistical issues are associated with use of HMIs?

a. Variables included
b. Use of statistical limits to identify outliers
c. Methods used to distinguish data artefact from quality of care/resource issues

ARTICLE ID (Author, year, journal): _____

The study addresses an appropriate and clearly focussed question	Yes No Unclear
Data source: Have the authors described the type of data used?	Yes No Unclear
Have the data attributes been described in sufficient detail e.g. socio-demographic profile of the population?	Yes No Unclear
Reliability and validity: have the reliability and validity of the data been described, including any data quality checks and data cleaning procedures?	Yes No Unclear
Describe methods used for "supplementing" data, such as imputation of missing values, linkage to other data sources (e.g. death data or socio-economic indices)	
Research design ○ Is there evidence of a well-developed data analysis plan (e.g. a priori study hypothesis)? ○ Study design is appropriate for the research question: Has the investigator provided a rationale for the particular research design? ○ Did the author identify and address potential limitations of that design?	Yes No Unclear
Study population and variable definitions ○ Sample selection: Inclusion and exclusion criteria defined (steps used to derive the final sample from the initial population are described)	Yes No Unclear
Are cases (subjects) and end point (outcomes) clearly defined (e.g. criteria explicitly defined using procedure codes/Dx codes and or other criteria)	Yes No Unclear
Definition validity: have the authors provided a rationale and/or supporting literature (e.g. ref) for the definitions and criteria used?	Yes No Unclear

Statistical methods well described ○ Variables included in the model are well defined, summarised with descriptive statistics ○ Main methods for analysing the primary objective of the study are well defined ○ The methods used for each analysis are clear ○ Data conformed to assumptions of the tests used to analyze them. ○ The authors have defined the p-value or effect size that determines clinical importance ○ Allowances or adjustments made for multiple comparisons are clearly defined (indicated whether and how) ○ If relevant, how any outlying or missing data were treated in the analysis is reported ○ Authors report the alpha level used in the univariate analysis, whether the variables were assessed for colinearity and interaction;	Yes No Unclear
Authors reported other analyses done—e.g. analyses of subgroups and interactions, and sensitivity analyses	
Authors summarise key results with reference to study objectives	
Authors discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	
Model prediction: if a multivariate predictive model is being developed in the analysis, do they discuss how well the model predicts what it is intended to predict?	Yes No Unclear
Have the statistical findings been interpreted in terms of their clinical or economic relevance?	Yes No Unclear
Generalisability: have the authors discussed the populations and settings to which the results can be generalised?	Yes No Unclear

Comments:

APPENDIX 2 – Condensed indicator summaries

1. Aggregated in-hospital mortality indicators

Aggregated in-hospital mortality						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment & statistical methods**	**Reporting and interpretation**
Australian Commission on Safety and Quality in Health Care (ACQSHC) National core, hospital-based outcome indicators ***Year:*** 2012	The ratio of the observed number of hospital separations that end in the patient's death, to the number of separations expected to end in death based on the patient's characteristics , for principal diagnoses accounting for 80% of in-hospital mortality.	***Numerator:*** Observed number of in-hospital deaths x 100 where: Observed number of in-hospital deaths = the total number of separations ***Denominator:*** Expected number of in-hospital deaths = the sum of the estimated probabilities of death for all separations meeting the denominator criteria, calculated using national risk adjustment coefficients.	***Inclusion criteria:*** • Principal diagnosis is in the national list of the top 80% of diagnoses, by frequency of in-hospital death, in the latest reference period (see Appendix 1) • Age at date of admission is between 29 days and 120 years, inclusive • Care type6 = acute care, geriatric evaluation and management and maintenance care • Length of stay (LOS, including leave days) is between 1 and 365 days, • inclusive (1 ≤ LOS ≤ 365) • Urgency status = emergency, elective. ***Exclusion criteria:*** • Neonates, aged ≤ 28 days at admission • Missing admission mode, sex.	Age 29 days -120 years	• Age at admission (years) • Sex • Principal diagnosis code (mapped to national in-hospital mortality risk deciles) • Admission urgency status: emergency, elective • Length of stay (including leave days) categorised as 1 day, 2 days, 3-9 days, 10-15 days, 16-21 days and 22-365 days • Additional (comorbid) diagnoses (Charlson index) categorised into 0 – Charlson Index score of 0; 1 – Charlson index score of 1; 2 Charlson index score ≥2 • Admission mode (inward transfer status) = admitted patient transferred from another hospital.	***How reported:*** Reported as HSMR - the ratio of observed (actual) number of in-hospital deaths to expected number of in-hospital deaths, multiplied by 100. ***Interpretation:*** A value of 100 indicates the mortality rate is the same as the national rate for patients with similar to those treated. A value of more than 100 corresponds to a higher than expected rate, while a value of less than 100 corresponds to a lower than expected mortality rate. ***Public reporting:*** TBA ***Hospital reporting:*** TBA
Canadian Health Indicators (CIHI) ***Year:*** 2013 Hospital	The ratio of the actual number of acute in-hospital deaths to the	***Numerator:*** Actual number of deaths among diagnosis groups accounting for 80% of inpatient	***Inclusion criteria:*** • Discharge between April 1 of a given year and March 31 of the following year • Admission to an acute care institution	Age at admission between 29 days and 120 years	For each of 72 diagnostic groups a logistic regression model is fitted with the following independent variables: • Age on admission	***How reported:*** HSMR - the ratio of observed (actual) number of in-hospital deaths to expected number of in-hospital deaths, multiplied by 100. Also reported are Supplementary HSMRs for: • Medical and surgical HSMRs

Aggregated in-hospital mortality						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment & statistical methods**	**Reporting and interpretation**
Standardized Mortality Ratio (HSMR) Technical notes, Updated April 2013, Canadian Institute for Health Information.	expected number of in-hospital deaths, for conditions accounting for about 80% of inpatient mortality.	mortality. ***Denominator:*** Expected number of deaths among diagnosis groups accounting for 80% of inpatient mortality	• Discharge with diagnosis group of interest (that is, one of the diagnosis groups that account for about 80% of in-hospital deaths, after excluding patients with palliative care) • Age at admission between 29 days and 120 years • Sex recorded as male or female • Length of stay of up to 365 consecutive days • Admission category is elective (L) or emergent/urgent (U) • Canadian resident (see Appendix II for information on identifying non-residents) ***Exclusion criteria:*** • Cadavers, with discharge disposition = 08 • Stillborns, with discharge disposition = 09 • Sign-outs (that is, discharged against medical advice), with discharge disposition = 06 • Patients who do not return from a pass, with discharge disposition = 12 • Neonates, with age at admission less than or equal to 28 days • Records with brain death as most responsible diagnosis code (ICD-10-CA): G93.81 • Records with palliative care		• Sex (recorded on discharge) • Comorbidity group • Length of stay groups (1day, 2 days, 3 to 9 days, 10 to 15 days, 16 to 21 days, 22 to 365 days) • Admission category (recorded on discharge) • Transfers to acute care institution Comorbidities are adjusted for using the Charlson Index, based on preadmission diagnoses, with the exception of the most responsible diagnosis identified by the hospital. Coefficients derived from logistic regression models are used to calculate the probability of in-hospital death. The 95% confidence interval is calculated using Bayar's approximation. The reference year for HSMR calculations is 2009–2010.	• ICU related cases • HSMR excluding transfers • Regional and organisational level HSMR. HSMR are not calculated for specific facilities (e.g children's cancer) or sub-acute facilities and these are not included in the regional HSMRs. ***Interpretation:*** A ratio equal to 100 is interpreted as no difference between the hospital's mortality rate and the average national rate in the baseline year. A ratio greater than 100 indicates that the hospital's mortality rate is higher than the average rate. A ratio of less than 100 indicates that the hospital's mortality rate is lower than the average rate. A confidence interval that includes 100 suggests that the HSMR is not statistically different from the 2009–2010 baseline of 100. HSMR results whose confidence interval does not include 100 and are therefore statistically different from the 2009–2010 baseline are denoted with a symbol in the reports. ***Public reporting:*** Via online interactive reporting portal with results viewable by hospital or region for the last 5 years, showing trends over time. Results reported only for facilities having at least 2,500 qualifying discharges. ***Hospital reporting:*** Via secure website.

Aggregated in-hospital mortality						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment & statistical methods**	**Reporting and interpretation**
Quality Accounts-Patient Safety (Dr Foster)	The ratio of the observed number of in-hospital deaths with a Hospital Standardised Mortality Ratio (HSMR) diagnosis to the expected number of deaths, multiplied by 100.	***Numerator:*** Denominator superspells with method of discharge as death (DISMETH=4,5) ***Denominator:*** Superspells containing a spell with a primary dominant diagnosis of any of the 56 CCS groups that comprise the HSMR basket (contributing to 80% of deaths)	Excluding day cases	All ages	• Sex • Age on admission (in five year bands up to 90+) • Interactions between age on admission (in five year bands up to 90+) and Charlson co-morbidity score • Admission method (non-elective or elective) • Socio-economic deprivation quintile of the area of residence of the patient (based on the Carstairs Index) • Diagnosis/procedure subgroup • Co-morbidities (based on Charlson score) • Number of previous emergency admissions • Year of discharge (financial year) • Whether or not palliative care • Month of admission • Source of admission	***How reported:*** Reported as HSMR - The ratio of the observed number of in-hospital deaths during admissions with a Hospital Standardised Mortality Ratio (HSMR) diagnosis to the expected number of deaths, multiplied by 100 ***Interpretation:*** Score of 100 represents the national average. A trust with An HSMR of 100 means the number of patients who died is exactly as it would be expected taking into account the standardisation factors. An HSMR above 100 means more patients died than would be expected; one below means fewer patients died than would be expected. ***Publicly reported:*** Dr Foster Quality Accounts (http://www.drfosterhealth.co.uk/quality-accounts/) and in the My Hospital Guide http://myhospitalguide.drfosterhealth.co.uk/ ***Hospital reporting:*** For member organisations via online system. No detail available.

2. In-hospital mortality indicators for acute myocardial infarction

In-hospital mortality indicators for acute myocardial infarction						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting and interpretation**
Australian Commission on Safety and Quality in Health Care (ACQSHC) National core, hospital-based outcome indicators ***Year:*** *2012*	In-hospital deaths of patients admitted for Acute Myocardial Infarction	***Numerator:*** Observed number of in-hospital deaths for AMI patients × national in-hospital mortality rate for AMI patients *where* Observed number of in-hospital deaths for AMI patients = the total number of separations (meeting the denominator criteria) where separation mode = d*ied* National mortality rate = national observed number of in-hospital deaths for AMI ÷ national observed number of separations for AMI. ***Denominator:*** Expected number of in-hospital deaths for AMI patients = the sum of the estimated probabilities of death for all separations (meeting the	***Inclusion criteria:*** • Principal diagnosis of AMI, represented by one of the following codes: (refer to specifications for specific codes) • Age at admission date is between 18 and 89 years, inclusive • Care type = *acute care* • Urgency status = *emergency* • Length of stay (LOS), including leave days) is between 1 and 30 days, inclusive (1 ≤ LOS ≤ 30) (but not including same day). ***Exclusion criteria:*** • Additional diagnosis of Cardiac arrest AND Condition onset flag = *Condition not noted as arising during the episode of admitted patient care*. • Same day separations (where date of admission is equal to the date of separation). Episode of care for angina or chest pain occurring prior to the denominator episode: Also include in the denominator episodes of care occurring prior to the admission for AMI (as identified above) where: • Date of separation of prior	Age at admission date is between 18 and 89 years, inclusive	Logistic regression model - the response variable will be the probability of in-hospital mortality, and the predictor variables include those listed below. Coefficients from national risk-adjustment modelling are used to calculate the probability of in-hospital death for each case from a hospital. The sum of the probabilities of death will form the expected number of deaths. • Age in years at date of admission • Sex • Additional comorbidities diagnoses (dichotomous variables): dementia, Alzheimer's, hypotension, shock, kidney (renal) failure, heart failure, dysrhythmia, malignancy, hypertension.	***How reported:*** The ratio of observed (actual) number of in-hospital deaths to expected number of in-hospital deaths for Acute Myocardial Infarction (AMI) patients, multiplied by the national mortality rate for AMI patients. A value higher than the national rate corresponds to a higher than expected mortality rate, while a value of lower than the national rate corresponds to a lower than expected mortality rate. High or rising rates signal that a problem might exist and that further investigation is required. ***Publicly reported:*** TBA ***Hospital reported:*** TBA

In-hospital mortality indicators for acute myocardial infarction						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting and interpretation**
		denominator criteria), calculated using national risk-adjustment coefficients	episode = date of admission of AMI episode (as identified under denominator inclusions and exclusions above). **AND** • Principal diagnosis of prior episode is Angina **OR** Chest pain **AND** • Separation mode of prior episode = *discharge / transfer to (an) other acute hospital*. **AND** • Care type of prior episode = *acute care*.			
Variable Life Adjusted Display Indicator (VLAD) Acute myocardial infarction (AMI) in hospital mortality. AMI VLAD Indicator Review, Summary of Activities, 2012 VLAD Indicator Definitions report- Queensland Health- June 2012 ***Year:*** 2012	In-hospital deaths of acute myocardial infarction (AMI) patients. In-hospital mortality rate is defined as the number of records where separation mode = "death" and length of stay is less than or equal to 30 days, divided by the total number of records.	***Numerator:*** ***Current:*** Patients who died in hospital ***Recommended change***: Acute Myocardial Infarction patients who died in-hospital and had a length of stay of less than or equal to 30 days. ***Denominator:*** ***Current:*** (no change) Patients with a principal diagnosis of AMI	***Inclusion criteria:*** ***Current:*** • 30-89 years • Length of stay 4-30 days; unless the patient had a length of stay from 1-3 days and died in hospital • Admitted through the ED only ***Recommended change***: • Remove I22 (Subsequent myocardial infarction) from Principal Diagnosis from inclusion criteria. • Expand age of patients to include all ages. • All lengths of patient days. • Include only emergency admissions identified through elective status of the patient rather than admission source or	***Current:*** Age 30-89 years ***Recommended change:*** All ages	***Current:*** • Sex • Age • Comorbidities: malignancy, diabetes, dementia (including Alzheimer's Disease), hypertension, dysrhythmias, heart failure, hypotension and shock, cerebrovascular disease, renal failure. ***Recommended change:*** (excludes diabetes, hypertension as comorbidities) • Age • Comorbidities -	***How reported:*** Rate per 100 separations ***Interpretation:*** Higher level represents higher than expected mortality. ***Public reporting:*** The Hospital Performance Reports are no longer available publicly on the website. At the time of the last literature review in 2009, the 2004 data was available publicly. ***Hospital reporting:*** Yes, via secure online platform provided in partnership with Opus 5 . Features of the website include charting to show performance against control

In-hospital mortality indicators for acute myocardial infarction						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting and interpretation**
			admitted through emergency department. ***Exclusion criteria:*** ***Current:*** • Excluding transfers out ***Recommended change:*** • Exclude out of hospital arrest. • Modify risk adjustment criteria (see below) Rules governing inclusion of transferred patients in contiguous episodes.		malignancy, dementia (inc. Alzheimer's disease),dysrhythmias, heart failure, cerebrovascular disease, hypotension and shock, renal failure	limits for a selected indicator and facility. Includes systems for actioning performance results found to be outside the control limits. The Opus 5 website also includes functionality for analysing causes and determining workflow to address quality issues. VLAD is updated on a monthly. A flag is initiated where the VLAD line meets the lower or upper control limits.
In-patient Quality Indicators (AHRQ) Acute myocardial infarction (AMI) mortality rate. ***Year:*** 2013	***Current definition:*** In-hospital deaths per 1,000 hospital discharges with acute myocardial infarction (AMI) as a principal diagnosis for patients ages 18 years and older. Excludes obstetric discharges and transfers to another hospital. ***Previous definition (2009)***: Number of deaths per 100 discharges with principal diagnosis of AMI.	***Numerator:*** ***Current:*** Number of deaths (DISP=20) among cases meeting the inclusion and exclusion rules for the denominator. ***Previous (2009)***: Number of deaths among cases meeting the inclusion and exclusion rules for the denominator (see below). ***Denominator:*** ***Current:*** Discharges, for	***Exclusion criteria:*** ***Current:*** • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • with missing: – discharge disposition (DISP=missing), – gender (SEX=missing), – age (AGE=missing), – quarter (DQTR=missing), – year (YEAR=missing) or – principal diagnosis (DX1=missing) ***Previous (2009):*** • missing discharge disposition • transferring to another short-term	Age greater than or equal to 18 years	QI software adjusts risk according to diagnosis-related groups (APR-DRG). Observed rates may be risk adjusted by: • hospitals, • age groups, race/ethnicity categories, • sex and • Payer categories.	***How reported:*** Reported as rate per 1000 discharges. ***Interpretation:*** Better quality is associated with a lower score. ***Public reporting:*** The public reports include in-hospital mortality for AMI. ***Hospital reporting:*** Yes, via website. Hospitals may also use the software to create their own reports.

In-hospital mortality indicators for acute myocardial infarction						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting and interpretation**
		patients ages 18 years and older, with a principal ICD-9-CM diagnosis code for AMI. ***Previous (2009):*** All discharges, age 18 years and older, with a principal diagnosis code of AMI.	hospital • pregnancy, childbirth and puerperium			
In-patient Quality Indicators (AHRQ) Acute myocardial infarction (AMI) mortality rate, without transfer cases. ***Year:*** 2013	***Current definition:*** In hospital deaths per 1,000 hospital discharges with acute myocardial infarction (AMI) as a principal diagnosis for patients ages 18 years and older. Excludes obstetric discharges, transfers to another hospital, and transfers in from another acute care hospital. ***Previous definition (2009)***: Number of deaths per 100 discharges with a principal diagnosis code of AMI, excluding cases transferred into or out of the hospital.	***Numerator:*** Number of deaths among cases meeting the inclusion and exclusion rules for the denominator (see below). ***Denominator*** All discharges, age 18 years and older, with a principal diagnosis code of AMI	***Exclusion criteria:*** • transferring to another short-term hospital (DISP=2) • transferring from another short-term hospital (SID ASOURCE=2 or POINTOFORIGINUB04=4) • MDC 14 (pregnancy, childbirth, and puerperium) • with missing: – discharge disposition (DISP=missing) – gender (SEX=missing) – age (AGE=missing) – quarter (DQTR=missing) – year (YEAR=missing) – principal diagnosis (DX1=missing), or admission source (SID ASOURCE=missing or POINTOFORIGINUB04=missing	Age greater than or equal to 18 years	QI software adjusts risk according to diagnosis-related groups (APR-DRG). Observed rates may be risk adjusted by: • hospitals, • age groups, race/ethnicity categories, • sex and • payer categories.	***How reported:*** Reported as rate per 1000 discharges. ***Interpretation:*** Better quality is associated with a lower score. ***Public reporting:*** None of the public reports include “without transfer” indicator for AMI. ***Hospital reporting:*** Yes, via website. Hospitals may also use the software to create their own reports.

In-hospital mortality indicators for acute myocardial infarction

Source and indicator name	Definition	Numerator / Denominator	Inclusion / Exclusion Criteria for Denominator	Age group	Risk adjustment	Reporting and interpretation
Canadian Health Indicators (CIHI) 30-day acute myocardial infarction (AMI) in-hospital mortality rate. Health Indicators May 2013, Canadian Institute for Health Information (CIHI). Canadian Hospital Reporting Project Technical Notes-Clinical Indicators, March 2013 ***Year:*** 2013	***Canadian Indicators definition:*** The risk adjusted rate of all-cause in- hospital death occurring within 30 days of first admission to an acute care hospital with a diagnosis of acute myocardial infarction (AMI). ***Canadian Hospital reporting Project definition:*** The rate of in-hospital deaths due to all causes occurring within 30 days after the first acute myocardial infarction (AMI) admission to an acute care hospital.	***Numerator:*** ***Canadian Indicators:*** Number of deaths from all causes occurring in hospital within 30 days of admission for AMI. ***Canadian Hospital reporting Project:*** Cases within the denominator where an in-hospital death occurred within 30 days of the AMI admission. ***Denominator:*** ***Canadian Indicators:*** Episodes of first AMI occurrence admitted between April 1 and March of the fiscal year. ***Canadian Hospital reporting Project:*** Cases within the denominator where an in-hospital death occurred within 30 days of the AMI admission.	***Canadian Indicators:*** ***Inclusion criteria:*** • a) Acute myocardial infarction (AMI) (ICD-10-CA: I21, I22; ICD-9/ICD-9-CM: 410) is coded as MRDx but not also as a diagnosis type (2); or • b) Where another diagnosis is coded as MRDx and also a diagnosis type (2), and a diagnosis of AMI is coded as a type (1), or [type (W), (X) or (Y) but not also as type (2)]; or • c) Where coronary artery disease (ICD-10-CA: I25.0, I25.1, I25.8, I25.9; • ICD-9/ICD-9-CM: 429.2, 414.0, 414.8, 414.9) is coded as MRDx, AMI as type (1), or [type (W), (X) or (Y) but not also as type (2)]; along with revascularization procedure • (percutaneous coronary intervention [CCI: 1.IJ.50^^, 1.IJ.57.GQ^^, 1.IJ.54.GQ-AZxxxvii; • CCP: 48.02, 48.03; ICD-9-CM: 36.01, 36.02, 36.05] or coronary artery bypass [CCI: • 1.IJ.76^^; CCP: 48.1^; ICD-9-CM: 36.1^]) • Admission between April 1 and March 1 of the following year (period of case selection ends • March 1 to allow for 30 days of	***Canadian Indicators:*** Age 20 to 105 years ***Canadian Hospital Reporting Project:*** excluding ages 19 and under	***Canadian Hospital Reporting Project*** Statistical regression modelling is used to risk-adjust patient characteristics. Risk factors controlled for include: • age, • gender and • selected pre-admit comorbid diagnoses applicable to the indicator. Risk-adjusted rates are calculated at the hospital, health administration region and provincial/ territorial levels. Regional and provincial risk-adjusted rates are aggregated hospital-level data.	***How reported:*** Reported as rate per 100 discharges. ***Interpretation:*** Better quality is associated with a lower score. ***Public reporting:*** Public reporting is available via the CIHI website. 30-day in-hospital mortality for AMI is one of the indicators that can be viewed by peer group and individual hospital through the ***Hospital Results*** report. Rates are based on three years of pooled data: April 1, 2009, to March 31, 2012 ***Hospital reporting:*** Yes, via online system

In-hospital mortality indicators for acute myocardial infarction						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting and interpretation**
			follow-up) • Age at admission between 20 and 105 years • Sex recorded as male or female • Admission to an acute care institution • Admission category recorded as urgent/emergent • Canadian resident ***Exclusion criteria:*** • Records with an invalid health card number • Records with an invalid date of birth • Records with an invalid admission date • Records with an invalid discharge date • Records with an AMI admission within one year prior to the admission date of the index episode • Records where the AMI coded as most responsible is also coded as a post-admission diagnosis [diagnosis type (2)] ***Canadian Hospital Reporting Project:*** ***Inclusion criteria:*** • Admission Category Code = U **AND** • Facility Type Code = 1 (acute care) **AND**			

In-hospital mortality indicators for acute myocardial infarction						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting and interpretation**
			• Admission date = April 1 to March 1 **AND** a) AMI (ICD-10-CA: I21.^ or I22.^) is coded as diagnosis type M but not also as type 2; OR b) Where another diagnosis is coded as type M and also as type 2, and a diagnosis of AMI is coded as type 1 (or type W, X or Y but not also as type 2); OR c) Coronary artery disease (ICD-10-CA: I25.0, I25.1^, I25.8 or I25.9) is coded as type M and AMI is coded as type 1 or type W, X or Y but not also as a type 2 **AND** • A revascularization procedure is coded: Percutaneous coronary intervention (CCI: 1.IJ.50^^, 1.IJ.57.GQ^^ or 1.IJ.54.GQ.AZ*) or • Coronary artery bypass (CCI: 1.IJ.76^^) ***Exclusion Criteria:*** • AMI admissions (ICD-10-CA: I21.^ or I22.^ as a diagnosis type M, 1, 2, W, X or Y in the 12 months preceding the admission date on the index AMI record • Age (in years) associated with index AMI record ≤19 • Refer to Section 5: Identifying Acute Care and Day			

In-hospital mortality indicators for acute myocardial infarction						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting and interpretation**
Quality Accounts-Patient Safety (Dr Foster) Hospital standardised mortality ratio - AMI.	The ratio of the observed number of in-hospital deaths to the expected number of deaths, multiplied by 100.	***Numerator*** All spells with method of discharge as death, defined by a specific diagnosis code for the primary diagnosis of the spell (AMI), excluding day cases. ***Denominator*** The expected number of in-hospitals deaths derived from logistic regression.	***Exclusion criteria:*** • Daycases (where classpat = 2 in the first episode)	Not specified	Risk adjustments are made for: • Sex • Age on admission (in five year bands up to 90+) • Admission method (non-elective or elective) • Socio-economic deprivation quintile of the area of residence of the patient (based on the Carstairs Index) • Primary diagnosis (based on the Clinical Classification System - CCS group) • Co-morbidities (no further information available) • Number of previous emergency admissions • Year of discharge (financial year) • Palliative care (whether the patient is being treated in specialty of palliative care).	***How reported:*** Standardised ratio for Trusts (147) Observed / expected x100 ***Interpretation:*** It is expressed as a relative risk, where a risk rating of 100 represents the national average. If the trust has an HSMR of 100, that means that the number of patients who died is exactly as it would be expected taking into account the standardisation factors. ***Publicly reporting:*** Dr Foster Quality Accounts (http://www.drfosterhealth.co.uk/quality-accounts/) ***Hospital reporting:*** Participating hospitals access details online via a secure website.

In-hospital mortality indicators for acute myocardial infarction						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting and interpretation**
Health Care Quality Indicators (OECD) Acute myocardial infarction: 30-day case-fatality rate / in-hospital mortality rate. ***Year:*** *2006*	Number of deaths in the hospital that occurred within 30 days of hospital admission with primary diagnosis of AMI.	***Numerator*** Number of deaths in the hospital that occurred within 30 days of hospital admission with primary diagnosis of AMI. ***Denominator*** Number of people hospitalised with primary diagnosis of AMI.	***Exclusion criteria:*** • death that occur out of hospital • AMI patient who were admitted with other conditions and died in the hospital	Not specified. Varies for participating countries.	Standardised rates adjust for differences in age (45+ years) and sex. Comparability issues include: variation in the data collection period, age groups, coding practice, collection methods.	***How reported:*** Rates per 100 patients, age-sex standardised rates per 100 patients with 95% confidence intervals. Better quality is associated with a lower score. ***Public reporting:*** Health at a Glance is an annual publication reporting indictor performance for participating countries. The data is also reported online via the OECD website. . Comparative analysis is performed from data collected from 17 different countries ***Hospital reporting:*** No

3. In-hospital mortality indicators for stroke

In-hospital mortality indicators for stroke						
Source	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting and interpretation**
Australian Commission on Safety and Quality in Health Care (ACQSHC) National core, hospital-based outcome indicators In hospital mortality for acute myocardial infarction (AMI) CHBOI3a	In-hospital deaths of patients admitted for Acute Myocardial Infarction	***Numerator:*** Observed number of in-hospital deaths for stroke patients × national in-hospital mortality rate for stroke patients *Where* Observed number of in-hospital deaths for stroke patients = the total number of separations (meeting the denominator criteria) where separation mode23 = *died*. National mortality rate = national observed number of in-hospital deaths for stroke ÷ national observed number of separations for stroke. ***Denominator:*** Expected number of in-hospital deaths for stroke patients = the sum of the estimated probabilities of death for all separations (meeting the denominator criteria), calculated using national risk-adjustment coefficients.	***Inclusion criteria:*** • Principal diagnosis of stroke (I61.x – I64.x)24 • Age at date of admission is between 18 and 89 years, inclusive • Care type25 = *acute care* • Length of stay (LOS, including leave days) is between 1 and 30 days, inclusive (1 ≤ LOS ≤ 30). ***Exclusion criteria:*** Any procedure: codes26 33500-00 [700], 32703-00 [718].	Adults aged 18 – 89 years (inclusive) at admission.	Logistic regression model - the response variable will be the probability of in-hospital mortality, and the predictor variables include those listed below. Coefficients from national risk-adjustment modelling are used to calculate the probability of in-hospital death for each case from a hospital. The sum of the probabilities of death will form the expected number of deaths. • Age in years at date of admission. • Additional (comorbidities) diagnoses (3 dichotomous variables): including: Kidney (renal) failure (N17.x, N19.x, N18.3, N18.4, N18.5,N18.9,R34.x); Heart failure (I50.x, I11.0, I13.0, I13.2); Malignancy (C00.x – C96.x (except C44.x)).	***How reported:*** The ratio of observed (actual) number of in-hospital deaths to expected number of in-hospital deaths for stroke patients, multiplied by the national mortality rate for stroke patients. ***Interpretation:*** A value higher than the national rate corresponds to a higher than expected mortality rate, while a value of lower than the national rate corresponds to a lower than expected mortality rate. High or rising rates signal that a problem might exist and that further investigation is required. ***Publicly reporting:*** TBA ***Hospital reporting:*** TBA

In-hospital mortality indicators for stroke

Source	Definition	Numerator / Denominator	Inclusion / Exclusion Criteria for Denominator	Age group	Risk adjustment	Reporting and interpretation
Variable Life Adjusted Display (VLAD) Indicators Stroke in-hospital mortality. Stroke VLAD Indicator Review, Summary of Activities, 2012 VLAD Indicator Definitions report- Queensland Health- June 2012 ***Year:*** 2012	In hospital death of stroke patients.	***Numerator:*** ***Current:*** Patients died in-hospital. ***Recommended change:*** (Review 2012) Patients who died in hospital and had a length of stay less than or equal to 30 days. ***Denominator*** ***Current:*** Patients with a principal diagnosis of Intracerebral haemorrhage; other non-traumatic intracranial haemorrhage; cerebral infarction; or stroke; not specified as haemorrhage or infarction	***Inclusion criteria:*** ***Current:*** • 30-89 years • length of stay 3 or more days unless the patient died in hospital ***Recommended from 2012 review – not yet incorporated into specifications:*** • Inclusion of all in hospital mortalities • Expand age of patients to include those aged 18-29 years • Linkage of episodes across hospitals to be the same as linkage within hospitals, i.e. – link to subsequent acute stroke episodes or other non-acute episodes • Transfers out from the initial hospital providing acute treatment are included, as are transfers in and out of subsequent hospitals in a single 'continuum of care'. A transferred case is defined as either: an admission to a subsequent hospital within 12 hours of separation from the previous hospital **OR** an admission to a subsequent hospital within 36 hours with indication of either a 'transfer	***Current:*** Age 30-89 years ***Recommended change:*** to include 18-29 years	***Current:*** Risk adjustment made for: Age group, septicaemia, malignancy, heart failure, acute lower respiratory tract infection and influenza, and renal failure. ***Recommended:*** To remove septicaemia and acute respiratory tract infection and include risk adjustment for stroke type: • Age group • Heart failure • Malignancy • Renal Failure • Stroke type (as defined by ICD code block: I61, I62, I63, or I64) • Refer to Stroke VLAD Indicator Review, Summary of Activities, 2012, pg 8 for rationale of risk adjustment recommendations.	***How reported:*** Rate per 100 separations ***Interpretation:*** A lower rate reflects higher quality ***Publicly reporting:*** The Hospital Performance Reports are no longer available publicly on the website. At the time of the last literature review in 2009, the 2004 data was available publicly. ***Hospital reporting*** Via secure online platform provided in partnership with Opus 5 . Features of the website include charting to show performance against control limits for a selected indicator and facility. Includes systems for actioning performance results found to be outside the control limits. The Opus 5 website also includes functionality for analysing causes and determining workflow to address quality issues. VLAD is updated on a monthly. A flag is initiated where the VLAD line meets the lower or upper control limits.

In-hospital mortality indicators for stroke						
Source	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting and interpretation**
			out' or a 'transfer in' ***Exclusion criteria:*** ***<u>Current</u>*** • transfers in • transfers out • changes of episode type, and • procedure codes for carotid endarectomy or resection of carotid artery with re-anastomosis ***Recommendations from 2012 review – not yet incorporated into specifications:*** • Exclusion of same day and overnight patients that do not die • Exclude procedure codes for carotid endarectomy or resection of carotid artery with re-anastomosis; Percutaneous transluminal angioplasty of single carotid artery, multiple stents; Percutaneous transluminal angioplasty of single carotid artery, single stent; Hind brain decompression; Subtemporal decompression; Posterior cranial fossa decompression; Insertion of external ventricular drain; or Removal of external ventricular drain to be excluded.			

In-hospital mortality indicators for stroke

Source	Definition	Numerator / Denominator	Inclusion / Exclusion Criteria for Denominator	Age group	Risk adjustment	Reporting and interpretation
In-patient Quality Indicators (AHRQ) Acute stroke mortality rate. **Year:** 2013	***Current definition:*** In-hospital deaths per 1,000 hospital discharges with acute stroke as a principal diagnosis for patients ages 18 years and older. Includes metrics for discharges grouped by type of stroke. Excludes obstetric discharges and transfers to another hospital. ***Previous definition (2009)***: Number of deaths per 100 discharges with principal diagnosis code of stroke	***Numerator*** ***Overall:*** Number of deaths (DISP=20) among cases meeting the inclusion and exclusion rules for the denominator. *[NOTE: Overall numerator may not match the sum of the strata numerators because the strata may not be mutually exclusive.]* ***Stratum A*** **(**subarachnoid stroke**):** Number of deaths (DISP=20) among cases meeting the inclusion and exclusion rules for the denominator. ***Stratum B*** **(**hemorrhagic stroke**):** Number of deaths (DISP=20) among cases meeting the inclusion and exclusion rules for the denominator. ***Stratum C*** (ischemic stroke)**:** Number of deaths (DISP=20) among cases meeting the inclusion and exclusion rules for the denominator. ***Denominator*** ***Overall:*** Discharges, for patients ages 18 years and older, with a principal ICD-9-CM diagnosis code for subarachnoid stroke	***Exclusion criteria:*** ***Overall:*** • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • with missing discharge disposition (DISP=missing), gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing) or principal diagnosis (DX1=missing) ***Stratum A*** • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • with missing discharge disposition (DISP=missing), gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing) or principal diagnosis (DX1=missing) ***Stratum B*** • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • with missing discharge disposition (DISP=missing), gender (SEX=missing), age	Age greater than or equal to 18 years.	QI software adjusts risk according to diagnosis-related groups (APR-DRG). Observed rates may be risk adjusted by: • hospitals, • age groups, race/ethnicity categories, • sex and • Payer categories.	***How reported:*** Reported as rate per 1000 discharges. ***Interpretation:*** Better quality is associated with a lower score. ***Public reporting:*** None of the public reports include in-hospital mortality for stroke. ***Hospital reporting:*** Via website. Hospitals may also use the software to create their own reports.

In-hospital mortality indicators for stroke						
Source	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting and interpretation**
		or a principal ICD-9-CM diagnosis code for hemorrhagic stroke or a principal ICD-9-CM diagnosis code for ischemic stroke. ***Stratum A*** (subarachnoid stroke)**:** Discharges, for patients ages 18 years and older, with a principal ICD-9-CM diagnosis code for subarachnoid stroke. ***Stratum B*** (hemorrhagic stroke)**:** Discharges, for patients ages 18 years and older, with a principal ICD-9-CM diagnosis code for hemorrhagic stroke. **Stratum C** (ischemic stroke)**:** Discharges, for patients ages 18 years and older, with a principal ICD-9-CM diagnosis code for ischemic stroke. ***Previous (2009):*** **NOTE:** Previously not broken up into types of stroke: ***Numerator:*** Number of deaths among cases meeting the inclusion or exclusion rules for the denominator. ***Denominator:*** All discharges, age 18 years and older, with a principal diagnosis code of stroke**.**	(AGE=missing), quarter (DQTR=missing), year (YEAR=missing) or principal diagnosis (DX1=missing) ***Stratum C*** • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • with missing discharge disposition (DISP=missing), gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing) or principal diagnosis (DX1=missing) ***Previous (2009):*** • missing discharge disposition • transferring to another short-term hospital • major Diagnostic Category (MDC): pregnancy, childbirth and puerperium.			

In-hospital mortality indicators for stroke

Source	Definition	Numerator / Denominator	Inclusion / Exclusion Criteria for Denominator	Age group	Risk adjustment	Reporting and interpretation
Canadian Health Indicators (CIHI) 30-day stroke in-hospital mortality rate. Health Indicators May 2013, Canadian Institute for Health Information (CIHI). Canadian Hospital Reporting Project Technical Notes-Clinical Indicators, March 2013 ***Year:*** 2013	***Canadian Indicators definition:*** Risk-adjusted rate of all cause in-hospital death occurring within 30 days of first admission to an acute care hospital with a diagnosis of stroke. ***Canadian Hospital Reporting Project definition:*** Rate of in-hospital deaths due to all causes occurring within 30 days after the first stroke admission to an acute care hospital.	***Numerator*** ***Canadian Indicators:*** Number of deaths from all causes occurring in-hospital within 30 days of admission for stroke. ***Canadian Hospital Reporting Project:*** Cases within the denominator where an in-hospital death (Discharge Disposition Code =07 (died)); facility code =1 (acute); occurred within 30 days of the stroke admission (Discharge date on death record_ - (Admission date on stroke record) ≤ 30 days. ***Denominator*** ***Canadian Indicators:*** Total Number of stroke episodes in an 11 month period ***Canadian Hospital Reporting Project:*** Episodes of first stroke occurrence admitted between April 1 and March 1 of the fiscal year.	***Canadian Indicators:*** ***Inclusions criteria:*** • 1.a) Stroke 1 (ICD-10-CA: I60-I64; ICD-9CM: 430-432; 433-434 with fifth digit of 1; 436) is coded as MRDx but not also as a diagnosis type (2); or • b) Where another diagnosis is coded as MRDx and also a diagnosis type (2), and a diagnosis of Stroke is coded as a type (1), or [type (W), (X) or (Y) but not also as type (2)]; or • Where rehabilitation (ICD-10: Z50.1, Z50.4-Z50.9; ICD-9CM: V57) is coded as MRDx and Stroke as a type (1), or [type (W), (X) or (Y) but not also as type (2)]. • Admission between April 1 and March 1 of the following year (period of case selection ends March 1 to allow for 30 days of follow-up) • Age at admission between 20 and 105 years • Gender recorded as male or female • Admission to an acute care institution • Admission category recorded as urgent/emergent • Canadian resident	***Canadian Indicators:*** Age 20 to 105 years ***Canadian Hospital Reporting Project:*** excluding ages 19 and under	***Canadian Hospital Reporting Project*** Statistical regression modelling is used to risk-adjust patient characteristics. Risk factors controlled for include: • Age, • Gender and • Selected pre-admit comorbid diagnoses applicable to the indicator. For stroke mortality these include cancer, shock, heart failure, pulmonary oedema, ischaemic heart disease (acute, chronic), renal failure, liver disease, other unspecified intracranial haemorrhage, intracerebral haemorrhage or infarction and subarachnoid haemorrhage. Risk-adjusted rates are calculated at the hospital, health administration region and provincial/ territorial levels. Regional and provincial risk-	***How reported:*** Reported as rate per 100 discharges. ***Interpretation:*** Better quality is associated with a lower score. ***Public reporting:*** Public reporting is available via the CIHI website. 30-day in-hospital mortality for stroke is one of the indicators that can be viewed by peer group and individual hospital through the ***Hospital Results*** report. Rates are based on three years of pooled data: April 1, 2009, to March 31, 2012 ***Hospital reporting:*** Via online system

In-hospital mortality indicators for stroke						
Source	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting and interpretation**
			Exclusion criteria: • Records with an invalid Health Card Number • Records with an invalid date of birth • Records with an invalid admission date or time • Records with an invalid discharge date or time • Records with a stroke admission within one year prior to the admission date of the index episode • Records where the stroke coded as most responsible is also coded as a post-admission diagnosis (diagnosis type (2)) **Further Notes** In the denominator population, a stroke episode must start as an inpatient case with a diagnosis of stroke. For multi-hospital episodes of care, death is attributed to the hospital to which the patient was admitted at the beginning of the episode of care (index record). If the patient was admitted for a stroke multiple times throughout the year, only the first episode was included in the denominator. Stroke episodes where the patient had a previous stroke		adjusted rates are aggregated hospital-level data.	

In-hospital mortality indicators for stroke

Source	Definition	Numerator / Denominator	Inclusion / Exclusion Criteria for Denominator	Age group	Risk adjustment	Reporting and interpretation
			admission within the last 12 months are excluded (washed out). ***Canadian Hospital Reporting Project:*** ***Inclusions*** and ***exclusions*** as above except upper age limit removed – (age excludes patients 19 and under).			
Quality accounts-Patient safety (Dr Foster) Hospital standardised mortality ratio – stroke.	The ratio of the observed number of in-hospital deaths to the expected number of deaths, multiplied by 100.	***Numerator*** All spells with method of discharge as death, defined by a specific diagnosis code for the primary diagnosis of the spell (stroke), excluding day cases. ***Denominator*** Expected number of in-hospitals deaths derived from logistic regression.	***Exclusion criteria:*** Daycases (where classpat = 2 in the first episode)	Not specified	Risk adjustments are made for: • Sex • Age on admission (in five year bands up to 90+) • Admission method (non-elective or elective) • Socio-economic deprivation quintile of the area of residence of the patient (based on the Carstairs Index) • Primary diagnosis (based on the Clinical Classification System - CCS group) • Co-morbidities (no further information available) • Number of previous emergency admissions • Year of discharge	***How reported:*** Standardised ratio for Trusts (147) Observed / expected x100 ***Interpretation:*** Risk rating of 100 represents the national average. If the trust has an HSMR of 100, that means that the number of patients who died is exactly as it would be expected taking into account the standardisation factors. ***Public reporting:*** Dr Foster Quality Accounts (http://www.drfosterhealth.co.uk/quality-accounts/) ***Hospital reporting:*** Participating hospitals access details online via a secure website.

In-hospital mortality indicators for stroke						
Source	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting and interpretation**
					(financial year) • Palliative care (whether the patient is being treated in specialty of palliative care).	
Health Care Quality Indicators (OECD) Stroke 30 day case-fatality rate/in-hospital mortality rate. ***Year:*** 2006	Number of deaths in the hospital that occurred within 30 days of hospital admission with primary diagnosis of hemorrhagic and ischemic stroke.	***Numerator*** Number of deaths in the hospital that occurred within 30 days of hospital admission with primary diagnosis of hemorrhagic stroke, and ischemic stroke (ICD-9 or ICD-10). ***Denominator*** Number of people hospitalised with primary diagnosis of stroke.	Not specified	Not specified. Varies for participating countries.	Standardised rates adjust for differences in age (45+ years) and sex. Comparability issues include: variation in the data collection period, age groups, coding practice, collection methods.	***How reported:*** Rates per 100 patients, age-sex standardised rates per 100 patients with 95% confidence intervals. ***Interpretation:*** Better quality is associated with a lower score. ***Public reporting:*** Health at a Glance is an annual publication reporting indictor performance for participating countries. The data is also reported online via the OECD website. Comparative analysis is performed from data collected from 17 different countries ***Hospital reporting:*** No

4. In-hospital mortality indicators for pneumonia

In-hospital mortality indicators for pneumonia						
Source	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting**
Australian Commission on Safety and Quality in Health Care (ACQSHC) National core, hospital-based outcome indicators ***Year:*** 2012	In-hospital deaths of patients admitted for pneumonia	***Numerator:*** Observed number of in-hospital deaths for pneumonia patients × national in hospital mortality rate for pneumonia patients *Where* Observed number of in-hospital deaths for pneumonia patients = the total number of separations (meeting the denominator criteria) where separation mode = *died*. National mortality rate = national observed number of in-hospital deaths for pneumonia ÷ national observed number of separations for pneumonia. ***Denominator:*** Expected number of in-hospital deaths for pneumonia patients,= the sum of the estimated probabilities of death for all separations (meeting the denominator criteria), calculated using national risk adjustment coefficients.	***Inclusion criteria:*** • Principal diagnosis35 of pneumonia (J13.x – J16.x, J18.x) • Age at date of admission is between 18 and 89 years, inclusive • Care type36 = *acute care* • Length of stay (LOS, including leave days) is between 1 and 30 days, inclusive [1 day ≤ LOS ≤ 30 days].	Age at date of admission is between 18 and 89 years, inclusive	***Risk adjustments made for:*** • Age in years at date of admission • Additional (comorbid) diagnoses: – Dementia – Alzheimer's disease – Hypotension – Shock – Kidney (renal) failure – Other chronic obstructive pulmonary disease – Heart failure – Dysrhythmia – Malignancy – Liver disease – Cerebrovascular disease – Parkinson's disease	***How reported:*** The ratio of observed (actual) number of in-hospital deaths to expected number of in-hospital deaths for pneumonia patients, multiplied by the national mortality rate for pneumonia patients : ***Interpretation:*** A value higher than the national rate corresponds to a higher than expected mortality rate, while a value of lower than the national rate corresponds to a lower than expected mortality rate. High or rising rates signal that a problem might exist and that further investigation is required. ***Public reporting:*** TBA ***Hospital reporting:*** TBA

In-hospital mortality indicators for pneumonia

Source	Definition	Numerator / Denominator	Inclusion / Exclusion Criteria for Denominator	Age group	Risk adjustment	Reporting
Variable Life Adjusted Display Indicators (VLAD) Pneumonia in hospital mortality. ***Year:*** 2008/09	In-hospital deaths of pneumonia patients. In-hospital mortality rate is defined as the number of records where separation mode = "death" and length of stay is less than or equal to 30 days, divided by the total number of records.	***Numerator:*** Patients died in-hospital. ***Denominator:*** Patients with a principal diagnosis of pneumonia due to Streptococcus pneumoniae; pneumonia due to Haemophilus influenzae; Bacterial pneumonia, not elsewhere classified; pneumonia due to other infectious organisms, not elsewhere classified; and Pneumonia, organism unspecified.	***Inclusion criteria***: • 20-89 years • length of stay 1-30 days ***Exclusion criteria:*** • transfers in and transfers out	20-89 years	***Risk adjustments are made for:*** • age • septicaemia • malignancy • dementia (inc Alzheimer's Disease) • Parkinson's Disease • dysrhythmias • heart failure • hypotension and shock • cerebrovascular disease • other chronic obstructive pulmonary disease • liver diseases • ulcer of lower limb or decubitus ulcer renal failure	***How reported:*** Reported as rate per 100 separations. ***Interpretation:*** Better quality is associated with a lower score. ***Public reporting:*** No ***Hospital reporting*** *Via secure website*
In-patient Quality Indicators (AHRQ) Pneumonia mortality rate. ***Year:*** 2013	***New definition (2013):*** In-hospital deaths per 1,000 hospital discharges with pneumonia as a principal diagnosis for patients ages 18 years and older. Excludes obstetric discharges and transfers to another hospital. ***Previous definition (2009):*** Mortality in discharges with	***Numerator:*** Number of deaths among cases meeting the inclusion and exclusion rules for the denominator. ***Denominator:*** Discharges, for patients ages 18 years and older, with a principal ICD-9-CM diagnosis code for pneumonia.	***New exclusion criteria (2013):*** • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • with missing discharge disposition (DISP=missing), gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing) or principal diagnosis (DX1=missing) ***Previous exclusion criteria (2009):*** All discharges, age 18 years and older, with a principal diagnosis code of pneumonia, excluding:	Age greater than or equal to 18 years	QI software adjusts risk according to diagnosis-related groups (APR-DRG). Observed rates may be stratified by hospitals, age groups, race/ethnicity categories, sex, and payer categories.	***How reported:*** Reported as rate per 1000 discharges. ***Interpretation:*** Better quality is associated with a lower score. ***Public reporting*** Public reports include in-hospital mortality for pneumonia. ***Hospital reporting:*** Via website. Hospitals may also use the software to create their own reports

In-hospital mortality indicators for pneumonia						
Source	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting**
	principal diagnosis code of pneumonia.		• missing discharge disposition • transferring to another short-term hospital • Major Diagnostic Category (MDC): pregnancy, childbirth, and puerperium			

5. In-hospital mortality indicators for hip fracture

In-hospital mortality indicators for hip fracture						
Source	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting**
Australian Commission on Safety and Quality in Health Care (ACQSHC) National core, hospital-based outcome indicators ***Year:*** *2012*	In-hospital deaths of patients admitted for fractured neck of femur operative intervention	***Numerator:*** Observed number of in-hospital deaths for NOF patients × national in-hospital mortality rate for NOF patients *Where* Observed number of in-hospital deaths for NOF patients = the total number of separations (meeting the denominator criteria) where separation mode = *died*. National mortality rate = national observed number of in-hospital deaths for NOF ÷ national observed number of separations for NOF ***Denominator:*** Expected number of in-hospital deaths for NOF patients = the sum of the estimated probabilities of death for all separations (meeting the denominator criteria), calculated using national risk-adjustment coefficients.	***Inclusion criteria:*** • Principal diagnosis29 of NOF (S72.0, S72.10, S72.11) **AND** – Procedure code30 in (47519-00 [1479] , 47522-00 [1489], 47528-01 [1486], 47531-00 [1486], 49315-00 [1489]) **AND** – External cause31 code of Falls (W00.x – W19.x,) OR secondary diagnosis code32 of Tendency to fall not elsewhere classified (R29.6). • Age at date of admission is between 50 and 120, inclusive • Length of stay (LOS, including leave days) is between 1 and 30 days, inclusive (1 ≤ LOS ≤ 30).	Age at date of admission is between 50 and 120, inclusive	***Risk adjustments made for:*** • Age in years at date of admission • Sex • Additional (comorbid) diagnoses: – Ischaemic heart disease – Dysrhythmia – Acute lower respiratory tract infection (LRTI) and influenza – Kidney (renal) failure – Heart failure	***How reported:*** Reported as the risk adjusted rate – the ratio of observed (actual) number of in-hospital deaths to expected number of in-hospital deaths for fractured neck of femur (NOF) patients, multiplied by the national mortality rate for NOF patients. ***Interpretation:*** A value higher than the national rate corresponds to a higher than expected mortality rate, while a value of lower than the national rate corresponds to a lower than expected mortality rate. High or rising rates signal that a problem might exist and that further investigation is required. ***Public reporting:*** TBA ***Hospital reporting:*** TBA

In-hospital mortality indicators for hip fracture

Source	Definition	Numerator / Denominator	Inclusion / Exclusion Criteria for Denominator	Age group	Risk adjustment	Reporting
Variable Life Adjusted Display Indicators (VLAD) Fractured neck of femur in hospital mortality. ***Year:*** 2008/09	Fractured Neck of Femur patients who died in-hospital and had a length of stay less than or equal to 30 days.	***Numerator:*** Patients died in-hospital. ***Denominator*** ***Current:*** Patients with a principal diagnosis of fracture of femur with at least one of the following procedures: Internal fixation of fracture of trochanteric or subcapital femur; Hemiarthroplasty of femur; Open reduction of fracture of femur with internal fixation; Closed reduction of fracture of femur with internal fixation; Partial arthroplasty of hip. ***Recommended (Revised)*** Patients with a principal diagnosis of fracture of femur: • S72.0: Fracture of neck of femur • S72.1: Pertrochanteric fracture • S72.2: Subtrochanteric fracture With at least one of the following procedures: • 47519-00: Internal fixation of fracture of trochanteric or subcapital femur • 47531-00: Closed	***Inclusion criteria:*** ***Current*** • 50 years or older • patients have spent at least one night in hospital ***Recommended (revised)*** • 50 years or older • All lengths of stays • All transfers in and transfers out • All episode types • All external cause codes ***Exclusion criteria:*** ***Current*** • excluding transfers in and transfers out ***Recommended (revised)*** Exclude if the patient's usual residence is interstate and the mode of separation in their last episode of care was 'Transferred out to another facility'.	50 years and older	***Risk adjustments are made for:*** ***Currently*** • age group • sex • ischaemic heart disease • dysrhythmias • heart failure • acute lower respiratory tract infection and influenza • renal failure ***Recommended (revised):*** • age group • sex • ischaemic heart disease • dysrhythmias • heart failure • renal failure • ASA score	***How reported:*** Reported as rate per 100 separations. ***Interpretation:*** Better quality is associated with a lower score. ***Publicly reporting:*** The Hospital Performance Reports are no longer available publicly on the website. At the time of the last literature review in 2009, the 2004 data was available publicly. ***Hospital reporting*** Via secure online platform provided in partnership with Opus 5 . Features of the website include charting to show performance against control limits for a selected indicator and facility. Includes systems for actioning performance results found to be outside the control limits. The Opus 5 website also includes functionality for analysing causes and determining workflow to address quality issues. VLAD is updated on a monthly. A flag is initiated where the VLAD line meets the lower or upper control limits.

In-hospital mortality indicators for hip fracture						
Source	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting**
		reduction of fracture of femur with internal fixation • 47528-01: Open reduction of fracture of femur with internal fixation • 47522-00: Hemiarthroplasty of femur • 49312-00: Excision arthroplasty of hip • 49315-00: Partial arthroplasty of hip • 49318-00: Total arthroplasty of hip (unilateral)				
In-patient Quality Indicators (AHRQ) Hip fracture mortality rate. ***Year:*** 2013	***New definition (2013):*** In-hospital deaths per 1,000 hospital discharges with hip fracture as a principal diagnosis for patients ages 65 years and older. Excludes periprosthetic fracture discharges, obstetric discharges,	***Numerator:*** Number of deaths among cases meeting the inclusion and exclusion rules for the denominator. ***Denominator:*** Discharges, for patients ages 65 years and older, with a principal ICD-9-CM diagnosis code for hip fracture.	***New exclusion criteria (2013):*** • with any-listed ICD-9-CM diagnosis codes for periprosthetic fracture (99644 PERIPROSTHETIC FX-PROS JT) • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • with missing discharge disposition (DISP=missing), gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing) or principal diagnosis (DX1=missing) ***Previous exclusion criteria (2009):*** • cases with any diagnosis of periprosthetic fracture • missing discharge disposition	65 years and older	Risk adjustment not provided. Observed rates may be stratified by: • Hospitals • Age groups • Race/ethnicity categories • Sex • Payer categories	***How reported:*** Reported as rate per 1000 discharges. ***Interpretation:*** Better quality is associated with a lower score. ***Public reporting*** None of the Public reports include in-hospital mortality for fractured neck of femur. ***Hospital reporting:*** Via website. Hospitals may also use the software to create their own reports

In-hospital mortality indicators for hip fracture						
Source	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting**
	and transfers to another hospital. ***Previous definition (2009):*** Number of deaths per 100 discharges with principal diagnosis code of hip fracture.		• transferring to another short-term hospital • Major Diagnostic Category (MDC): pregnancy, childbirth, and puerperium			
Quality accounts-Patient safety (Dr Foster) Hospital standardised mortality ratio – fracture neck of femur.	The ratio of the observed number of in-hospital deaths to the expected number of deaths, multiplied by 100.	***Numerator:*** All spells with method of discharge as death (DISMETH=4), defined by a specific diagnosis code for the primary diagnosis of the spell. ***Denominator:*** Expected number of in-hospitals deaths derived from logistic regression.	***Exclusion criteria:*** • Daycases (where classpat = 2 in the first episode)	Not specified	***Risk adjustments are made for:*** • Sex • Age on admission (in five year bands up to 90+) • Admission method (non-elective or elective) • Socio-economic deprivation quintile of the area of residence of the patient (based on the Carstairs Index) • Primary diagnosis (based on the Clinical Classification System - CCS group) • Co-morbidities	***How reported:*** Reported as standardised ratios for Trusts (147) (observed / expected). The ratio is calculated by dividing the actual number of deaths by the expected number and multiplying the figure by 100. ***Interpretation:*** It is expressed as a relative risk, where a risk rating of 100 represents the national average. If the trust has an HSMR of 100, that means that the number of patients who died is exactly as it would be expected taking into account the standardisation factors. An HSMR above 100 means more patients died than would be expected; one below 100 means that fewer than expected died.

In-hospital mortality indicators for hip fracture						
Source	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment**	**Reporting**
					• Number of previous emergency admissions • Year of discharge (financial year) • Palliative care (whether the patient is being treated in specialty of palliative care)	Control limits tell us the range of values which are consistent with random or chance variation. Data points falling within the control limits are consistent with random or chance variation and are said to display 'common-cause variation'; for data points falling outside the control limits, chance is an unlikely explanation and hence they are said to display 'special-cause variation' - that is, where the trust's rate diverges significantly from the national rate. ***Public reporting*** Dr Foster Quality Accounts (http://www.drfosterhealth.co.uk/quality-accounts/)

6. In-hospital death in low mortality DRG

Death in low mortality DRG						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment & statistical methods**	**Reporting & interpretation**
Australian Commission on Safety and Quality in Health Care (ACQSHC) National core, hospital-based outcome indicators ***Year:*** 2012	In-hospital deaths in Diagnosis Related Groups with a mortality rate less than 0.5%	***Numerator*** Number of in-hospital deaths for low mortality DRGs x 100 *Where* Number of in-hospital deaths = total number of separations (meeting denominator criteria) and separation mode11 = *died.* ***Denominator*** Number of separations in low-mortality DRGs. Low mortality DRGs are defined as DRGs with a national mortality rate of less than 0.5% over the previous 3 years.	***Inclusion criteria:*** • Age at date of admission is between 18 and 120 years, inclusive • DRGs codes: low mortality DRG*s* (see Appendix 2 for list of codes) • Care type12 = acute care. ***Exclusion criteria:*** • Any diagnosis (principal or additional) and/or any procedure of trauma, immuno-compromised state, cancer.	Age 18 – 120 years	There is no risk adjustment for CHBOI 2 Death in low mortality DRGs however, stratification of results by hospital peer group will improve the comparability and relevance of the unadjusted rates.	***How reported:*** Reported as the percentage of separations for low mortality diagnosis-related groups (DRGs) that end in death in hospital. ***Interpretation:*** High or rising rates signal that a problem might exist and that further investigation is required. Investigations should consider a range of possible explanations including: differences from the national patient population; structural or resource issues (e.g. staff shortages, ward closures, etc.); changes in treatment protocols; and professional practice (i.e. individual clinical staff actions) (Mohammed et al. 2004). For this indicator, the main risk lies in allocation of a low mortality DRG to a patient with multiple reasons for admission. ***Publicly reported:*** TBA ***Hospital reported:*** TBA
Victorian State Government, Australia, Department of Health, Patient Safety Indicators, AusPSI, October 2012 ***Year:*** October		***Numerator*** Episodes with a separation type of "death". ***Denominator*** Episodes, 18 years and older, in low-mortality DRGs, defined as DRGs with a total mortality rate	***Inclusion criteria:*** • AR DRGs version 5.1 codes: *low mortality DRGs* (see Appendix for list of codes) ***Exclusion criteria:*** • Episodes with any code for trauma, immunocompromised state or cancer.	Age 18 – 120 years	There is no risk adjustment for CHBOI 2 Death in low mortality DRGs however, stratification of results by hospital peer group will improve the	***How reported:*** Reported as the percentage of separations for low mortality diagnosis-related groups (DRGs) that end in death in hospital. ***Interpretation:*** High or rising rates signal that a problem might exist and that further investigation is required.

Death in low mortality DRG						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment & statistical methods**	**Reporting & interpretation**
2012		less than 0.5% over the previous 3 years or less than 0.5% in any of the previous 3 years.			comparability and relevance of the unadjusted rates.	Investigations should consider a range of possible explanations including: differences from the national patient population; structural or resource issues (e.g. staff shortages, ward closures, etc.); changes in treatment protocols; and professional practice (i.e. individual clinical staff actions) (Mohammed et al. 2004). For this indicator, the main risk lies in allocation of a low mortality DRG to a patient with multiple reasons for admission. ***Publicly reported:*** TBA ***Hospital reported:*** TBA
In-patient Quality Indicators (AHRQ) US ***Year:*** 2013	In-hospital deaths per 1,000 discharges for low mortality (< 0.5%) Diagnosis Related Groups (DRGs) among patients ages 18 years and older or obstetric patients. Excludes cases with trauma, cases with cancer, cases with an immunocomp	***Numerator:*** Number of deaths (DISP=20) among cases meeting the inclusion and exclusion rules for the denominator. ***Denominator:*** Discharges, for patients ages 18 years and older or MDC 14 (pregnancy, childbirth, and puerperium), with a low-mortality (less than 0.5%) DRG or MS-DRG code. If a DRG or MS-DRG is divided into "without/with complications," both DRG or MS-DRG codes must have mortality rates below 0.5% to qualify for	***Inclusion criteria:*** • ages 18 years and older • or MDC 14 (pregnancy, childbirth, and puerperium) with a low-mortality (less than 0.5%) DRG or MS-DRG code. • (NB: If a DRG or MS-DRG is divided into "without/with complications," both DRG or MS-DRG codes must have mortality rates below 0.5% to qualify for inclusion.) • For details of low mortality DRGs see Table Pages 2-3 in Death Rate in Low-Mortality Diagnosis Related Groups (DRGs) Technical Specifications ***Exclusion criteria:*** • with any-listed ICD-9-CM	Aged 18 years plus	Risk adjustments are made for: • Age • Sex • transfers in • comorbidities (congestive heart failure, other neurological conditions, chronic pulmonary disease, hypothyroidism, renal failure, obesity, deficiency anaemia) • certain modified DRGs • mental diseases and disorders	***How reported:*** Reported as the in-hospital deaths per 1,000 discharges for low mortality (< 0.5%) Diagnosis Related Groups (DRGs) ***Interpretation:*** Higher rates point to higher likelihood of errors associated with deaths. High or rising rates signal that a problem might exist and that further investigation is required. ***Public reporting*** Deaths in low mortality DRG are reported publicly via the online National Health Quality and Disparities Reports (HQRDRnet) and Death in low mortality DRG is also included as one of the indicators reported in the State Snap shot reports which expresses a composite comparative measure of performance as well as specific data relating to the indicator and whether the

Death in low mortality DRG						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment & statistical methods**	**Reporting & interpretation**
	romised state, and transfers to an acute care facility.	inclusion.	diagnosis codes for trauma • with any-listed ICD-9-CM diagnosis codes for cancer • with any-listed ICD-9-CM diagnosis codes or any-listed ICD-9-CM procedure codes for immunocompromised state • transfer to an acute care facility (DISP=2) • with missing discharge disposition (DISP=missing), gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing), or principal diagnosis (DX1=missing)		• when procedures days data is not available. Risk adjustment coefficients are described in Patient Safety Indicators Risk Adjustment Coefficients	performance for that indicator is the same, better or worse that other states. ***Hospital reporting:*** Yes via web site Hospitals are also able to use the software to create their own reports
Dr Foster, Quality Accounts-Patient Safety (UK) ***Date:*** Not provided	Deaths per 1000 spells for conditions normally associated with a very low rate of mortality.	***Numerator:*** Denominator spells with method of discharge as death. *DISMETH:*4 Died ***Denominator:*** Spells with a primary diagnosis associated with a low mortality diagnosis group (mortality rate has been shown to be consistently below 0.5%)	***Inclusion criteria:*** Low mortality CCS groups ***Exclusion criteria:*** • Spells with a diagnosis code for trauma, immunocompromised state, or cancer in any diagnosis field • Admission age under 19	Age 19 years plus	Crude Rate: Expected values are based on the national average rate. Relative Risk: The ratio is calculated by dividing the actual number of deaths by the expected number and multiplying the figure by 100. It is expressed as a relative risk, where a risk rating of 100 represents the national average. Control limits set at 99.8%	***How reported:*** Relative Risk ratio ***Interpretation:*** • If the trust has an RR of 100, that means that the number of patients who died is exactly as it would be expected taking into account the standardisation factors. An RR above 100 means more patients died than would be expected; one below 100 means that fewer than expected died. • Data points falling above the upper 99.8% binomial control limit are said to be significantly 'higher than expected', data points falling below the lower 99.8% binomial control limit are said to be significantly 'lower than expected', otherwise 'within expected range'.

Death in low mortality DRG						
Source and indicator name	**Definition**	**Numerator / Denominator**	**Inclusion / Exclusion Criteria for Denominator**	**Age group**	**Risk adjustment & statistical methods**	**Reporting & interpretation**
					No additional information provided about risk adjustment methods	***Publicly reporting:*** My Hospital Guide (http://myhospitalguide.drfosterhealth.co.uk/) *and* Dr Foster Quality Account (http://www.drfosterhealth.co.uk/quality-accounts/trust.aspx?otype=2&id=58) ***Hospital reporting:*** For member organisations via online system. No detail available.

APPENDIX 3 – Detailed indicator summaries

1. Aggregated in-hospital mortality

1.1 ACQSHC National core, hospital-based outcome indicators

Indicator name/ number	Hospital standardised mortality ratio (HSMR) CHBOI 1
Source	Australian Commission on Safety and Quality in Health Care 2012, *National core, hospital based outcome indicator specification*, *CONSULTATION DRAFT*, ACSQHC, Sydney.
Purpose / rationale	Hospital standardised mortality ratios (HSMRs) should be used as screening tools, rather than being assumed to be definitively diagnostic of poor quality and/or safety. This indicator is intended to signal that a problem may exist and that further detailed investigation is required. High relative mortality should be seen as a prompt to further detailed investigation. Learnings may be applied from low relative mortality (Ben-Tovim et al. 2009, pp. 4; 95; 38)
Dimension of quality	Not indicated
Data source	Hospital administrative data
Definition	The ratio of the observed number of hospital separations that end in the patient's death, to the number of separations expected to end in death based on the patient's characteristics, for principal diagnoses accounting for 80% of in-hospital mortality.
Numerator	Observed number of in-hospital deaths x 100 where: Observed number of in-hospital deaths = the total number of separations
Denominator	Expected number of in-hospital deaths = the sum of the estimated probabilities of death for all separations meeting the denominator criteria, calculated using national risk adjustment coefficients. <u>Inclusions criteria:</u> • Principal diagnosis is in the national list of the top 80% of diagnoses, by frequency of in-hospital death, in the latest reference period (see Appendix 1) • Age at date of admission is between 29 days and 120 years, inclusive • Care type6 = acute care, geriatric evaluation and management and maintenance care • Length of stay (LOS, including leave days) is between 1 and 365 days, inclusive ($1 \leq LOS \leq 365$) • Urgency status = emergency, elective. <u>Exclusion criteria:</u> • Neonates, aged ≤ 28 days at admission • Missing admission mode, sex.
Target population	Age 29 days -120 years

Indicator name/ number	Hospital standardised mortality ratio (HSMR) CHBOI 1
Risk adjustment	Risk adjustments are made for: • Age at admission (years) • Sex • Principal diagnosis code (mapped to national in-hospital mortality risk deciles) • Admission urgency status: emergency, elective • Length of stay (including leave days) categorised as 1 day, 2 days, 3-9 days, 10-15 days, 16-21 days and 22-365 days • Additional (comorbid) diagnoses (Charlson index) categorised into 0 – Charlson Index score of 0; 1 – Charlson index score of 1; 2 Charlson index score ≥2 • Admission mode (inward transfer status) = admitted patient transferred from another hospital.
Reporting and interpretation	Reported as HSMR - the ratio of observed (actual) number of in-hospital deaths to expected number of in-hospital deaths, multiplied by 100. A value of 100 indicates that the mortality rate is the same as the national rate for patients with similar characteristics to those treated. A value of more than 100 corresponds to a higher than expected mortality rate, while a value of less than 100 corresponds to a lower than expected mortality rate. Variations in hospital mortality should be viewed as screening tests rather than being diagnostic of poor safety or quality. High or rising HSMRs signal that a problem might exist and that further investigation is required. Low or falling HSMRs might signal good performance, from which lessons could be learned (Ben-Tovim et al. 2009). Investigations of significant variations from 100 should consider a range of possible explanations including: data quality (e.g. relevant co-morbidities not recorded); differences from the national patient population that are not addressed by the risk adjustment model; structural or resource issues (e.g. staff shortages, ward closures, etc.); changes in treatment protocols; and professional practice (i.e. individual clinical staff actions) (Mohammed et al.2004).
References	Australian Institute of Health and Welfare 2009, *Towards national indicators of safety and quality in health care*, AIHW cat. No. HSE 75, AIHW, Canberra Ben-Tovim, D, Woodman, R, Harrison, J, Pointer, S, Hakendorf, P & Henley,G 2009, *Measuring and reporting mortality in hospital patients* . Quan, H, Sundararajan, V, Halfon, P, Fong, A, Burnand, B, Luthi, J-C,Saunders, LD, Beck, C, Feasby, T & Ghali, W 2005, 'Coding Algorithms for Defining Comorbidities in ICD-9-CM and ICD-10 Administrative Data', *Medical Care*, vol. 43, no. 11, pp. 1130-9.

1.2 Canadian Institute for Health Information (CIHI)

Indicator name/ number	Hospital Standardised Mortality Ratio (HSMR)
Source	Hospital Standardized Mortality Ratio (HSMR) Technical notes, Updated April 2013, Canadian Institute for Health Information.
Purpose / rationale	The HSMR provides a measure of overall mortality and it is intended primarily as a tool to track changes over time within a facility. If the patient mix within a facility is relatively stable over time, then changes in outcomes may be identified. The purpose of the HSMR is to provide a reflection of in-hospital mortality changes over time for a broad range of disease groups for an organization. CIHI believes that the HSMR should be used along with other indicators to help assess quality of care in hospitals. While HSMR adjusts for a number of factors affecting the risk of in-hospital mortality, it does not control for everything. Therefore, HSMR results are most useful in tracking trends over time.
Data source	Hospital Morbidity Database, CIHI. Discharge Abstract Database, CIHI.
Definition	The ratio of the actual (observed) number of acute in-hospital deaths to the expected number of in-hospital deaths, for conditions accounting for about 80% of inpatient mortality.
Numerator	Actual number of deaths among diagnosis groups accounting for 80% of inpatient mortality (see table overleaf).
Denominator	Expected deaths, or number of deaths that would have occurred in a hospital or region had the mortality of these patients been the same as the mortality of similar patients across the country, based on the reference year (2009–2010). Regional or corporation-level HSMRs are calculated as the sum of observed deaths for all acute care sites divided by the sum of expected deaths for all acute care sites multiplied by 100. Regional and facility HSMR results are based on where patients were treated, not where they lived. Inclusion criteria: • Discharge between April 1 of a given year and March 31 of the following year • Admission to an acute care institution • Discharge with diagnosis group of interest (that is, one of the diagnosis groups that account for about 80% of in-hospital deaths, after excluding patients with palliative care) See table overleaf • Age at admission between 29 days and 120 years • Sex recorded as male or female • Length of stay of up to 365 consecutive days • Admission category is elective (L) or emergent/urgent (U) • Canadian resident (see Appendix II for information on identifying non-residents)

Indicator name/ number	Hospital Standardised Mortality Ratio (HSMR)

Exclusion criteria:

- Cadavers, with discharge disposition = 08
- Stillborns, with discharge disposition = 09
- Sign-outs (that is, discharged against medical advice), with discharge disposition = 06
- Patients who do not return from a pass, with discharge disposition = 12 Neonates, with age at admission less than or equal to 28 days Records with brain death as most responsible diagnosis code (ICD-10-CA): G93.81
- Records with palliative care

Conditions accounting for 80% of deaths

Diagnosis Group	Description	Diagnosis Group	Description
A04	Other bacterial intestinal infections	I62	Other nontraumatic intracranial haemorrhage
A41	Sepsis	I63	Cerebral infarction
C15	Malignant neoplasm of oesophagus	I64	Stroke, not specified as haemorrhage or infarction
C16	Malignant neoplasm of stomach	I70	Atherosclerosis
C18	Malignant neoplasm of colon	I71	Aortic aneurism and dissection
C22	Malignant neoplasm of liver and intrahepatic bile ducts	J18	Pneumonia
C25	Malignant neoplasm of pancreas	J44	Other chronic obstructive pulmonary disease
C34	Malignant neoplasm of bronchus and lung	J69	Pneumonitis due to solids and liquids
C50	Malignant neoplasm of breast	J80	Adult respiratory distress syndrome
C61	Malignant neoplasm of prostate	J84	Other interstitial pulmonary diseases
C67	Malignant neoplasm of bladder	J90	Pleural effusion, not elsewhere classified
C71	Malignant neoplasm of brain	J96	Respiratory failure, not elsewhere classified
C78	Secondary malignant neoplasm of respiratory and digestive organs	K26	Duodenal ulcer
C79	Secondary malignant neoplasm of other sites	K55	Vascular disorders of intestine
C80	Malignant neoplasm without specification of site	K56	Paralytic ileus and intestinal obstruction without hernia
C83	Diffuse non-Hodgkin's lymphoma	K57	Diverticular disease of intestine
C85	Other and unspecified types of non-Hodgkin's lymphoma	K63	Other diseases of intestine

Indicator name/ number	Hospital Standardised Mortality Ratio (HSMR)

C90	Multiple myeloma and malignant plasma cell neoplasms	K65	Peritonitis
C92	Myeloid leukemia	K70	Alcoholic liver disease
E11	Diabetes mellitus type 2	K72	Hepatic failure
E86	Volume depletion	K74	Fibrosis and cirrhosis of liver
E87	Other disorders of fluid, electrolyte and acid-base balance	K85	Acute pancreatitis
F03	Unspecified dementia	K92	Other diseases of digestive system
F05	Delirium, not induced by alcohol and other psychoactive substances	L03	Cellulitis
G30	Alzheimer's disease	N17	Acute renal failure
G93	Other disorders of brain	N18	Chronic renal failure
I21	Acute myocardial infarction (AMI)	N39	Other disorders of urinary system
I24	Other acute ischemic heart diseases	R53	Malaise and fatigue
I25	Chronic ischemic heart disease	R57	Shock, not elsewhere classified
I26	Pulmonary embolism	R64	Cachexia
I35	Nonrheumatic aortic valve disorders	S06	Intracranial injury
I46	Cardiac arrest	S32	Fracture of lumbar spine and pelvis
I48	Atrial fibrillation and flutter	S72	Fracture of femur
I50	Heart failure	T81	Complications of procedures, not elsewhere classified
I60	Subarachnoid haemorrhage	T82	Complications of cardiac and vascular prosthetic devices, implants and grafts
I61	Intracerebral haemorrhage	Z54	Convalescence

Target population	Age at admission between 29 days and 120 years
Risk adjustment and statistical modelling	For each of 72 diagnostic groups a logistic regression model is fitted with the following independent variables: • Age on admission • Sex (recorded on discharge) • Comorbidity group • Length of stay groups (1day, 2 days, 3 to 9 days, 10 to 15 days, 16 to 21 days, 22 to 365 days) • Admission category (recorded on discharge) • Transfers to acute care institution

Indicator name/ number	Hospital Standardised Mortality Ratio (HSMR)

The comorbidities are measured using the Charlson Index, a weighted score based on the number and type of diagnoses on the hospital discharge abstract. A higher score generally indicates a more complex case. This index was calculated based on preadmission diagnoses, with the exception of the most responsible diagnosis identified by the hospital.

The models are based on data from all acute hospitals in Canada. Coefficients derived from the logistic regression models are used to calculate the probability of in-hospital death. The expected number of deaths for a hospital, corporation or region is based on the sum of the probabilities of in-hospital death for eligible discharges from that organization. The 95% confidence interval is calculated using Byar's approximation.

The reference year for HSMR calculations is 2009–2010. To allow for comparisons over time, the coefficients derived from the model using the reference year are used to determine expected deaths for all reported years.

Charlson Index

Comorbid Condition	ICD-10 Codes (First Three or Four Digits, as Specified)	Weight
Congestive heart failure	I099, I255, I420, I425, I426, I427, I428, I429, I43, I50 P290	2
Dementia	F00, F01, F02, F03, F051 G30, G311	2
Chronic pulmonary disease	I278, I279 J40, J41, J42, J43, J44, J45, J47, J60, J61, J62, J63, J64, J65, J66, J67, J684, J701, J703	1
Connective tissue disease/rheumatic disease	M05, M06, M315, M32, M33, M34, M351, M353, M360	1
Mild liver disease	B18 K700, K701, K702, K703, K709, K713, K714, K715, K717, K73, K74, K760, K762, K763, K764, K768, K769 Z944	1
Diabetes with complications	E102, E103, E104, E105, E107, E112, E113, E114, E115, E117, E132, E133, E134, E135, E137, E142, E143, E144, E145, E147	1
Paraplegia and hemiplegia	G041, G114, G801, G802, G81, G82, G830, G831, G832, G833, G834, G839	2
Renal disease	N032, N033, N034, N035, N036, N037, N052, N053, N054, N055, N056, N057, N18, N19, N250 Z490, Z491, Z492, Z940, Z992	1
Cancer	C00, C01, C02, C03, C04, C05, C06, C07, C08, C09, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24, C25, C26, C30, C31, C32, C33, C34, C37, C38, C39, C40, C41, C43, C45, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C57, C58, C60, C61, C62, C63, C64, C65, C66, C67, C68, C69, C70, C71, C72, C73, C74, C75, C76, C81, C82, C83, C84, C85, C88, C90, C91, C92, C93, C94, C95, C96, C97	2
Moderate or severe liver disease	I850, I859, I864, I982 K704, K711, K721, K729, K765, K766, K767	4
Metastatic carcinoma	C77, C78, C79, C80	6
AIDS	B24, O987	4

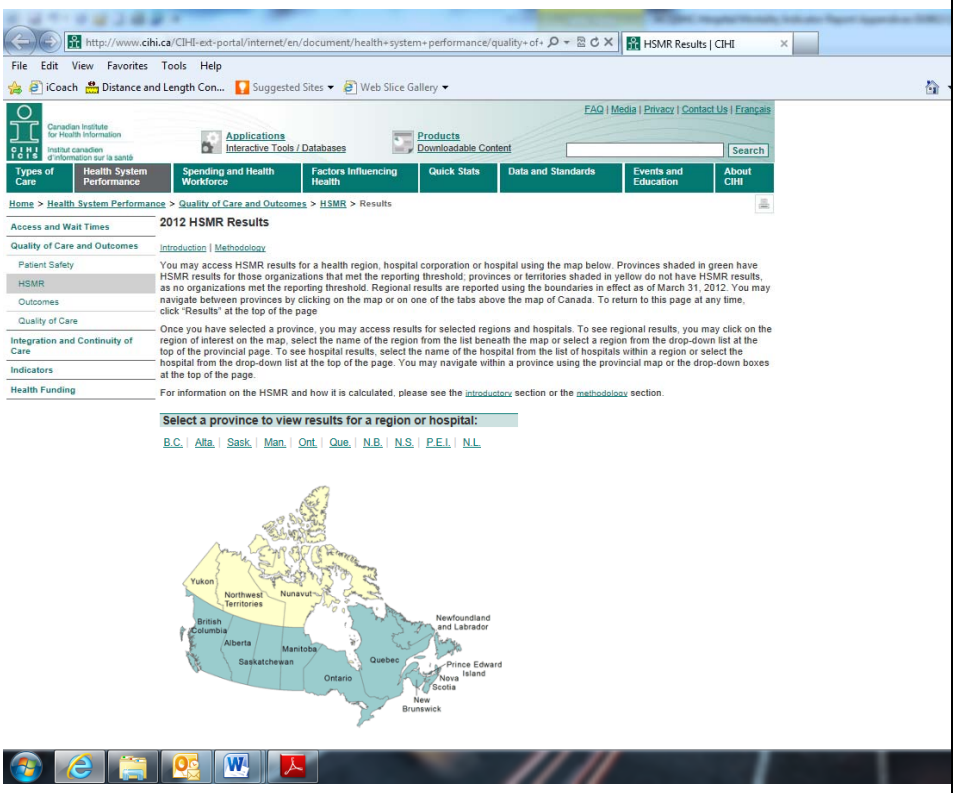
Diagnosis types 1, W, X and Y are used to calculate the Charlson score. Starting in February 2012, type 3 codes for the following conditions are also included (to account for coding and classification standards):

Reporting and interpretation	HSMR - the ratio of observed (actual) number of in-hospital deaths to expected number of in-hospital deaths, multiplied by 100. Also reported are Supplementary HSMRs for: • Medical and surgical HSMRs • ICU related cases • HSMR excluding transfers

Indicator name/ number	Hospital Standardised Mortality Ratio (HSMR)

- Regional and organisational level HSMR. HSMR are not calculated for specific facilities (e.g. children's cancer) or sub-acute facilities and these are not included in the regional HSMRs.

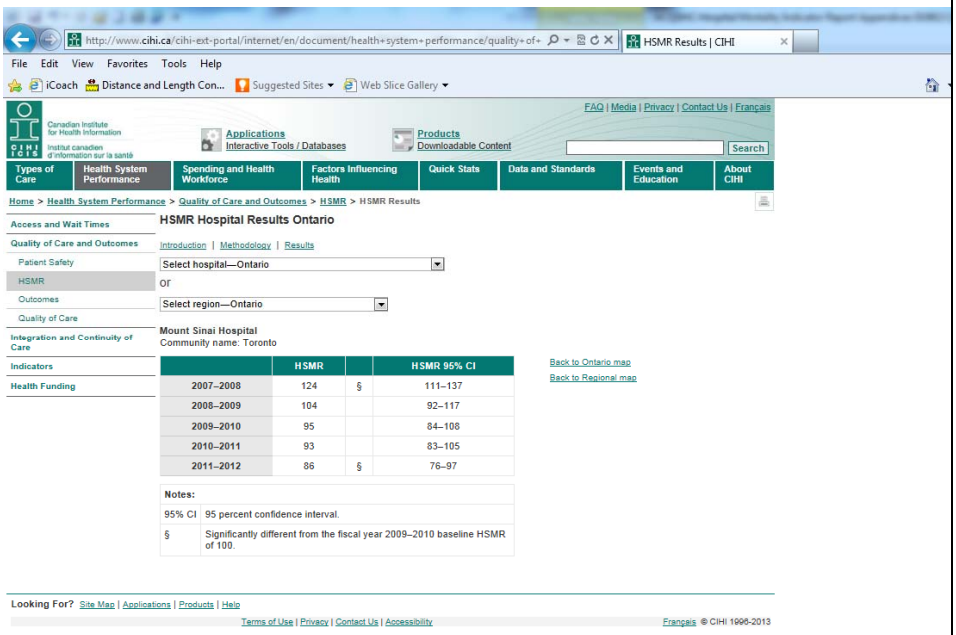
A ratio equal to 100 is interpreted as no difference between the hospital's mortality rate and the average national rate in the baseline year. A ratio greater than 100 indicates that the hospital's mortality rate is higher than the average rate. A ratio of less than 100 indicates that the hospital's mortality rate is lower than the average rate. The confidence intervals describe the precision of the HSMR estimate. Smaller hospitals with fewer HSMR cases have less precise HSMR estimates with wider confidence intervals. A confidence interval that includes 100 suggests that the HSMR is not statistically different from the 2009–2010 baseline of 100. HSMR results whose confidence interval does not include 100 and are therefore statistically different from the 2009–2010 baseline are denoted with a symbol in the reports.



While HSMR adjusts for a number of factors affecting the risk of in-hospital mortality, it does not control for everything. Therefore, HSMR results are most useful in tracking trends over time.

Public online reporting is available and enables review of HSMR by individual hospital or by region for the last 5 years, showing trends over time rather than comparisons between hospitals and regions.

The reports do however highlight regions according to whether they are above or below HSMR of 100.

Indicator name/ number	Hospital Standardised Mortality Ratio (HSMR)
	 On the report, a warning symbol ("!") is shown when the number of expected deaths used in the calculation is less than 20. Results based on small numbers of cases are unstable and should be interpreted with caution. Open-year quarterly and monthly HSMR reports are based on data available when the SAS data cut is made (usually at the beginning of January for Q1/Q2 reports, the beginning of April for Q3 reports and after the database closure for Q4 reports). Therefore, the counts in the open-year reports may differ until database closure. Results are only reported for regions and acute care facilities that meet a statistical threshold for public reporting: at least 2,500 qualifying discharges in each of the last three years being reported i.e. 2009–2010, 2010–2011 and 2011–2012
References	HSMR A new approach for measuring hospital mortality trends in Canada 2007 http://www.cihi.ca/CIHI-ext-portal/internet/EN/TabbedContent/health+system+performance/quality+of+care+and+outcomes/hsmr/cihi022025#_Methodology **HSMR website information** *Reports and analyses about HSMR* • See the 2012 HSMR results • In Focus: A National Look at Sepsis (Dec. 2009) • HSMR: A New Approach for Measuring Hospital Mortality Trends in Canada (Nov. 2007) *HSMR resources* • Understanding the HSMR Report (updated March 2009) (PDF, 304 KB) • What Is the HSMR? (updated July 2008) (PDF, 274 KB)

Indicator name/ number	Hospital Standardised Mortality Ratio (HSMR)
	• Technical Notes (updated Apr. 2013) (PDF, 251 KB) • Frequently Asked Questions for Hospitals and Health Providers (updated Apr. 2013) (PDF, 167 KB) • Using CIHI's HSMR eReporting Service (updated May 2010) (PDF, 52 KB) • Resources for Getting Started (PDF, 227 KB) *Key projects about HSMR* • HSMR public release 2012 (updated Sept. 2012) • HSMR public release 2011 (updated Sept. 2011) • HSMR eReporting service launched (updated May 2010)

1.3 Dr Foster's Hospital Standardised Mortality Ratio (UK)

Indicator name/ number	Hospital standardised mortality ratio (HSMR)
Source	Understanding HSMRs. A Toolkit on Hospital Standardised Mortality Ratios *Version 7: March 2012*.
Purpose / rationale	The HSMR is a calculation used to monitor death rates in a trust. The HSMR is based on a subset of diagnoses which give rise to 80% of in-hospital deaths. HSMRs are based on the routinely collected administrative data often known as Hospital Episode Statistics (HES), Secondary Uses Service Data (SUS) or Commissioning Datasets (CDS). The HSMR was conceived by Professor Sir Brian Jarman, director of the Dr Foster Unit at Imperial College, London. Measuring hospital performance is complex. Dr Foster understands that complexity and is clear that HSMRs should not be used in isolation, but rather considered with a basket of other indicators that give a well-rounded view of hospital quality and activity.
Dimension of quality	Not indicated
Data source	SUS - CDS Secondary Uses Service – Commissioning Data Sets
Definition	The ratio of the observed number of in-hospital deaths with a Hospital Standardised Mortality Ratio (HSMR) diagnosis to the expected number of deaths, multiplied by 100.
Numerator	Denominator superspells with method of discharge as death (DISMETH=4,5) (a group of spells linked by transfer)
Denominator	Superspells containing a spell with a primary dominant diagnosis of any of the 56 CCS groups that comprise the HSMR basket (accounts for approximately 83% of all in-hospital deaths in England.) **Appendix M: HSMR basket** CCS Group / Description Septicemia (except in labour) / A021,A207,A227,A267,A327,A392,A393,A394,A40,A41,A427,B007 Cancer of oesophagus / C15,D001 Cancer of stomach / C16,D002 Cancer of colon / C18,D010 Cancer of rectum and anus / C19-C21,D011-D013 Cancer of pancreas / C25 Cancer of bronchus, lung / C34,D022 Cancer of breast / C50,D05 Cancer of ovary / C56 Cancer of prostate / C61,D075 Cancer of bladder / C67,D090 Non-Hodgkin's lymphoma / C463,C82-C85,C963,C967,C969 Leukaemias / C901,C91-C95,D46 Secondary malignancies / C77-C79 Malignant neoplasm without specification of site / C80,C97,D099 Fluid and electrolyte disorders / E86,E87 Deficiency and other anaemia / D50-D56,D58-D61,D63,D64 Senility and organic mental disorders / F00-F09,F53,G30,G3310,G311,R54 Acute myocardial infarction / I21,I22 Coronary atherosclerosis and other heart disease / I20,I24,I251,I252,I255-I259 Pulmonary heart disease / I26-I28 Cardiac dysrhythmias / I47,I48,I491-I499,R00 Cardiac arrest and ventricular fibrillation / I46,I490 Congestive heart failure, nonhypertensive / I50 Acute cerebrovascular disease / G46,I60-I64,I66 Peripheral and visceral atherosclerosis / I70,I739,K55 Aortic, peripheral, and visceral artery aneurysms / I71,I72,I790 Other circulatory disease / I730,I731,I738,I77,I78,I791,I792,I798,I95,I988,I99,M30,M31,R03,R58,R943 Pneumonia / A202,A212,A221,A310,A420,A430,A481,A78,B012,B052,B250,B583,B59,B671,J12-J16,J170-J173,J178,J18,J850,J851 Acute bronchitis / J20-J22 Chronic obstructive pulmonary disease and bronchiectasis / J40-J44,J47

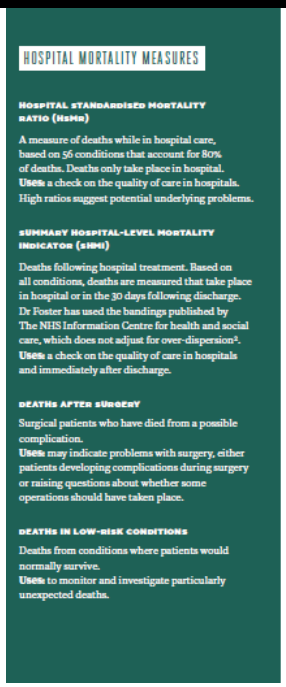
<table>
<tr><th>Indicator name/ number</th><th>Hospital standardised mortality ratio (HSMR)</th></tr>
<tr><td></td><td>
<table>
<tr><th>CCS Group</th><th>Description</th></tr>
<tr><td>Aspiration pneumonitis, food/vomitus</td><td>J690</td></tr>
<tr><td>Pleurisy, pneumothorax, pulmonary collapse</td><td>J86,J90-J94,J981-J983,R091</td></tr>
<tr><td>Respiratory failure, insufficiency, arrest (adult)</td><td>J80,J96,R092</td></tr>
<tr><td>Other lower respiratory disease</td><td>A065,J81,J82,J84,J852,J853,J984,J986,J988,J989,J99,R042,R05,R061,R066,R093,R098,R230,R91,R942</td></tr>
<tr><td>Other upper respiratory disease</td><td>J30,J31,J33,J34,J37-J39,J980,J985,R040,R041,R048,R049,R060,R062-R065,R067,R068,R070,R49</td></tr>
<tr><td>Intestinal obstruction without hernia</td><td>K56</td></tr>
<tr><td>Peritonitis and intestinal abscess</td><td>K630,K65,K67</td></tr>
<tr><td>Biliary tract disease</td><td>K80-K83,K870,R932</td></tr>
<tr><td>Liver disease, alcohol-related</td><td>K70</td></tr>
<tr><td>Other liver diseases</td><td>A064,K710,K711,K717-K719,K72,K74,K750,K751,K758,K759,K76,K770,K778,R160,R162,R17,R18,R74,R945</td></tr>
<tr><td>Gastrointestinal haemorrhage</td><td>I850,K250,K252,K254,K256,K260,K262,K264,K266,K270,K272,K274,K276,K280,K282,K284,K286,K625,K920-K922</td></tr>
<tr><td>Noninfectious gastroenteritis</td><td>K52</td></tr>
<tr><td>Other gastrointestinal disorders</td><td>B054,K58,K590-K593,K598,K599,K63,K66,K900-K902,K904,K908,K909,K928,K929,K93,R12-R15,R161,R19,R933,R935</td></tr>
<tr><td>Acute and unspecified renal failure</td><td>N17,N19</td></tr>
<tr><td>Chronic renal failure</td><td>N18,Z49</td></tr>
<tr><td>Urinary tract infections</td><td>N10,N11,N151,N158,N159,N16,N291,N30,N330,N34,N351,N37,N390,P393</td></tr>
<tr><td>Skin and subcutaneous tissue infections</td><td>A067,A201,A210,A220,A260,A311,A320,A363,A431,A441,A46,A480,B653,B781,B870,B871,L00-L03,L05,L08,L303,L444,L88,L946,L980,L983</td></tr>
<tr><td>Chronic ulcer of skin</td><td>L89,L97,L984</td></tr>
<tr><td>Other perinatal conditions</td><td>A33,P00-P04,P08,P221,P228,P229,P23-P28,P290-P292,P294-P299,P350,P351,P358,P359,P36,P371-P379,P38,P390-P392,P394-P399,P50-P53,P540-P545,P60,P61,P70-P95,P960,P961,P964-P969</td></tr>
<tr><td>Fracture of neck of femur (hip)</td><td>S720-S722</td></tr>
<tr><td>Other fractures</td><td>S12,S22,S32,S420,S421,S429,T021,T026-T029,T08,T142,T911,T912</td></tr>
<tr><td>Intracranial injury</td><td>S06,T060,T904,T905,T908,T909</td></tr>
<tr><td>Complication of device, implant or graft</td><td>T82-T87</td></tr>
<tr><td>Syncope</td><td>R55</td></tr>
<tr><td>Abdominal pain</td><td>R10</td></tr>
</table>
</td></tr>
<tr><td>Target population</td><td>All ages</td></tr>
<tr><td>Risk adjustment and statistical modelling</td><td>Logistic regression
Expected number of in-hospitals deaths is derived from logistic regression, adjusting for factors to indirectly standardise for differences in case-mix.

Adjustments are made for:
• Sex
• Age on admission (in five year bands up to 90+)
• Interactions between age on admission (in five year bands up to 90+) and Charlson co-morbidity score**
• Admission method (non-elective or elective)
• Socio-economic deprivation quintile of the area of residence of the patient (based on the Carstairs Index)
• Diagnosis/procedure subgroup
• Co-morbidities (based on Charlson score)
• Number of previous emergency admissions
• Year of discharge (financial year)
• Palliative care (if any episode in the spell has the treatment function code 315 or contains ICD10 code Z515 in any of the diagnoses fields)
• Month of admission
• Source of admission

**new to logistic regression model in 2011</td></tr>
<tr><td>Reporting and</td><td>Reported as HSMR - The ratio of the observed number of in-hospital deaths</td></tr>
</table>

Indicator name/ number	Hospital standardised mortality ratio (HSMR)
interpretation	during admissions with a Hospital Standardised Mortality Ratio (HSMR) diagnosis to the expected number of deaths, multiplied by 100 The ratio is calculated by dividing the actual number of deaths by the expected number and multiplying the figure by 100. It is expressed as a relative risk, where a risk rating of 100 represents the national average. If the trust has an SMR of 100, that means that the number of patients who died is exactly as it would be expected taking into account the standardisation factors. An SMR above 100 means more patients died than would be expected; one below 100 means that fewer than expected died. Control limits indicate the range of values which are consistent with random or chance variation. Data points falling within the control limits are consistent with random or chance variation and are said to display 'common-cause variation'; for data points falling outside the control limits, chance is an unlikely explanation and hence they are said to display 'special-cause variation' - that is, where the trust's rate diverges significantly from the national rate. Data points falling above the upper 99.8% poisson control limit are said to be significantly 'higher than expected', data points falling below the lower 99.8% Poisson control limit are said to be significantly 'lower than expected', otherwise 'within expected range'. Public reporting is via the annual Hospital Guide report, the latest being in 2012. Four mortality measures are reported including HSMR, summary hospital level mortality, death in low mortality DRG and mortality after surgery. The *Hospital Guide* annually publishes the names of trusts that have been determined as 'outliers', which means their results are significantly different to what is expected. The HSMR is a measure of overall mortality, but it should be used in conjunction with other indicators in the assessment of the quality of care. Analysis of mortality in individual diagnoses and procedures, as well as the examination of other outcome and process indicators is invaluable in explaining and exploring variations between trusts.

Indicator name/ number	Hospital standardised mortality ratio (HSMR)



HOSPITAL MORTALITY MEASURES

HOSPITAL STANDARDISED MORTALITY RATIO (HSMR)

A measure of deaths while in hospital care, based on 56 conditions that account for 80% of deaths. Deaths only take place in hospital.
Uses a check on the quality of care in hospitals. High ratios suggest potential underlying problems.

SUMMARY HOSPITAL-LEVEL MORTALITY INDICATOR (SHMI)

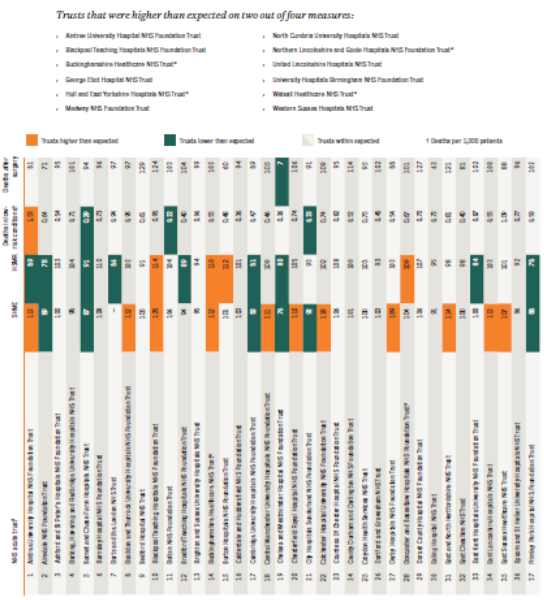
Deaths following hospital treatment. Based on all conditions, deaths are measured that take place in hospital or in the 30 days following discharge. Dr Foster has used the bandings published by The NHS Information Centre for health and social care, which does not adjust for over-dispersion[3].
Uses a check on the quality of care in hospitals and immediately after discharge.

DEATHS AFTER SURGERY

Surgical patients who have died from a possible complication.
Uses may indicate problems with surgery, either patients developing complications during surgery or raising questions about whether some operations should have taken place.

DEATHS IN LOW-RISK CONDITIONS

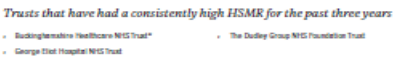
Deaths from conditions where patients would normally survive.
Uses to monitor and investigate particularly unexpected deaths.



Trusts that were higher than expected on two out of four measures:

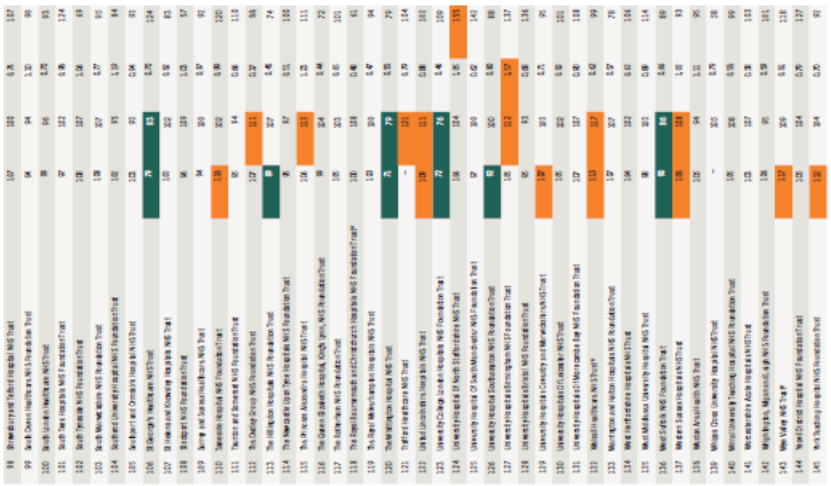
- Aintree University Hospital NHS Foundation Trust
- Blackpool Teaching Hospitals NHS Foundation Trust
- Buckinghamshire Healthcare NHS Trust*
- George Eliot Hospital NHS Trust
- Hull and East Yorkshire Hospitals NHS Trust*
- Medway NHS Foundation Trust
- North Cumbria University Hospitals NHS Trust
- Northern Lincolnshire and Goole Hospitals NHS Foundation Trust*
- United Lincolnshire Hospitals NHS Trust
- University Hospitals Birmingham NHS Foundation Trust
- Walsall Healthcare NHS Trust*
- Western Sussex Hospitals NHS Trust

Trusts higher than expected | Trusts lower than expected | Trusts within expected | † Deaths per 1,000 patients

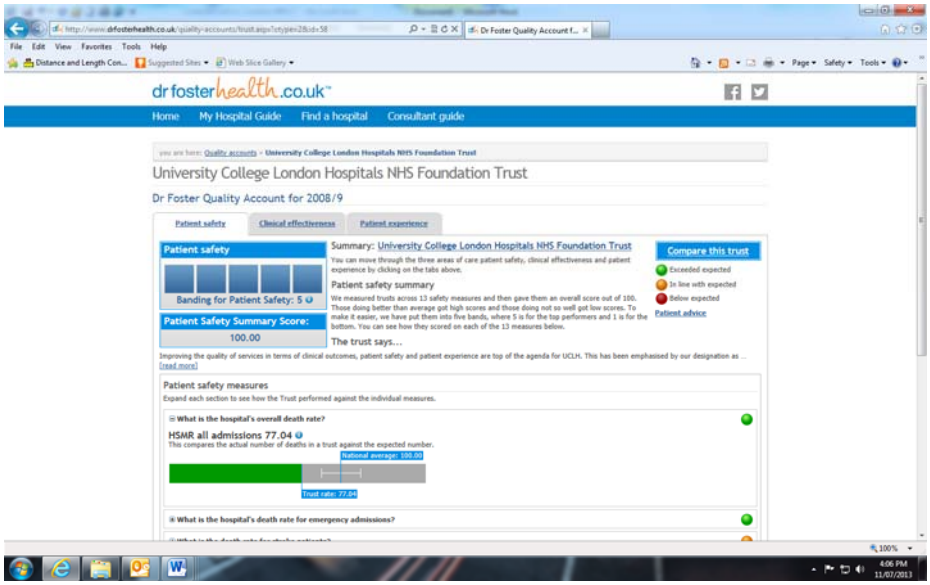


Trusts that have had a consistently high HSMR for the past three years

- Buckinghamshire Healthcare NHS Trust*
- George Eliot Hospital NHS Trust
- The Dudley Group NHS Foundation Trust



[Dr Foster Quality Account] reports provide online reports for participating health services. Mortality indicators, including in-hospital mortality indicators for AMI, stroke and fractured neck of femur, are included under the domain of Patient Safety. Comparisons with other trusts are indicated by a colour coded rating system – green for 'exceeded expected', orange for 'in line with expected' and red for 'below expected'. The results are expressed as a ratio of actual deaths to expected deaths. These mortality indicators use a control limit (displayed on the graph as a white line), which is set at 99.8%. Data points 'falling within the control limits are said to display 'common-cause

Indicator name/ number	Hospital standardised mortality ratio (HSMR)
	variation', which means it may be due to chance. Data points falling outside the control limits are known as 'outliers' and chance is an unlikely explanation. They are said to display 'special-cause variation' that is, factors other than chance are the cause. In addition to the ratios for the individual indicators, the trusts are given a composite score summarising performance across the 13 patient safety indicators (Patient Safety Summary Score). These score are out of 100 and reported across five bands of performance. 
References	Dr Foster Intelligence HSMR specifications 2012 Dr Foster HSMR Toolkit Version 7 2012 Dr Foster HSMR Basket (included conditions)

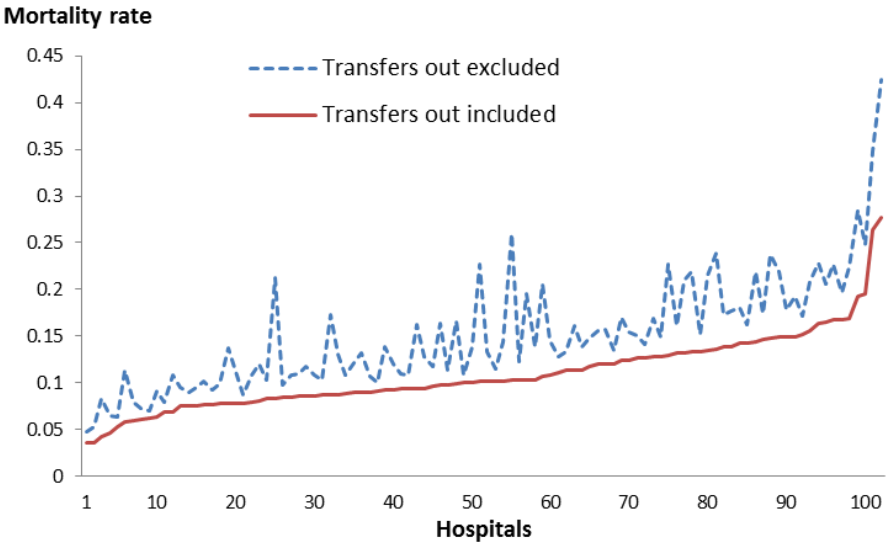
2. Condition specific mortality indicators

2.1 Acute myocardial infarction

2.1.1 ACQSHC National core, hospital-based outcome indicators

Indicator name/ number	**In hospital mortality for acute myocardial infarction (AMI) CHBOI 3a**
Source	Australian Commission on Safety and Quality in Health Care 2012, *National core, hospital based outcome indicator specification, CONSULTATION DRAFT*, ACSQHC, Sydney.
Purpose / rationale	Hospital mortality indicators should be used as screening tools, rather than being assumed to be definitively diagnostic of poor quality and/or safety. This indicator is intended to signal that a problem may exist and that further detailed investigation is required. High outlier rates should be seen as a prompt to further investigation. Learnings may be applied from low outlier rates.
Dimension of quality	Not indicated
Data source	Hospital administrative data
Definition	In-hospital deaths of patients admitted for Acute Myocardial Infarction
Numerator	Observed number of in-hospital deaths for AMI patients × national in-hospital mortality rate for AMI patients *where* Observed number of in-hospital deaths for AMI patients = the total number of separations (meeting the denominator criteria) where separation mode = d*ied* National mortality rate = national observed number of in-hospital deaths for AMI ÷ national observed number of separations for AMI.
Denominator	Expected number of in-hospital deaths for AMI patients = the sum of the estimated probabilities of death for all separations (meeting the denominator criteria), calculated using national risk- adjustment coefficients ***Inclusions:*** • Principal diagnosis of AMI, represented by one of the following codes: I21.0 Acute transmural myocardial infarction of anterior wall I21.1 Acute transmural myocardial infarction of inferior wall I21.2 Acute transmural myocardial infarction of other sites I21.3 Acute transmural myocardial infarction of unspecified site I21.4 Acute subendocardial myocardial infarction I21.9 Acute myocardial infarction, unspecified

Indicator name/ number	In hospital mortality for acute myocardial infarction (AMI) CHBOI 3a
	• Age at admission date is between 18 and 89 years, inclusive • Care type = *acute care* • Urgency status = *emergency* • Length of stay (LOS), including leave days) is between 1 and 30 days, inclusive (1 ≤ LOS ≤ 30) (but not including same day). ***Exclusions:*** • Additional diagnosis17 of Cardiac arrest (I46.x) AND Condition onset flag = *Condition not noted as arising during the episode of admitted patient care*. • Same day separations (where date of admission is equal to the date of separation). Episode of care for angina or chest pain occurring prior to the denominator episode: Also include in the denominator episodes of care occurring prior to the admission for AMI (as identified above) where: • Date of separation of prior episode = date of admission of AMI episode (as identified under denominator inclusions and exclusions above). **AND** • Principal diagnosis19 of prior episode is Angina (I20) **OR** Chest pain (R07.4). **AND** • Separation mode of prior episode20 = *discharge / transfer to (an) other acute hospital*. **AND** • Care type of prior episode21 = *acute care*.
Target population	Age at admission date is between 18 and 89 years, inclusive
Risk adjustment	Risk adjustment should be performed using a logistic regression model. The response variable will be the probability of in-hospital mortality, and the predictor variables include those listed under the risk adjustment. Coefficients from national risk-adjustment modelling are used to calculate the probability of in-hospital death for each case from a hospital. The sum of the probabilities of death will form the expected number of deaths. • Age in years at date of admission • Sex • Additional (comorbidities) diagnoses (10 dichotomous variables): Dementia (F00.x (G30.x†), F01.x, F02.x, F03.x); Alzheimer's disease (G30.x, G31.0, G31.1); Hypotension (I95.x); Shock (R57.x, A48.3); Kidney (renal) failure (N17.x, N19.x, N18.3, N18.4, N18.5, N18.9, R34.x); Heart failure (I50.x, I11.0, I13.0, I13.2); Dysrhythmia (I46.x, I47.x, I49.x, I48.x); Malignancy (C00.x -C96.x, except C44.x); Hypertension (I10.x -I15.x, I27.0, I27.2, I67.4,

Indicator name/ number	In hospital mortality for acute myocardial infarction (AMI) CHBOI 3a
Reporting and interpretation	Reported as the Risk adjusted rate which is the ratio of observed (actual) number of in-hospital deaths to expected number of in-hospital deaths for Acute Myocardial Infarction (AMI) patients, multiplied by the national mortality rate for AMI patients. A value higher than the national rate corresponds to a higher than expected mortality rate, while a value of lower than the national rate corresponds to a lower than expected mortality rate. High or rising rates signal that a problem might exist and that further investigation is required. Investigations should consider a range of possible explanations including: differences from the national patient population that are not addressed by the risk adjustment model; structural or resource issues (e.g. staff shortages, ward closures, etc.); changes in treatment protocols; and professional practice (i.e. individual clinical staff actions) (Mohammed et al 2004). **Figure 1. Effect of excluding Transfers out (2008-09 data) AMI in-hospital mortality** 
References	Australian Commission on Safety and Quality in Health Care 2012, *National core, hospital based outcome indicator specification*, *CONSULTATION DRAFT*, ACSQHC, Sydney.

2.1.2 *Variable Life Adjusted Display Indicators, Queensland Health*

Indicator name/ number	Acute myocardial infarction (AMI) in hospital mortality C001-1
Source	Variable Life Adjusted Display (VLAD) indicators, Queensland Health, Australia, 2008/2009 AMI VLAD Indicator Review, Summary of Activities, 2012 VLAD Indicator Definitions report- Queensland Health- June 2012 The indicator has not been changed since 2008/09 however changes have been recommended in a report published in 2012 as referenced above. Recommended changes are noted below.

Purpose / rationale	The following rationale is described in 2012 review document, referring to other indictor programs:
	National Core Hospital Based Outcome Indicators (NCHBOI)
	Both AMI In-hospital Mortality and AMI Readmission Indicators are part of the National Core Hospital Based Outcome Indicators being developed by the Australian Commission on Safety and Quality in Health Care.
	
	AHRQ (Agency for Healthcare Research and Quality) Guide to Inpatient Quality Indicators USA (2007):
	• AMI In-hospital Mortality indicator should be considered in conjunction with length of stay indicators and transfer rates.
	• Refers to studies that show processes of care linked to survival improvements. e.g. hospitals with highest risk adjusted mortality had significantly lower utilisation of beneficial therapies.e.g. California Hospital Outcomes Project.
	• States hospitals with low risk adjusted AMI mortality were more likely to give aspirin within 6 hours of arrival in the emergency room, perform catheterisation and revascularisation procedures within 24 hours, and give heparin to prevent thromboembolic complications.
	• Cites that AMI In-hospital Mortality indicator is widely used US State health departments and the Joint Commission for Accreditation of Healthcare Organisations.
	
	Canadian Medical Association Journal: Indicators of quality of care for patients with acute myocardial infarction (Oct 21, 2008)
	• There is a wide gap between optimal and actual care for patients with AMI in hospitals around the world.
	• A 12 member expert panel was convened in 2007 to develop a set of updated quality indicators for AMI. The panel reviewed literature, clinical practice guidelines and other published quality indicators.
	• Recommendation was made for a suite of both process and outcome measures including:
	  ○ In-hospital Mortality (recommended as a key outcome indicator).
	  ○ 30 day readmission.
	  ○ 30 day Mortality (difficult to measure).
	  ○ 1 year Mortality (difficult to measure).

Indicator name/ number	**Acute myocardial infarction (AMI) in hospital mortality** **C001-1**
Dimension of quality	Effectiveness
Data source	Queensland Hospital Admitted Patient Data Collection (QHAPDC)
Definition	In-hospital deaths of acute myocardial infarction (AMI) patients. In-hospital mortality rate is defined as the number of records where separation mode = "death" and length of stay is less than or equal to 30 days, divided by the total number of records.
Numerator	***Current:*** Patients who died in hospital ***Recommended change*** (Review 2012): Acute Myocardial Infarction patients who died in-hospital and had a length of stay of less than or equal to 30 days.
Denominator	***Current:*** Patients with a principal diagnosis of AMI ***Inclusion criteria:*** • 30-89 years • Length of stay 4-30 days; unless the patient had a length of stay from 1-3 days and died in hospital • Admitted through the ED only ***Exclusion criteria:*** • Excluding transfers out ***Recommendations from 2012 review – not yet incorporated into specifications:*** Continue the production of the Stroke In-hospital AMI indicator with modifications outlined below (to align the indicator with the National Core Hospital Outcome indicators): ***Inclusion criteria:*** • Remove I22 (Subsequent myocardial infarction) from Principal Diagnosis from inclusion criteria. • Expand age of patients to include all ages. • All lengths of patient days. • Include only emergency admissions identified through elective status of the patient rather than admission source or admitted through emergency department. ***Exclusion criteria:*** • Exclude out of hospital arrest. • Modify risk adjustment criteria (see below) • Rules governing inclusion of transferred patients in contiguous episodes.

Indicator name/ number	**Acute myocardial infarction (AMI) in hospital mortality** **C001-1**
Target population	***Current:*** Age 30-89 years ***Recommended change:*** All ages
Risk adjustment	Risk adjustments are made for: ***Current:*** Sex, age, malignancy, diabetes, dementia (including Alzheimer's Disease), hypertension, dysrhythmias, heart failure, hypotension and shock, cerebrovascular disease, renal failure. ***Recommended change:*** (excludes diabetes, hypertension) Age, Malignancy, Dementia (inc. Alzheimer's Disease),Dysrhythmias, Heart Failure, Cerebrovascular Disease, Hypotension and Shock, Renal Failure Note: Sex, Diabetes, Valvular Disorders, Conduction Disorders, Acute LRTI and Influenza, and COPD were also explored in the AMI-in-hospital mortality risk adjustment model but not statistically significant Note: The risk adjustment co-morbidities are determined in a systematic manner as described below. 1. A data set of all episodes for the period 1 July 2008 to 30 June 2011 meeting the new definition is collated; 2. Age groups are collapsed to ensure there are at least 5 separations with and without the indicator in each group using data from the latest financial year (a statistical requirement); 3. A cross tabulation (with a Chi-squared test of significance) is performed for each potential comorbidity with data from the latest financial year. Those having at least 5 separations with and without the indicator and a significant test result (at the 20% level) are shortlisted for consideration in the risk adjustment model; 4. Risk adjustment models (logistic regression) using the shortlisted co-morbidities are performed for each financial year and the significance of the included predictors is examined. Co-morbidities failing to be significant (at the 10% level) for the majority of years are progressively dropped from the model or collapsed with other categories of the same variable and the process is run repeatedly until all predictors are significant for the majority of the period.
Reporting and interpretation	Reported as rate per 100 separations. Better quality is associated with a lower score. The VLAD system is managed through a partnership with Opus 5 which provides the platform for analysis and reporting of VLAD data (previously available through the QH website), as well as comprehensive systems for actioning performance results found to be outside the control limits. The operation of the system is described in detail in the Opus 5 Clinical Monitoring brochure. The use of VLAD within Queensland Health is governed by the Health Service

Indicator name/ number	Acute myocardial infarction (AMI) in hospital mortality C001-1
	Directive (current 17 June 2013), which makes reference to the VLAD Implementation Standard and Implementation Guideline which is currently not available on the QH website. VLAD is updated on a monthly basis and as such, the VLAD technique allows timely detection of potential problems or improved performance. A flag is initiated where the VLAD line meets the lower or upper control limits (refer graph below). Further details about the flagging processes are no longer available publicly on the website (they were previously 2009). Features of the website include charting to show performance against control limits for a selected indicator and facility. The Opus 5 website also includes functionality for analysing causes and determining workflow to address quality issues.  The Hospital Performance Reports are no longer available publicly on the website. At the time of the last literature review in 2009, the 2004 data was available publicly.
References	Queensland Health, Clinical Practice Improvement Centre, Indicator Definitions, October 2009, page 1. http://www.health.qld.gov.au/quality/docs/vlad_clnclind_def_sep.pdf (no longer available on the website – possibly under review) VLAD Indicator Definitions report- Queensland Health- June 2012 Report on the Acute Myocardial Infarction VLAD Indicator Review Summary of Activity November 2012

2.1.3 Agency for Healthcare Research and Quality (AHRQ) Inpatient Quality Indicators

Indicator name/ number	**Acute myocardial infarction (AMI) mortality rate** **IQI 15**
Source	Agency for Healthcare Research and Quality (AHRQ) Inpatient Quality Indicators, Inpatient Quality Indicator #15 (IQI #15) AHRQ Quality Indicators™, Version 4.5, May 2013 Indicator has been updated since 2009. Both current and previous details are included below.
Purpose / rationale	Better processes of care may reduce mortality for AMI, which represents better quality.
Dimension of quality	Effectiveness
Data source	Hospital administrative data
Definition	In-hospital deaths per 1,000 hospital discharges with acute myocardial infarction (AMI) as a principal diagnosis for patients ages 18 years and older. Excludes obstetric discharges and transfers to another hospital. *[NOTE: The software provides the rate per hospital discharge. However, common practice reports the measure as per 1,000 discharges. The user must multiply the rate obtained from the software by 1,000 to report in-hospital deaths per 1,000 hospital discharges.]* ***Previous definition (2009)***: Number of deaths per 100 discharges with principal diagnosis of AMI.
Numerator	Number of deaths (DISP=20) among cases meeting the inclusion and exclusion rules for the denominator. ***Previous numerator (2009)***: Number of deaths among cases meeting the inclusion and exclusion rules for the denominator (see below).

Denominator	Discharges, for patients ages 18 years and older, with a principal ICD-9-CM diagnosis code for AMI.
	Exclusion criteria:
	• transferring to another short-term hospital (DISP=2)
	• MDC 14 (pregnancy, childbirth, and puerperium)
	• with missing:
	  ○ discharge disposition (DISP=missing),
	  ○ gender (SEX=missing),
	  ○ age (AGE=missing),
	  ○ quarter (DQTR=missing),
	  ○ year (YEAR=missing) or
	  ○ principal diagnosis (DX1=missing)
	
	Previous (2009): All discharges, age 18 years and older, with a principal diagnosis code of AMI, excluding cases:
	• missing discharge disposition
	• transferring to another short-term hospital
	• pregnancy, childbirth and puerperium

Indicator name/ number	Acute myocardial infarction (AMI) mortality rate IQI 15
Target population	Age greater than or equal to 18 years
Risk adjustment	QI software adjusts risk according to diagnosis-related groups (APR-DRG). Observed rates may be stratified by hospitals, age groups, race/ethnicity categories, sex and payer categories.

Table 7. Risk Adjustment Coefficients for IQI #15 Acute Myocardial Infarction (AMI) Mortality Rate

PARAMETER	LABEL	DF	ESTIMATE	STANDARD ERROR	WALD CHI-SQUARE	PR > CHI-SQUARE
INTERCEPT		1	-5.1609	0.0407	16086.28	< 0.0001
AGE	18 to 39	1	-0.4815	0.0722	44.43	< 0.0001
AGE	40 to 44	1	-0.4941	0.0653	57.16	< 0.0001
AGE	45 to 49	1	-0.4317	0.0435	98.36	< 0.0001
AGE	50 to 54	1	-0.2358	0.0364	41.95	< 0.0001
AGE	55 to 59	1	-0.1613	0.0323	25.00	< 0.0001
AGE	65 to 79	1	0.0173	0.0247	0.49	0.4836
AGE	80 to 84	1	0.0570	0.0274	4.33	0.0375
AGE	85+	1	0.2089	0.0257	66.05	< 0.0001
APR-DRG	'1611' to '1612'	1	1.3298	0.1681	62.62	< 0.0001
APR-DRG	'1613' to '1614'	1	3.0198	0.0716	1779.35	< 0.0001
APR-DRG	'1621' to '1622'	1	1.3740	0.2161	40.43	< 0.0001
APR-DRG	'1623'	1	3.0742	0.1090	796.18	< 0.0001
APR-DRG	'1624'	1	4.1672	0.1173	1261.27	< 0.0001
APR-DRG	'1651' to '1652'	1	0.4057	0.0767	27.96	< 0.0001
APR-DRG	'1653'	1	2.1239	0.0608	1220.56	< 0.0001
APR-DRG	'1654'	1	3.6326	0.0704	2664.15	< 0.0001
APR-DRG	'1731' to '1734'	1	3.1595	0.1019	961.04	< 0.0001
APR-DRG	'1742'	1	0.6930	0.0442	245.39	< 0.0001
APR-DRG	'1743'	1	2.1763	0.0465	2186.10	< 0.0001
APR-DRG	'1744'	1	4.1474	0.0392	11197.34	< 0.0001
APR-DRG	'1901'	1	0.1061	0.0779	1.86	0.1731
APR-DRG	'1902'	1	1.4698	0.0433	1152.89	< 0.0001
APR-DRG	'1903'	1	2.7050	0.0368	5393.03	< 0.0001
APR-DRG	'1904'	1	4.3352	0.0383	12823.65	< 0.0001

(CONTINUED)

PARAMETER	LABEL	DF	ESTIMATE	STANDARD ERROR	WALD CHI-SQUARE	PR > CHI-SQUARE
MDC	5	1	2.8773	0.0470	3740.82	< 0.0001
TRNSFER	Transfer-in	1	-0.0168	0.0218	0.59	0.4423

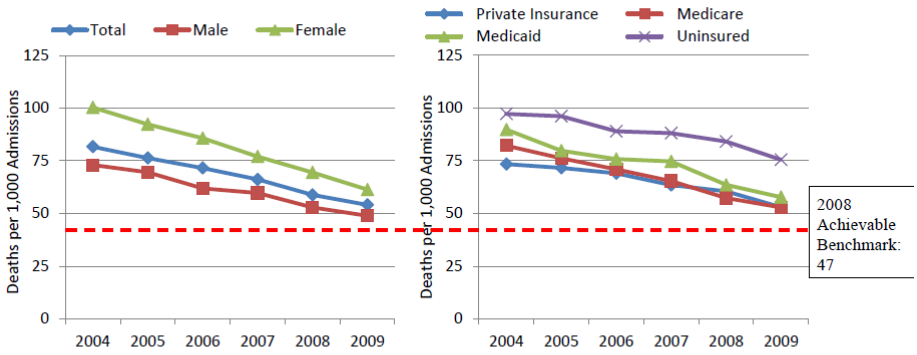
c-statistic = 0.864

Reporting and interpretation	Reported as rate per 1000 discharges. Better quality is associated with a lower score. Each year, the Agency for Healthcare Research and Quality (AHRQ) produces the National Healthcare Quality Report and National Healthcare Disparities Report (NHQR/DR). Three online resources provide access to information from the reports: • NHQR/DR Reports Web Site - The AHRQ issues two reports annually, The National Healthcare Quality Report and The National Healthcare Disparities Report. The reports present, in chart form, the latest available findings on quality of and access to health care. The most recent report is for 2012, available online at http://www.ahrq.gov/research/findings/nhqrdr/index.html In addition there are links to related reports • NHQRDRnet • State Snapshots All of these reports include data in relation to in-hospital mortality for AMI.

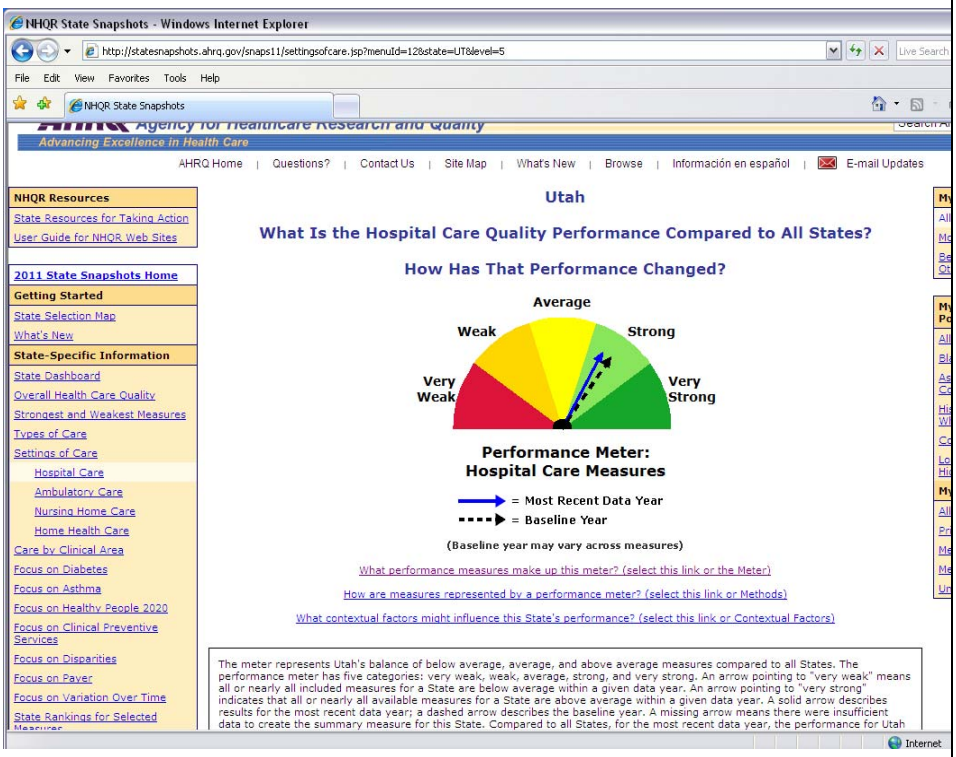
Indicator name/ number	Acute myocardial infarction (AMI) mortality rate IQI 15

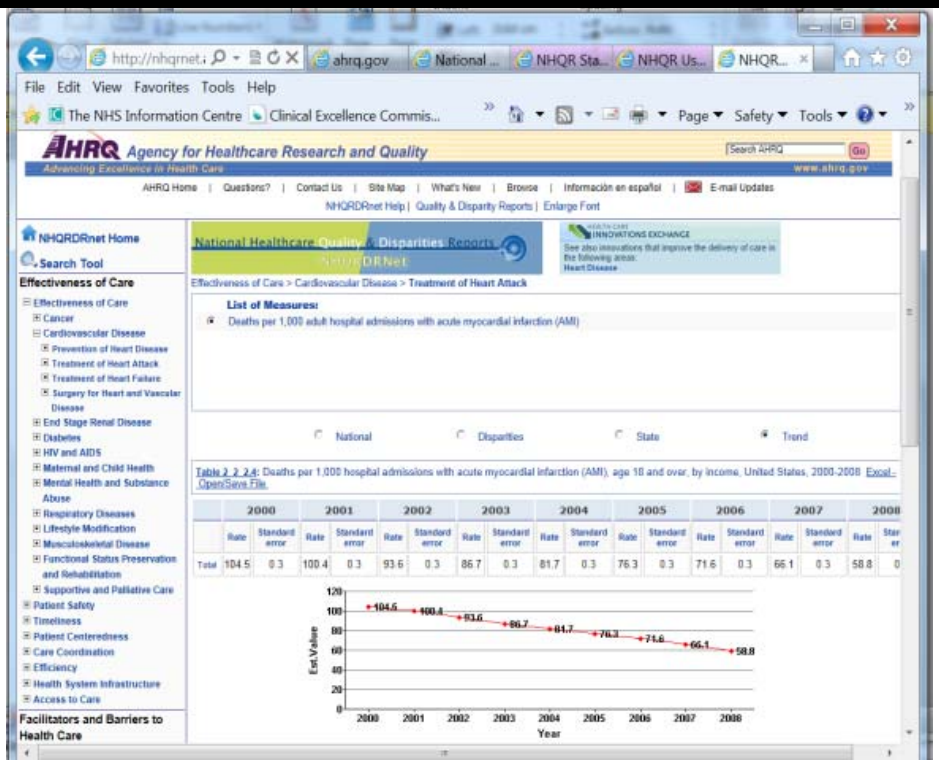
This includes State Snapshots that comprise composite measures with comparisons with previous years.

Figure 2.8. Inpatient deaths per 1,000 adult hospital admissions with heart attack, by gender and expected payment source, 2004-2009



Source: Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project, Nationwide Inpatient Sample and AHRQ Quality Indicators modified version 4.1, 2004-2009.
Denominator: Adults age 18 and over admitted to a non-Federal community hospital in the United States with acute myocardial infarction as principal discharge diagnosis.
Note: For this measure, lower rates are better. Rates are adjusted by age, major diagnostic category, all payer refined-diagnosis related group risk of mortality score, and transfers into the hospital.



Indicator name/ number	Acute myocardial infarction (AMI) mortality rate IQI 15
	 Software and user guides are available to assist users in applying the indicators to their own data. Some organisations have used the AHRQ quality indicators to produce web-based comparative reports on hospital quality (e.g. the Texas Department of State Health Services http://www.dshs.state.tx.us/thcic/publications/hospitals/IQIReport/Indicators-of-Inpatient-Care-in-Texas-Hospitals-2010/ Other organisations have incorporated selected AHRQ indicators into pay for performance demonstration projects, such as The Premier Hospital Quality Incentive Demonstration http://www.premierinc.com/quality-safety/tools-services/p4p/hqi/index.jsp The Centers for Medicare & Medicaid Services' Office of Research, Development, and Information (ORDI), CMS/Premier Hospital Quality Incentive Demonstration Project - Year 6, Participants in Acute Myocardial Infarction (AMI), 2009 https://www.premierinc.com/quality-safety/tools-services/p4p/hqi/resources/ami/HQID_AMI_Results_Year_6.pdf Guidance on these alternative uses of the AHRQ Quality Indicators is summarised in *Guide for Hospital-level Comparative Reporting* http://www.qualityindicators.ahrq.gov/Downloads/News/AHRQ%20QI%20Guide%20to%20Comparative%20Reporting%20v10.pdf
References	AHRQ Inpatient Quality Indicators Technical Specifications May 2013 AHRQ Quality Indicators Risk Adjustment Tables Version 4.5 May 2013 AHRQ Quality Indicator Measure Development, Implementation,

Indicator name/ number	Acute myocardial infarction (AMI) mortality rate IQI 15
	Maintenance and Retirement (May 2011) AHRQ Patient Safety Indicators Overview

Indicator name /number	**Acute myocardial infarction (AMI) mortality rate, without transfer cases ICI 32**
Source	Agency for Healthcare Research and Quality (AHRQ) Inpatient Quality Indicators 32, Technical Specifications, ACUTE Myocardial Infarction (AMI) Mortality rate, without transfer cases, version 4.5, AHRQ, USA, May 2013.
Purpose / rationale	Better processes of care may reduce mortality for AMI, which represents better quality. Hospitals that transfer-out a higher percentage of patients generally have lower in-hospital mortality rates, but similar 30-day mortality rates. This indicator is closely related to an existing NQF endorsed measure for AMI mortality. Future development might harmonize with the endorsed measure specifications
Dimension of quality	Effectiveness
Data source	Hospital administrative data
Definition	In hospital deaths per 1,000 hospital discharges with acute myocardial infarction (AMI) as a principal diagnosis for patients ages 18 years and older. Excludes obstetric discharges, transfers to another hospital, and transfers in from another acute care hospital. ***Previous definition (2009)*** Number of deaths per 100 discharges with a principal diagnosis code of AMI, excluding cases transferred into or out of the hospital.
Numerator	Number of deaths among cases meeting the inclusion and exclusion rules for the denominator (see below).
Denominator	All discharges, age 18 years and older, with a principal diagnosis code of AMI, **ICD-9-CM AMI diagnosis codes:** 41000 AMI ANTEROLATERAL, UNSPEC 41001 AMI ANTEROLATERAL, INIT 41010 AMI ANTERIOR WALL, UNSPEC 41011 AMI ANTERIOR WALL, INIT 41020 AMI INFEROLATERAL, UNSPEC 41021 AMI INFEROLATERAL, INIT 41030 AMI INFEROPOST, UNSPEC 41031 AMI INFEROPOST, INITIAL 41040 AMI INFERIOR WALL, UNSPEC 41041 AMI INFERIOR WALL, INIT E***xclusion criteria:*** • transferring to another short-term hospital (DISP=2) • transferring from another short-term hospital (SID ASOURCE=2 or POINTOFORIGINUB04=4) • MDC 14 (pregnancy, childbirth, and puerperium) • with missing: ○ discharge disposition (DISP=missing) ○ gender (SEX=missing) ○ age (AGE=missing)

<table>
<tr><th>Indicator name /number</th><th><u>Acute myocardial infarction (AMI) mortality rate, without transfer cases</u>
<u>ICI 32</u></th></tr>
<tr><td></td><td>

quarter (DQTR=missing)
year (YEAR=missing)
principal diagnosis (DX1=missing), or
admission source (SID ASOURCE=missing or POINTOFORIGINUB04=missing

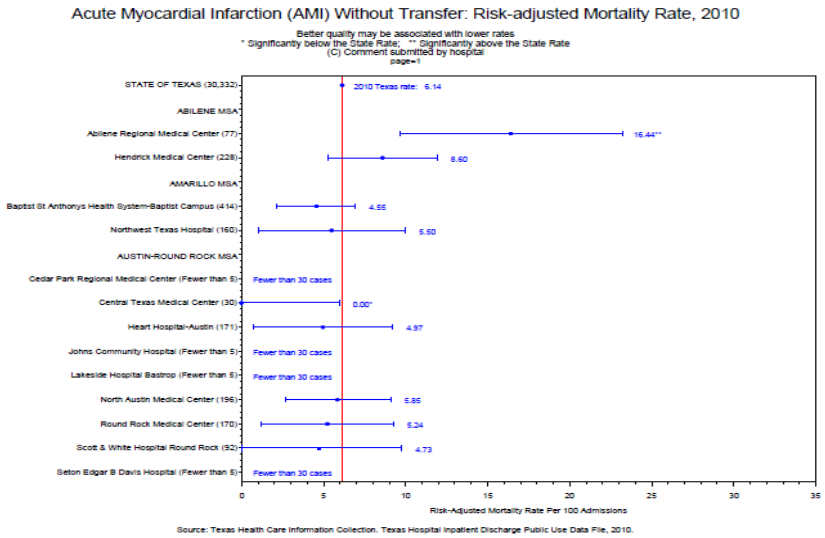
</td></tr>
<tr><td>Target population</td><td>Age greater than or equal to 18 years</td></tr>
<tr><td>Risk adjustment</td><td>QI software adjusts risk according to diagnosis-related groups (APR-DRG).
Observed rates may be stratified by hospitals, age groups, race/ethnicity categories, sex and payer categories.
Table 15. Risk Adjustment Coefficients for IQI #32 Acute Myocardial Infarction (AMI) Mortality Rate, Without Transfer Cases
<table>
<tr><th>PARAMETER</th><th>LABEL</th><th>DF</th><th>ESTIMATE</th><th>STANDARD ERROR</th><th>WALD CHI-SQUARE</th><th>PR > CHI-SQUARE</th></tr>
<tr><td>INTERCEPT</td><td></td><td>1</td><td>-5.1429</td><td>0.0493</td><td>10863.20</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>18 to 39</td><td>1</td><td>-0.5153</td><td>0.0839</td><td>37.76</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>40 to 44</td><td>1</td><td>-0.4995</td><td>0.0713</td><td>49.05</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>45 to 49</td><td>1</td><td>-0.3989</td><td>0.0511</td><td>60.88</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>50 to 54</td><td>1</td><td>-0.2132</td><td>0.0444</td><td>23.06</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>55 to 59</td><td>1</td><td>-0.1541</td><td>0.0385</td><td>16.05</td><td>0.0001</td></tr>
<tr><td>AGE</td><td>65 to 84</td><td>1</td><td>0.0309</td><td>0.0286</td><td>1.17</td><td>0.2796</td></tr>
<tr><td>AGE</td><td>85+</td><td>1</td><td>0.1969</td><td>0.0296</td><td>44.12</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1611' to '1614'</td><td>1</td><td>2.5804</td><td>0.0828</td><td>971.28</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1621' to '1622'</td><td>1</td><td>1.5321</td><td>0.2286</td><td>44.92</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1623'</td><td>1</td><td>2.9364</td><td>0.1371</td><td>459.02</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1624'</td><td>1</td><td>4.1696</td><td>0.1331</td><td>981.80</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1651' to '1652'</td><td>1</td><td>0.4001</td><td>0.0856</td><td>21.83</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1653'</td><td>1</td><td>2.0923</td><td>0.0677</td><td>955.86</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1654'</td><td>1</td><td>3.5650</td><td>0.0798</td><td>1998.32</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1731' to '1734</td><td>1</td><td>3.1666</td><td>0.1206</td><td>689.44</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1742'</td><td>1</td><td>0.6702</td><td>0.0486</td><td>189.96</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1743'</td><td>1</td><td>2.1841</td><td>0.0533</td><td>1681.17</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1744'</td><td>1</td><td>4.1365</td><td>0.0464</td><td>7950.77</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1901'</td><td>1</td><td>0.0998</td><td>0.0865</td><td>1.33</td><td>0.2488</td></tr>
<tr><td>APR-DRG</td><td>'1902'</td><td>1</td><td>1.4637</td><td>0.0509</td><td>826.81</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1903'</td><td>1</td><td>2.7026</td><td>0.0439</td><td>3788.26</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1904'</td><td>1</td><td>4.2851</td><td>0.0457</td><td>8776.48</td><td>< 0.0001</td></tr>
<tr><td>MDC</td><td>5</td><td>1</td><td>2.9629</td><td>0.0556</td><td>2836.35</td><td>< 0.0001</td></tr>
</table>
c-statistic = 0.860</td></tr>
<tr><td>Reporting and interpretation</td><td>Reported as rate per 1000 discharges. Better quality is associated with a lower score.
Each year, the Agency for Healthcare Research and Quality (AHRQ) produces the National Healthcare Quality Report and National Healthcare Disparities Report (NHQR/DR). Three online resources provide access to information from the reports:

NHQR/DR Reports Web Site - The AHRQ issues two reports annually, The National Healthcare Quality Report and The National Healthcare Disparities Report. The reports present, in chart form, the latest available findings on quality of and access to health care. The most recent report is for 2012, available online at http://www.ahrq.gov/research/findings/nhqrdr/index.html

In addition there are links to related reports

NHQRDRnet
State Snapshots

None of these reports include reports of the “without transfer” indicator.
Software and user guides are available to assist users in applying the indicators to their own data. Some organisations have used the AHRQ quality indicators to produce web-based comparative reports on hospital quality (e.g.</td></tr>
</table>

Indicator name /number	Acute myocardial infarction (AMI) mortality rate, without transfer cases ICI 32
	the Texas Department of State Health Services  Other organisations have incorporated selected AHRQ indicators into pay for performance demonstration projects, such as The Premier Hospital Quality Incentive Demonstration http://www.premierinc.com/quality-safety/tools-services/p4p/hqi/index.jsp The Centers for Medicare & Medicaid Services' Office of Research, Development, and Information (ORDI), CMS/Premier Hospital Quality Incentive Demonstration Project - Year 6, Participants in Acute Myocardial Infarction (AMI) 2009 https://www.premierinc.com/quality-safety/tools-services/p4p/hqi/resources/ami/HQID_AMI_Results_Year_6.pdf Guidance on these alternative uses of the AHRQ Quality Indicators is summarised in *Guide for Hospital-level Comparative Reporting* http://www.qualityindicators.ahrq.gov/Downloads/News/AHRQ%20QI%20Guide%20to%20Comparative%20Reporting%20v10.pdf
References	AHRQ Quality Indicators. Inpatient Quality Indicators: Technical specifications – Acute Myocardial Infarction (AMI) Mortality Rate, Without Transfer Cases. December 2009. AHRG Inpatient Quality Indicators Technical Specifications May 2013 http://www.qualityindicators.ahrq.gov/Modules/IQI_TechSpec.aspx AHRQ Quality Indicators Risk Adjustment Tables Version 4.5 May 2013 AHRQ Quality Indicator Measure Development, Implementation, Maintenance and Retirement (May 2011) Patient Safety Indicators Overview

2.1.5 Health Indicators 2013, Canadian Institute for Health Information

Indicator name /number	**30-day acute myocardial infarction (AMI) in-hospital mortality rate**
Source	Indicator definitions are included in two documents, one being the overall indicator set (Health Indictors May2013) and other being a suite defined for the Canadian Hospital Reporting Project. Health Indicators May 2013, Canadian Institute for Health Information (CIHI). Canadian Hospital Reporting Project Technical Notes- Clinical Indicators, March 2013
Purpose /rationale	AMIs, or heart attacks, are a manifestation of heart disease, which is the second leading cause of death in Canada after cancer 1 and one of the top 10 causes of death in the world. Over the past several decades, advances in the treatment of AMI have made it a highly treatable condition. Clinical guidelines have been created to assist health care providers in clinical decision-making for the purpose of improving the quality of cardiovascular care. In addition, performance measures based on existing clinical guidelines have been developed to evaluate the three domains of Donabedian's concept of quality of care: 1) the structure of care, such as provider training/experience and treatment/discharge plans; 2) the process of care; and 3) the outcomes of care, which are the results of the care provided. Measuring and monitoring patient outcomes have been identified as essential components of quality improvement, and reductions in mortality rates for patients with AMI have been related to better processes of care. Not all deaths are preventable. Nevertheless, 30-day risk-adjusted mortality is considered an appropriate measure to reflect the quality of care for AMI, which could be used to potentially identify opportunities for improving patient outcomes.
Dimension of quality	Effectiveness
Data source	Administrative data (Discharge Abstract Database, CIHI)
Definition	***Canadian Indicators definition:*** The risk adjusted rate of all-cause in- hospital death occurring within 30 days of first admission to an acute care hospital with a diagnosis of acute myocardial infarction (AMI). ***Canadian Hospital reporting Project definition:*** The rate of in-hospital deaths due to all causes occurring within 30 days after the first acute myocardial infarction (AMI) admission to an acute care hospital. **Further Notes** In the denominator population, an AMI episode must start as an inpatient

Indicator name /number	30-day acute myocardial infarction (AMI) in-hospital mortality rate
	case with a diagnosis of AMI. For multi-hospital episodes of care, the death must have been attributed to the hospital to which the patient was admitted at the beginning of the episode of care (index record). If the patient was admitted for an AMI multiple times throughout the fiscal year, only the first episode is included in the denominator. AMI episodes where the patient had a previous AMI admission within the last 12 months are excluded (washed out).
Numerator	***Canadian Indicators:*** Number of deaths from all causes occurring in hospital within 30 days of admission for AMI. ***Canadian Hospital reporting Project:*** Cases within the denominator where an in-hospital death occurred within 30 days of the AMI admission.
Denominator	***Canadian Indicators:*** Episodes of first AMI occurrence admitted between April 1 and March of the fiscal year. ***Inclusion criteria:*** 1. a) Acute myocardial infarction (AMI) (ICD-10-CA: I21, I22; ICD-9/ICD-9-CM: 410) is coded as MRDx but not also as a diagnosis type (2); or b) Where another diagnosis is coded as MRDx and also a diagnosis type (2), and a diagnosis of AMI is coded as a type (1), or [type (W), (X) or (Y) but not also as type (2)]; or c) Where coronary artery disease (ICD-10-CA: I25.0, I25.1, I25.8, I25.9; ICD-9/ICD-9-CM: 429.2, 414.0, 414.8, 414.9) is coded as MRDx, AMI as type (1), or [type (W), (X) or (Y) but not also as type (2)]; along with revascularization procedure (percutaneous coronary intervention [CCI: 1.IJ.50^^, 1.IJ.57.GQ^^, 1.IJ.54.GQ-AZxxxvii; CCP: 48.02, 48.03; ICD-9-CM: 36.01, 36.02, 36.05] or coronary artery bypass [CCI: 1.IJ.76^^; CCP: 48.1^; ICD-9-CM: 36.1^]) 2. Admission between April 1 and March 1 of the following year (period of case selection ends March 1 to allow for 30 days of follow-up) 3. Age at admission between 20 and 105 years 4. Sex recorded as male or female 5. Admission to an acute care institution 6. Admission category recorded as urgent/emergent 7. Canadian resident ***Exclusion criteria:*** 1. Records with an invalid health card number 2. Records with an invalid date of birth 3. Records with an invalid admission date

Indicator name /number	30-day acute myocardial infarction (AMI) in-hospital mortality rate
	4. Records with an invalid discharge date 5. Records with an AMI admission within one year prior to the admission date of the index episode 6. Records where the AMI coded as most responsible is also coded as a post-admission diagnosis [diagnosis type (2)] ***Canadian Hospital reporting Project:*** Cases within the denominator where an in-hospital death occurred within 30 days of the AMI admission. ***Inclusion criteria:*** • Admission Category Code = U **AND** • Facility Type Code = 1 (acute care) **AND** • Admission date = April 1 to March 1 **AND** d) AMI (ICD-10-CA: I21.^ or I22.^) is coded as diagnosis type M but not also as type 2; OR e) Where another diagnosis is coded as type M and also as type 2, and a diagnosis of AMI is coded as type 1 (or type W, X or Y but not also as type 2); OR f) Coronary artery disease (ICD-10-CA: I25.0, I25.1^, I25.8 or I25.9) is coded as type M and AMI is coded as type 1 or type W, X or Y but not also as a type 2 **AND** • A revascularization procedure is coded: Percutaneous coronary intervention (CCI: 1.IJ.50^^, 1.IJ.57.GQ^^ or 1.IJ.54.GQ.AZ*) or 5. Coronary artery bypass (CCI: 1.IJ.76^^) ***Exclusion Criteria:*** 1. AMI admissions (ICD-10-CA: I21.^ or I22.^ as a diagnosis type M, 1, 2, W, X or Y in the 12 months preceding the admission date on the index AMI record 2. Age (in years) associated with index AMI record ≤19 3. Refer to Section 5: Identifying Acute Care and Day 4. Procedure Data—Table 2A.
Target population	***Canadian Indicators:*** Age 20 to 105 years ***Canadian Hospital Reporting Project:*** excluding ages 19 and under
Risk adjustment	A logistic regression model is fitted with age, gender, and select preadmission comorbid diagnoses as independent variables. Coefficients derived from the logistic model are used to calculate the probability of in-hospital death following AMI for each case (episode). The expected number of in-hospital deaths in a region is the sum of the case probabilities of that region. The risk adjusted mortality rate (RAMR) is calculated by dividing the observed number of in-hospital deaths of each region by the expected number of in-

Indicator name /number	30-day acute myocardial infarction (AMI) in-hospital mortality rate
	hospital deaths of the region and multiplying by the Canadian average in-hospital death rate.

30-Day In-Hospital Mortality Following AMI (Rate per 100)

Risk Factor	Co-efficient 2007-2008	P value 2007-2008	Co-efficient 2008-2009	P value 2008-2009	Co-efficient 2009-2010	P value 2009-2010	Co-efficient 2010-2011	P value 2010-2011	Co-efficient 2011-2012	P value 2011-2012	ICD-10-CA/Other Codes	Qualifier
Intercept	-4.5933	<.0001	-4.2448	<.0001	-4.5878	<.0001	-4.4315	<.0001	-5.4768	<.0001		
Male (vs. Female)	-0.0115	0.7845	0.0142	0.7433	-0.0354	0.4303	-0.0199	0.6590	-0.0707	0.1308	sex_code = M	
Age 45-64 (vs. Age 20-44)	0.6937	0.0030	0.2236	0.2642	0.5759	0.0171	0.5483	0.0129	1.4914	0.0001	45 ≤ age_years ≤ 64	
Age 65-74 (vs. Age 20-44)	1.7024	<.0001	1.2017	<.0001	1.5211	<.0001	1.3065	<.0001	2.3395	<.0001	65 ≤ age_years ≤ 74	
Age 75-84 (vs. Age 20-44)	2.2897	<.0001	1.8850	<.0001	2.2768	<.0001	1.9233	<.0001	3.0209	<.0001	75 ≤ age_years ≤ 84	
Age 85+ (vs. Age 20-44)	2.9651	<.0001	2.5010	<.0001	2.8809	<.0001	2.6302	<.0001	3.6660	<.0001	85 ≤ age_years	
Cancer	0.8805	<.0001	1.0764	<.0001	0.5884	0.0028	1.2098	<.0001	0.7830	<.0001	C00-C26, C30-C44, C45-C97, Z51.0, Z51.1	Type 1 or (W, X or Y but
Diabetes With Complications	0.2310	<.0001	0.2235	<.0001	0.1061	0.0263	0.1745	0.0002	0.1617	0.0010	E10.0-E10.7, E11.0-E11.7, E13.0-E13.7, E14.0-E14.7	Type 1, 3 or (W, X or Y
Shock	2.6736	<.0001	2.8454	<.0001	2.6380	<.0001	2.5911	<.0001	2.5122	<.0001	R57	Type 1 or (W, X or Y but
Renal Failure	1.0555	<.0001	0.9690	<.0001	0.8741	<.0001	1.0416	<.0001	0.9470	<.0001	N17, N18, N19	Type 1 or (W, X or Y but
Cerebrovascular Disease	1.1675	<.0001	1.1431	<.0001	1.0830	<.0001	0.8832	<.0001	0.6240	0.0040	I60-I67, I69, G45.0, G45.2, G45.4, G45.8, G45.9	Type 1 or (W, X or Y but
Heart Failure	0.5432	<.0001	0.6245	<.0001	0.4908	<.0001	0.5914	<.0001	0.4702	<.0001	I50	Type 1 or (W, X or Y but
Pulmonary Edema	0.1554	0.5293	0.1053	0.7198	0.4558	0.0976	0.9883	<.0001	0.8450	0.0008	J81	Type 1 or (W, X or Y but

Risk-adjustment modelling method	Canada Average* 2007-2008	Canada Average* 2008-2009	Canada Average* 2008-2010	Canada Average* 2010-2011	Canada Average* 2011 2012
Logistic regression	8.79	8.41	7.58	7.60	7.07

*average for all provinces and territories outside of Quebec

Risk-adjusted rates are calculated at the hospital, health administration region and provincial/ territorial levels. Regional and provincial risk-adjusted rates are aggregated hospital-level data.

Reporting and interpretation

Public reporting is available via the CIHI website.

30-day in-hospital mortality for AMI is one of the indicators that can be viewed by peer group and individual hospital through the ***Hospital Results*** report.

Rates are based on three years of pooled data: April 1, 2009, to March 31, 2012.

References

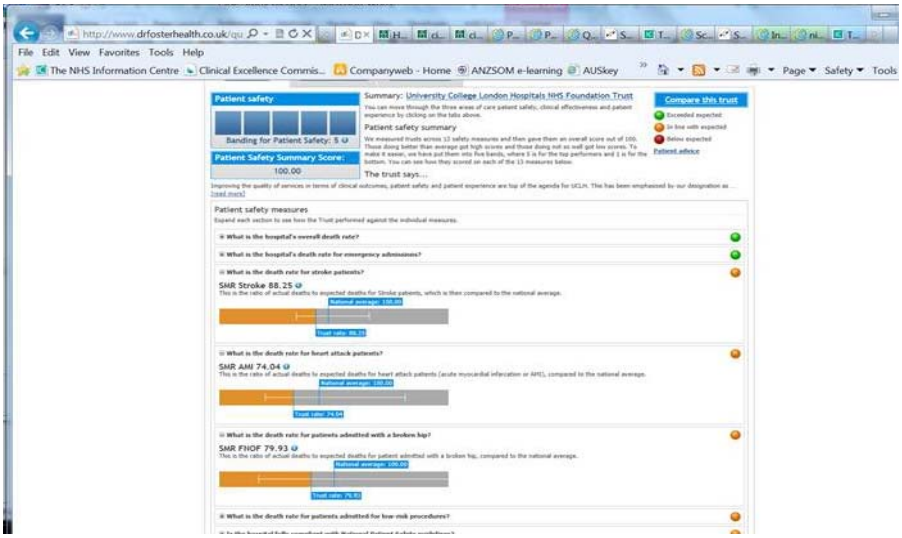
Health Indicators 2010 Definitions, Data Sources and Rationale, May 2010, page 17.

Canadian Institute of Health Information, Indicators

Indicator name /number	30-day acute myocardial infarction (AMI) in-hospital mortality rate
	Health indicators 2010, Canadian Institute for Health Information (CIHI). Canadian Hospital Reporting Project Technical Notes- Clinical Indicators, March 2013 Canadian Hospital Reporting Project – Clinical Indicators Risk Adjustment Tables 2013

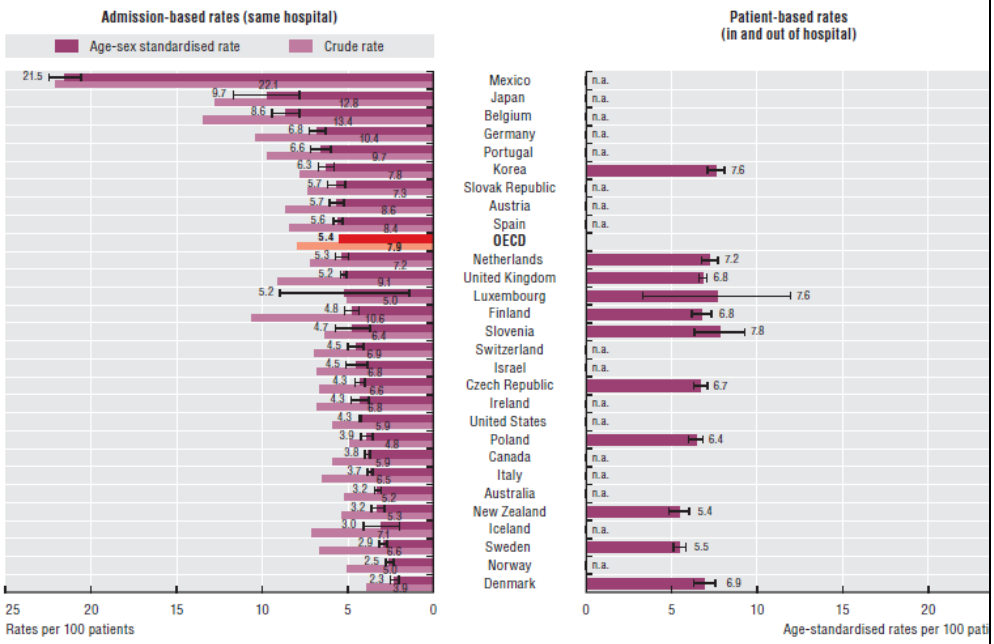
2.1.6 Dr Foster, Quality Accounts UK

Indicator name /number	Hospital standardised mortality ratio - AMI
Source	Quality Accounts – Patient Safety, Dr Foster Health, UK, 2009.
Purpose / rationale	Not specifically identified in indicator specifications. Overall purpose of indicator set is for the comparative analysis of health care quality across different hospitals in England.
Dimension of quality	Effectiveness
Data source	Much of the data used by the Care Quality Council comes from existing, mandatory data collections; data is also commissioned from the Department of Health, the Health and Social Care Information Centre, and the Royal Colleges.
Definition	The ratio of the observed number of in-hospital deaths to the expected number of deaths, multiplied by 100.
Numerator	All spells with method of discharge as death, defined by a specific diagnosis code for the primary diagnosis of the spell (AMI) ***Exclusion criteria:*** • Day cases
Denominator	Expected number of in-hospitals deaths derived from logistic regression.
Target population	Not specified
Risk adjustment	Risk adjustments are made for: • Sex • Age on admission (in five year bands up to 90+) • Admission method (non-elective or elective) • Socio-economic deprivation quintile of the area of residence of the patient (based on the Carstairs Index) • Primary diagnosis (based on the Clinical Classification System - CCS group) • Co-morbidities (no further information available) • Number of previous emergency admissions • Year of discharge (financial year) • Palliative care (whether the patient is being treated in specialty of palliative care).
Reporting and interpretation	Reported as standardised ratios for Trusts (147) (observed / expected). The ratio is calculated by dividing the actual number of deaths by the expected number and multiplying the figure by 100. It is expressed as a relative risk, where a risk rating of 100 represents the national average. If the trust has an HSMR of 100, that means that the number of patients who died is exactly as it would be expected taking into account the standardisation factors. An HSMR above 100 means more patients died than would be expected; one below 100 means that fewer than expected died. Control limits tell us the range of values which are consistent with random or chance variation. Data points falling within the control limits are consistent

Indicator name /number	Hospital standardised mortality ratio - AMI
	with random or chance variation and are said to display 'common-cause variation'; for data points falling outside the control limits, chance is an unlikely explanation and hence they are said to display 'special-cause variation' - that is, where the trust's rate diverges significantly from the national rate. AMI mortality is not reported through the My Hospital Guide report Participating hospitals access details online via a secure website. Dr Foster Quality Account reports provide online reports for participating health services. Mortality indicators, including in-hospital mortality indicators for AMI, stroke and fractured neck of femur, are included under the domain of Patient Safety. Comparisons with other trusts are indicated by a colour coded rating system – green for 'exceeded expected', orange for 'in line with expected' and red for 'below expected'. The results are expressed as a ratio of actual deaths to expected deaths. These mortality indicators use a control limit (displayed on the graph as a white line), which is set at 99.8%. Data points 'falling within the control limits are said to display 'common-cause variation', which means it may be due to chance. Data points falling outside the control limits are known as 'outliers' and chance is an unlikely explanation. They are said to display 'special-cause variation' that is, factors other than chance are the cause. In addition to the ratios for the individual indicators, the trusts are given a composite score summarising performance across the 13 patient safety indicators (Patient Safety Summary Score). These score are out of 100 and reported across five bands of performance. 
References	Dr Foster Intelligence (2009). How healthy is your hospital? Special Edition Hospital Guide. UK, Dr Foster Research Limited. Gavin Thompson, Social and General Statistics (2009). Indicators of hospital performance published by the Care Quality Commission and Dr. Foster Research.

2.1.7 *Health Care Quality Indicators, Organisation for Economic Co-operation and Development*

Indicator name /number	**Acute myocardial infarction 30-day case-fatality rate/in-hospital mortality rate**
Source	Health Care Quality Indicators, Organisation for Economic Co-operation and Development (OECD), 2006.
Purpose / rationale	Not specifically identified in indicator specifications. Overall purpose of indicator set is for the comparative analysis of health care quality across different participating countries and to be used as the basis for investigation to understand why differences exist and what can be done to reduce those differences and improve care in all countries.
Dimension of quality	Effectiveness
Data source	Administrative data from various participating countries.
Definition	Number of deaths in the hospital that occurred within 30 days of hospital admission with primary diagnosis of acute myocardial infarction (AMI).
Numerator	Number of deaths in the hospital that occurred within 30 days of hospital admission with primary diagnosis of acute myocardial infarction.
Denominator	Number of people hospitalised with primary diagnosis of acute myocardial infarction, ***exclusion criteria:*** • death that occur out of hospital • AMI patient who were admitted with other conditions and died in the hospital
Target population	Not specified. Varies for participating countries.
Risk adjustment	Not specified. Comparative analysis was performed from data collected from 20 different countries. Comparability issues include: variation in the data collection period, age groups, collection methods. Standardised rates adjust for differences in age (45+ years) and sex and facilitate more meaningful international comparisons. Crude rates are likely to be more meaningful for internal consideration by individual countries.
Reporting and interpretation	Health at a Glance is an annual publication reporting indictor performance for participating countries. The data is also reported online via the OECD website. Comparative analysis is performed from data collected from 17 different countries Rates per 100 patients, age-sex standardised rates per 100 patients with 95% confidence intervals. Better quality is associated with a lower score. In-hospital case-fatality rate following AMI is defined as the number of people who die within 30 days of being admitted (including same day admissions) to hospital with an AMI. Ideally, rates would be based on individual patients; however, only some countries have the ability to track patients in and out of hospitals, across hospitals or even within the same hospital because they do not currently use a unique patient identifier. In order to increase country coverage, this indicator is also presented based on individual hospital admissions and restricted to mortality within the same hospital, so differences in practices in discharging and transferring

Indicator name /number	Acute myocardial infarction 30-day case-fatality rate/in-hospital mortality rate
	patients may influence the findings. **5.3.1 Admission-based and patient-based in-hospital case-fatality rates within 30 days after admission for AMI, 2009 (or nearest year)**  *Note:* Rates age-sex standardised to 2005 OECD population (45+). 95% confidence intervals represented by ⊢⊣. *Source: OECD Health Data 2011.* http://www.oecd.org/els/health-systems/49105858.pdf
References	Health Care Quality indicators project: initial indicator report (2006), page 98 Care for acute exacerbation of chronic conditions, OECD Health Care Quality Indicators project, 2009 Health Care Quality Indicators, Organisation for Economic Co-operation and Development (OECD), 2010., page 108 Health at a Glance, OECD Health Care Quality Indicators project, 2011

2.2 Stroke

2.2.1 ACQSHC National core, hospital-based outcome indicators

Indicator name/ number	In-hospital mortality of patients admitted for stroke CHBOI 3b
Source	Australian Commission on Safety and Quality in Health Care 2012, *National core, hospital based outcome indicator specification*, *CONSULTATION DRAFT*, ACSQHC, Sydney.
Purpose / rationale	Hospital mortality indicators should be used as screening tools, rather than being assumed to be definitively diagnostic of poor quality and/or safety. This indicator is intended to signal that a problem may exist and that further detailed investigation is required. Quality processes of care may reduce short-term mortality. High outlier rates should be seen as a prompt to further investigation. Learnings may be applied from low outlier rates.
Dimension of quality	Not
Data source	Hospital administrative data
Definition	In-hospital deaths of patients admitted for stroke
Numerator	Observed number of in-hospital deaths for stroke patients × national in-hospital mortality rate for stroke patients *Where* Observed number of in-hospital deaths for stroke patients = the total number of separations (meeting the denominator criteria) where separation mode23 = *died*. National mortality rate = national observed number of in-hospital deaths for stroke ÷ national observed number of separations for stroke.
Denominator	Expected number of in-hospital deaths for stroke patients = the sum of the estimated probabilities of death for all separations (meeting the denominator criteria), calculated using national risk-adjustment coefficients ***Inclusion criteria:*** • Principal diagnosis of stroke (I61.x – I64.x)24 • Age at date of admission is between 18 and 89 years, inclusive • Care type25 = *acute care* • Length of stay (LOS, including leave days) is between 1 and 30 days, inclusive (1 ≤ LOS ≤ 30). ***Exclusion criteria:*** • Any procedure: codes26 33500-00 [700], 32703-00 [718].
Target population	Adults aged 18 – 89 years (inclusive) at admission.
Risk adjustment	Risk adjustment should be performed using a logistic regression model. The response variable will be the probability of in-hospital mortality, and the predictor variables include those listed below. Coefficients from national risk-adjustment modelling are used to calculate the probability of in-hospital death for each case from a hospital. The sum of the probabilities of death will

Indicator name/ number	In-hospital mortality of patients admitted for stroke CHBOI 3b
	form the expected number of deaths. • Age in years at date of admission. • Additional (comorbidities) diagnoses27 (3 dichotomous variables): including: Kidney (renal) failure (N17.x, N19.x, N18.3, N18.4, N18.5, N18.9,R34.x); Heart failure (I50.x, I11.0, I13.0, I13.2); Malignancy (C00.x – C96.x (except C44.x)).
Reporting and interpretation	The ratio of observed (actual) number of in-hospital deaths to expected number of in-hospital deaths for stroke patients, multiplied by the national mortality rate for stroke patients. A value higher than the national rate corresponds to a higher than expected mortality rate, while a value of lower than the national rate corresponds to a lower than expected mortality rate. High or rising rates signal that a problem might exist and that further investigation is required. Investigations should consider a range of possible explanations including: coding and clinical documentation issues, differences from the national patient population that are not addressed by the risk adjustment model; structural or resource issues (e.g. staff shortages, ward closures, etc.); changes in treatment protocols; and professional practice (i.e. individual clinical staff actions) (Mohammed et al 2004).
References	Australian Commission on Safety and Quality in Health Care 2012, *National core, hospital based outcome indicator specification, CONSULTATION DRAFT*, ACSQHC, Sydney.

2.2.2 *Variable Life Adjusted Display Indicators, Queensland Health*

Indicator name/ number	Stroke in-hospital mortality C003-1
Source	Variable Life Adjusted Display (VLAD) indicators, Queensland Health, Australia, 2008/2009 Stroke VLAD Indicator Review, Summary of Activities, 2012 VLAD Indicator Definitions report- Queensland Health- June 2012 The indicator has not been changed since 2008/09 however changes have been recommended in a report published in 2012 as referenced above. Recommended changes are noted below.
Purpose / rationale	Not specifically identified in indicator specifications. Overall purpose of indicator set is to aid monitoring and quality improvement of services provided by the various health care services. The indicator is selected based on existing indicators.
Dimension of quality	Effectiveness
Data source	Queensland Hospital Admitted Patient Data Collection (QHAPDC)
Definition	In-hospital deaths of stroke patients. In-hospital mortality rate is defined as the number of records where separation mode = "death" and length of stay is less than or equal to 30 days, divided by the total number of records.
Numerator	***Current:*** Patients died in-hospital. ***Recommended change*** (Review 2012) Patients who died in hospital and had a length of stay less than or equal to 30 days.
Denominator	***Current:*** Patients with a principal diagnosis of Intracerebral haemorrhage; other non-traumatic intracranial haemorrhage; cerebral infarction; or stroke; not specified as haemorrhage or infarction ***Inclusion criteria:*** • 30-89 years • length of stay 3 or more days unless the patient died in hospital ***Exclusion criteria:*** • transfers in • transfers out • changes of episode type, and • procedure codes for carotid endarectomy or resection of carotid artery with re-anastomosis ***Recommendations from 2012 review – not yet incorporated into specifications:*** Continue the production of the Stroke In-hospital Mortality indicator with modifications outlined below: ***Inclusion criteria:*** • Inclusion of all in hospital mortalities • Expand age of patients to include those aged 18-29 years • Linkage of episodes across hospitals to be the same as linkage within hospitals, i.e. – link to subsequent acute stroke episodes or other

Indicator name/ number	Stroke in-hospital mortality C003-1
	non-acute episodes • Transfers out from the initial hospital providing acute treatment are included, as are transfers in and out of subsequent hospitals in a single 'continuum of care'. A transferred case is defined as either: an admission to a subsequent hospital within 12 hours of separation from the previous hospital **OR** an admission to a subsequent hospital within 36 hours with indication of either a 'transfer out' or a 'transfer in' ***Exclusion criteria:*** • Exclusion of same day and overnight patients that do not die • Procedure codes for carotid endarectomy or resection of carotid artery with re-anastomosis; Percutaneous transluminal angioplasty of single carotid artery, multiple stents; Percutaneous transluminal angioplasty of single carotid artery, single stent; Hind brain decompression; Subtemporal decompression; Posterior cranial fossa decompression; Insertion of external ventricular drain; or Removal of external ventricular drain to be excluded
Target population	***Current:*** Age 30-89 years ***Recommended change:*** to include 18-29 years
Risk adjustment	***Current:*** Risk adjustment made for: Age group, septicaemia, malignancy, heart failure, acute lower respiratory tract infection and influenza, and renal failure. ***Recommended:*** To remove septicaemia and acute respiratory tract infection and include risk adjustment for stroke type: • Age group • Heart failure • Malignancy • Renal Failure • Stroke type (as defined by ICD code block: I61, I62, I63, or I64) Please refer to Stroke VLAD Indicator Review, Summary of Activities, 2012, pg 8 for rationale of risk adjustment recommendations
Reporting and interpretation	Reported as rate per 100 separations. Better quality is associated with a lower score. The VLAD system is managed through a partnership with Opus 5 which provides the platform for analysis and reporting of VLAD data (previously available through the QH website), as well as comprehensive systems for actioning performance results found to be outside the control limits. The operation of the system is described in detail in the Opus 5 Clinical Monitoring brochure. The use of VLAD within Queensland Health is governed by the Health Service Directive (current 17 June 2013), which makes reference to the VLAD Implementation Standard and Implementation Guideline which is currently not available on the QH website.

Indicator name/ number	Stroke in-hospital mortality C003-1
	VLAD is updated on a monthly basis and as such, the VLAD technique allows timely detection of potential problems or improved performance. A flag is initiated where the VLAD line meets the lower or upper control limits (refer graph below). Further details about the flagging processes are no longer available publicly on the website (they were previously 2009). Features of the website include charting to show performance against control limits for a selected indicator and facility. The Opus 5 website also includes functionality for analysing causes and determining workflow to address quality issues.  The Hospital Performance Reports are no longer available publicly on the website. At the time of the last literature review in 2009, the 2004 data was available publicly.
References	Stroke VLAD Indicator Review, Summary of Activities, 2012 VLAD Indicator Definitions report- Queensland Health- June 2012

2.2.3 Agency for Healthcare Research and Quality (AHRQ) Inpatient Quality Indicators

Indicator name /number	**Acute stroke mortality rate IQI 17**
Source	Agency for Healthcare Research and Quality (AHRQ) Inpatient Quality Indicators, AHRQ, USA #17 (IQI #17) AHRQ Quality Indicators™, Version 4.5, May 2013
Purpose / rationale	Better processes of care may reduce short-term mortality, which represents better quality. ***Rationale:*** Hospital mortality indicators should be used as screening tools, rather than being assumed to be definitively diagnostic of poor quality and/or safety. This indicator is intended to signal that a problem may exist and that further detailed investigation is required. Quality processes of care may reduce short-term mortality. High outlier rates should be seen as a prompt to further investigation. Learnings may be applied from low outlier rates.
Dimension of quality	Effectiveness
Data source	Hospital administrative data
Definition	In-hospital deaths per 1,000 hospital discharges with acute stroke as a principal diagnosis for patients ages 18 years and older. Includes metrics for discharges grouped by type of stroke. Excludes obstetric discharges and transfers to another hospital. *[NOTE: The software provides the rate per hospital discharge. However, common practice reports the measure as per 1,000 discharges. The user must multiply the rate obtained from the software by 1,000 to report in-hospital deaths per 1,000 hospital discharges.]* ***Previous definition (2009)***: Number of deaths per 100 discharges with principal diagnosis code of stroke
Numerator	**Overall:** Number of deaths (DISP=20) among cases meeting the inclusion and exclusion rules for the denominator. *[NOTE: Overall numerator may not match the sum of the strata numerators because the strata may not be mutually exclusive.]* **Stratum A (**subarachnoid stroke**):** Number of deaths (DISP=20) among cases meeting the inclusion and exclusion rules for the denominator. **Stratum B** (hemorrhagic stroke)**:** Number of deaths (DISP=20) among cases meeting the inclusion and exclusion rules for the denominator. **Stratum C** (ischemic stroke)**:** Number of deaths (DISP=20) among cases meeting the inclusion and exclusion rules for the denominator.
Denominator	**Overall:** Discharges, for patients ages 18 years and older, with a principal ICD-9-CM diagnosis code for subarachnoid stroke or a principal ICD-9-CM diagnosis

Indicator name /number	Acute stroke mortality rate IQI 17
	code for hemorrhagic stroke or a principal ICD-9-CM diagnosis code for ischemic stroke. ***Exclusion criteria:*** • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • with missing discharge disposition (DISP=missing), gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing) or principal diagnosis (DX1=missing) *[NOTE: Overall denominator may not match the sum of the strata denominators because the strata may not be mutually exclusive.]* **Stratum A** (subarachnoid stroke)**:** Discharges, for patients ages 18 years and older, with a principal ICD-9-CM diagnosis code for subarachnoid stroke. ***Exclusion criteria:*** • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • with missing discharge disposition (DISP=missing), gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing) or principal diagnosis (DX1=missing) **Stratum B** (hemorrhagic stroke)**:** Discharges, for patients ages 18 years and older, with a principal ICD-9-CM diagnosis code for hemorrhagic stroke. ***Exclusion criteria:*** • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • with missing discharge disposition (DISP=missing), gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing) or principal diagnosis (DX1=missing) **Stratum C** (ischemic stroke)**:** Discharges, for patients ages 18 years and older, with a principal ICD-9-CM diagnosis code for ischemic stroke. ***Exclusion criteria:*** • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • with missing discharge disposition (DISP=missing), gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing) or principal diagnosis (DX1=missing)

<table>
<tr><th>Indicator name /number</th><th>Acute stroke mortality rate
IQI 17</th></tr>
<tr><td></td><td>
<table>
<tr><td colspan="2">ICD-9-CM Subarachnoid stroke diagnosis codes:</td></tr>
<tr><td>430</td><td>SUBARACHNOID HEMORRHAGE</td></tr>
<tr><td colspan="2">ICD-9-CM Hemorrhagic stroke diagnosis codes:</td></tr>
<tr><td>431</td><td>INTRACEREBRAL HEMORRHAGE</td></tr>
<tr><td>4320</td><td>NONTRAUM EXTRADURAL HEM</td></tr>
<tr><td>4321</td><td>SUBDURAL HEMORRHAGE</td></tr>
<tr><td>4329</td><td>INTRACRANIAL HEMORR NOS</td></tr>
<tr><td colspan="2">ICD-9-CM Ischemic stroke diagnosis codes:</td></tr>
<tr><td>43301</td><td>OCL BSLR ART W INFRCT</td></tr>
<tr><td>43311</td><td>OCL CRTD ART W INFRCT</td></tr>
<tr><td>43321</td><td>OCL VRTB ART W INFRCT</td></tr>
<tr><td>43331</td><td>OCL MLT BI ART W INFRCT</td></tr>
<tr><td>43381</td><td>OCL SPCF ART W INFRCT</td></tr>
<tr><td>43391</td><td>OCL ART NOS W INFRCT</td></tr>
<tr><td>43401</td><td>CRBL THRMBS W INFRCT</td></tr>
<tr><td>43411</td><td>CRBL EMBLSM W INFRCT</td></tr>
<tr><td>43491</td><td>CRBL ART OCL NOS W INFRC</td></tr>
<tr><td>436</td><td>CVA</td></tr>
</table>

NOTE: Previously not broken up into types of stroke:
Numerator: Number of deaths among cases meeting the inclusion or exclusion rules for the denominator.
Denominator: All discharges, age 18 years and older, with a principal diagnosis code of stroke, excluding:

missing discharge disposition
transferring to another short-term hospital
major Diagnostic Category (MDC): pregnancy, childbirth and puerperium

</td></tr>
<tr><td>Target population</td><td>Age greater than or equal to 18 years.</td></tr>
<tr><td>Risk adjustment</td><td>QI software adjusts risk according to diagnosis-related groups (APR-DRG).
Observed rates may be stratified by hospitals, age groups, race/ethnicity categories, sex and payer categories.</td></tr>
</table>

Indicator name /number	Acute stroke mortality rate IQI 17

Table 9. Risk Adjustment Coefficients for IQI #17 Acute Stroke Mortality Rate

PARAMETER	LABEL	DF	ESTIMATE	STANDARD ERROR	WALD CHI-SQUARE	PR > CHI-SQUARE
INTERCEPT		1	-4.8190	0.0435	12283.36	< 0.0001
SEX	Female	1	0.0889	0.0119	55.58	< 0.0001
AGE	18 to 59	1	-0.1685	0.0239	49.82	< 0.0001
AGE	65 to 84	1	0.0315	0.0223	2.00	0.1574
AGE	85+	1	0.4676	0.0258	327.29	< 0.0001
APR-DRG	'0211'	1	1.6099	0.0729	488.23	< 0.0001
APR-DRG	'0212'	1	2.3177	0.0644	1293.18	< 0.0001
APR-DRG	'0213'	1	3.6171	0.0465	6049.04	< 0.0001
APR-DRG	'0214'	1	4.8732	0.0567	7374.43	< 0.0001
APR-DRG	'0221'	1	1.5959	0.8993	3.15	0.0760
APR-DRG	'0222'	1	2.1657	0.7023	9.51	0.0020
APR-DRG	'0223' to '0224'	1	4.0903	0.0844	2347.12	< 0.0001
APR-DRG	'0241'	1	0.8871	0.1667	28.34	< 0.0001
APR-DRG	'0242'	1	1.5332	0.0723	449.66	< 0.0001
APR-DRG	'0243'	1	2.9467	0.0772	1458.41	< 0.0001
APR-DRG	'0244'	1	4.8179	0.1050	2106.82	< 0.0001
APR-DRG	'0261' to '0263'	1	0.5856	0.1458	16.14	0.0001
APR-DRG	'0264'	1	3.3734	0.1984	289.20	< 0.0001
APR-DRG	'0441'	1	2.3209	0.0516	2023.71	< 0.0001
APR-DRG	'0442'	1	2.3736	0.0431	3035.50	< 0.0001
APR-DRG	'0443'	1	3.2257	0.0441	5351.97	< 0.0001
APR-DRG	'0444'	1	5.5956	0.0433	16695.42	< 0.0001
APR-DRG	'0452'	1	1.1227	0.0366	941.48	< 0.0001
APR-DRG	'0453'	1	2.1956	0.0392	3132.15	< 0.0001
APR-DRG	'0454'	1	4.2522	0.0397	11461.22	< 0.0001

PARAMETER	LABEL	DF	ESTIMATE	STANDARD ERROR	WALD CHI-SQUA
MDC	OTHER	1	2.6431	0.0492	288
NOPOUB04	UB-04 Point-of-Origin Data Not Available	1	0.0350	0.0315	

c-statistic = 0.889

Table 9A. Risk Adjustment Coefficients for IQI #17A Acute Stroke Mortality Rate - Stratum A

PARAMETER	LABEL	DF	ESTIMATE	STANDARD ERROR	WALD CHI-SQUARE
INTERCEPT		1	-2.1406	0.2313	85.6
SEX	Female	1	0.1132	0.0417	7.3
AGE	18 to 59	1	-0.1998	0.0656	9.2
AGE	65 to 84	1	0.1784	0.0683	6.8
AGE	85+	1	0.6760	0.0965	49.1
APR-DRG	'0211'	1	-0.5778	0.2316	6.2
APR-DRG	'0212'	1	0.9270	0.2623	12.4
APR-DRG	'0213'	1	0.9082	0.2211	16.8
APR-DRG	'0214'	1	2.6021	0.2413	116.2
APR-DRG	'0223' to '0224'	1	1.0355	0.2326	19.8
APR-DRG	'0241'	1	-1.6556	0.2692	37.8
APR-DRG	'0242'	1	-0.9033	0.3073	8.6
APR-DRG	'0243'	1	0.5110	0.2828	3.2
APR-DRG	'0244'	1	2.0440	0.2846	51.5
APR-DRG	'0264'	1	2.2674	0.9688	5.4
APR-DRG	'0442'	1	-1.0511	0.2269	21.4
APR-DRG	'0443'	1	0.2698	0.2217	1.4
APR-DRG	'0444'	1	3.3044	0.2233	219.0
MDC	OTHER	1	0.0422	0.2239	0.0
NOPOUB04	UB-04 Point-of-Origin Data Not Available	1	0.0714	0.0692	1.0

c-statistic = 0.861

Indicator name /number	Acute stroke mortality rate IQI 17

Table 9B. Risk Adjustment Coefficients for IQI #17B Acute Stroke Mortality Rate - Stratum B

PARAMETER	LABEL	DF	ESTIMATE	STANDARD ERROR	WALD CHI-SQUA
INTERCEPT		1	-1.5808	0.1468	11
SEX	Female	1	0.1029	0.0183	3
AGE	18 to 59	1	-0.1203	0.0335	1
AGE	65 to 84	1	0.0790	0.0328	
AGE	85+	1	0.3280	0.0376	7
APR-DRG	'0211'	1	-1.9367	0.1694	13
APR-DRG	'0212'	1	-1.1868	0.1548	5
APR-DRG	'0213'	1	0.4967	0.1454	1
APR-DRG	'0214'	1	1.4372	0.1548	8
APR-DRG	'0222'	1	-1.1231	0.7993	
APR-DRG	'0223' to '0224'	1	1.4440	0.1650	7
APR-DRG	'0241'	1	-1.7624	0.5083	1
APR-DRG	'0242'	1	-0.5682	0.4209	
APR-DRG	'0243'	1	-0.4169	0.3778	
APR-DRG	'0244'	1	1.8300	0.4056	2
APR-DRG	'0261' to '0263'	1	-1.8382	0.3570	2
APR-DRG	'0264'	1	-0.2021	0.4944	
APR-DRG	'0441'	1	-0.7227	0.1431	2
APR-DRG	'0442'	1	-0.6214	0.1411	1
APR-DRG	'0443'	1	0.1245	0.1471	
APR-DRG	'0444'	1	2.3712	0.1418	27
MDC	OTHER	1	-0.2590	0.1441	
NOPOUB04	UB-04 Point-of-Origin Data Not Available	1	-0.0540	0.0393	

Table 9C. Risk Adjustment Coefficients for IQI #17C Acute Stroke Mortality Rate - Stratum C

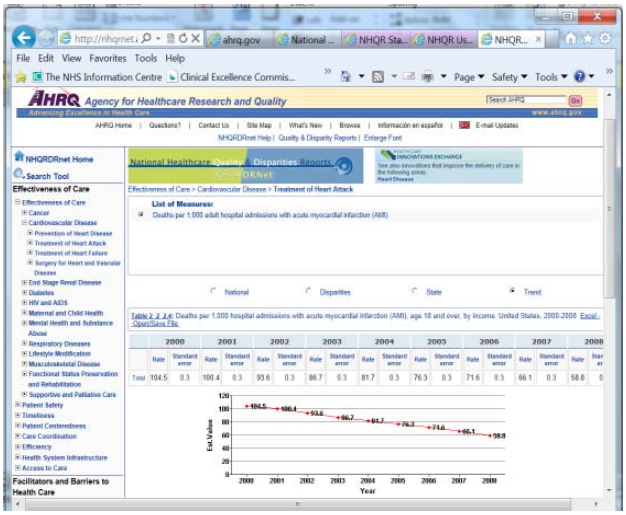
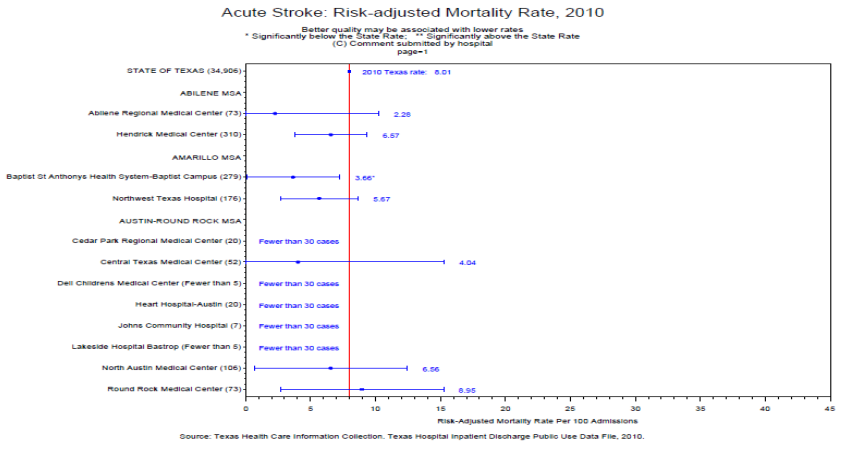
PARAMETER	LABEL	DF	ESTIMATE	STANDARD ERROR	WALD CHI-SQUA
INTERCEPT		1	-5.1383	0.0524	959
SEX	Female	1	0.0407	0.0158	
AGE	18 to 59	1	-0.2393	0.0366	4
AGE	65 to 84	1	-0.0287	0.0334	
AGE	85+	1	0.4964	0.0373	17
APR-DRG	'0211'	1	3.3114	0.1733	36
APR-DRG	'0212'	1	4.1946	0.1376	92
APR-DRG	'0213'	1	4.2220	0.1349	97
APR-DRG	'0214'	1	5.3068	0.1104	230
APR-DRG	'0221'	1	-2.6592	1.0923	
APR-DRG	'0222'	1	3.1751	1.1388	
APR-DRG	'0223' to '0224'	1	4.4502	0.3665	14
APR-DRG	'0242'	1	1.7647	0.0813	47
APR-DRG	'0243'	1	3.2006	0.0939	116
APR-DRG	'0244'	1	5.1228	0.1163	193
APR-DRG	'0261' to '0263'	1	0.7975	0.1773	2
APR-DRG	'0264'	1	3.6649	0.2386	23
APR-DRG	'0452'	1	1.4427	0.0420	118
APR-DRG	'0453'	1	2.5177	0.0445	319
APR-DRG	'0454'	1	4.5898	0.0469	958
MDC	OTHER	1	2.8093	0.0644	190
NOPOUB04	UB-04 Point-of-Origin Data Not Available	1	0.0493	0.0343	

Reporting and interpretation

Reported as rate per 1000 discharges. Better quality is associated with a lower score.

Each year, the Agency for Healthcare Research and Quality (AHRQ) produces the National Healthcare Quality Report and National Healthcare Disparities Report (NHQR/DR). Three online resources provide access to information from the reports:

- NHQR/DR Reports Web Site - The AHRQ issues two reports annually, The National Healthcare Quality Report and The National Healthcare Disparities Report. The reports present, in chart form, the latest available findings on quality of and access to health care. The most recent report is for 2012, available online at http://www.ahrq.gov/research/findings/nhqrdr/index.html

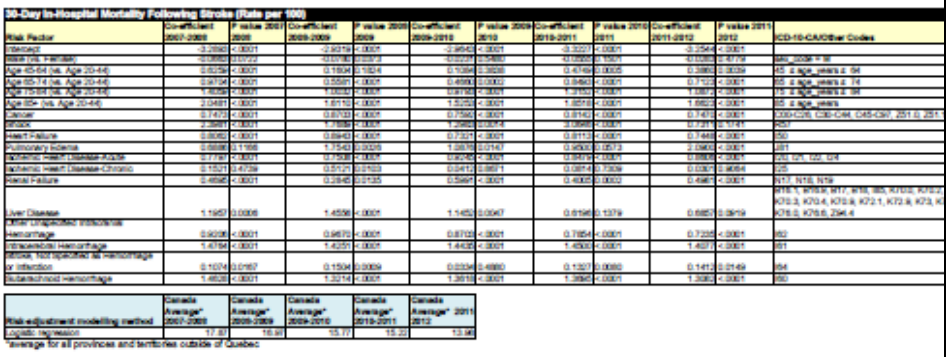
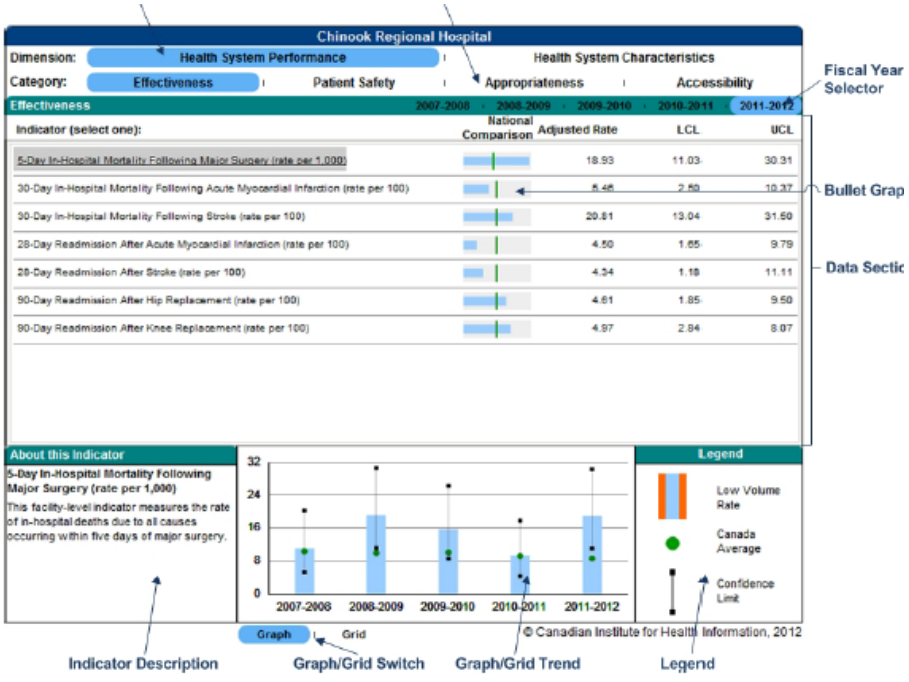
Indicator name /number	Acute stroke mortality rate IQI 17
	In addition there are links to related reports • NHQRDRnet • State Snapshots None of these public reports include data in relation to in-hospital mortality for stroke.  Software and user guides are available to assist users in applying the indicators to their own data. Some organisations have used the AHRQ quality indicators to produce web-based comparative reports on hospital quality (e.g. the Texas Department of State Health Services  Other organisations have incorporated selected AHRQ indicators into pay for performance demonstration projects, such as The Premier Hospital Quality Incentive Demonstration . Guidance on these alternative uses of the AHRQ Quality Indicators is summarised in *Guide for Hospital-level Comparative Reporting*
References	AHRQ Quality Indicators. Inpatient Quality Indicators: Technical specifications – Acute stroke: mortality rate. May 2013 AHRQ Quality Indicators Risk Adjustment Tables http://www.qualityindicators.ahrq.gov/Downloads/Modules/IQI/V45/Risk%

Indicator name /number	Acute stroke mortality rate IQI 17
	20Adjustment%20Tables%20IQI%204.5.pdf AHRQ Quality Indicator Measure Development, Implementation, Maintenance and Retirement (May 2011) http://www.qualityindicators.ahrq.gov/Downloads/Resources/Publications/2011/QI%20Measure%20Development%20Implementation%20Maintenance%20Retirement%20Full%205-3-11.pdf Patient Safety Indicators Overview http://www.qualityindicators.ahrq.gov/Modules/psi_resources.aspx Inpatient Quality Indicators Technical Specifications May 2013 http://www.qualityindicators.ahrq.gov/Modules/IQI_TechSpec.aspx

2.2.4 Health Indicators, Canadian Institute for Health Information

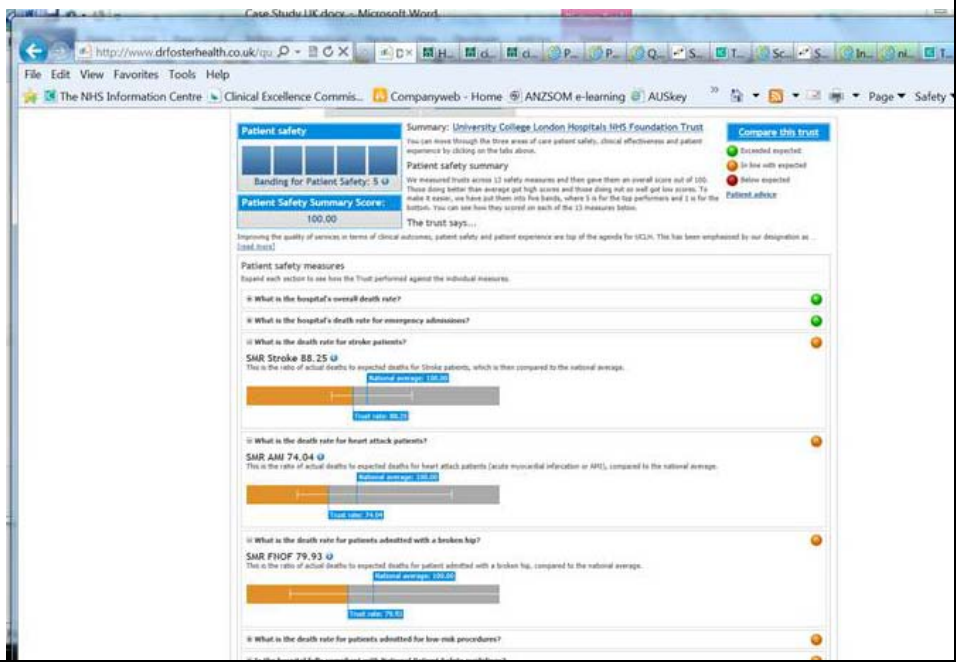
Indicator name /number	30-day stroke in-hospital mortality rate
Source	Health indicators 2010, Canadian Institute for Health Information (CIHI). Canadian Hospital Reporting Project Technical Notes- Clinical Indicators, March 2013
Purpose / rationale	Stroke and other cerebrovascular diseases are one of the top 10 causes of death in the world and the third leading cause of death in Canada. Improving care for stroke patients has become a priority, and expert working groups have been formed to develop guidelines, best practices and performance measures for quality improvement for stroke care. Mortality 30 days following stroke is influenced by certain processes of care and may be improved by involving an interdisciplinary stroke team, using brain imaging for diagnostic testing and managing intracerebral hemorrhage.4 Not all deaths are preventable. Nevertheless, an examination of the rate of death within 30 days after stroke could identify improvement opportunities in the processes of stroke care. Risk-adjusted mortality rates following stroke may reflect, for example, the severity of the stroke, the underlying effectiveness of treatment and quality of care. Variations in stroke mortality rates may reflect differences in standards of care, as well as other factors, such as early recognition of symptoms and seeking medical care as quickly as possible. Monitoring the percentage of patients who die in hospital after a stroke can be used to review practice patterns, evaluate progress and initiate improvements in care.
Dimension of quality	Effectiveness
Data source	Administrative data (Discharge Abstract Database, CIHI)
Definition	***Canadian Indicators Definition:*** Risk-adjusted rate of all cause in-hospital death occurring within 30 days of first admission to an acute care hospital with a diagnosis of stroke. ***Canadian Hospital Reporting Project Definition:*** Rate of in-hospital deaths due to all causes occurring within 30 days after the first stroke admission to an acute care hospital.
Numerator	***Canadian Indicators:*** Number of deaths from all causes occurring in-hospital within 30 days of admission for stroke. ***Canadian Hospital Reporting Project:*** Cases within the denominator where an in-hospital death (Discharge Disposition Code =07 (died)); facility code =1 (acute); occurred within 30 days of the stroke admission (Discharge date on death record_ - (Admission date on stroke record) ≤ 30 days.
Denominator	***Canadian Indicators:*** Total Number of stroke episodes in an 11 month period ***Inclusions criteria:*** 1.a) Stroke 1 (ICD-10-CA: I60-I64; ICD-9CM: 430-432; 433-434 with fifth digit of 1; 436) is coded as MRDx but not also as a diagnosis type (2); or b) Where another diagnosis is coded as MRDx and also a diagnosis type (2), and a diagnosis of Stroke is coded as a type (1), or [type (W), (X) or (Y) but not also as type (2)]; or

Indicator name /number	30-day stroke in-hospital mortality rate
	c) Where rehabilitation (ICD-10: Z50.1, Z50.4-Z50.9; ICD-9CM: V57) is coded as MRDx and Stroke as a type (1), or [type (W), (X) or (Y) but not also as type (2)]. 2. Admission between April 1 and March 1 of the following year (period of case selection ends March 1 to allow for 30 days of follow-up) 3. Age at admission between 20 and 105 years 4. Gender recorded as male or female 5. Admission to an acute care institution 6. Admission category recorded as urgent/emergent 7. Canadian resident ***Exclusion criteria:*** 1. Records with an invalid Health Card Number 2. Records with an invalid date of birth 3. Records with an invalid admission date or time 4. Records with an invalid discharge date or time 5. Records with a stroke admission within one year prior to the admission date of the index episode 6. Records where the stroke coded as most responsible is also coded as a post-admission diagnosis (diagnosis type (2)) **Further Notes** In the denominator population, a stroke episode must start as an inpatient case with a diagnosis of stroke. For multi-hospital episodes of care, death is attributed to the hospital to which the patient was admitted at the beginning of the episode of care (index record). If the patient was admitted for a stroke multiple times throughout the year, only the first episode was included in the denominator. Stroke episodes where the patient had a previous stroke admission within the last 12 months are excluded (washed out). ***Canadian Hospital Reporting Project:*** Episodes of first stroke occurrence admitted between April 1 and March 1 of the fiscal year. Inclusions and exclusions as above except upper age limit removed – (age excludes patients 19 and under).
Target population	***Canadian Indicators:*** Age 20 to 105 years ***Canadian Hospital Reporting Project:*** excluding ages 19 and under
Risk adjustment	***Canadian Hospital Reporting Project*** Statistical regression modelling is used to risk-adjust patient characteristics. Risk factors controlled for include age, gender and selected pre-admit comorbid diagnoses applicable to the indicator. For stroke mortality these include cancer, shock, heart failure, pulmonary oedema, ischaemic heart disease (acute, chronic), renal failure, liver disease, other unspecified intracranial haemorrhage, intracerebral haemorrhage or infarction and subarachnoid haemorrhage.

Indicator name /number	30-day stroke in-hospital mortality rate
	 Risk-adjusted rates are calculated at the hospital, health administration region and provincial/ territorial levels. Regional and provincial risk-adjusted rates are aggregated hospital-level data.
Reporting and interpretation	Public reporting is available via the CIHI website. 30-day in-hospital mortality for stroke is one of the indicators that can be viewed by peer group and individual hospital through the ***Hospital Results*** report**.** Reported as rate per 100 patients.  Rates are based on three years of pooled data: April 1, 2009, to March 31, 2012.
Reference	Canadian Institute of Health Information, Indicators Health indicators 2010, Canadian Institute for Health Information (CIHI). Canadian Hospital Reporting Project Technical Notes- Clinical Indicators, March 2013 Canadian Hospital Reporting Project – Clinical Indicators Risk Adjustment Tables 2013

2.2.5 Dr Foster UK

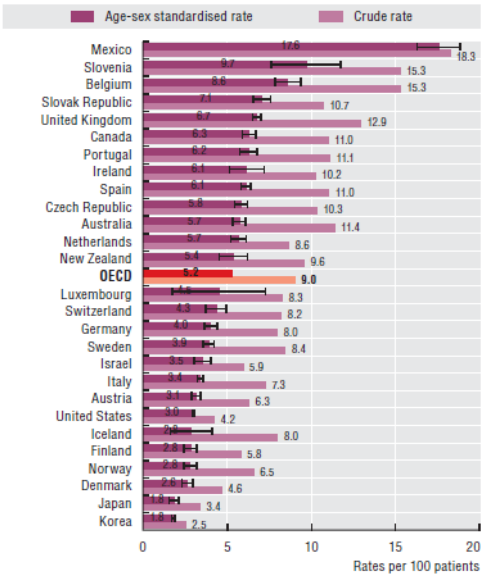
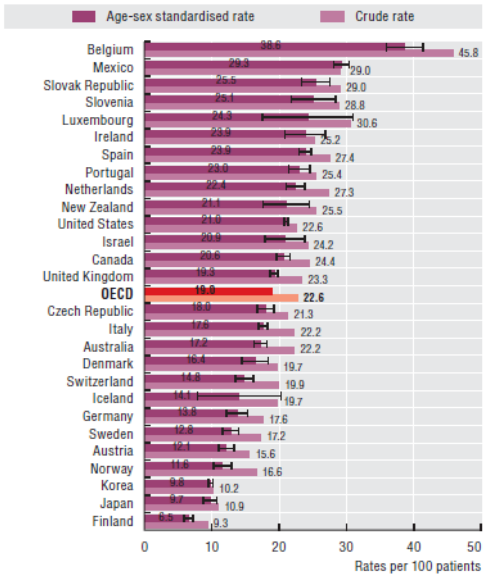
Indicator name /number	Hospital standardised mortality ratio - stroke
Source	Quality Accounts – Patient Safety, Dr Foster Health, UK, 2009. (appears not to be updated since then)
Purpose / rationale	Not specifically identified in indicator specifications. Overall purpose of indicator set is for the comparative analysis of health care quality across different hospitals in England.
Dimension of quality	Effectiveness
Data source	Much of the data used by the Care Quality Council comes from existing, mandatory data collections; data is also commissioned from the Department of Health, the Health and Social Care Information Centre, and the Royal Colleges.
Definition	The ratio of the observed number of in-hospital deaths to the expected number of deaths, multiplied by 100.
Numerator	All spells with method of discharge as death, defined by a specific diagnosis code for the primary diagnosis of the spell (stroke), excluding day cases. ICD10 codes: G46,I60-I64,I66 ***Exclusion criteria:*** • Daycases (where classpat = 2 in the first episode)
Denominator	Expected number of in-hospitals deaths derived from logistic regression.
Target population	Not specified
Risk adjustment and statistical methods	Risk adjustments are made for: • Sex • Age on admission (in five year bands up to 90+) • Admission method (non-elective or elective) • Socio-economic deprivation quintile of the area of residence of the patient (based on the Carstairs Index) • Primary diagnosis (based on the Clinical Classification System - CCS group) • Co-morbidities (no further information available) • Number of previous emergency admissions • Year of discharge (financial year) • Palliative care (whether the patient is being treated in specialty of palliative care).
Reporting and interpretation	Reported as standardised ratios for Trusts (147) (observed / expected). The ratio is calculated by dividing the actual number of deaths by the expected number and multiplying the figure by 100. It is expressed as a relative risk, where a risk rating of 100 represents the national average. If the trust has an HSMR of 100, that means that the number of patients who died is exactly as it would be expected taking into account the standardisation

Indicator name /number	Hospital standardised mortality ratio - stroke
	factors. An HSMR above 100 means more patients died than would be expected; one below 100 means that fewer than expected died. Control limits tell us the range of values which are consistent with random or chance variation. Data points falling within the control limits are consistent with random or chance variation and are said to display 'common-cause variation'; for data points falling outside the control limits, chance is an unlikely explanation and hence they are said to display 'special-cause variation' - that is, where the trust's rate diverges significantly from the national rate. Stroke mortality is not reported through the My Hospital Guide report Participating hospitals access details online via a secure website. Dr Foster Quality Account reports provide online reports for participating health services. Mortality indicators, including in-hospital mortality indicators for AMI, stroke and fractured neck of femur, are included under the domain of Patient Safety. Comparisons with other trusts are indicated by a colour coded rating system – green for 'exceeded expected', orange for 'in line with expected' and red for 'below expected'. The results are expressed as a ratio of actual deaths to expected deaths. These mortality indicators use a control limit (displayed on the graph as a white line), which is set at 99.8%. Data points 'falling within the control limits are said to display 'common-cause variation', which means it may be due to chance. Data points falling outside the control limits are known as 'outliers' and chance is an unlikely explanation. They are said to display 'special-cause variation' that is, factors other than chance are the cause. In addition to the ratios for the individual indicators, the trusts are given a composite score summarising performance across the 13 patient safety indicators (Patient Safety Summary Score). These score are out of 100 and reported across five bands of performance. 

Indicator name /number	Hospital standardised mortality ratio - stroke
References	Dr Foster Intelligence (2009). How healthy is your hospital? Special Edition Hospital Guide. UK, Dr Foster Research Limited. Gavin Thompson, Social and General Statistics (2009). Indicators of hospital performance published by the Care Quality Commission and Dr. Foster Research.

2.2.6 *Health Care Quality Indicators, Organisation for Economic Co-operation and Development*

Indicator name /number	Stroke 30 day case-fatality rate/in-hospital mortality rate
Source	Health Care Quality Indicators, Organisation for Economic Co-operation and Development (OECD), 2006.
Purpose / rationale	Not specifically identified in indicator specifications. Overall purpose of indicator set is for the comparative analysis of health care quality across different participating countries and to be used as the basis for investigation to understand why differences exist and what can be done to reduce those differences and improve care in all countries.
Dimension of quality	Effectiveness
Data source	Administrative data from various participating countries.
Definition	Number of deaths in the hospital that occurred within 30 days of hospital admission with primary diagnosis of hemorrhagic and ischemic stroke.
Numerator	Number of deaths in the hospital that occurred within 30 days of hospital admission with primary diagnosis of hemorrhagic stroke, and ischemic stroke (ICD-9 or ICD-10).
Denominator	Number of people hospitalised with primary diagnosis of stroke.
Target population	Not specified. Varies for participating countries.
Risk adjustment	Standardised rates adjust for differences in age (45+ years) and sex and facilitate more meaningful international comparisons. Comparability issues include: variation in the data collection period, age groups, coding practice, collection methods.
Reporting and interpretation	Health at a Glance is an annual publication reporting indictor performance for participating countries. The data is also reported online via the OECD website. Comparative analysis is performed from data collected from 17 different countries Rates per 100 patients, age-sex standardised rates per 100 patients with 95% confidence intervals. Better quality is associated with a lower score. In-hospital case-fatality rate following ischemic and hemorrhagic stroke is defined as the number of people who die within 30 days of being admitted (including same day admissions) to hospital. Ideally, rates would be based on individual patients; however, not all countries have the ability to track patients in and out of hospitals, across hospitals or even within the same hospital because they do not currently use a unique patient identifier. Therefore, this indicator is based on unique hospital admissions and restricted to mortality within the same hospital, so differences in practices in discharging and transferring patients may influence the findings. The Czech Republic, Denmark, Finland, Korea, Luxembourg, New Zealand, the Netherlands, Poland, Slovenia, Sweden and the United Kingdom also provided patient-based (in and out of hospitals) data. Their relative performance is generally similar as the case-fatality rate within the same hospital, although the rates are obviously higher. Both crude and age and sex standardised rates are presented. Standardised rates adjust for differences in age (45+ years) and sex and facilitate more meaningful international comparisons. Crude rates are likely to be more

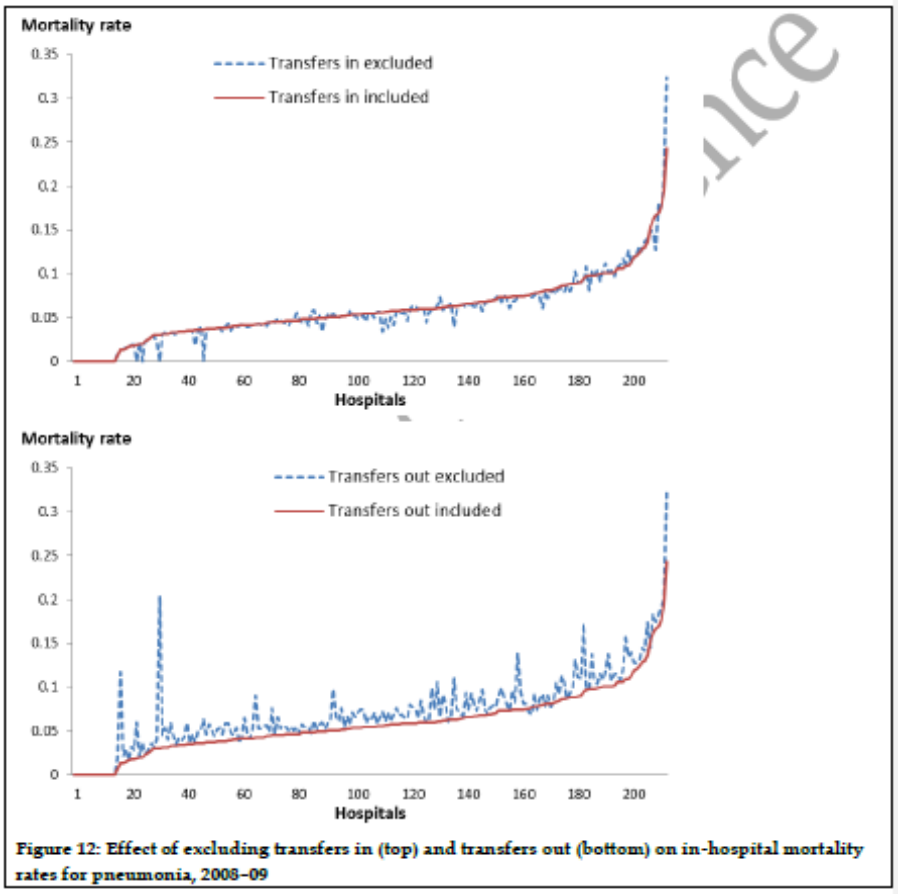
Indicator name /number	Stroke 30 day case-fatality rate/in-hospital mortality rate
	meaningful for internal consideration by individual countries. **5.4.1 In-hospital case-fatality rates within 30 days after admission for ischemic stroke, 2009 (or nearest year)**  *Note:* Rates age-sex standardised to 2005 OECD population (45+). 95% confidence intervals represented by ⊢⊣. *Source: OECD Health Data 2011.* **5.4.2 In-hospital case-fatality rates within 30 days after admission for hemorrhagic stroke, 2009 (or nearest year)**  *Note:* Rates age-sex standardised to 2005 OECD population (45+). 95% confidence intervals represented by ⊢⊣. *Source: OECD Health Data 2011.*
References	Health Care Quality indicators project: initial indicator report (2006), page 104 Care for acute exacerbation of chronic conditions, OECD Health Care Quality Indicators project, 2009 Health Care Quality Indicators, Organisation for Economic Co-operation and Development (OECD), 2010. Refer pg 112 Health at a Glance. OECD Indicators Report 2011

2.3 Pneumonia

2.3.1 ACQSHC National core, hospital-based outcome indicators

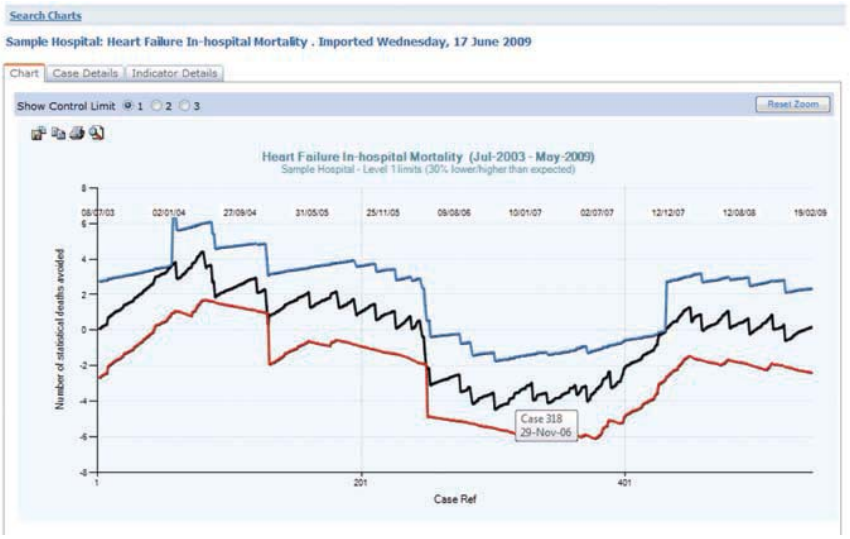
Indicator name/ number	In-hospital mortality of patients admitted for pneumonia CHBOI 3d
Source	Australian Commission on Safety and Quality in Health Care 2012, *National core, hospital based outcome indicator specification*, *CONSULTATION DRAFT*, ACSQHC, Sydney.
Purpose / rationale	Hospital mortality indicators should be used as screening tools, rather than being assumed to be definitively diagnostic of poor quality and/or safety. This indicator is intended to signal that a problem may exist and that further detailed investigation is required. High outlier rates should be seen as a prompt to further investigation. Learnings may be applied from low outlier rates.
Dimension of quality	Not indicated
Data source	Hospital administrative data
Definition	In-hospital deaths of patients admitted for pneumonia
Numerator	Observed number of in-hospital deaths for pneumonia patients × national in hospital mortality rate for pneumonia patients *where* Observed number of in-hospital deaths for pneumonia patients = the total number of separations (meeting the denominator criteria) where separation mode = *died*. National mortality rate = national observed number of in-hospital deaths for pneumonia ÷ national observed number of separations for pneumonia.
Denominator	Expected number of in-hospital deaths for pneumonia patients,= the sum of the estimated probabilities of death for all separations (meeting the denominator criteria), calculated using national risk adjustment coefficients. ***Inclusion criteria:*** • Principal diagnosis35 of pneumonia (J13.x – J16.x, J18.x) • Age at date of admission is between 18 and 89 years, inclusive • Care type36 = *acute care* • Length of stay (LOS, including leave days) is between 1 and 30 days, inclusive [1 day ≤ LOS ≤ 30 days].
Target population	Age at date of admission is between 18 and 89 years, inclusive
Risk adjustment	Risk adjustment should be performed using a logistic regression model. The response variable will be the probability of in-hospital mortality, and the predictor variables include those listed below. Coefficients from national risk adjustment modelling are used to calculate the probability of in-hospital death for each case from a hospital. The sum of the probabilities of death will form the expected number of deaths.

Indicator name/ number	In-hospital mortality of patients admitted for pneumonia CHBOI 3d
	Risk adjustments made for: • Age in years at date of admission • Additional (comorbid) diagnoses37 (12 dichotomous variables): – Dementia (F00.x (G30.x †), F01.x, F02.x *, F03.x) – Alzheimer's disease (G30.x, G31.0, G31.1) – Hypotension (I95.x) – Shock (R57.x, A48.3) – Kidney (renal) failure (N17.x, N19.x, N18.3, N18.4, N18.5, N18.9, R34.x) – Other chronic obstructive pulmonary disease (J43.x, J44.x, J47.x) – Heart failure (I50.x, I11.0, I13.0, I13.2) – Dysrhythmia (I46.x, I47.x, I48.x, I49.x) – Malignancy (C00.x -C96.x, except C44.x) – Liver disease (K70.x – K77.x) – Cerebrovascular disease (I60.x – I69.x) – Parkinson's disease (G20.x).
Reporting and interpretation	The ratio of observed (actual) number of in-hospital deaths to expected number of in-hospital deaths for pneumonia patients, multiplied by the national mortality rate for pneumonia patients: A value higher than the national rate corresponds to a higher than expected mortality rate, while a value of lower than the national rate corresponds to a lower than expected mortality rate. High or rising rates signal that a problem might exist and that further investigation is required. Investigations should consider a range of possible explanations including: differences from the national patient population that are not addressed by the risk adjustment model; structural or resource issues (e.g. staff shortages, ward closures, etc.); changes in treatment protocols; and professional practice (i.e. individual clinical staff actions) (Mohammed et al 2004).

Indicator name/ number	In-hospital mortality of patients admitted for pneumonia CHBOI 3d
	Figure 2 - Effect of excluding transfers in and transfers out (2008-09 data) pneumonia  Figure 12: Effect of excluding transfers in (top) and transfers out (bottom) on in-hospital mortality rates for pneumonia, 2008–09
References	Australian Commission on Safety and Quality in Health Care 2012, *National core, hospital based outcome indicator specification, CONSULTATION DRAFT*, ACSQHC, Sydney.

2.3.2 Variable Life Adjusted Display Indicators, Queensland Health

Indicator name/ number	**Pneumonia in hospital mortality** **C004-1 Version 1 2009/09**
Source	Variable Life Adjusted Display (VLAD) indicators, Queensland Health, Australia, 2008/2009 (No change since 2009)
Purpose / rationale	Not specifically identified in indicator specifications. Overall purpose of indicator set is to aid monitoring and quality improvement of services provided by the various health care services. The indicator is selected based on existing indicators.
Dimension of quality	Effectiveness
Data source	Queensland Hospital Admitted Patient Data Collection (QHAPDC)
Definition	In-hospital deaths of pneumonia patients. In-hospital mortality rate is defined as the number of records where separation mode = "death" and length of stay is less than or equal to 30 days, divided by the total number of records.
Numerator	Patients died in-hospital.
Denominator	Patients with a principal diagnosis of pneumonia due to Streptococcus pneumoniae; pneumonia due to Haemophilus influenzae; Bacterial pneumonia, not elsewhere classified; pneumonia due to other infectious organisms, not elsewhere classified; and Pneumonia, organism unspecified, and ***inclusion criteria***: • 20-89 years • length of stay 1-30 days and ***Exclusion criteria:*** • transfers in and transfers out
Target population	Age 20-89 years
Risk adjustment	Risk adjustments are made for: Age, septicaemia, malignancy, dementia (inc Alzheimer's Disease), Parkinson's Disease, dysrhythmias, heart failure, hypotension and shock , cerebrovascular disease, other chronic obstructive pulmonary disease, liver diseases, ulcer of lower limb or decubitus ulcer, renal failure. **Risk Adjustment Comorbidity** / **ICD Codes** Age Group Septicaemia: A40-A41 Malignancy: C00-C97 Dementia (inc. Alzheimers Disease): F00-F03; G30-G311 Parkinsons Disease: G20 Dysrhythmias: I46-I49 Heart Failure: I50 Hypotension and Shock: I95; R57 Cerebrovascular Disease: I60-I69 Other Chronic Obstructive Pulmonary Disease: J40-J44; J47 Liver Disease: K70-K77 Ulcer of lower limb or decubitus ulcer: L89; L97 Renal Failure: N17; N18.3; N18.4; N18.5; N18.9; N19; R34 How control limits are worked out

Indicator name/ number	Pneumonia in hospital mortality C004-1 Version 1 2009/09
Reporting and interpretation	Reported as rate per 100 separations. Better quality is associated with a lower score. Hospitals can access online reporting via the Opus 5 system. This indicator is not reported publicly via the QH site. The VLAD system is managed through a partnership with Opus 5 which provides the platform for analysis and reporting of VLAD data (previously available through the QH website), as well as comprehensive systems for actioning performance results found to be outside the control limits. The operation of the system is described in detail in the Opus 5 Clinical Monitoring brochure. The use of VLAD within Queensland Health is governed by the Health Service Directive (current 17 June 2013), which makes reference to the VLAD Implementation Standard and Implementation Guideline which is currently not available on the QH website. VLAD is updated on a monthly basis and as such, the VLAD technique allows timely detection of potential problems or improved performance. A flag is initiated where the VLAD line meets the lower or upper control limits (refer graph below). Further details about the flagging processes are no longer available publicly on the website (they were previously 2009). Features of the website include charting to show performance against control limits for a selected indicator and facility. The Opus 5 website also includes functionality for analysing causes and determining workflow to address quality issues.  The Hospital Performance Reports are no longer available publicly on the website. At the time of the last literature review in 2009, the 2004 data was available publicly.
References	Queensland Health, Clinical Practice Improvement Centre, Indicator Definitions.

2.3.3 Agency for Healthcare Research and Quality (AHRQ) Inpatient Quality Indicators

Indicator name /number	**Pneumonia mortality rate** **IQI 20**
Source	Agency for Healthcare Research and Quality (AHRQ) Inpatient Quality Indicators, AHRQ, USA #20 (IQI #20) AHRQ Quality Indicators™, Version 4.5, May 2013
Purpose / rationale	Inappropriate treatment for pneumonia may increase mortality.
Dimension of quality	Effectiveness
Data source	Hospital administrative data
Definition	**New definition (2013):** In-hospital deaths per 1,000 hospital discharges with pneumonia as a principal diagnosis for patients ages 18 years and older. Excludes obstetric discharges and transfers to another hospital. *[NOTE: The software provides the rate per hospital discharge. However, common practice reports the measure as per 1,000 discharges. The user must multiply the rate obtained from the software by 1,000 to report in-hospital deaths per 1,000 hospital discharges.]* **Previous definition (2009):** Mortality in discharges with principal diagnosis code of pneumonia.
Numerator	Number of deaths among cases meeting the inclusion and exclusion rules for the denominator (see below).
Denominator	**New definition (2013):** Discharges, for patients ages 18 years and older, with a principal ICD-9-CM diagnosis code for pneumonia. **ICD-9-CM Pneumonia diagnosis codes[1]:** 00322 SALMONELLA PNEUMONIA 0212 PULMONARY TULAREMIA 0391 PULMONARY ACTINOMYCOSIS 0521 VARICELLA PNEUMONITIS 0551 POSTMEASLES PNEUMONIA 0730 ORNITHOSIS PNEUMONIA 1124 CANDIDIASIS OF LUNG 1140 PRIMARY COCCIDIOIDOMYCOS 1144 CH PL COCCIDIOIDOMYCOSIS 1145 PL COCIDIOIDOMYCOSIS NOS 11505 HISTOPLASM CAPS PNEUMON 11515 HISTOPLASM DUB PNEUMONIA 11595 HISTOPLASMOSIS PNEUMONIA 1304 TOXOPLASMA PNEUMONITIS 1363 PNEUMOCYSTOSIS 4800 ADENOVIRAL PNEUMONIA 4801 RESP SYNCYT VIRAL PNEUM 4802 PARINFLUENZA VIRAL PNEUM 4803 PNEUMONIA DUE TO SARS 4808 VIRAL PNEUMONIA NEC 4809 VIRAL PNEUMONIA NOS 481 PNEUMOCOCCAL PNEUMONIA 4820 K. PNEUMONIAE PNEUMONIA 4821 PSEUDOMONAL PNEUMONIA 4822 H.INFLUENZAE PNEUMONIA 48230 STREPTOCOCCAL PNEUMN NOS 48231 PNEUMONIA STRPTOCOCCUS A 48232 PNEUMONIA STRPTOCOCCUS B 48239 PNEUMONIA OTH STREP *4824 STAPHYLOCOCCAL PNEU NOS* 48240 STAPHYLOCOCCAL PNEU NOS 48241 METH SUS PNEUM D/T STAPH 48242 METH RES PNEU D/T STAPH 48249 STAPH PNEUMONIA NEC 48281 PNEUMONIA ANAEROBES 48282 PNEUMONIA E COLI 48283 PNEUMO OTH GRM-NEG BACT 48284 LEGIONNAIRES' DISEASE 48289 PNEUMONIA OTH SPCF BACT 4829 BACTERIAL PNEUMONIA NOS 4830 PNEU MYCPLSM PNEUMONIAE 4831 PNEUMONIA D/T CHLAMYDIA 4838 PNEUMON OTH SPEC ORGNSM 4841 PNEUM W CYTOMEG INCL DIS 4843 PNEUMONIA IN WHOOP COUGH 4845 PNEUMONIA IN ANTHRAX 4846 PNEUM IN ASPERGILLOSIS 4847 PNEUM IN OTH SYS MYCOSES 4848 PNEUM IN INFECT DIS NEC 485 BRONCOPNEUMONIA ORG NOS 486 PNEUMONIA, ORGANISM NOS 4870 INFLUENZA WITH PNEUMONIA [1] The procedure or diagnosis codes are continuously updated. The current list of ICD-9-CM codes is valid for October 2012 through September 2013. Italicized codes are not active in Fiscal Year 2013. ***Exclusions:***

<table>
<tr><th>Indicator name /number</th><th>Pneumonia mortality rate
IQI 20</th></tr>
<tr><td></td><td>

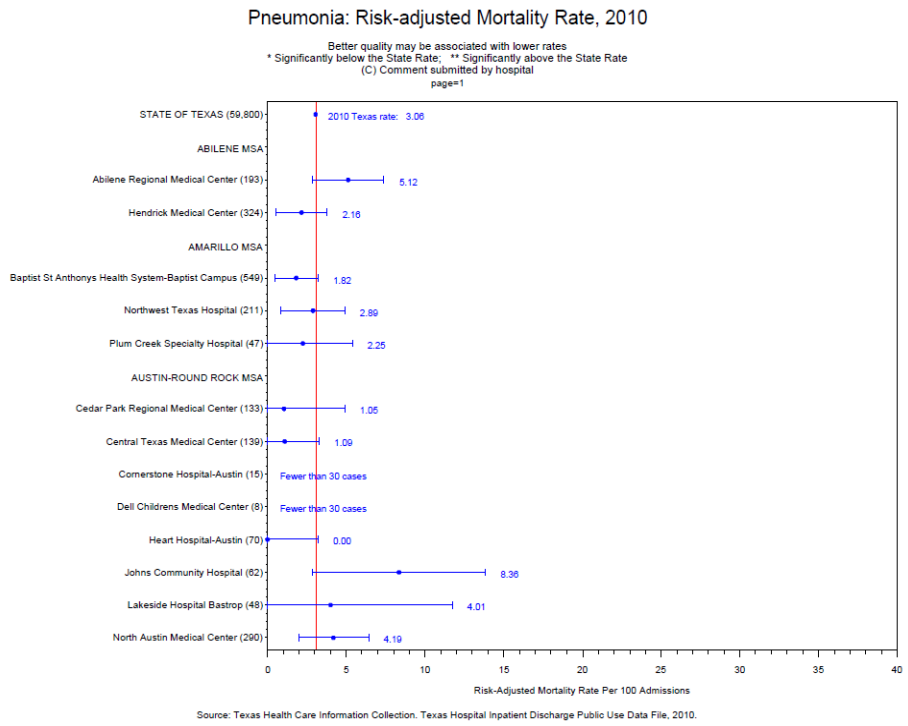
transferring to another short-term hospital (DISP=2)
MDC 14 (pregnancy, childbirth, and puerperium)
with missing discharge disposition (DISP=missing), gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing) or principal diagnosis (DX1=missing)

<u>Previous definition (2009):</u>
All discharges, age 18 years and older, with a principal diagnosis code of pneumonia, excluding:

missing discharge disposition
transferring to another short-term hospital
Major Diagnostic Category (MDC): pregnancy, childbirth, and puerperium

</td></tr>
<tr><td>Target population</td><td>Age greater than or equal to 18 years</td></tr>
<tr><td><u>Risk adjustment</u></td><td>QI software adjusts risk according to diagnosis-related groups (APR-DRG).
Observed rates may be stratified by hospitals, age groups, race/ethnicity categories, sex, and payer categories.
Table 12. Risk Adjustment Coefficients for IQI #20 Pneumonia Mortality Rate
<table>
<tr><th>PARAMETER</th><th>LABEL</th><th>DF</th><th>ESTIMATE</th><th>STANDARD ERROR</th><th>WALD CHI-SQUARE</th><th>PR > CHI-SQUARE</th></tr>
<tr><td>INTERCEPT</td><td></td><td>1</td><td>-5.2858</td><td>0.0441</td><td>14393.74</td><td>< 0.0001</td></tr>
<tr><td>SEX</td><td>Female</td><td>1</td><td>-0.0802</td><td>0.0121</td><td>44.26</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>18 to 24</td><td>1</td><td>-1.3299</td><td>0.0924</td><td>206.92</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>25 to 29</td><td>1</td><td>-1.0483</td><td>0.0936</td><td>125.46</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>30 to 34</td><td>1</td><td>-1.1133</td><td>0.0963</td><td>133.53</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>35 to 39</td><td>1</td><td>-0.7935</td><td>0.0762</td><td>108.31</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>40 to 44</td><td>1</td><td>-0.6704</td><td>0.0608</td><td>121.43</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>45 to 49</td><td>1</td><td>-0.4763</td><td>0.0482</td><td>97.64</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>50 to 54</td><td>1</td><td>-0.3217</td><td>0.0413</td><td>60.68</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>55 to 59</td><td>1</td><td>-0.1671</td><td>0.0358</td><td>21.74</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>80 to 84</td><td>1</td><td>0.1625</td><td>0.0268</td><td>36.64</td><td>< 0.0001</td></tr>
<tr><td>AGE</td><td>85+</td><td>1</td><td>0.6413</td><td>0.0289</td><td>492.37</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1211'</td><td>1</td><td>1.6275</td><td>0.1894</td><td>73.86</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1212'</td><td>1</td><td>3.0432</td><td>0.1411</td><td>464.89</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1213'</td><td>1</td><td>3.5566</td><td>0.1097</td><td>1052.07</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1214'</td><td>1</td><td>4.5066</td><td>0.1400</td><td>1036.54</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1301'</td><td>1</td><td>3.8377</td><td>0.1074</td><td>1275.71</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1302'</td><td>1</td><td>4.4578</td><td>0.0598</td><td>5563.51</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1303' to '1304</td><td>1</td><td>4.7064</td><td>0.0475</td><td>9809.37</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1371'</td><td>1</td><td>-0.6092</td><td>0.2067</td><td>8.68</td><td>0.0032</td></tr>
<tr><td>APR-DRG</td><td>'1372'</td><td>1</td><td>1.0699</td><td>0.0569</td><td>353.21</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1373'</td><td>1</td><td>2.3129</td><td>0.0456</td><td>2575.44</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1374'</td><td>1</td><td>3.3333</td><td>0.0482</td><td>4780.66</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1392'</td><td>1</td><td>1.1038</td><td>0.0350</td><td>995.32</td><td>< 0.0001</td></tr>
<tr><td>APR-DRG</td><td>'1393'</td><td>1</td><td>2.3595</td><td>0.0355</td><td>4418.55</td><td>< 0.0001</td></tr>
</table>
(CONTINUED)
<table>
<tr><th>PARAMETER</th><th>LABEL</th><th>DF</th><th>ESTIMATE</th><th>STANDARD ERROR</th><th>WALD CHI-SQUARE</th><th>PR > CHI-SQUARE</th></tr>
<tr><td>APR-DRG</td><td>'1394'</td><td>1</td><td>3.5152</td><td>0.0384</td><td>8375.27</td><td>< 0.0001</td></tr>
<tr><td>MDC</td><td>4</td><td>1</td><td>2.9036</td><td>0.0460</td><td>3981.23</td><td>< 0.0001</td></tr>
<tr><td>MDC</td><td>25</td><td>1</td><td>1.8942</td><td>0.1108</td><td>292.09</td><td>< 0.0001</td></tr>
<tr><td>TRNSFER</td><td>Transfer-in</td><td>1</td><td>0.5412</td><td>0.0343</td><td>249.01</td><td>< 0.0001</td></tr>
</table>
c-statistic = 0.829</td></tr>
<tr><td>Reporting and interpretation</td><td>Reported as rate per 1000 discharges. Better quality is associated with a lower score.</td></tr>
</table>

Indicator name /number	Pneumonia mortality rate IQI 20
	Each year, the Agency for Healthcare Research and Quality (AHRQ) produces the National Healthcare Quality Report and National Healthcare Disparities Report (NHQR/DR). Three online resources provide access to information from the reports: • NHQR/DR Reports Web Site - The AHRQ issues two reports annually, The National Healthcare Quality Report and The National Healthcare Disparities Report. The reports present, in chart form, the latest available findings on quality of and access to health care. The most recent report is for 2012, available online at http://www.ahrq.gov/research/findings/nhqrdr/index.html The reports do not include data relating to in-hospital pneumonia mortality In addition there are links to related reports • NHQRDRnet • State Snapshots Both of these reports include data relating to in hospital mortality for pneumonia. NHQRDRnet includes this indicator as part of a composite score for quality of care in the hospital setting.  National Disparities State Trend Select a category: -- Select -- Table 8_2_7.1: Deaths per 1,000 hospital admissions with pneumonia, age 18 and over, United States, 2000, 2004, 2005, 2007, and 2008 Excel - Open/Save File 2000 2004 2005 2007 2008 Population Group / Rate / Standard error / Rate / Standard error / Rate / Standard error / Rate / Standard error / Rate / Standard error Total 71.6 0.2 53.7 0.2 48.0 0.2 39.7 0.2 35.5 0.2 Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, Nationwide Inpatient Sample and AHRQ Quality Indicators, modified version of 4.1. Software and user guides are available to assist users in applying the indicators to their own data. Some organisations have used the AHRQ quality indicators to produce web-based comparative reports on hospital quality (e.g. the Texas Department of State Health Services

Indicator name /number	Pneumonia mortality rate IQI 20
	 Guidance on these alternative uses of the AHRQ Quality Indicators is summarised in *Guide for Hospital-level Comparative Reporting*
References	Agency for Healthcare Research and Quality (AHRQ) Inpatient Quality Indicators, AHRQ, USA #20 (IQI #20) AHRQ Quality Indicators™, Version 4.5, May 2013 AHRQ Inpatient Quality Indicators (IQI): Risk Adjustment Coefficients. Version 4.5. May 2013. AHRQ Quality Indicator Measure Development, Implementation, Maintenance and Retirement (May 2011)

2.4 Hip fracture

2.4.1 ACQSHC National core, hospital-based outcome indicators

Indicator name/ number	In-hospital mortality of patients admitted for fractured neck of femur CHBOI 3c
Source	Australian Commission on Safety and Quality in Health Care 2012, *National core, hospital based outcome indicator specification, CONSULTATION DRAFT*, ACSQHC, Sydney.
Purpose / rationale	Hospital mortality indicators should be used as screening tools, rather than being assumed to be definitively diagnostic of poor quality and/or safety. This indicator is intended to signal that a problem may exist and that further detailed investigation is required. High outlier rates should be seen as a prompt to further investigation. Learnings may be applied from low outlier rates.
Dimension of quality	Not indicated
Data source	Hospital administrative data
Definition	In-hospital deaths of patients admitted for fractured neck of femur operative intervention
Numerator	Observed number of in-hospital deaths for NOF patients × national in-hospital mortality rate for NOF patients *where* Observed number of in-hospital deaths for NOF patients = the total number of separations (meeting the denominator criteria) where separation mode = *died*. National mortality rate = national observed number of in-hospital deaths for NOF ÷ national observed number of separations for NOF
Denominator	Expected number of in-hospital deaths for NOF patients = the sum of the estimated probabilities of death for all separations (meeting the denominator criteria), calculated using national risk-adjustment coefficients ***Inclusion criteria:*** • Principal diagnosis29 of NOF (S72.0, S72.10, S72.11) **AND** – Procedure code30 in (47519-00 [1479] , 47522-00 [1489], 47528-01 [1486], 47531-00 [1486], 49315-00 [1489]) **AND** – External cause31 code of Falls (W00.x – W19.x,) OR secondary diagnosis code32 of Tendency to fall not elsewhere classified (R29.6). • Age at date of admission is between 50 and 120, inclusive • Length of stay (LOS, including leave days) is between 1 and 30 days, inclusive (1 ≤ LOS ≤ 30).
Target population	Age at date of admission is between 50 and 120, inclusive

Indicator name/ number	In-hospital mortality of patients admitted for fractured neck of femur CHBOI 3c
Risk adjustment	Risk adjustment should be performed using a logistic regression model. The response variable will be the probability of in-hospital mortality, and the predictor variables include those listed under the risk adjustment. Coefficients from national risk adjustment modelling are used to calculate the probability of in-hospital death for each case from a hospital. The sum of the probabilities of death will form the expected number of deaths. Risk adjustments made for: • Age in years at date of admission • Sex • Additional (comorbid) diagnoses33 (5 dichotomous variables): – Ischaemic heart disease (I20.x - I25.x (excluding I25.2)) – Dysrhythmia (I46.x, I47.x, I49.x, I48.x) – Acute lower respiratory tract infection (LRTI) and influenza (J09.x –J18.x, J20.x – J22.x) – Kidney (renal) failure (N17.x, N19.x, N18.3, N18.4, N18.5, N18.9, R34.x) – Heart failure (I50.x, I11.0, I13.0, I13.2).
Reporting and interpretation	Reported as the risk adjusted rate – the ratio of observed (actual) number of in-hospital deaths to expected number of in-hospital deaths for fractured neck of femur (NOF) patients, multiplied by the national mortality rate for NOF patients. A value higher than the national rate corresponds to a higher than expected mortality rate, while a value of lower than the national rate corresponds to a lower than expected mortality rate. High or rising rates signal that a problem might exist and that further investigation is required. Outcomes for management of hip fracture are sensitive to adherence to clinical best practice (Mak et al. 2010), and guidelines exist for management of hip fracture (SIGN 2010). Bottle & Aylin (2006) used a cohort of 129,522 admissions for hip fracture in the UK, from which 18,508 deaths resulted. They found an association between delay in operation and risk of death in hospital. Other authors, however, attribute both the delay and the higher mortality to medical reasons (Vidán et al. 2011).

Indicator name/ number	In-hospital mortality of patients admitted for fractured neck of femur CHBOI 3c
	Figure 3 – Effect of excluding transfers in and transfers out (2008-09 data) # NOF
References	Australian Commission on Safety and Quality in Health Care 2012, *National core, hospital based outcome indicator specification, CONSULTATION DRAFT,* ACSQHC, Sydney.

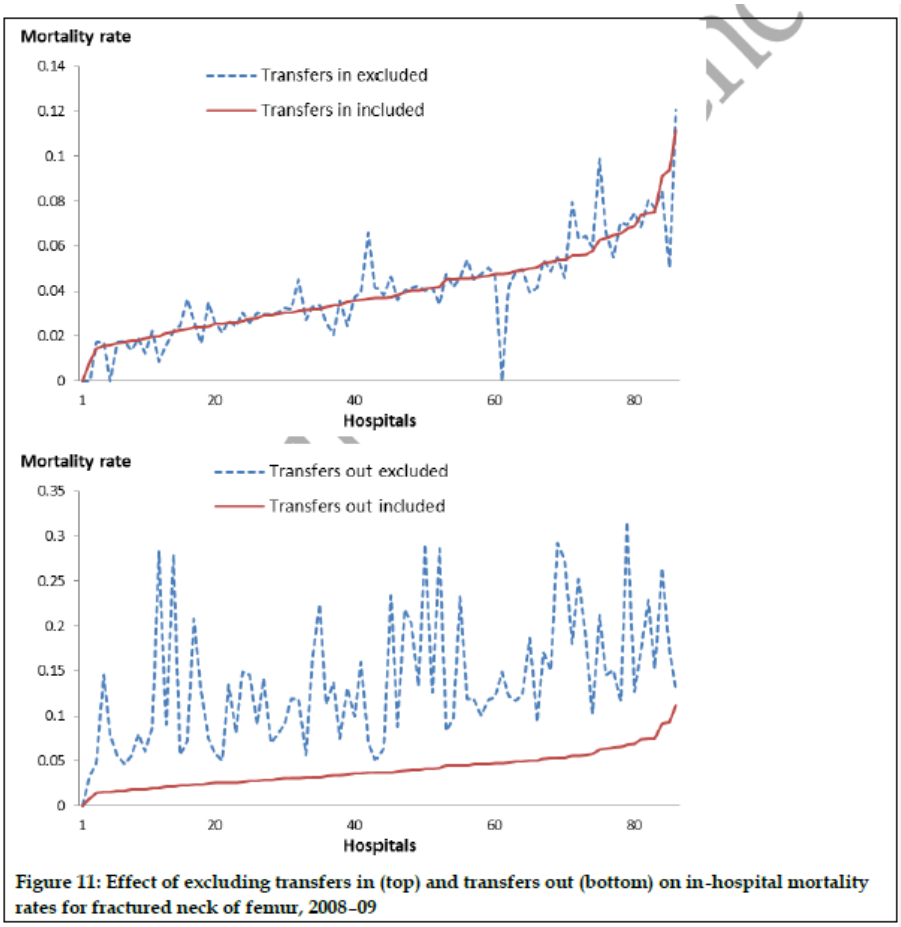


Figure 11: Effect of excluding transfers in (top) and transfers out (bottom) on in-hospital mortality rates for fractured neck of femur, 2008–09

2.4.2 Variable Life Adjusted Display Indicators, Queensland Health

Indicator name/ number	**Fractured neck of femur in hospital mortality** **C051-1**
Source	Variable Life Adjusted Display (VLAD) indicators, Queensland Health, Australia, 2008/2009 Report of the Orthopaedic VLAD Indicator Review November 2012
Purpose / rationale	Not specifically identified in indicator specifications. Overall purpose of indicator set is to aid monitoring and quality improvement of services provided by the various health care services. The indicator is selected based on existing indicators.
Dimension of quality	Effectiveness
Data source	Queensland Hospital Admitted Patient Data Collection (QHAPDC)
Definition	Fractured Neck of Femur patients who died in-hospital and had a length of stay less than or equal to 30 days.
Numerator	Patients died in-hospital (no limit on timeframe).
Denominator	***Current:*** Patients with a principal diagnosis of fracture of femur with at least one of the following procedures: • Internal fixation of fracture of trochanteric or subcapital femur; • Closed reduction of fracture of femur with internal fixation; • Open reduction of fracture of femur with internal fixation; • Hemiarthroplasty of femur; • Partial arthroplasty of hip. ***Inclusion criteria:*** • 50 years or older • patients have spent at least one night in hospital ***Exclusion criteria:*** • excluding transfers in and transfers out ***Recommended change:*** Patients with a principal diagnosis of fracture of femur : • S72.0: Fracture of neck of femur • S72.1: Pertrochanteric fracture • S72.2: Subtrochanteric fracture With at least one of the following procedures: • 47519-00: Internal fixation of fracture of trochanteric or subcapital femur • 47531-00: Closed reduction of fracture of femur with internal fixation • 47528-01: Open reduction of fracture of femur with internal fixation • 47522-00: Hemiarthroplasty of femur

<table>
<tr><th>Indicator name/ number</th><th>Fractured neck of femur in hospital mortality
C051-1</th></tr>
<tr><td></td><td>

49312-00: Excision arthroplasty of hip
49315-00: Partial arthroplasty of hip
49318-00: Total arthroplasty of hip (unilateral)

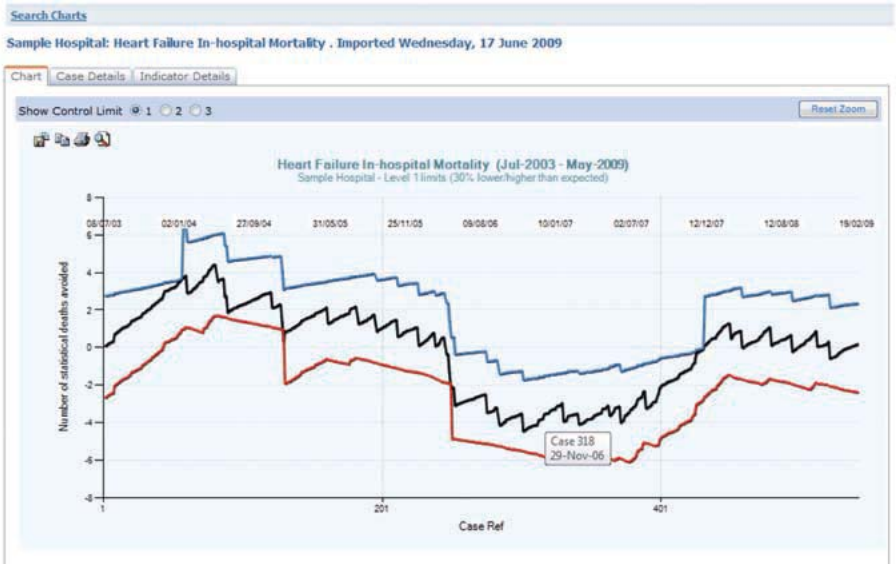
Inclusion criteria:

50 years or older
All lengths of stays
All transfers in and transfers out
All episode types
All external cause codes

Exclusion criteria:
Exclude if the patient’s usual residence is interstate and the mode of separation in their last episode of care was ‘Transferred out to another facility’.
</td></tr>
<tr><td>Target population</td><td>Age 50 years or older (no change recommended)</td></tr>
<tr><td>Risk adjustment</td><td>
<u>Current:</u>
Risk adjustments are made for:
Age group, sex, ischaemic heart disease, dysrhythmias, heart failure, acute lower respiratory tract infection and influenza, renal failure
<table>
<tr><th>Risk Adjustment Comorbidity</th><th>ICD Codes</th></tr>
<tr><td>Age Group</td><td></td></tr>
<tr><td>Sex</td><td></td></tr>
<tr><td>Ischaemic Heart Disease</td><td>I20-I25</td></tr>
<tr><td>Dysrhythmias</td><td>I46-I49</td></tr>
<tr><td>Heart Failure</td><td>I50</td></tr>
<tr><td>Acute LRTI and Influenza</td><td>J9-J22</td></tr>
<tr><td>Renal Failure</td><td>N17; N18.3; N18.4; N18.5; N18.9; N19; R34</td></tr>
</table>
<u>Recommended change:</u>
To remove acute lower respiratory tract infection and influenza and include ASA score. i.e. risk adjustments to be made for:

Age group
Sex
Ischaemic heart disease
Dysrhythmias
Heart failure
Renal failure
American Society of Anaesthesiologists (ASA) score.

Please refer to Report of the Orthopaedic VLAD Indicator Review November 2012 pg 3 for rationale of risk adjustment recommendations
</td></tr>
</table>

Indicator name/ number	Fractured neck of femur in hospital mortality C051-1
Reporting and interpretation	Reported as rate per 100 separations. Better quality is associated with a lower score. The VLAD system is managed through a partnership with Opus 5 which provides the platform for analysis and reporting of VLAD data (previously available through the QH website), as well as comprehensive systems for actioning performance results found to be outside the control limits. The operation of the system is described in detail in the Opus 5 Clinical Monitoring brochure. The use of VLAD within Queensland Health is governed by the Health Service Directive (current 17 June 2013), which makes reference to the VLAD Implementation Standard and Implementation Guideline which is currently not available on the QH website. VLAD is updated on a monthly basis and as such, the VLAD technique allows timely detection of potential problems or improved performance. A flag is initiated where the VLAD line meets the lower or upper control limits (refer graph below). Further details about the flagging processes are no longer available publicly on the website (they were previously 2009). Features of the website include charting to show performance against control limits for a selected indicator and facility. The Opus 5 website also includes functionality for analysing causes and determining workflow to address quality issues.  The Hospital Performance Reports are no longer available publicly on the website. At the time of the last literature review in 2009, the 2004 data was available publicly.
References	VLAD Indicator Definitions report- Queensland Health- June 2012 Patient Safety Unit Report on the Orthopaedic VLAD Indicator Review Summary of Activity. November 2012.

2.4.3 Agency for Healthcare Research and Quality (AHRQ) Inpatient Quality Indicators

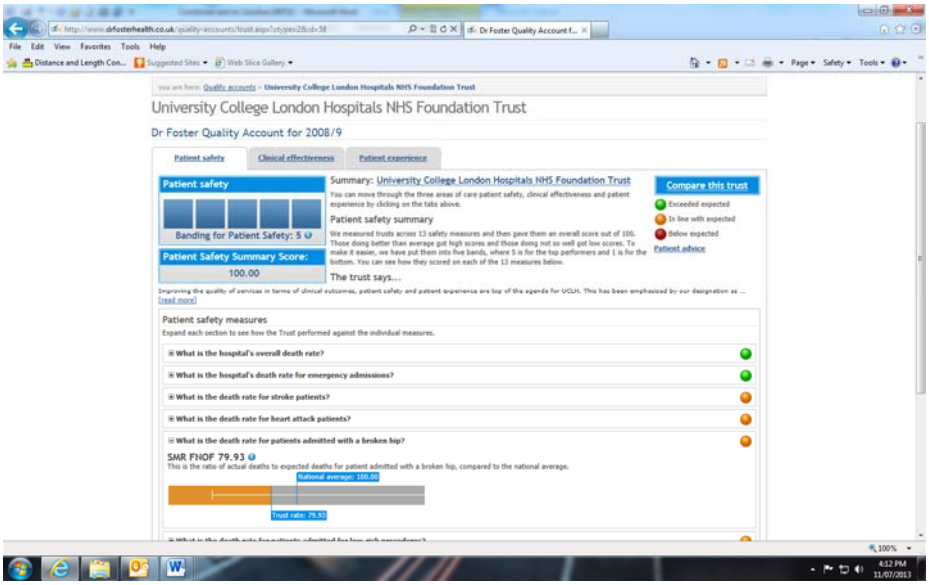
Indicator name /number	**Hip fracture mortality rate** **IQI 19**
Source	Agency for Healthcare Research and Quality (AHRQ) Inpatient Quality Indicators #19 (IQI #19) AHRQ Quality Indicators™, Version 4.5, May 2013
Purpose / rationale	Better processes of care may reduce mortality for hip fracture, which represents better quality.
Dimension of quality	Effectiveness
Data source	Hospital administrative data
Definition	***Current definition:*** In-hospital deaths per 1,000 hospital discharges with hip fracture as a principal diagnosis for patients ages 65 years and older. Excludes periprosthetic fracture discharges, obstetric discharges, and transfers to another hospital. *[NOTE: The software provides the rate per hospital discharge. However, common practice reports the measure as per 1,000 discharges. The user must multiply the rate obtained from the software by 1,000 to report in-hospital deaths per 1,000 hospital discharges.]* ***Previous definition (2009):*** Number of deaths per 100 discharges with principal diagnosis code of hip fracture.
Numerator	Number of deaths among cases meeting the inclusion and exclusion rules for the denominator (see below).
Denominator	***Current:*** Discharges, for patients ages 65 years and older, with a principal ICD-9-CM diagnosis code for hip fracture (see below): **ICD-9-CM Hip fracture diagnosis codes:** 82000 FX FEMUR INTRCAPS NOS-CL 82001 FX UP FEMUR EPIPHY-CLOS 82002 FX FEMUR, MIDCERVIC-CLOS 82003 FX BASE FEMORAL NCK-CLOS 82009 FX FEMUR INTRCAPS NEC-CL 82010 FX FEMUR INTRCAP NOS-OPN 82011 FX UP FEMUR EPIPHY-OPEN 82012 FX FEMUR, MIDCERVIC-OPEN 82013 FX BASE FEMORAL NCK-OPEN 82019 FX FEMUR INTRCAP NEC-OPN 82020 TROCHANTERIC FX NOS-CLOS 82021 INTERTROCHANTERIC FX-CL 82022 SUBTROCHANTERIC FX-CLOSE 82030 TROCHANTERIC FX NOS-OPEN 82031 INTERTROCHANTERIC FX-OPN 82032 SUBTROCHANTERIC FX-OPEN 8208 FX NECK OF FEMUR NOS-CL 8209 FX NECK OF FEMUR NOS-OPN ***Exclusion criteria:*** • with any-listed ICD-9-CM diagnosis codes for periprosthetic fracture (99644 PERIPROSTHETIC FX-PROS JT) • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • with missing discharge disposition (DISP=missing), gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing) or principal diagnosis (DX1=missing) ***Previous (2009):***

Indicator name /number	Hip fracture mortality rate IQI 19
	All discharges, age 65 years and older, with a principal diagnosis code for hip fracture, excluding: • cases with any diagnosis of periprosthetic fracture • missing discharge disposition • transferring to another short-term hospital • Major Diagnostic Category (MDC): pregnancy, childbirth, and puerperium
Target population	Age greater than or equal to 65 years
Risk adjustment	QI software adjusts risk according to diagnosis-related groups (APR-DRG). Observed rates may be stratified by hospitals, age groups, race/ethnicity categories, sex, and payer categories. **Risk Adjustment Coefficients for IQI #19 Hip Fracture Mortality Rate** PARAMETER | LABEL | DF | ESTIMATE | STANDARD ERROR | WALD CHI-SQUARE | PR > CHI-SQUARE INTERCEPT | | 1 | -4.8673 | 0.0850 | 3275.40 | < 0.0001 SEX | Female | 1 | -0.5463 | 0.0269 | 413.58 | < 0.0001 AGE | 70 to 84 | 1 | 0.4429 | 0.0745 | 35.36 | < 0.0001 AGE | 85+ | 1 | 0.9903 | 0.0737 | 180.74 | < 0.0001 APR-DRG | '3011' to '3012' | 1 | 0.2460 | 0.0565 | 18.95 | < 0.0001 APR-DRG | '3013' | 1 | 1.4300 | 0.0633 | 510.23 | < 0.0001 APR-DRG | '3014' | 1 | 3.2881 | 0.0964 | 1163.73 | < 0.0001 APR-DRG | '3082' | 1 | 0.3729 | 0.0562 | 44.06 | < 0.0001 APR-DRG | '3083' | 1 | 1.3375 | 0.0601 | 494.56 | < 0.0001 APR-DRG | '3084' | 1 | 3.3167 | 0.0839 | 1562.32 | < 0.0001 APR-DRG | '3401' | 1 | 0.8764 | 0.1198 | 53.54 | < 0.0001 APR-DRG | '3402' | 1 | 1.8461 | 0.0715 | 666.33 | < 0.0001 APR-DRG | '3403' | 1 | 3.0592 | 0.0710 | 1854.08 | < 0.0001 APR-DRG | '3404' | 1 | 4.5938 | 0.0957 | 2302.79 | < 0.0001 MDC | 8 | 1 | 2.7556 | 0.1195 | 531.69 | < 0.0001 MDC | 24 | 1 | 1.8192 | 0.0856 | 451.82 | < 0.0001 TRNSFER | Transfer-in | 1 | -0.0537 | 0.0730 | 0.54 | 0.4616 NOPOUB04 | UB-04 Point-of-Origin Data Not Available | 1 | -0.1287 | 0.0434 | 8.78 | 0.0030 c-statistic = 0.780
Reporting and interpretation	Reported as rate per 1000 discharges. Better quality is associated with a lower score. Each year, the Agency for Healthcare Research and Quality (AHRQ) produces the National Healthcare Quality Report and National Healthcare Disparities Report (NHQR/DR). Three online resources provide access to information from the reports: • NHQR/DR Reports Web Site - The AHRQ issues two reports annually, The National Healthcare Quality Report and The National Healthcare Disparities Report. The reports present, in chart form, the latest available findings on quality of and access to health care. The most recent report is for 2012, available online at http://www.ahrq.gov/research/findings/nhqrdr/index.html In addition there are links to related reports • NHQRDRnet • State Snapshots None of these public reports include data in relation to in-hospital mortality for fractured neck of femur. Software and user guides are available to assist users in applying the indicators to their own data.

Indicator name /number	Hip fracture mortality rate IQI 19
	Guidance on alternative uses of the AHRQ Quality Indicators is summarised in *Guide for Hospital-level Comparative Reporting*
References	Agency for Healthcare Research and Quality (AHRQ) Inpatient Quality Indicators #19 (IQI #19) AHRQ Quality Indicators™, Version 4.5, May 2013 AHRQ Inpatient Quality Indicators (IQI): Risk Adjustment Coefficients. Version 4.5. May 2013. AHRQ Quality Indicator Measure Development, Implementation, Maintenance and Retirement (May 2011)

2.4.4 Dr Foster UK

Indicator name /number	Hospital Standardised Mortality Ratio – fracture neck of femur
Source	Quality Accounts – Patient Safety, Dr Foster Health, United Kingdom, 2009.
Purpose / rationale	Not specifically identified in indicator specifications. Overall purpose of indicator set is for the comparative analysis of health care quality across different hospitals in England.
Dimension of quality	Effectiveness
Data source	SUS (Secondary Uses Service) - April 2008- March 2009 Much of the data used by the Care Quality Council comes from existing, mandatory data collections; data is also commissioned from the Department of Health, the Health and Social Care Information Centre, and the Royal Colleges.
Definition	The ratio of the observed number of in-hospital deaths to the expected number of deaths, multiplied by 100.
Numerator	All spells with method of discharge as death (DISMETH=4), defined by a specific diagnosis code for the primary diagnosis of the spell.
Denominator	Expected number of in-hospitals deaths derived from logistic regression. ***Exclusion criteria:*** • Daycases (where classpat = 2 in the first episode)
Target population	Not specified
Risk adjustment and statistical methods	Risk adjustments are made for: • Sex • Age on admission (in five year bands up to 90+) • Admission method (non-elective or elective) • Socio-economic deprivation quintile of the area of residence of the patient (based on the Carstairs Index) • Primary diagnosis (based on the Clinical Classification System - CCS group) • Co-morbidities • Number of previous emergency admissions • Year of discharge (financial year) • Palliative care (whether the patient is being treated in specialty of palliative care)
Reporting and interpretation	Reported as standardised ratios for Trusts (147) (observed / expected). The ratio is calculated by dividing the actual number of deaths by the expected number and multiplying the figure by 100. It is expressed as a relative risk, where a risk rating of 100 represents the national average. If the trust has an HSMR of 100, that means that the number of patients who died is exactly as it would be expected taking into account the standardisation factors. An HSMR above 100 means more patients died than would be expected; one below 100 means that fewer than expected died.

Indicator name /number	Hospital Standardised Mortality Ratio – fracture neck of femur
	Control limits tell us the range of values which are consistent with random or chance variation. Data points falling within the control limits are consistent with random or chance variation and are said to display 'common-cause variation'; for data points falling outside the control limits, chance is an unlikely explanation and hence they are said to display 'special-cause variation' - that is, where the trust's rate diverges significantly from the national rate. Fractured neck of femur mortality is not reported through the My Hospital Guide report. Participating hospitals access details online via a secure website. Dr Foster Quality Account reports provide online reports for participating health services. Mortality indicators, including in-hospital mortality indicators for AMI, stroke and fractured neck of femur, are included under the domain of Patient Safety. Comparisons with other trusts are indicated by a colour coded rating system – green for 'exceeded expected', orange for 'in line with expected' and red for 'below expected'. The results are expressed as a ratio of actual deaths to expected deaths. These mortality indicators use a control limit (displayed on the graph as a white line), which is set at 99.8%. Data points 'falling within the control limits are said to display 'common-cause variation', which means it may be due to chance. Data points falling outside the control limits are known as 'outliers' and chance is an unlikely explanation. They are said to display 'special-cause variation' that is, factors other than chance are the cause. In addition to the ratios for the individual indicators, the trusts are given a composite score summarising performance across the 13 patient safety indicators (Patient Safety Summary Score). These score are out of 100 and reported across five bands of performance. 
References	Quality Accounts – Patient Safety, Dr Foster Health, United Kingdom, 2009.

Indicator name /number	Hospital Standardised Mortality Ratio – fracture neck of femur
	Dr Foster Intelligence (2009). How healthy is your hospital? Special Edition Hospital Guide. UK, Dr Foster Research Limited. Gavin Thompson, Social and General Statistics (2009). Indicators of hospital performance published by the Care Quality Commission and Dr. Foster Research.

3. In-hospital death in low-mortality DRG

3.1 ACQSHC National core, hospital-based outcome indicators

Indicator name/ number	Death in low-mortality DRGs CHBOI 2
Source	Australian Commission on Safety and Quality in Health Care 2012, *National core, hospital based outcome indicator specification, CONSULTATION DRAFT,* ACSQHC, Sydney.
Purpose / rationale	Hospital mortality indicators should be used as screening tools, rather than being assumed to be definitively diagnostic of poor quality and/or safety. This indicator is intended to signal that a problem may exist and that further detailed investigation is required. This indicator is intended to identify in-hospital deaths in patients unlikely to die during hospitalisation. The underlying assumption is that when patients admitted for an extremely low-mortality condition or procedure die, a health care error is more likely to be responsible.
Dimension of quality	Not indicated
Data source	Hospital administrative data
Definition	In-hospital deaths in Diagnosis Related Groups with a mortality rate less than 0.5%
Numerator	Number of in-hospital deaths for low mortality DRGs x 100 *Where* Number of in-hospital deaths = total number of separations (meeting denominator criteria) and separation mode11 = *died.*
Denominator	Number of separations in low-mortality DRGs. Low mortality DRGs are defined as DRGs with a national mortality rate of less than 0.5% over the previous 3 years. Inclusion criteria: • Age at date of admission is between 18 and 120 years, inclusive • DRGs codes: *low mortality DRGs* (see Appendix 2 for list of codes) • Care type12 = *acute care.* Exclusion criteria: • Any diagnosis (principal or additional) and/or any procedure of *trauma*, *immuno-compromised state*, *cancer*.
Target population	Age 18 – 120 years
Risk adjustment	There is no risk adjustment for CHBOI 2 Death in low mortality DRGs however, stratification of results by hospital peer group will improve the comparability and relevance of the unadjusted rates.

Indicator name/ number	Death in low-mortality DRGs CHBOI 2
Reporting and interpretation	Reported as the percentage of separations for low mortality diagnosis-related groups (DRGs) that end in death in hospital. High or rising rates signal that a problem might exist and that further investigation is required. Investigations should consider a range of possible explanations including: differences from the national patient population; structural or resource issues (e.g. staff shortages, ward closures, etc.); changes in treatment protocols; and professional practice (i.e. individual clinical staff actions) (Mohammed et al. 2004). For this indicator, the main risk lies in allocation of a low mortality DRG to a patient with multiple reasons for admission.
References	Australian Commission on Safety and Quality in Health Care 2012, *National core, hospital based outcome indicator specification, CONSULTATION DRAFT*, ACSQHC, Sydney Australian Institute of Health and Welfare 2009, *Towards national indicators of safety and quality in health care*, AIHW cat. No. HSE 75, AIHW, Canberra Department of Health [Victoria] 2009, *Patient Safety Indicators Translated Technical Specifications*, Melbourne

3.2 AusPSI- Patient safety indicators

Indicator name/ number	Death in low-mortality DRGs PSI 2
Source	Victorian State Government, Australia, Department of Health, Patient Safety Indicators, AusPSI, October 2012
Purpose / rationale	The AusPSIs are being developed primarily to support health services and the Department of Human Services in monitoring quality of care and patient safety. Although they will not provide the complete answer they will serve as a screening or flagging tool for potential areas of concern. They can be used to help hospitals identify potential adverse event trends that might need further study. The AusPSIs are being developed for application to any ICD-10-AM hospital inpatient routine data that uses condition onset flags. These data are readily available and relatively inexpensive to use. There are 18 core indicators and 7 sub indicators in the AusPSI set. These indicators have their roots in the Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicator module but have been refined and adapted following detailed consideration of the indicator definitions, the data limitations/ strengths of ICD-10-AM and the Victorian clinical environment. The AusPSIs tools will be made freely available on this website. At present all necessary technical tools are available for the translated AHRQ PSIs. This set of PSIs has been translated for use with ICD-10-AM datasets.
Dimension of quality	Not indicated
Data source	Hospital administrative data
Definition	
Numerator	Episodes with a separation type of "death".
Denominator	Episodes, 18 years and older, in low-mortality DRGs, defined as DRGs with a total mortality rate less than 0.5% over the previous 3 years or less than 0.5% in any of the previous 3 years. Inclusion criteria: • AR DRGs version 5.1 codes: *low mortality DRGs* (see Appendix for list of codes) Exclusion criteria: • Episodes with any code for trauma, immunocompromised state or cancer.
Target population	Age 18 – 120 years
Risk adjustment	There is no risk adjustment for CHBOI 2 Death in low mortality DRGs however, stratification of results by hospital peer group will improve the comparability and relevance of the unadjusted rates.

Indicator name/ number	Death in low-mortality DRGs PSI 2
Reporting and interpretation	Reported as the percentage of separations for low mortality diagnosis-related groups (DRGs) that end in death in hospital. High or rising rates signal that a problem might exist and that further investigation is required. Investigations should consider a range of possible explanations including: differences from the national patient population; structural or resource issues (e.g. staff shortages, ward closures, etc.); changes in treatment protocols; and professional practice (i.e. individual clinical staff actions) (Mohammed et al. 2004). For this indicator, the main risk lies in allocation of a low mortality DRG to a patient with multiple reasons for admission.
References	Department of Health [Victoria] 2012, *Patient Safety Indicators Translated Technical Specifications*, Melbourne

3.3 Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicators

Indicator name/ number	Death Rate in Low-Mortality Diagnosis Related Groups (DRGs) PSI #2
Source	Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicators AHRQ, USA #2 (PSI #2) AHRQ Quality Indicators™, Version 4.5, May 2013
Purpose / rationale	No specific rationale identified for this indicator. Rationale for patient safety indicators as follows: • Can be used to help hospitals and health care organizations assess, monitor, track, and improve the safety of inpatient care. Can be used for comparative public reporting and pay-for-performance initiatives. • Can identify potentially avoidable complications that result from a patient's exposure to the health care system. • Include *hospital-level* indicators to detect potential safety problems that occur during a patient's hospital stay.
Dimension of quality	Patient Safety
Definition	In-hospital deaths per 1,000 discharges for low mortality (< 0.5%) Diagnosis Related Groups (DRGs) among patients ages 18 years and older or obstetric patients. Excludes cases with trauma, cases with cancer, cases with an immunocompromised state, and transfers to an acute care facility. *[NOTE: The software provides the rate per hospital discharge. However, common practice reports the measure as per 1,000 discharges. The user must multiply the rate obtained from the software by 1,000 to report in-hospital deaths per 1,000 hospital discharges.]*
Numerator	Number of deaths (DISP=20) among cases meeting the inclusion and exclusion rules for the denominator.
Denominator	Discharges, for patients ages 18 years and older or MDC 14 (pregnancy, childbirth, and puerperium), with a low-mortality (less than 0.5%) DRG or MS-DRG code (see table below). If a DRG or MS-DRG is divided into "without/with complications," both DRG or MS-DRG codes must have mortality rates below 0.5% to qualify for inclusion. Exclude cases: • with any-listed ICD-9-CM diagnosis codes for trauma • with any-listed ICD-9-CM diagnosis codes for cancer • with any-listed ICD-9-CM diagnosis codes or any-listed ICD-9-CM procedure codes for immunocompromised state • transfer to an acute care facility (DISP=2) • with missing discharge disposition (DISP=missing), gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing), or principal diagnosis (DX1=missing)
Target population	Aged 18 years plus

Indicator name/ number	Death Rate in Low-Mortality Diagnosis Related Groups (DRGs) PSI #2
Risk adjustment and statistical methods	Risk adjustments are made for age, sex, transfers in, comorbidities (congestive heart failure, other neurological conditions, chronic pulmonary disease, hypothyroidism, renal failure, obesity, deficiency anaemia), certain modified DRGs, mental diseases and disorders and when procedures days data is not available. Risk adjustment coefficients are shown below and described in Patient Safety Indicators Risk Adjustment Coefficients
Reporting and interpretation	Reported as the in-hospital deaths per 1,000 discharges for low mortality (< 0.5%) Diagnosis Related Groups (DRGs) Each year, the Agency for Healthcare Research and Quality (AHRQ) produces the National Healthcare Quality Report and National Healthcare Disparities Report (NHQR/DR). Three online resources provide access to information from the reports: • NHQR/DR Reports Web Site - The AHRQ issues two reports annually, The National Healthcare Quality Report and The National Healthcare Disparities Report. The reports present, in chart form, the latest available findings on quality of and access to health care. The most recent report is for 2012, available online at http://www.ahrq.gov/research/findings/nhqrdr/index.html - death in low mortality DRG is not included in this report. In addition there are links to related reports • National Health Quality and Disparities Reports (HQRDRnet) • State Snapshots NHQRDnet reports data from 2000 to 2008 including national data, State, trends and disparities, with further categorisation by: • Location of resident • Ownership of hospital • Region of inpatient treatment • Teaching status

PARAMETER	LABEL	DF	ESTIMATE	STANDARD ERROR	WALD CHI-SQUARE	PR > CHI-SQUARE
INTERCEPT		1	-7.7775	0.1124	4791.79	< 0.0001
SEX	Female	1	-0.5129	0.0524	95.73	< 0.0001
AGE	18 to 24	1	-1.2611	0.1415	79.44	< 0.0001
AGE	25 to 29	1	-1.1063	0.1436	59.36	< 0.0001
AGE	30 to 59	1	-0.5488	0.1137	23.31	< 0.0001
AGE	65 to 69	1	0.6016	0.1421	17.92	< 0.0001
AGE	70 to 74	1	0.9062	0.1384	42.87	< 0.0001
AGE	75 to 79	1	1.2878	0.1298	98.46	< 0.0001
AGE	80 to 84	1	1.7786	0.1254	201.20	< 0.0001
AGE	85+	1	2.3398	0.1206	376.49	< 0.0001
MDRG	413	1	0.6377	0.0941	45.89	< 0.0001
MDRG	533	1	0.4485	0.0777	33.34	< 0.0001
MDRG	1915	1	0.7966	0.0735	117.44	< 0.0001
MDRG	2019	1	-2.1631	2.0670	1.10	0.2953
MDC	19	1	0.6909	0.1440	23.03	< 0.0001
TRNSFER	Transfer-in	1	1.0270	0.0918	125.04	< 0.0001
NOPRDAY	Procedure Days Data Not Available	1	-1.1342	0.0540	441.85	< 0.0001
COMORB	CHF	1	0.9991	0.0850	138.22	< 0.0001
COMORB	NEURO	1	0.3675	0.0763	23.19	< 0.0001
COMORB	CHRNLUNG	1	0.3440	0.0669	26.47	< 0.0001
COMORB	HYPOTHY	1	-0.0770	0.0765	1.01	0.3139
COMORB	RENLFAIL	1	0.5928	0.0753	61.95	< 0.0001
COMORB	OBESE	1	0.4614	0.0762	36.70	< 0.0001
COMORB	ANEMDEF	1	0.2497	0.0724	11.91	0.0006

c-statistic = 0.831

Indicator name/ number	Death Rate in Low-Mortality Diagnosis Related Groups (DRGs) PSI #2

- Location of hospital
- Bed size
- Median income of patient's zip code
- Expected payment source

http://nhqrnet.ahrq.gov/nhqrdr/jsp/nhqrdr.jsp?catId=503&msrId=80207&tableTypeId=1&msridRO=120309&tableTypeRO=1&PopCatIdCB=0#snhere

National Disparities State Trend

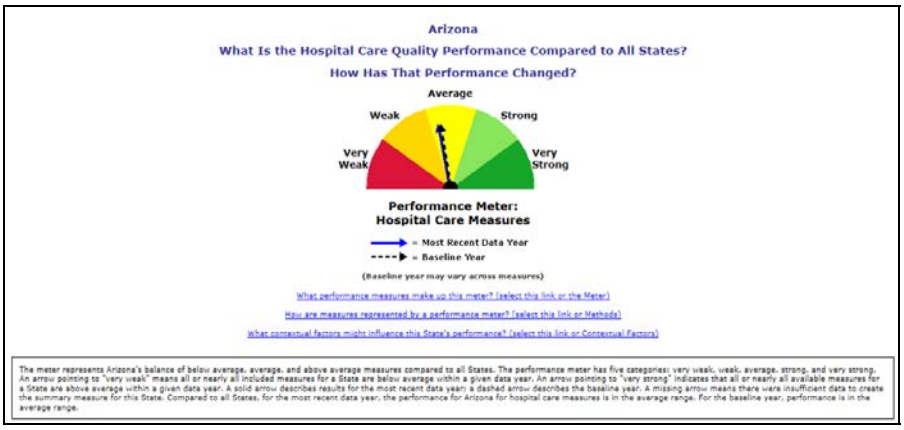
Select a category: -- Select --

Table 12_3_9.1: Deaths per 1,000 hospital admissions with expected low-mortality, age 18 and over or obstetric admissions, United States, 2000, 2004, 2005, 2007, and 2008 Excel - Open/Save File

	2000		2004		2005		2007		2008	
Population Group	Rate	Standard error	Rate	Standard error	Rate	Standard error	Rate	Standard error	Rate	Standard error
Total	0.63	0.01	0.58	0.01	0.54	0.01	0.49	0.01	0.46	0.01

Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, Nationwide Inpatient Sample and AHRQ Quality Indicators, modified version of 4.1

Death in low mortality DRG is also included as one of the indicators reported in the State Snap shot reports which expresses a composite comparative measure of performance as well as specific data relating to the indicator and whether the performance for that indicator is the same, better or worse that other states.



Arizona

What Is the Hospital Care Quality Performance Compared to All States?

How Has That Performance Changed?

Average

Weak Strong

Very Weak Very Strong

Performance Meter: Hospital Care Measures

= Most Recent Data Year

= Baseline Year

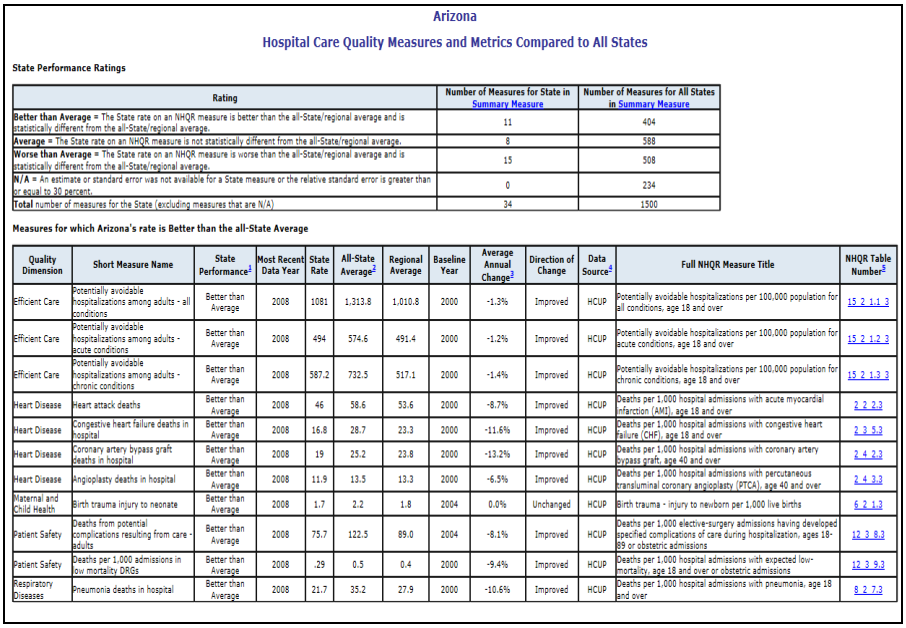
(Baseline year may vary across measures)

What performance measures make up this meter? (select this link or the Meter)

How are measures represented by a performance meter? (select this link or Methods)

What contextual factors might influence this State's performance? (select this link or Contextual Factors)

The meter represents Arizona's balance of below average, average, and above average measures compared to all States. The performance meter has five categories: very weak, weak, average, strong, and very strong. An arrow pointing to "very weak" means all or nearly all included measures for a State are below average within a given data year. An arrow pointing to "very strong" indicates that all or nearly all available measures for a State are above average within a given data year. A solid arrow describes results for the most recent data year; a dashed arrow describes the baseline year. A missing arrow means there were insufficient data to create the summary measure for this State. Compared to all States, for the most recent data year, the performance for Arizona for hospital care measures is in the average range. For the baseline year, performance is in the average range.



Arizona

Hospital Care Quality Measures and Metrics Compared to All States

State Performance Ratings

Rating	Number of Measures for State in Summary Measure	Number of Measures for All States in Summary Measure
Better than Average = The State rate on an NHQR measure is better than the all-State/regional average and is statistically different from the all-State/regional average.	11	404
Average = The State rate on an NHQR measure is not statistically different from the all-State/regional average.	8	588
Worse than Average = The State rate on an NHQR measure is worse than the all-State/regional average and is statistically different from the all-State/regional average.	15	508
N/A = An estimate or standard error was not available for a State measure or the relative standard error is greater than or equal to 30 percent.	0	234
Total number of measures for the State (excluding measures that are N/A)	34	1500

Measures for which Arizona's rate is Better than the all-State Average

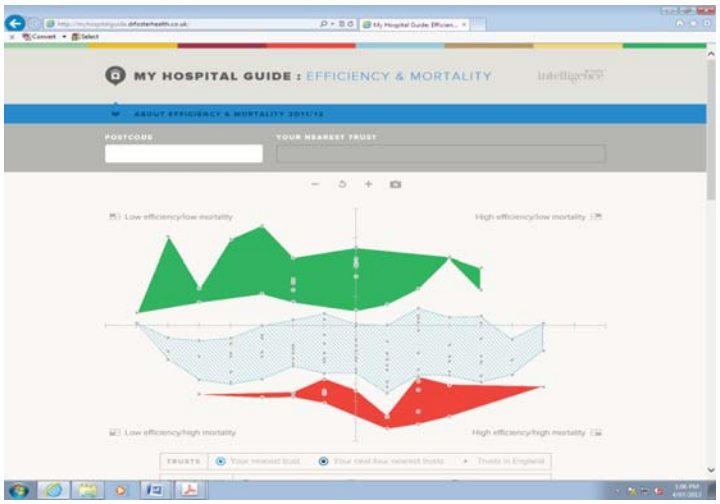
Quality Dimension	Short Measure Name	State Performance	Most Recent Data Year	State Rate	All-State Average	Regional Average	Baseline Year	Average Annual Change	Direction of Change	Data Source	Full NHQR Measure Title	NHQR Table Number
Efficient Care	Potentially avoidable hospitalizations among adults - all conditions	Better than Average	2008	1081	1,313.8	1,010.8	2000	-1.3%	Improved	HCUP	Potentially avoidable hospitalizations per 100,000 population for all conditions, age 18 and over	15_2_1.1_3
Efficient Care	Potentially avoidable hospitalizations among adults - acute conditions	Better than Average	2008	494	574.6	491.4	2000	-1.2%	Improved	HCUP	Potentially avoidable hospitalizations per 100,000 population for acute conditions, age 18 and over	15_2_1.2_3
Efficient Care	Potentially avoidable hospitalizations among adults - chronic conditions	Better than Average	2008	587.2	732.5	517.1	2000	-1.4%	Improved	HCUP	Potentially avoidable hospitalizations per 100,000 population for chronic conditions, age 18 and over	15_2_1.3_3
Heart Disease	Heart attack deaths	Better than Average	2008	46	58.6	53.6	2000	-8.7%	Improved	HCUP	Deaths per 1,000 hospital admissions with acute myocardial infarction (AMI), age 18 and over	2_2_2.3
Heart Disease	Congestive heart failure deaths in hospital	Better than Average	2008	16.8	28.7	23.3	2000	-11.6%	Improved	HCUP	Deaths per 1,000 hospital admissions with congestive heart failure (CHF), age 18 and over	2_3_5.3
Heart Disease	Coronary artery bypass graft deaths in hospital	Better than Average	2008	19	25.2	23.8	2000	-13.2%	Improved	HCUP	Deaths per 1,000 hospital admissions with coronary artery bypass graft, age 40 and over	2_4_2.3
Heart Disease	Angioplasty deaths in hospital	Better than Average	2008	11.9	13.5	13.3	2000	-6.5%	Improved	HCUP	Deaths per 1,000 hospital admissions with percutaneous transluminal coronary angioplasty (PTCA), age 40 and over	2_4_3.3
Maternal and Child Health	Birth trauma injury to neonate	Better than Average	2008	1.7	2.2	1.8	2004	0.0%	Unchanged	HCUP	Birth trauma - injury to newborn per 1,000 live births	6_2_1.3
Patient Safety	Deaths from potential complications resulting from care - adults	Better than Average	2008	75.7	122.5	89.0	2004	-8.1%	Improved	HCUP	Deaths per 1,000 elective-surgery admissions having developed specified complications of care during hospitalization, ages 18-89 or obstetric admissions	12_3_8.3
Patient Safety	Deaths per 1,000 admissions in low mortality DRGs	Better than Average	2008	.29	0.5	0.4	2000	-9.4%	Improved	HCUP	Deaths per 1,000 hospital admissions with expected low-mortality, age 18 and over or obstetric admissions	12_3_9.3
Respiratory Diseases	Pneumonia deaths in hospital	Better than Average	2008	21.7	35.2	27.9	2000	-10.6%	Improved	HCUP	Deaths per 1,000 hospital admissions with pneumonia, age 18 and over	8_2_7.3

Indicator name/ number	Death Rate in Low-Mortality Diagnosis Related Groups (DRGs) PSI #2
	Software and user guides are available to assist users in applying the indicators to their own data. Some organisations have used the AHRQ quality indicators to produce web-based comparative reports on hospital quality Other organisations have incorporated selected AHRQ indicators into pay for performance demonstration projects, such as The Premier Hospital Quality Incentive Demonstration . Guidance on these alternative uses of the AHRQ Quality Indicators is summarised in *Guide for Hospital-level Comparative Reporting*
Reference	Agency for Healthcare Research and Quality (AHRQ) 2012, *Patient Safety Indicators Overview*, US Department of Health and Human Services, Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicators #2, Technical Specifications – Death Rate in Low-Mortality Diagnosis Related Groups (DRGs). May 2013 Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicators (PSI) Risk Adjustment Coefficients. Version 4.5 May 2013 Agency for Healthcare Research and Quality (AHRQ) Quality Indicators. Patient Safety Indicators (Brochure). *A tool to help assess quality and safety of care to adults in the hospital* AHRQ Quality Indicator Measure Development, Implementation, Maintenance and Retirement (May 2011)

3.4 Dr Foster's Intelligence (UK), Deaths in Low Risk Diagnosis Groups (PSI)

Indicator name/ number	Deaths in Low Risk Diagnosis Groups (PSI) 36
Source	HG2012 36_Deaths in Low Risk Diagnosis Groups (PSI)
Purpose / rationale	Deaths from conditions where patients would normally survive are used to monitor and investigate particularly unexpected deaths.
Dimension of quality	
Data source	SUS - CDS Secondary Uses Service – Commissioning Data Sets
Definition	Deaths per 1000 spells for conditions normally associated with a very low rate of mortality.
Numerator	Denominator spells with method of discharge as death. *DISMETH:*4 Died
Denominator	Spells with a primary diagnosis associated with a low mortality diagnosis group (mortality rate has been shown to be consistently below 0.5%). See table overleaf for low mortality DRGs. Exclusions: • Spells with a diagnosis code for trauma, immunocompromised state, or cancer in any diagnosis field • Admission age under 19 **Low mortality CCS groups**
Target population	Age 19 years plus
Risk adjustment	• Crude Rate: Expected values are based on the national average rate. • Relative Risk: The ratio is calculated by dividing the actual number of deaths by the expected number and multiplying the figure by 100. It is expressed as a relative risk, where a risk rating of 100 represents the national average. If the trust has an RR of 100, that means that the number of patients who died is exactly as it would be expected taking into account the standardisation factors. An RR above 100 means more patients died than would be expected; one below 100 means that fewer than expected died. • Control Limits: Control limits tell us the range of values which are consistent with random or chance variation. Data points falling within the control limits are consistent with random or chance variation and are said to display 'common-cause variation'; for data points falling outside the control limits, chance is an unlikely explanation and hence they are said to display 'special cause variation' – that is, where the trust's rate diverges significantly from the national rate. Data points falling above the upper 99.8% binomial control limit are said to be significantly 'higher than expected', data points falling below the lower 99.8% binomial control limit are said to be significantly 'lower than expected', otherwise 'within expected range'.

Indicator name/ number	Deaths in Low Risk Diagnosis Groups (PSI) 36
Reporting and interpretation	My Hospital Guide (http://myhospitalguide.drfosterhealth.co.uk/) is an online public report which provides a visual representation of efficiency and quality for all acute non-specialist trusts in England for 2011/12. The relationship between clinical efficiency and quality is reported by comparing mortality ratios with an index of 13 indicators of inefficient practice.



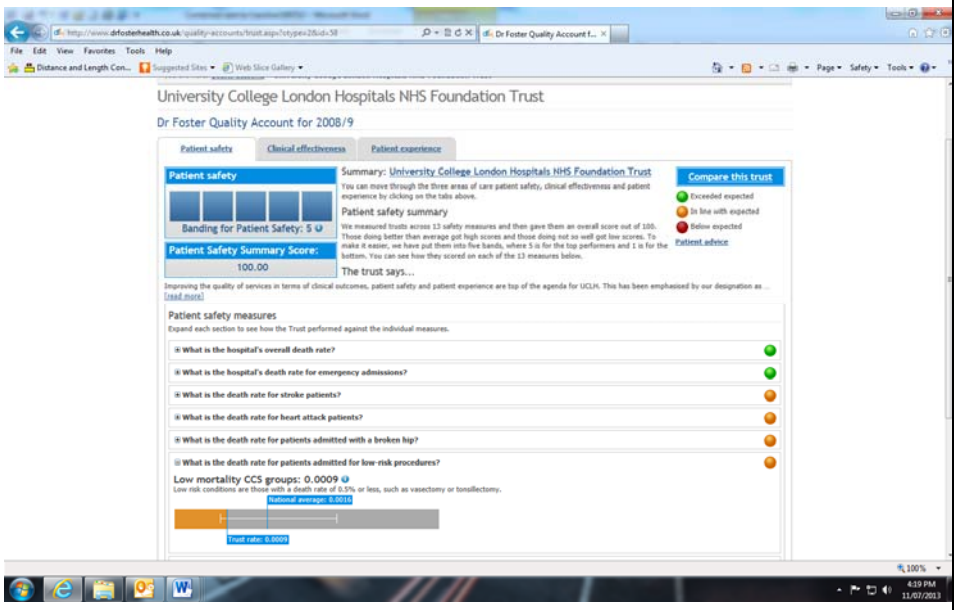
The following table is from the Hospital Guide 2012 and provides an example of how data is reported. This table shows Trusts that were higher than expected on two out of four measures (Hospital Standardised Mortality Ratio, Summary Hospital-Level Mortality Indicator, Deaths After Surgery, Deaths in Low-Risk Conditions).

Trusts that were higher than expected on two out of four measures:

- Aintree University Hospital NHS Foundation Trust
- Blackpool Teaching Hospitals NHS Foundation Trust
- Buckinghamshire Healthcare NHS Trust*
- George Eliot Hospital NHS Trust
- Hull and East Yorkshire Hospitals NHS Trust*
- Medway NHS Foundation Trust
- North Cumbria University Hospitals NHS Trust
- Northern Lincolnshire and Goole Hospitals NHS Foundation Trust*
- United Lincolnshire Hospitals NHS Trust
- University Hospitals Birmingham NHS Foundation Trust
- Walsall Healthcare NHS Trust*
- Western Sussex Hospitals NHS Trust

Trusts higher than expected | Trusts lower than expected | Trusts within expected | † Deaths per 1,000 patients

	NHS acute trust†	SHMI	HSMR	Deaths in low-risk conditions†	Deaths after surgery
1	Aintree University Hospital NHS Foundation Trust	113	89	1.53	81
2	Airedale NHS Foundation Trust	89	78	0.64	71
3	Ashford and St Peter's Hospitals NHS Foundation Trust	100	103	0.54	95
4	Barking, Havering and Redbridge University Hospitals NHS Trust	98	104	0.71	101
5	Barnet and Chase Farm Hospitals NHS Trust	87	91	0.29	94
6	Barnsley Hospital NHS Foundation Trust	108	110	0.73	96
7	Barts and The London NHS Trust	–	86	0.94	97
8	Basildon and Thurrock University Hospitals NHS Foundation Trust	112	102	0.95	97
9	Bedford Hospital NHS Trust	105	91	0.61	129
10	Blackpool Teaching Hospitals NHS Foundation Trust	125	114	0.95	124
11	Bolton NHS Foundation Trust	106	104	0.22	103
12	Bradford Teaching Hospitals NHS Foundation Trust	94	89	0.40	104
13	Brighton and Sussex University Hospitals NHS Trust	95	94	0.96	99
14	Buckinghamshire Healthcare NHS Trust*	112	110	0.55	103
15	Burton Hospitals NHS Foundation Trust	101	112	0.48	60
16	Calderdale and Huddersfield NHS Foundation Trust	103	101	0.36	94
17	Cambridge University Hospitals NHS Foundation Trust	83	81	0.47	89
18	Central Manchester University Hospitals NHS Foundation Trust	111	109	0.46	105
19	Chelsea and Westminster Hospital NHS Foundation Trust	76	88	0.36	7
20	Chesterfield Royal Hospital NHS Foundation Trust	110	105	0.74	106
21	City Hospitals Sunderland NHS Foundation Trust	92	93	0.33	91
22	Colchester Hospital University NHS Foundation Trust	118	102	0.74	109
23	Countess Of Chester Hospital NHS Foundation Trust	106	108	0.82	95
24	County Durham and Darlington NHS Foundation Trust	101	100	0.52	114
25	Croydon Health Services NHS Trust	100	103	0.75	95
26	Dartford and Gravesham NHS Trust	103	93	0.45	102
27	Derby Hospitals NHS Foundation Trust	109	103	0.54	88
28	Doncaster and Bassetlaw Hospitals NHS Foundation Trust*	104	109	0.67	101
29	Dorset County Hospital NHS Foundation Trust	106	107	0.70	127
30	Ealing Hospital NHS Trust	91	95	0.73	63
31	East and North Hertfordshire NHS Trust	114	98	0.81	121
32	East Cheshire NHS Trust	100	98	0.40	81
33	East Kent Hospitals University NHS Foundation Trust	100	84	0.87	102
34	East Lancashire Hospitals NHS Trust	113	103	0.55	100
35	East Sussex Healthcare NHS Trust	107	101	1.09	88
36	Epsom and St Helier University Hospitals NHS Trust	96	92	0.77	96
37	Frimley Park Hospital NHS Foundation Trust	88	78	0.50	102

Indicator name/ number	Deaths in Low Risk Diagnosis Groups (PSI) 36
	Dr Foster Quality Account reports provide online reports for participating health services. Mortality indicators, including in-hospital mortality indicators for AMI, stroke and fractured neck of femur, are included under the domain of Patient Safety. Comparisons with other trusts are indicated by a colour coded rating system – green for 'exceeded expected', orange for 'in line with expected' and red for 'below expected'. The results are expressed as a ratio of actual deaths to expected deaths. These mortality indicators use a control limit (displayed on the graph as a white line), which is set at 99.8%. Data points 'falling within the control limits are said to display 'common-cause variation', which means it may be due to chance. Data points falling outside the control limits are known as 'outliers' and chance is an unlikely explanation. They are said to display 'special-cause variation' that is, factors other than chance are the cause. In addition to the ratios for the individual indicators, the trusts are given a composite score summarising performance across the 13 patient safety indicators (Patient Safety Summary Score). These score are out of 100 and reported across five bands of performance. 
References	Dr Foster Intelligence, Deaths in low risk diagnosis groups methodology 2012 Dr Foster Hospital Guide 2012

APPENDIX 4 – Peer review articles summaries

Aelvoet W, 2010, Belgium

Study title	Do inter-hospital comparisons of in-hospital, acute myocardial infarction case-fatality rates serve the purpose of fostering quality improvement? An evaluative study
Study objective(s)	To determine the existence of inter-hospital differences in acute myocardial infarction case-fatality rates (AMI-CFR): • to evaluate to which extent Belgian discharge records allow the assessment of quality of care in the field of AMI; and • to identify starting points for quality improvement.
Study type	Retrospective, cohort study using administrative data.
HMI definition **Data sources**	• AMI-CFR based on the AHRQ Inpatient Quality Indicators. • The proportion of patients with AMI, who die within a specified time period. Exclusively based on hospitalized cases and fatalities within the hospital regardless of any time constraint. (STEMI & non-STEMI analyses also). • Belgian Minimal Clinical Data (MCD) and the Monitoring of Trends and Determinants in Cardiovascular Disease (MONICA) project registries for Ghent and Bruges. Note the definition of death in the MONICA dataset is 28 days after the occurrence of first symptoms. • The MONICA dataset includes specifically collected registry data and event diagnosis draws on ECG results, cardiac enzymes, necropsy findings. It is considered the gold standard against which the MCD is compared. • Due to privacy issues the two databases could not be compared at the level of hospital or individual. • ICD-9-CM
Settings **Participants** **Reporting period**	• Belgium • 109 short-term general hospitals fulfilled criteria for inclusion (total number of hospitals is not reported). Hospitals were classified as type A (no catheterisation facility) Intermediary Type B (provide coronary angiography but not percutaneous coronary intervention (PCI) and tertiary Type B2-B3 (offering PCI and/or CABG) • Reporting period: 2002 -2005
Selection of subjects	• MCD includes all discharge records for patients >18 years hospitalised with a principal diagnosis of AMI (ICD-9-CM code 410). N = 46,287; 7,099 fatalities. • MCD exclusions: cases with no information re vitals status at discharge; aged < 18 years; those transferred out to another short term hospital; short term hospitals registering less than 20 cases per year. • Note: the comparator set, the MONICA dataset includes patients 25-74 years.
Risk adjustment and /or other variables of interest	• Multivariable logistic regression models. Two models used, one excluding transfers out and the other excluding all transferred cases. • Covariates: Charlson comorbidity index, age (5 year groupings), gender, shock.
Statistical issues	• Fixed effects models used – considered the entire population of Belgian hospitals. • Bonferroni correction used for multiple comparisons. • Trends over time within hospitals were assessed by fitting models with a linear time trend. The slope of each hospital's time trend was compared with others using linear contrasts. Interactions between 'trend' and 'hospital' was investigated. • To reduce bias if the % fatal cases in the AMI-CFR exceeds 10% or the odds ratio is less than 0.5 or greater than 2.5, the approximation of the relative risk was used (Zhang J 1998)[#] • To account for correlation within the data, rescaling techniques were used • To assess departure from other hospital results and to avoid misinterpretation, a. "inconclusive zone" was defined as a departure of -25% or +35% for AMI-CFR. • A Generalises Estimating Equations (GEE) method was used to study national trends • ROC curves were used to assess model fit and were very good (discrimination between

	0.832-0.844). • No unique patient identifier but attempted to track transferred patients. • Problems identified with both the numerator and denominator of the case-fatality rates, related to different coding and discharge practices between hospitals. • Assessed data quality through a comparison of MCD with MONICA data, however the definition of AMI-CFR differs between the two databases i.e. MCD in-hospital versus MONICA = 28 days.
Data presentation Feedback	• The AMI-CFR of each individual hospital was compared with the corresponding rate of the whole of the other Belgian hospitals. • Feedback occurred at two levels: o Feedback to hospitals in a graphical format displaying the departure of each hospital from the rate and trend of the other hospitals, and an anonymous and tabular representation of these departures incl. statistic evidence. o Feedback to College of Physicians presenting "average" and "outlying" (>+35%, <25%) categories of hospitals and for trends (+/- 5%).
Management of outliers	Reference to outliers was in relation to using caution to not rank hospitals but rather encourage outliers to implement updated evidence based guidelines.
Main findings	• The age adjusted mortality rates were higher in type A hospitals than Type B2-B3. • There was "huge" variability across institutions of the same type regarding CCI, LOS and shock and similar variability n volume. • There were more fatalities and higher AMI_CFR in the MONICA registry and significant underestimation of the AMI-CFR by the MCD (RR0.39, 95% CI 0.31-0.51). It was not possible to determine whether 'place' was associated with these findings. • There were differences in documented cases of PTCA between MCD and MONICA – the numbers in MCD far exceeding those in MONICA. • Discrepancies between the datasets were also found for recurrent events. • Identified problems with both the numerator and denominator of the case-fatality rates. • Shock was the strongest determinant of AMI-CFR in all models • For the model excluding transferred cases, there were 7 high AMI_CFR and 9 low AMI-CFR outlying hospitals, and for the model excluding transferred out cases, there were 4 high AMI-CFR and 8 low AMI-CFR outliers. • The analysis performed in a subset of B2-B3 tertiary hospitals also demonstrated significant inter-hospital differences (2 high, 1 low for model with transfer out exclusions, but no trend over time differences) and for all transfer exclusions (1 high AMI-CFR for the period analysis and 1 low AMI-CFR for the trend analysis)) • Sensitivity analyses revealed differential coding and / or case management practices. • In the model, with exclusion of transfer-out case, the main determinants of AMI-CFR were cardiogenic shock. • Sizeable inter-hospital and inter-type of hospital differences and non-conformities to guidelines for treatment were observed.
Authors' conclusion	• There were numerous data quality issues prompting very cautious interpretation of results. • AMI is characterised by diagnostic uncertainty which may be reflected in the denominator differences between MCD and MONICA (they note the lack of national guidelines). • Their results for AMI-CFR were very different to those reported in a German study • The limitations of comparing MCD and MOICA are noted, however the authors suggest the increased number of AMI diagnoses in MCD may reflect propensity of administrative data to maximize coding, whilst registering previous events is low reflecting lack of financial reimbursement associated with this documentation. • There are a number of limitations in data for instance lack of information about symptom onset to needle time, and time lag between symptom onset and treatment intervention and lack of socioeconomic data. • Despite established data quality shortcomings, the magnitude of the observed

	differences and the nonconformities constitute leads to quality improvement. However, to measure progress, ways to improve and routinely monitor data quality should be developed.
Critical analysis □ Good □ Adequate □ Poor/None	□□□ The study addresses an appropriate and clearly focused question □□□ Clear and explicit definition of the study population and participation rate □□□ The outcomes are clearly defined □□□ Data quality adequately described □□□ Statistical analysis (OR, CI) □□□ Study limitations discussed
Reviewer comments / relevance to Australian setting	• The major findings in this paper relate to data quality issues associated with use of administrative datasets. • In keeping with other studies it provides evidence for good mortality model discriminatory attributes. • Also in keeping with other studies it presents evidence of variability in adjusted mortality rates between peer group hospitals, however the degree to which these are related to quality sensitive issues or to varying coding and discharge practices between hospitals is uncertain. • There are several study limitations, particularly related to comparability of the two datasets for which there are different mortality definitions. • The study reinforces the need to establish a clear definition of HMI including inclusion / exclusion criteria, consistency of coding and case management practices to ensure the HSMR is generalisable across settings and jurisdictions. • Although the investigators described feeding back information to the College of Physicians and to hospitals it did not describe the process whereby the data is used to drive improvement or indeed if improvement was associated with use of AMI-CRF reporting.

[#] Zhang, J. and Yu, K. F. (1998) 'What's the relative risk? A method of correcting the odds ratio in cohort studies of common outcomes', *JAMA,* 280(19), 1690-1.

Barker AL, 2011, Australia

Study title	"Death in low-mortality diagnosis-related groups": frequency, and the impact of patient and hospital characteristics
Study objective(s)	To examine frequency of deaths in low mortality diagnosis-related groups (DRGs) and the patient and hospital characteristics associated with them.
Study type	Retrospective cohort study
HMI definition **Data sources**	• Low Mortality-DRGs (LMDRGs) • Based on AHRQ's definition – DRGs with a total mortality rate of <0.5% in any of the previous 3 years • Victorian state hospital administrative data (VAED) • ICD-10-AM
Settings Participants **Reporting period**	• Victoria, Australia • 122 public hospitals' episodes • Reporting period: 1/7/2006 – 20/6/2008
Selection of subjects	Excluded episodes: • Trauma, immunocompromised state, cancer as they have a higher non-preventable mortality • Care type indicative of posthumous donor, hospital boarder, neonates 9 days or less
Risk adjustment and /or other variables of interest	• Variables of interest: age (5 year groups), sex, unplanned (emergency) admission, transfer from hospital or from Residential Aged Care Facility (RACF), comorbidity level (Elixhauser score using P and A codes, not C codes, the latter indicative of diagnosis timing in-hospital), volume (low, medium, high), major provider/teaching hospital, metropolitan.
Statistical methods **Data presentation**	• Hierarchical logistic regression model used to test associations of LMDRGs with patient and hospital characteristics. • Incorporated adjustments for data clustering • Fit to a single cohort without cross validation due to inconsistency in DRGs across the 2 cohorts restricting ability to use derivation/validation cohorts. • 2 stage analysis; univariable associations between variables and LMDRGs assessed in a logistic regression then significant variables were entered into a multivariate analysis. Testing undertaken for colinearity. • Logistic regression used to generate an expected probability of death for each LMDRG episode, including adjustment for risk factors significantly associated with LMDRG death. Expected probabilities were summed to develop hospital LM- DRG SMR, where the SMR= sum observed deaths/expected deaths. These were presented as OR with 95%CI.
Main findings	• Total 1,008,816 LMDRG deaths over 2 years. • LMDRG deaths were infrequent; ranging from 0-15 deaths per hospital 2006/7 and 0-20 in 2007/8. • 63 (51.64%) hospitals in 2006/7 and 62 (51.24%) in 2007/8 experienced no LMDRG death. • High variability; No single DRG diagnosis, procedure or complication reported in more than 10% cases. • 40% LMDRG deaths were among patients aged 83 years or more. • 39% LMDRG deaths had LOS 1 day or less. • 74% admissions were emergency and medical DRGs. • Transfers accounted for 20% LMDRG deaths in 2006/7 and <12% in 2007/8. • Older age, male gender, comorbidity level, unplanned admission, transfer from hospital or RACF, smaller volume hospitals were associated with increased risk of death in LMDRGs, and were included in the adjusted model. • Hospital metropolitan location and teaching hospital status had no association with risk of death. • Significantly fewer outlier hospitals were identified once the data was adjusted for

	significant patient and hospital characteristics (15 vs 59, p<0.05), however confidence intervals for all hospitals were wide indicating uncertainty in results.
Authors' conclusion	• Although the LMDRG has good face validity and is easy to generate from administrative datasets, patient-hospital characteristics unrelated to quality of care influence likelihood of death in these episodes. • The low frequency of LMDRG deaths suggests the indicator will be insensitive to true variations in quality of care and requires further refinement before application as a quality and safety metric. • There are likely to be a large number of false positives, given the number of patients who are over 80 years old, emergency admissions and transfers from RACF • LMDRG is defined as an unadjusted indicator; however adjustment changed the outlier status of many hospitals indicating the need to perform adjusted analyses. • Associations of LMDRG deaths and low volume hospitals is in keeping with other studies and further investigation is indicated to exclude confounding by unmeasured operational and casemix factors. • Association with hospital transfers also deserves further investigation. • Whilst the authors were unable to use accepted methods for model development given the limitations of DRG stability over time, the a priori objectives and statistical methods are well described and reported.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This is a good quality study, undertaken in an Australian setting that demonstrates the limitations of this indicator at a system level for measuring comparative quality and safety performance. Further research is indicated before widespread adoption occurs. • In view of the infrequency of LMDRG, individual case review at a local hospital level may contribute more to quality improvement activities than higher level system surveillance.

Bhat SK, 2013, Australia

Study title	Validation of Jarman's method of calculation of hospital standardised mortality ratios
Study objective(s)	To compare Jarman-derived HSMR and Linkage derived cumulative mortality ratios (CMR) across 4 time periods, 1980, 1985, 1990, 1995.
Study type	Cross-sectional study with 4 time periods
HMI definition **Data sources**	• HSMR inpatient mortality (Jarman/Dr Foster method) • CMR death within 30-days of admission • Linked Western Australia hospital morbidity and mortality registry data • ICD-9
Settings **Participants** **Reporting period**	• Western Australian hospitals grouped into: metropolitan public teaching, metropolitan public non-teaching, rural public/private, metropolitan private/other. • Data was cleaned, merged, sequenced. • Deaths were assigned to one of 12 disease categories. • The 4-calendar-year database was trimmed to include only the last admission that resulted in death, so that its respective domain contained only patient death records with no transfer. • The Jarman-derived and CMR databases were standardised indirectly: applying the age-, sex- and hospital-stratified mortality rates of the Jarman-derived database to each of the tow denominators for expected deaths. • Unmatched Jarman deaths (1060/12,389) were excluded from the analysis. • Reporting period: Analysis for 4x14 month time periods, 11/79-1/81, 11/84-1/86, 11/89-1/91, 11/94-1/96, with lookup periods to avoid including re-hospitalisations.
Selection of subjects	Not well defined.
Risk adjustment and /or other variables of interest	• Age (0-18 then deciles to 79, then 79+), sex, hospital group, disease group (12 groupings)
Statistical methods **Data presentation**	• Indirect standardisation using Jarman age, sex and hospital stratified mortality rates based on Jarman dataset to reach 'expected deaths'. • HSMR and CMR calculated from 'estimated/expected' ratio for each hospital.
Main findings	• 'Any acute vascular disease condition' and 'Malignancies' contributed to deaths in approximately 70% of cases recorded by both methods. • 78 (15%) ICD-9 conditions contributed to 80% deaths. • Condition specific 30-day survival higher in 1995 than 1980. • Significant differences in determination of vascular deaths between methods and inaccuracies were identified in Jarman method. • Metropolitan teaching hospitals accounted for 50% of deaths. • Jarman-derived HSMR were significantly higher for metropolitan public non-teaching hospitals (1.02, 95%CI 0.98-1.07) than CMR (0.81, 95% CI 0.77-0.85). • CMR has greater capability to identify hospital transfers, and accurately identifies deaths.
Authors' conclusion	• The linked method offers better ways of identifying transfers. • Lookup period longer and contributes to data accuracy and fewer unmatched deaths which can influence the HSMR.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed

Reviewer comments / relevance to Australian setting	• The data for this study was very old and changes in coding could have occurred over the 15 year time period. • There were differences between the two datasets in relation to proportion of different hospital groups and major disease group variables vascular disease conditions, liver/spleen disease conditions and social problem related. However, these may reflect the large numbers within the dataset rather than be of clinical significance. • Differences in determination of death between methods limits the ability to compare across jurisdictions. • 30-day data for improving survival may provide an excellent high level view of system performance over time to inform policy and planning.

Borzecki AM, 2010, USA

Study title	Comparison of in-hospital versus 30-day mortality assessments for selected medical conditions
Study objective(s)	To compare in-hospital and 30-day mortality rates for 6 medical conditions using the AHRQ Inpatient Quality Indicators (IQI) software
Study type	Cross-sectional study
HMI definition **Data sources**	• In-hospital and 30-day postadmission standardised mortality rates • For each condition mortality was defined as deaths per 100 discharges with the specified principal diagnosis and ratios of observed to expected (O/E) at the level specified (Veterans Affairs (VA) wide or hospital/facility level) • National Patient Care Database's Patient Treatment File (PTF) that includes information on all VA discharges based on ICD-9-CM coding. • Additional vital status information was obtained from the VA's Vital Status files.
Settings **Participants** **Reporting period**	• VA hospitals – USA's largest integrated healthcare system, providing care to approximately 7 million veterans • VA patients discharged with primary diagnosis of AMI, CHF, stroke, gastrointestinal (GI) haemorrhage, hip fracture, pneumonia. For those with more than one admission within a 30-day period and who died within 30-days of the original admission were only counted once in the 30-day numerator • Reporting period: Financial years 2004-2007
Selection of subjects	• IQI methods not described in detail (referred to AHRQ document 'Guide to inpatient quality indicators' v 3, 2006) ○ 4 step process; literature review, structured clinical panel review, coding expert consultation, empirical analyses of IQIs
Risk adjustment and /or other variables of interest	• Risk adjustment and statistical analyses methods were defined by IQI methods (see above)
Statistical methods **Data presentation**	• Current analyses – IQI and APR-DRG software was applied to the PTF for 2004-2007. • Generated IQI O/Es and calculated 95% confidence intervals (CI). • Standardised facility level O/Es and CIs to overall VA rate during the 4 years by multiplying a constant equal to the inverse of the VA national O/E. Sites were considered outliers if the 95% CI did not include 1.0. • 30-day standardised mortality was calculated in the same way after linking of PTF to VA vital status files. • In-hospital and 30-day median mortality rates were compared using Wilcoxon rank sum tests and standardised mortality O/Es using correlation coefficients; agreement was calculated using weighted kappas. • Facility-level O/E pairs were defined as concordant if there was no difference in facility assessment by mortality method versus discordant if there was a change.
Main findings	• The sample was male (98%), white (64%) and participants had a high number of comorbidities. • All medical conditions had higher observed 30-day mortality rates than in-hospital mortality rates. • Correlations between in-hospital and 30-day mortality rates showed strong positive associations with coefficients ≥0.70, $p<0.05$ except for hip fracture ($r=0.31$, $p<0.05$). • Measures of agreement on outlier status followed similar trends as correlations, and were at least moderate agreement $k>0.40$ for all IQIs except hip fracture ($k=0.12$) and stroke ($k=0.22$) IQIs. • Simple observed agreement (concordance) between paired data did not always follow the same kappa trends. Median observed agreement ranged from 0.81 (pneumonia) to 0.89 (GI haemorrhage and hip fracture) even though there was lowest kappa for hip fracture. • The median number of facilities that changed outlier status was 18 (range 12-23), the number of sites changing status being highest for pneumonia.

	• Facilities were slightly more likely to change from a nonoutlier based on in-hospital mortality to an outlier (low or high) using 30-day mortality. • Only 1 facility changed from a high to a low outlier (IQI pneumonia). • Facilities were more likely to change from low/nonoutlier to a high outlier for 4 indicators (CHF, GI haemorrhage, hip fracture, stroke). • The median number of facilities changing from high to non/low outlier was 10 (range 7-13); highest number of sites changing for stroke.
Authors' conclusion	• Assessments of outlier status comparing in-hospital and 30-day post admission SMRs were similar regardless of the indicator. • At most 19% facilities changed status on any one IQI when changing to 30-day SMR. • Potential mislabelling of sites as high outliers was uncommon, occurring in approximately 10% for any given indicator. • The findings are consistent with previous literature.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This study supports other literature that compares SMRs derived using in-patient and 30-day post admission mortality rates, and suggests that the two are largely comparable except for conditions in which rehabilitation (particularly stroke and hip fracture) is required as this introduces potential bias related to differential discharge policies and access to inpatient rehabilitation services. • The authors may have underplayed the potential impact of changing to 30-day SMRs as 1/5 may change status and 1/10 could be potentially mislabelled as an outlier. This may not results in adverse impact if the data is used solely within a hospital, however could have significant ramifications if the data are publicly reported.

Bottle A, 2011, UK

Study title	Hospital standardized mortality ratios: Sensitivity analyses on the impact of coding
Study objective(s)	To compare HSMRs derived from 9 variant adjustment methods to the Dr Foster derived HSMR.
Study type	Cross-sectional study
HMI definition **Data sources**	• Dr Foster HSMR – 56 Clinical Classification System (CCS) diagnostic groups • NHS trusts hospital episodes statistics • ICD-10
Settings **Participants** **Reporting period**	• England • 146 NHS trusts; N=11,269,377 episodes • 5 specific diagnoses including AMI, stroke, fractured neck of femur • Reporting period: 2005-2009
Selection of subjects	Excluded episodes where there was missing data for age, sex, LOS, admissions with other primary diagnoses.
Risk adjustment and /or other variables of interest	• Compared regular HSMR model (Dr Foster) to 9 variant methods: o Using patients' first admission o Using patients' last admission o Not adjusting for palliative care o Not adjusting for comorbidity (CCI) o Excluding unplanned same day admissions that end in live DC o Combine 3-5 o 30-day total mortality (from admission date) o Indirect standardisation of all in-hospital deaths (not just 56 Dx)
Statistical methods **Data presentation**	• Logistic regression analysis. • No adjustments made for data clustering and main effects for variables were fitted. • HSMR Models' discrimination tested using c-statistic. • HSMR Models' explanatory power tested using R^2. • Sensitivity analyses (correlation coefficient). • Funnel plots with 99.8% exact Poisson control limits.
Main findings	• Over the 4 year period – 11,269,377 admissions for 56 CCS groups making up HSMR, 851,671 in-hospital deaths (7.6% fatality rate) • C-statistic for regular model was good (0.87). Between CCS groups c-statistic varied from 0.66 (senility and organic mental disorders) to 0.95 (breast cancer) • Proportion of the variation explained by the model (R^2) varied from 5.8% (senility and organic mental disorders) to 42.7% (breast cancer) • The most important variable for explaining variation was 'age' (in 35/56 models), Charlson in 4 models – in one this was just palliative care. • Using the patient's last admission in the 4 years rather than the first, resulted in more deaths. • Exclusion of zero-days unplanned stay - ranged between 7.5%-24% admissions across hospitals • Overall regular and variant HSMRs were highly correlated. • The correlation between regular HSMRs and those based on deaths within 30-days of admission was 0.84. Hospitals with more post discharge deaths were affected by this modification. • Small to medium changes in HSMRs were reported; in a small number of cases funnel plot limits changed significantly depending on choice of model used. The proportion of outliers was lower when using first admission per patient and when using only 5 diagnostic groups. The move from 'average' to 'high' outlier was greatest when regular

	HSMRs changed to 30-day total mortality • Excluding zero days unplanned stay had the smallest effect on outlier status • Across all analyses only one case changed from low to high or high to low.
Authors' conclusion	• The impact of the nine sets of changes was very variable except for inclusion of zero days stay and inclusion of 100% in-hospital deaths. • Correlation between models was high but occasionally lead to large impact on HSMRs point estimate, especially when palliative care was not included in the model. • Including all admissions had a modest impact on HSMR but 4 hospitals flagged as 'average' in regular HSMR flagged as 'high'. • Palliative care flag did impact on HSMR and outlier status but the code is unreliable, introduces bias and is prone to gaming. • Increasing numbers of short stay patients 'inflates' the denominator but excluding them made little impact on HSMR except for 1 hospital which moved from 'average' to 'high' outlier status. • Multiple admissions impacts on HSMR. • Depth of coding comorbidity does impact on HSMR. • Failure to capture post discharge deaths influenced HSMR and outlier status. • Overall despite the differences noted, high outliers stayed high and low stayed low with some movement in the middle. • The focus should not be on an HSMR point estimate and alternatives include use of banding (funnel plots) or Bayesian ranking and the presentation of confidence intervals.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This is an important, albeit somewhat dense, paper as it addresses many of the issues associated with using HSMR in relation to population definition and inclusion of variables in the risk models. It does not attempt to address statistical modeling issues and the models did not include adjustment for data clustering for instance. It would be useful to test the models in the Australian context. • The issue of how to include/exclude palliative care and the problems of coding reliability, bias and gaming need to be further addressed.

Bradley E, 2012, USA

Study title	Hospital strategies for reducing risk-standarized mortality rates in acute myocardial infarction
Study objective(s)	To identify hospital strategies that were associated with lower 30-day risk-standardised mortality rates (RSMRs).
Study type	Cross-sectional survey (web-based)
HMI definition, **Data sources**	• 30-day (admission) risk-standardised mortality rates (RSMRs) for AMI. • Calculated using the Centres for Medicare & Medicaid Services (CMS) methodology: the RSMR for each hospital was calculated by dividing the predicted number of deaths within 30-days of admission at that hospital by the expected number of deaths within 30-days of admission at the hospital assuming average performance, and then multiplying the ratio by the overall 30-day mortality rate of the cohort. • A quantitative web-based survey of self-reported hospital characteristics/strategies associated with AMI care. The survey questions were close-ended and based on a previous qualitative study of high performing hospital characteristics. The survey was pilot tested, and had multiple choice answers.
Settings **Participants Reporting period**	• USA, acute care hospitals that publicly reported Centres for Medicare & Medcaid Services (CMS) data • 537 acute care hospitals with an annualized AMI volume of at least 25 patients • Patients hospitalized with AMI • Reporting period: 1/1/2008 – 31/12/2009
Selection of subjects	• Hospitals with at least 75 AMI discharges during the 3-year period (n=1969). Random sample of 600 of these hospitals attempted to contact for participation in the survey and asked to report strategies in use during the reporting period Exclusions: • Hospitals with less than 75 AMI discharges during the 3 year period • Hospitals that could not be linked to the 2006 America Hospital Association hospital survey.
Risk adjustment and /or other variables of interest	• Weighted multivariate regression analysis examining hospital strategies and hospital RSMRs based on previously reported methods. Limited information provided in this report. There was no discussion re data quality contributing to the RSMR, rather there was an implicit acceptance of the indicator and it's use for comparisons between hospitals. • Hospital structural characteristics obtained from the 2008 American Hospital Association survey of hospitals, including teaching status, number of staffed beds (fewer than 300, 300 to 600, more than 600), geographic location, and volume of AMIs (25 to 75, 76 to 125, 126 to 250, and more than 250 discharges annually). Cardiac capability performed primary PCI as reported on the Web-based survey.
Statistical issues	• A dummy indicator was used for survey questions missing more than 5% responses. • For each strategy, the number and percentage of hospitals in each response category was determined with mean/SD of RSMRs, weighted by the inverse variance of the RSMR. • Respondent and non-respondent hospitals were compared (t test, chi-squared) • The relationship between independent variables and 30-day RSMR was evaluated using weighted linear regression models with RSMR as the dependent variable, weighted by the inverse of the RSMR • Independent associations of specific strategies with RSMR were examined using multivariate least-squares regression weighted by the inverse variance of the RSMR. • Multicollinearity amongst independent variables was assessed using the variance decomposition proportions. • In a secondary analysis a model was estimated that excluded the indicator for cardiologists always being present as this is not always feasible • In secondary analyses the added effect of hospital characteristics (teaching stsud, geographic region and AMI volume) was tested. • The relationship between number of strategies and RSMR was assessed using a non parametric test for trend of RSMR.

Report presentation Feedback	Not applicable
Management of outliers	Not applicable

Main findings	• Final sample 533 (590 contacted, as 10 had closed, 537 responded - 91% response rate; 4 hospitals were eliminated because they did not have CMS mortality data for AMI)
	• Responder and non-responder hospitals did not differ significantly for teaching status, geographic region, AMI volume, cardiac capability or RSMR.
	• The overall weighted mean RSMR was 15.4% (SD 1.5%, Range 11.5%-21.7%)
	• There were numerous associations between hospital strategies and RSMRs. Main model MVA
	  o Clinicians meet monthly (p<0.001) – RSMR lower by 0.70% points
	  o Cardiologists always on site (p=0.002) – RSMR lower by 0.54% points
	  o Clinicians encouraged to problem solve (p=0.011)
	  o Physician champion only (p=0.033), Physician and nurse champion (P=0.002)- RSMR lower by 0.88% points, nurse champion only (higher RSMRs)
	  o Critical care nurses not cross trained for cath lab (p=0.011)- RSMR lower by 0.84 % points
	  o Pharmacists rounded (P=0,025) – for model 2 only (without cardiologists)
	• There was a significant trend in the number of key strategies used (ie strategies listed above) and lower RSMRs (p<0.001) – however the data indicate that confidence intervals for RSMRs according to numbers of strategies all overlapping suggesting there was no absolute difference between groups.
	• Fewer than 10% of hospitals reported using at least 4 of these 5 strategies.

Authors' conclusion	• Several strategies, which are currently implemented by relatively few hospitals, are associated with significantly lower 30-day RSMRs for patients with AMI. • The size of the effect is modest (absolute RSMR difference of 1%) but when generalised to the whole population could translate to many lives saved. • Several strategies are not resource intensive eg meeting monthly to discuss AMI patients. • Having cardiologists always on site is resource intensive and was only implemented in 14% hospitals. Similarly having pharmacists rounding and not only reviewing medications is of benefit but only implemented in 35% hospitals. • The reason for higher RSMR associated with only nurse champions requires further investigation • The study overall is in keeping with previous qualitative studies – higher performing hospitals being characterised by organisational environments that foster high quality care – eg effective communication, broad staff presence and expertise, culture of problem solving. • Limitations include; single respondent, observational design, cannot prove a causal role for strategies, where no differences were found one cannot infer the strategies had not impact on outcomes.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ The study addresses an appropriate and clearly focused question ☐☐☐ Clear and explicit definition of the study population and participation rate ☐☐☐ The outcomes are clearly defined ☐☐☐ Data quality adequately described ☐☐☐ Statistical analysis (OR, CI) ☐☐☐ Study limitations discussed
Reviewer comments / relevance to Australian setting	• An American study with a good sample size and excellent response rate to a retrospective survey, however one respondent completed the survey for each hospital and a number of the questions are subjective and poorly defined. • There was no discussion of the validity of the RSMR i.e. quality of data, coding differences etc. The study provides an example of how RSMRs could be used to improve quality but caution should be used to ensure the RSMR is valid for making comparisons between hospitals.

	• Limitations of the study include; o Recall of hospital strategies in place may not be accurate due to the retrospective nature of the survey and completion of the survey by a single respondent. o The cross sectional design demonstrates statistical associations but cannot establish causal relationships. o The hospital RSMRs are publicly reported and the respondent may have been aware of the results, which may have biased their responses.

Carretta HJ, 2012, USA

Study title	Examination of hospital characteristics and patient quality outcomes using four inpatient quality indicators and 30-day all-cause-mortality
Study objective(s)	To examine hospital structural and patient characteristics associated with 4 inpatient quality indicators (IQIs) and 30-day mortality.
Study type	Cross-sectional study
HMI definition **Data sources**	• Inpatient Quality Indicators (IQIs) for AMI, CHF, stroke, pneumonia, defined by standardised algorithms in the Agency for Healthcare Research and Quality (AHRQ) IQI Software Version 4.2 • All-payer 30-day post discharge mortality indicator: 30-day post discharge all-cause mortality after hospitalisation was computed using merged inpatient and mortality data. • Florida Agency for Health Care Administration (AHCA) discharge data for general acute care hospitals merged with death registry data from the Florida Department of Health (FDOH). • AHCA data classified using ICD-9-CM. • AHCA Accreditation and certification file was used to obtain hospital organisational characteristics including unique facility identifier, type of hospital, profit status, affiliation with health system, teaching status and bed capacity.
Settings **Participants** **Reporting period**	• Florida, USA • 173 general acute care hospitals • Reporting period: 2008
Selection of subjects	• Final sample 1,772,984 (69%) discharges and 1,215,966 (80%) unique persons. • 2,571,736 records associated with 1,514,946 unique Social Security Numbers. Discharge records retained if they were associated with general short-term hospitals and Florida residents. • Exclusions: all patients < 18 years; missing social security number (81% people with missing data were < 18 years), identifier for sex, DRG codes; hospitals with type code other than teaching, general short-term or general other, hospitals with fewer than 30 cases of 30-day post discharge mortality
Risk adjustment and /or other variables of interest	• Risk-adjusted multivariable logistic regression models for the likely of inpatient mortality for 4 condition-specific IQIs and all-cause mortality within 30-days of discharge. Variables of interest were; • Age, sex, race/ethnicity, payer status (Medicare, Medicaid, Private, self pay, other insurance), patient DRG based acuity (mild, moderate, severe, extreme), mortality risk based on patient's principal and secondary diagnoses (comorbidities) • Hospital structural characteristics: bed size; volume; ownership; teaching status; system affiliation.
Statistical methods **Data presentation**	• Descriptive results were prepared for hospital structural and patient characteristics. • Risk-adjusted multivariable logistic regression models for likelihood of inpatient mortality for the condition specific indicators were performed on patient-level dsciharge data using SAS version 9.2
Main findings	• Total 30-day all-cause mortality sample 1,772,984, AMI in patient mortality 30,843; Stroke inpatient mortality 30,836; CHF inpatient mortality 62,686; and pneumonia inpatient mortality 41,661. • Higher hospital volume was associated in lower mortality in AMI, CHF, stroke, and 30-day mortality. • Similarities and differences in the direction and magnitude of the relationship of structural characteristics to 30-day post discharge and IQI mortality measures were observed. • Hospital volume was inversely correlated with inpatient mortality outcomes except for pneumonia. • Hospital system affiliation was associated with reduced mortality for CHF (20% reduction versus non system affiliated hospitals). • For profit hospitals had 20% higher higher in-hospital CHF mortality but 12% lower 30-day

	discharge mortality • Teaching hospitals had 46% higher odds of inpatient CHF death but lower odds of 30-day mortality. • Large hospital size was found consistently to have increased mortality for CHF, stroke and 30-day mortality. • The pneumonia model demonstrated evidence for decreasing mortality in moderate versus smaller hospitals. • Overall, hospital characteristics were most relevant for CHF and Stroke indicators but little influence on pneumonia and AMI outcomes • Further study is needed to understand the relationship between 30-day post discharge mortality and hospital quality.
Authors' conclusion	The authors suggest that volume may be a useful proxy for quality and may be helpful in identifying high-quality hospitals in the inpatient and post discharge setting.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This study demonstrates the potential usefulness of condition specific mortality indicators in drilling down to characteristics that increase quality of care. • This study supports previous data that associates hospital volume with improved outcomes. • There does not appear to be a definitive relationship between hospital size and condition specific volume, however the study did not investigate hospital bed size per condition as such. • All cause 30-day mortality is a potential measure for improved post discharge quality of care i.e. captures aspects associated with successful transition to community care such as patient assessment at discharge; hospital practices or structures that enhance continuity of care and communication; identification of sources of social support for the patient. • The limitation to a single USA state and focus on hospital organisational factors which are different to Australian settings and classifications limit the generalisability of the study. • There was limited discussion relating to statistical methods and data quality • The study only examined a limited number of structural characteristics, for instance staffing type and ratios / disciplines was not considered.

Cassel J, 2010, USA

Study title	Hospital mortality rates: how is palliative care taken into account?
Study objective(s)	To answer questions about how hospital mortality rates are computed and how the involvement of hospice or palliative care (PC) are recognized and handled.
Study type	Review of the mortality rate methodology used by 4 entities
HMI definition **Data sources**	• Risk-adjusted "all cause" mortality rates • CMS "Hospital Compare"; U.S. News & World Report "Best Hospitals"; Thomson-Reuters "100 Top Hospitals"; HealthGrades
Settings **Participants** **Reporting period**	• USA • 4 national sources of hospital quality and performance data • Reporting period: 6th July 2010
Selection of subjects	• 15 entities identified that calculate mortality scores based on hospital claims data, with 4 entities meeting inclusion criteria. • Exclusions: benchmarking entities whose data are not available to public; Leapfrog group – mortality scores for high risk surgeries; State based entities; entities that repackage existing CMS "Hospital Compare" mortality data.
Risk adjustment and /or other variables of interest	Descriptions of the risk adjustment methods, including the treatment of palliative care coding provided for each of the four entities. The methodologies were confirmed with a contact person at each of the entities.
Statistical issues	• The main commonalities between the entities' methodology was the use of Medicare data, rates are risk adjusted and mortality is "all cause". However, there was wide variability for most other elements e.g. number and kind of conditions, procedures or specialties analysed, risk adjustment methodologies. • Two entities did not exclude or incorporate palliative care into the mortality rate; one excluded palliative care based on V66.7 Palliative Care Encounter ICD-9 code; and one excluded palliative care in 12 diagnosis-based cohorts but not for other procedural codes; not excluded or otherwise incorporated into risk adjustment for procedure cohorts. • Difficulties in identifying palliative / hospice cases include: inconsistent use of V66.7 Palliative Care Encounter Code; obstacles obtaining hospice enrolment data; caution re excluding hospital deaths too liberally; excluding cases that involve hospice only at the end of an admission may create an incentive for hospitals to use hospice as a way to hide problems with quality of care earlier in the admission.
Report presentation **Feedback**	Not applicable
Management of outliers	Not applicable
Main findings	• The methodology used to calculate mortality rates varies considerably including handling of cases that involved hospice care or palliative care. • One entity excludes cases with prior hospice care and another excludes those discharged to hospice at the end of the index hospitalisation. • Two entities exclude some or all cases that were coded with V66.7 "Palliative Care Encounter" ICD-9-CM diagnosis code.
Authors' conclusion	Proliferation of, and variability among, hospital mortality measures creates a challenge for hospital administrator. Palliative care and hospice leaders need to educate themselves and their hospital administrators about the extent to which these mortality rates take end-of-life care into account. At the national level, palliative care and hospice leaders should take advantage of opportunities to engage these mortality raters in conversation about possible changes in their methods and to conduct further research on this topic.

Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ The study addresses an appropriate and clearly focused question ☐☐☐ Clear and explicit definition of the study population and participation rate ☐☐☐ The outcomes are clearly defined ☐☐☐ Data quality adequately described ☐☐☐ Statistical analysis (OR, CI) ☐☐☐ Study limitations discussed
Reviewer comments / relevance to Australian setting	• A relevant study for the Australian setting, when considering the impact of patient level characteristics, such as palliative care and hospice care, on the HSMR. The authors cite findings of another of their studies stating the V66.7 code is a strong predictor of mortality. (Cassel JB. Impact of palliative care reporting on publicly reported performance data. University of HealthSystem Consortium Webinar. Available from https//www.uhc.edu/34895.htm). • The ACSQHC HSMR data definition does not exclude cases coded as palliative care "based on the principle that a problem may exist if a patient is admitted for acute care (regardless of whether or not they also received palliative care) and they subsequently die in hospital, and that further detailed investigation is required." (page 15)

Chong C, 2012, Canada

Study title	Trends in Canadian hospital standardised mortality ratios and palliative care coding 2004-2010 a retrospective database analysis
Study objective(s)	To determine whether palliative coding in Canada has changed since the 2007 national introduction of publicly released HSMRs, and how such changes may have affected results.
Study type	Retrospective database analysis
HMI definition **Data sources**	• Crude mortality; palliative care coding rates: HSMRs calculated with same methodology as Canadian Institute for Health Information (CIHI). • A derived hospital standardised palliative ratio (HSPR) adjusted to a baseline average of 100 in 2004-2005. • Recalculated HSMRs that included palliative cases under varying scenarios. • Canadian Institute of Health Information (CIHI) Discharge Abstract Database (DAD).
Settings **Participants** **Reporting period**	• Canada (excluding Quebec) • 606 hospitals • Reporting period: April 2004 to March 2010
Selection of subjects	• 12,593,329 hospital discharges recorded in the Canadian Institute for Health Information (CIHI) Discharge Abstract Database.

Risk adjustment and /or other variables of interest	• Recalculated HSMRs using the methodology released by CIHI and the same inclusion and exclusion criteria:
	  ○ Inpatient deaths only
	  ○ Excludes palliative care cases (code Z51.5)
	• Constructed a hospital standardised palliative ratio (HSPR) using the same approach to build the HSMR.
	• Binary logistic regression model to predicted the expected number of palliative cases.
	• Compared HPSR April 2004 – March 2006 (prior to palliative care coding changes) to April 2008 – 2010 (after coding changes)

Statistical issues	• Close timing of the introduction of new palliative care coding guidelines and plans to release HSMR publically make it difficult to distinguish between relative contributions of publication of HSMRs and changes in coding practices. • The authors noted that study focussed on palliative care coding and did not take into consideration other coding practices that may have happened over time e.g. comorbidities, readmitted patients, shifts towards out of hospital or other facility deaths.
Report presentation / Feedback	Not applicable
Management of outliers	Not applicable
Main findings	• Crude mortality and palliative care coding rates have been increasing over time ($p<0.001$), in keeping with the nation's advancing overall morbidity. • HSMRs in 2008-2010 were significantly lower than in 2004-2006 by 8.55 points ($p<0.001$). • Under various HSMR scenarios that included palliative cases, the HSMR would have at most decreased by 6.35 points, and may even increase slightly.
Authors' conclusion	Palliative care coding rates in Canadian hospitals have increased dramatically since the public release of HSMR results. This change may have partially contributed to the observed national decline in HSMR.

Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ The study addresses an appropriate and clearly focused question ☐☐☐ Clear and explicit definition of the study population and participation rate ☐☐☐ The outcomes are clearly defined ☐☐☐ Data quality adequately described ☐☐☐ Statistical analysis (OR, CI) ☐☐☐ Study limitations discussed
Reviewer comments / relevance to Australian setting	• A Canadian study assessing whether the release of public HSMR data was correlated with changes in palliative care coding. Patients labelled palliative are typically excluded from the calculation of HSMR in Canada. HSMR rates declined following publication and as a result the strategy of publication of HSMRs was promoted as having a positive impact on quality. However, concurrently, new guidelines for palliative care coding also appear to have contributed to the lower HSMR. • A relevant study for the Australian setting, when considering the impact of patient level characteristics, such as palliative care and hospice care, on the HSMR. The key message is coding practices have a clear impact on the HSMR and comparison of HSMR overtime, need to take into account changes in coding practices.

Clarke A, 2010, Australia

Study title	Investigating apparent variation in quality of care: the critical role of clinician engagement
Study objective(s)	Reports the experience of the Victorian Department of Health in seeking clinician engagement in the testing of 11 quality-of-care indicators in 20 health services in Victoria.
Study type	Narrative
HMI definition **Data sources**	• 11 indicators including in-hospital mortality for: Low mortality DRGs; Stroke; Heart failure; AMI; Pneumonia; Fractured neck of femur • Victorian Admitted Episodes Database (VAED) • ICD-10-AM
Settings **Participants** **Reporting period**	• Victoria, Australia • 20 Health Services • April 2009
Selection of subjects	Victorian health services
Risk adjustment and /or other variables of interest	Not described
Statistical issues	Although using readily available and inexpensive routinely collected administrative data to measure clinical performance has a certain appeal, the use of administrative data and VLADs to identify apparent variations has posed significant challenges due to concerns about the quality of the data and resource requirements.
Report presentation / Feedback	Variable life-adjusted display (VLAD) control charts, using de-identified hospital level statewide rates in the form of funnel plots (not shown).
Management of outliers	Not described
Main findings	• Engagement of clinicians in to test quality of care indicators is difficult due to concerns re the quality of administrative data and the burden upon resources, which detracts from the provision of clinical care. • One example provided demonstrating how quality indicators can be used to improve clinical practice.
Authors' conclusion	• The use of administrative data and VLADs (variable life-adjusted displays) to identify apparent variations in patient safety and quality of care has presented significant challenges for the Victorian Department of Health. • Although provision of comparative information can be a strong motivator to improve performance diverting clinicians from care provision can itself jeopardise patient care. The critical nature of clinician engagement cannot be overstated. Indeed, genuine clinician ownership is the only way to really understand, persuade and lead changes in care processes that arise from apparent variations in clinical outcome measures.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ The study addresses an appropriate and clearly focused question ☐☐☐ Clear and explicit definition of the study population and participation rate ☐☐☐ The outcomes are clearly defined ☐☐☐ Data quality adequately described ☐☐☐ Statistical analysis (OR, CI) ☐☐☐ Study limitations discussed
Reviewer comments / relevance to Australian setting	• A study describing the Victorian Department of Health's attempt to engage with clinicians to test quality-of-care indicators. Whilst the Department acknowledges clinicians and clinical teams are directly responsible and accountable for the safety and quality of the care they provide, they encountered difficulties in engaging them in the process. • Participating hospitals reported limited involvement of clinicians (partly due to a lack of confidence in the data source), a higher-than anticipated level of strain on resources (although this was difficult to quantify), and too great a delay between incident and report at the hospital level. Concerns were also expressed about diverting clinicians away from

	clinical care to engage in the investigation of variation in VLADs.

Coory M, 2008, Australia

Study title	Using control charts to monitor quality of hospital care with administrative data
Study objective(s)	To compare cross-sectional analyses with sequential monitoring using control charts
Study type	Cross-sectional data analysis
HMI definition **Data sources**	• 30-day in-hospital mortality rate for AMI • Queensland Hospital Admitted Patients Data Collection (QHAPDC)
Settings **Participants** **Reporting period**	• Queensland tertiary and base hospitals (n=18) • People with AMI classified using ICD-10 codes I21x-I22x • Financial years 2003-4 and 2004-5
Selection of subjects	All admitted patients with AMI • admitted through the emergency department, • aged between 30-89 years, • died or discharge status of alive with LOS greater than 3 days.
Risk adjustment and /or other variables of interest	5 year age groups, sex, comorbidities (shock, dysrhythmias, CHF, hypertension, diabetes, chronic renal failure, dementia, stroke, malignancy) [Comorbidities were based on other studies and predicted short-term mortality for AMI]
Statistical issues	Report presentation 1. Funnel plots – two- and three- sigma limits as defined by Spiegelhalter, D.J. (2005).* Report presentation 2. CUSUM plots • Alternative hypotheses pre-specified as relative risk increased/decreased of 30%, 50% or 75% • Average run lengths were determined for CUSUM using simulation techniques • Log-likelihood-ratio form of the CUSUM was used • Set the initial log-likelihood-ratio CUSUM value at h/2 (half the threshold value). Similarly for resetting h/2
Report presentation / Feedback/management of outliers	Described for Queensland as • For 30% relative increase – hospitals advised to investigate • 50% relative increase – Area Health Service would be advised to investigate 75% increased relative risk – Patient Safety and Quality Board would be notified
Main findings	• There were 4158 AMI admissions during the study period (2079/year) • Median number of admissions/hospital – 103 (range 40-265, IQR 74-154) • Average 30-day mortality – 12.4% • Using the funnel plots, no hospital flagged at the three-sigma level in either year as a high or low outlier. • Using the funnel plots, at the two-sigma level, in 2003-4 there were two low outliers hospitals and In 2004-5 one hospital was a high-outlier. • Using the CUSUM control charts 5/18 (28%) hospitals flagged an increase relative risk of 75% • Using the CUSUM control charts, for instance in September 2003 one hospital flagged once at 75% relative risk, twice at 50% and 30%. For 2003-4 this hospital just failed to signal at the two-sigma level using the funnel plot.
Authors' conclusion	• Control charts potentially provide more useful information than cross-sectional analyses for being a starting point for quality improvement. They detect problems early. • Control charts should not be used to make definitive judgements and thresholds should not be used to label poor performance but rather to identify when investigation is warranted • An interpretation of the cross-sectional charts is that most of the variation is due to statistical noise • The signals in the CUSUM control charts are not likely to be statistical noise – the average

	run length to a false alarm for 75% relative risk increase is 3118 admissions. Therefore for an average hospital with 103 admissions per year, a statistical false alarm would occur every 30 years. • There is inherent trade-off between sensitivity and specificity (false alarms) that needs to be considered when developing control charts • False alarms are not necessarily a waste of time if they lead to improved data quality
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ The study addresses an appropriate and clearly focused question ☐☐☐ Clear and explicit definition of the study population and participation rate ☐☐☐ The outcomes are clearly defined ☐☐☐ Data quality adequately described ☐☐☐ Statistical analysis (OR, CI) ☐☐☐ Study limitations discussed
Reviewer comments / relevance to Australian setting	• This is a high quality study, which neatly demonstrates the utility of control charts such as CUSUM for timely quality monitoring, investigation and potentially intervention. • The study does not negate the utility of funnel plots for high level understanding of system variation but highlights the importance of considering the purpose for which the data is to be used and the target audience in determining the nature of the data presentation.

*Spiegelhalter, D. J. (2005) 'Funnel plots for comparing institutional performance', *Stat Med,* 24(8), 1185-202.

Dalton JE, 2013, USA

Study title	Impact of present–on-admission indicators on risk-adjusted hospital mortality measurement
Study objective(s)	• To develop and validate a risk index for in-hospital mortality using present on admission (POA) diagnoses, principal procedures and secondary procedures occurring before the date of the principal procedure (POARisk). • To compare POARisk with a model ignoring timing of diagnoses and procedures (AllCodeRisk).
Study type	Cross-sectional analysis
HMI definition **Data sources**	• In-hospital mortality • California State Inpatient Database • ICD-9-CM (Clinical Modification)
Settings **Participants** **Reporting period**	• All discharges within California 2004-2009 excluding those in which there was no procedure. • Data from 2004-2008 used to develop model (80% initial model, 20% initial calibration/bias correction). • Data from 2009 was used as a validation sample.
Selection of subjects	• In model development the researchers excluded discharges with zero procedures. • In model verification there was testing with and without cases with zero days LOS.
Risk adjustment and /or other variables of interest	• Variables of interest; POA diagnoses (truncated ID codes where discharges less than 1000), principal and secondary procedures (date prior to principal procedure), age, gender.
Statistical methods **Data presentation**	• The initial POARisk model was developed with logistic regression, in-hospital mortality being the dependent variable • 'Elastic net approach' to fit logistic models based on aggregated predictors (shrinkage method to protect against 'overfit' to development cohort) • Calibration: used an in-house technique summarized in the appendix. • Comparative performance tested between POARisk, ALLCodeRisk and a third model based on original RSI using 2009 data, excluding hospitals with <500 episodes • Discriminative attributes tested using C-statistic and included Bonferroni correction for multiple comparisons. • Scatterplots of hospital observed:expected deaths (O/E) ratios were made to depict the nature of changes in individual hospital performance • Good approximation of hospital performance was defined as an O/E ratio of within +/- 20% of that defined by the POARisk model, ie a 'ratio of O/E ratios' of between 0.8-1.2. • Also used rank-based categories –top 10%, 10-30%, 30-70%, 70-90%, bottom 10%.
Main findings	• The initial development cohort included 10.1M discharges and 2.5M were used for calibration. • There were 2,476 predictors (1,807 diagnoses, 666 procedures, 3 demographic) for the POARisk model and 2,584 predictors for the AllCodeRisk model. • Approximately 20% were removed as irrelevant during logistic regression modeling. • Calibration of raw risk scores in the randomly retained 20% sample was poor and correction led to improved calibration in the application to 2009 data. • The original RSI was consistently higher (it was developed using a high risk Medicare population). • AllCodeRisk model predicted outcomes better than other models. • The O/E ratios under AllCodeRisk model was between -18.1% and +51.2% of the O/E ratios under POARisk model. • 122/353 (34.6%) hospitals had a different rank based categorization under AllCodeRisk versus POARisk model.
Authors' conclusion	• The authors suggest calibration and correction be undertaken for use of models in external datasets.

	• If proper modelling techniques are used. Models based on administrative data are highly predictive. The AllcodeRisk model performed slightly better because it was predicting risk on discharge and included in-hospital complications, however adjusting for hospital-acquired complications inflates expected outcomes and low performing hospitals can look high performing.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This is a well-designed study that extends the study into risk model variables, POA diagnoses and Procedures. • The risk models developed apply to hospital discharges in which there was a procedure undertaken which limits generalisability to other hospital populations. • The study highlights important aspects of model development and testing, in particular the need for calibration of initial models before application in comparative performance testing. • The study also highlights the potential impacts on ranking differences of hospitals when applying different risk models • As the POA is now used in Australia, the methods may be useful to test. The use of principal and secondary procedure codes is subject to knowledge of timing and this may not be possible in Australian systems.

Drye EE, 2012, USA

Study title	Comparison of hospital risk-standardized mortality rates calculated by using in-hospital and 30-day models: An observational study with implications for hospital profiling
Study objective(s)	To assess agreement between in-hospital and 30-day from admission mortality for acute myocardial infarction (AMI), heart failure (HF), and pneumonia episodes.
Study type	Cross-sectional study
HMI definition **Data sources**	• In-hospital and 30-day from admission mortality for AMI, HF and pneumonia RSMRs (risk standardized mortality rates); use a ratio based on individual hospital predicted (called the predicted), all hospital predicted (called the expected) and individual hospital observed (called the raw mortality rate) mortality rates. Definition RSMR= predicted/expected x raw mortality rate. • Medicare Standard Analytic File and post-discharge mortality status from the Medicare Enrolment Database • ICD-9
Settings **Participants** **Reporting period**	• Nonfederal acute care hospitals in USA; that treated at least 30 cases of that condition over the 3 year period • Medicare patients aged 65 years and over admitted with principal diagnosis of AMI, HF, or pneumonia • Reporting period: 1/1/2004-31/12/2006
Selection of subjects	• Excluded same day patients with live discharge; patients who left against medical advice; used hospice prior to admission, had unclear mortality status • For multiple hospitalisations – 1 admission/year randomly selected • Transfers – linked hospitalisations and assigned outcome to the first hospital
Risk adjustment and /or other variables of interest	• Used methods endorsed by the National Quality Forum (NQF) and applied by the Centers for Medicare and Medicaid Services • Variables of interest: patient volume, length of stay (LOS), %transfers
Statistical methods **Data presentation**	▪ Hierarchical generalised linear models used to derive RSMRs simultaneously used patient and hospital levels. ▪ Hospitals classified into 3 performance categories by their in-hospital and 30-day RSMRs ▪ Bootstrapping used to construct 95% confidence intervals. ▪ 30-day mortality rates considered the gold standard, then calculated sensitivity and specificity of in-hospital mortality for classifying 'better' or 'worse' performance. ▪ Quantified between-hospital variation in rates after adjustment for patient risk factors and number of cases. ▪ Calculated odds of dying when treated at a hospital 1 SD above national mortality rate relative to a patient treated at a hospital 1 SD below. • Examined association between LOS and mortality.
Main findings	• 718,508 admissions to 3135 hospitals for AMI, 1,3315,845 to 4209 for HF and 1,415,237 to 4498 for pneumonia over the 3 years. • Variation in mean LOS between conditions; AMI (2.3-13.7), HF (3.5-11.9) and pneumonia (3.8-14.8) • % transfers varied; AMI (mean 10.4%, range 0-80.6%), HF (mean 1.3%, range 0-19.4%, pneumonia (mean 0.7%, range 0-52.5%) • % deaths within 30-day; AMI (mean 34.3% IQR 25.7-41.7), HF (mean 54.9%, IQR 47.7-63.50), pneumonia (mean 50.3%, IQR 41.9-58.6) • Mean RSMR differences between 30-day and in-hospital deaths were AMI 5.3 percentage points for AMI (SD1.3), 6.0 (SD 1.3) for HF and 5.7 (SD1.4) for pneumonia. The range across hospitals was large with AMI (1.3-11.2 percentage points), HF (1.4-11.2) and pneumonia (-0.4 to 12.1) • In-hospital models resulted in different performance classifications for hospitals; AMI (257, 8.2%), HF (456, 10.8%), pneumonia (662, 14.7%).

	• Patients with previous classification differed depending on which model was applied for 8.2% of hospitals for AMI, 10.8% hospitals for HF; and 14.7% hospitals for pneumonia. For all conditions the position shifted to less favourable using the in-hospital model. • Hospitals transferred-out rates for AMI were negatively associated with in-hospital RSMRs. • Sensitivity and specificity for in-hospital mortality for identifying 'better' hospitals was AMI (sn 38.7%, sp 98.3%), HF (sn 34.4%, sp 98.5%), pneumonia (sn 43.0%, sp 97.3%); for identifying 'worse' hospitals AMI (sn 61.7%, sp 96.8%), HF (sn 50.5%, sp 96.2%), Pneumonia (sn 66.6%, sp93.8%) • In-hospital mortality measures were associated with more between-hospital variation than 30-day mortality. For example, OR for pneumonia in-hospital death was 2.11 and for 30-day death 1.68. • Using in-hospital mortality ratios favoured hospitals with shorter LOS – mean LOS was positively correlated to in-hospital RSMR for all 3 conditions and highest with pneumonia.
Authors' conclusion	• The authors argue against using in-hospital measures for assessing quality of Care performance. • The measure 'In-hospital mortality' results in a different assessment of hospital quality than 30-day mortality. It has higher sensitivity for identifying 'worse' hospitals than 'better' hospitals. • Greater variation between hospitals in in-hospital mortality measures reflects differences in LOS and transferred out rates and this measure overstates variability attributable to quality of care issues. • In-hospital rates favour hospitals with shorter LOS.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• The paper provides robust data in relation to the conditions of interest and two mortality outcome measures and reinforces other studies that highlight the limitation of using in-hospital measures alone • The study limits the patient population under examination to a relatively small number of condition specific outcomes and to persons 65 years or more therefore generalisation of findings to other conditions or different patient populations need to be made with caution.

Girling AJ, 2012, UK

Study title	Case-mix adjusted hospital mortality is a poor proxy for preventable mortality" a modelling study
Study objective(s)	To develop a model to estimate the proportion of the variation in standardised mortality ratios (SMRs) that can be accounted for by variation in preventable mortality.
Study type	Theoretical mathematical modelling study
HMI definition **Data sources**	• Hospital level SMR • Literature derived data to populate mathematical model
Settings **Participants** **Reporting period**	• The rationale for this paper was the Shahian paper that cites 'fundamental flaws in the hypothesized association between hospital-wide mortality and quality of care' • The authors note the lack of empirical studies that directly support the relationship between SMR and preventable mortality
Selection of subjects	Not applicable
Risk adjustment and /or other variables of interest	Not applicable
Statistical methods **Data presentation**	• Mortality partitioned into: M= U + V, where U =unavoidable deaths and V= deaths due to suboptimal care • Critical quantities for assessing proportional variance in SMRs due to preventable mortality; o the average proportion of deaths that are preventable (ξ), based on rates of clinical error associated with death = 0.6 o the coefficient of variation (standard deviation (SD) ÷ mean) of preventable mortality (C_V) = approximated 0.4 o the coefficient of variation of the total in-hospital mortality rate (C_M) = 0.2 in UK Trusts o the proportion of variance explained by the risk adjustment model (R^2) =0.8 o the correlation coefficient between hospital SMR and preventable mortality rate (Q) o assumptions relating to a relationship between a high rate of unavoidable death accompanied by a high rate of preventable death, and variation in mortality rates among hospitals with identical case-mix are acknowledged & tested (alternative assumption A2').
Main findings	• If 6% deaths are preventable (Hayward and Hofer) the Q^2 = 0.072 (0.079 for alternative assumption, A2') ie no more than 8% of the variation in SMRs is accounted for by preventable mortality • PPV for identifying a hospital as performing within the worst 2.5% is no greater than 0.09 (9%) • 10/11 warnings would be false alarms • 10/11 poorly performing hospitals would escape attention • For PPV to be 30% would require more than 15% deaths to be preventable.
Authors' conclusion	• Worthwhile correlations between case-mix adjusted SMRs and rates of preventable mortality are not attainable unless rates of preventable mortality are either a) higher than current estimates suggest or b) implausibly variable between different hospitals • Institution-level data outcomes are critically dependent upon the preventability index. • The authors discuss issues of sensitivity and specificity noting that there is always a tradeoff and that high false positives (low specificity) waste resource, stigmatise hospitals and lead to gaming whilst false negatives (low sensitivity) provide false reassurance and deflect attention away from quality issues. • The authors suggest that it is unsafe to use high SMRs to identify poor quality of care until risk models explain greater proportion of the variance in mortality as variation may also be due to differences in discharge policies, sampling fluctuations in mortality rates and inadequacies of risk adjustment models.

Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This paper addresses issues of 'preventability' of death, which are so important if hospitals are to respond and 'action' identified variation in hospital outcomes. Most studies assume residual variation is due to quality of care issues. This paper clearly indicates that there is more to consider. Their data is limited in that they rely for 'preventability' on studies, which report 'preventable factors' rather than preventable deaths. Therefore further information about the proportion of preventable deaths is required to confirm this theoretical model. • This study, whilst theoretical, highlights the important issue of measurement attributes of sensitivity and specificity and associated practical implications at the hospital level in terms of potential wasted resource and deviation from issues of quality of care. In the absence of literature pertaining to implementation efficiency of HMIs this is an issue that has not been adequately addressed as yet.

Gomes AS, 2010, Brazil

Study title	Mortality prediction model using data from the hospital information system
Study objective(s)	To develop a hospital mortality prediction model.
Study type	Cross-sectional study
HMI definition **Data sources**	• HSMR • Hospital Information System, of the Brazilian National Health System • ICD-10
Settings **Participants** **Reporting period**	• Rio Grande do Sul, Southern Brazil • 332 hospitals; N=208, 428,701 admissions • Reporting period: 2005
Selection of subjects	Excluded psychiatric, obstetrics, long-term care patients, age less than 18, 'phthisiology' admissions.
Risk adjustment and /or other variables of interest	• It is unclear exactly which variables were included in model
Statistical methods **Data presentation**	First stage: • Episodes were divided into development (2/3) and validation (1/3) sample • Observation unit (admission) and data aggregated at hospital level. • Conditions with high death rates were kept independent (Coding Chapters 1,11,VI, IX, X, XVIII) and others 'other'. • Variables p value <0.25 included in the regression analysis. • Performance of model ('fit') measured using Hosmer-Lemeshow, sensitivity analyses using random samples of 5000. • The final model was evaluated for sensitivity, specificity, accuracy, likelihood ratios, area under curve (AUC). • The validation sample was used to test – AUC, accuracy. • The likelihood of hospital death/admission was obtained using the logistic regression model. Expected deaths (E) was obtained from the sum of the likelihoods of the occurrences of death for each hospital. Second stage: application of model to 332 hospitals to derive observed/expected ratio (limited to hospitals with at least 365 admissions, and stratified for homogeneity based on size).
Main findings	• The mortality rate for the 332 hospitals was 6.3%. • Variables influencing the model; sex, disease circulatory, ICU use, age> 60 years. • Risk Index defined. • Model performance: development sample AUC 0.781 (0.778, 0.784), validation sample 0.780 (0.775, 0.785). • Final model Hosmer-Lemeshow =0.256 (good fit). • 40/206 observed worse than expected performance. • Length of stay (LOS) did not influence the model unlike other studies.
Authors' conclusion	• A predictive model with adequate predictive ability for inpatient death was developed for Brazil • The variable ICU was the most important predictor in keeping with other studies but other variables such as age and emergency status were also predictive and improved the discrimination of the model. However the authors note the unreliability of the emergency code in some parts of Brazil. • Unlike other studies, LOS did not contribute to the model • Use of adjusted models resulted in difference in assessed hospital 'performance' than using crude mortality rates

Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This study provides another example of development of a risk adjustment model to predict inpatient death that demonstrates good accuracy. • Comorbidity details could not be used due to poor documentation highlighting potential cross jurisdictional differences in data collection • Inclusion of ICU in model may be debatable as this could represent a quality issue – useful for explanatory analysis rather than 'adjustment' of variation.

Groene O, 2011, Spain

Study title	Is the maturity of hospitals' quality improvement systems associated with measures of quality and patient safety?
Study objective(s)	To explore associations between the 'maturity' of the hospitals' quality improvement system (maturity index) and hospital wide quality and a patient safety outcomes (clinical outcomes).
Study type	Cross sectional study
HMI definition **Data sources**	• Adjusted hospital-wide mortality: The number of deaths observed in the unit of analysis divided by the number of expected deaths. Other outcomes that were studies included; hospital complications, readmissions and length of stay (LOS) • Methods of Assessing Response to Quality Improvement Strategies (MARQuIS) • Minimum Basic Data Set (MBDS) via IASIST, 20 Top Hospitals – a voluntary benchmarking initiative available to all Spanish hospitals
Settings **Participants** **Reporting period**	• Spain • 43 hospitals • 2006 / 2007
Selection of subjects	• The MARQuIS questionnaire was administered in 2006 by online survey to 113 hospitals in Spain, 105 provided data to compute the maturity index and of these 51 also were involved in the IASIST project in 2007. • Final sample comprised 43 hospitals, with sufficient information and permission to merge the two datasets.
Risk adjustment and /or other variables of interest	• Maturity Index (MI): Measure of the "maturity" of hospitals' quality improvement systems based on the European MARQuIS project – a classification model for assessing hospital quality improvement systems. The model assesses 'maturity' - the developmental stage of quality improvement (QI) strategies. The model was developed based on data collected from 389 hospitals in 8 countries (Europe, Ireland, UK). • The MI includes 113 items across 7 domains (policy, planning & documentation, leadership, structure, general QI activities, specific QI activities, patient involvement, accountability). Answers are scored on a 4 point scale and responses are weighted according to level of maturity (from 'in preparation' to 'fully implemented and data being used to guide QI efforts') • Risk adjustment variables: age, sex, risk of death for first diagnostic code, risk of death for second diagnostic code with maximum risk, risk of death for the procedure with maximum risk, type of admission (urgent/non-urgent), type of DRG (surgical/non-surgical), type of hospital (teaching/non-teaching), hospital service contract (public/private), catchment area (urban/rural), transfer policies of the hospital to long term care.
Statistical issues	• Hospital characteristics from IASIST were compared to those in MARQuIS using Fisher's exact test and Mann Whitney U-test • Statistical analysis included bivariate correlations for parametrically and non-parametrically distributed data, multiple robust regression models and bootstrapping techniques to obtain confidence intervals for the correlation and regression estimates. • A multiple regression model was used to assess the effect of MI after adjusting for potentially confounding hospital characteristics. • A multiple regression analysis was performed separately with hierarchical variable entry assess the effect of MI and structural hospital characteristics (ownership, size, type) • A number of methods were employed when considering outliers in the dataset.
Report presentation / Feedback	Scatter plot of hospital adjusted mortality rate and hospital quality improvement system maturity.
Management of outliers	Not applicable
Main findings	• The MAQuIS survey was administered to 113 Spanish hospitals in 2006. Of these 105 (quality manager) provided self reported data on QI maturity, of whom 51 were also involved in the ASSIST project in 2007. Overall, 43 hospitals providing permission and sufficient data were included. Compared to the original sample of 113, this sample was characterized by a higher

	representation of university hospitals. Maturity of the quality improvement system was similar, although the matched sample showed less variability. • There was no association between maturity of quality improvement systems and adjusted hospital mortality – in fact hospitals with a more mature quality improvement system had higher mortality rates than other hospitals although this results did not reach significance. • There was a significant correlation for the indicator adjusted hospital complications, and borderline significance for adjusted hospital readmissions.
Authors' conclusion	• The authors suggest that an association between QI maturity and hospital complications has face validity. However the relationship between QI maturity and hospital mortality is more difficult to interpret due to methodological difficulties associated with the mortality indicator including; low signal to noise ratio, problems with risk adjustment such as the constant risk fallacy and case-mix adjustment fallacy. Further quality of care accounts for only a small amount of variation and QI systems are far removed from the mortality outcomes. • Further research should aim at identifying the latent dimensions of quality improvement systems that predict quality and safety outcomes. Such research would add pertinent knowledge regarding the implementation of organizational strategies related to quality of care outcomes.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ The study addresses an appropriate and clearly focused question ☐☐☐ Clear and explicit definition of the study population and participation rate ☐☐☐ The outcomes are clearly defined ☐☐☐ Data quality adequately described ☐☐☐ Statistical analysis (OR, CI) ☐☐☐ Study limitations discussed
Reviewer comments / relevance to Australian setting	• A Spanish study exploring associations between hospital quality systems using a Maturity Index with a range of indicators including mortality. The study found hospitals with a more mature quality improvement system had higher mortality rates than other hospitals, but not a significant association. The authors discuss this finding from the perspective of the "methodological challenges" that limit the use of HSMR i.e. " low signal noise ratio and subsequent problems of risk adjustment such as the case-mix adjustment fallacy or constant risk fallacy." • The study includes less than 50% of Spanish hospitals and was weighted towards larger public hospitals and therefore cannot be generalised, particularly for the Australian setting where quality improvement systems are likely to be different. • There was no discussion about the quality of the data within the Minimum Basic Data Set (MBDS), nor how this is handled within the IASIST data, nor the validity of the Adjusted Hospital Mortality Index. • The data was adjusted for confounders such as type, ownership and size of hospital, but the investigators were unable to adjust for nurse patient ratios or organisational culture.

Jarman B, 2010, Netherlands

Study title	The hospital standardised mortality ratio: a powerful tool for Dutch hospitals to assess their quality of care?
Study objective(s)	To use the HSMR as a tool for Dutch hospitals to analyse their death rates by comparing their risk-adjusted mortality with the national average.
Study type	Cross-sectional study
HMI definition **Data sources**	• HSMR • Routinely collected hospital data in the National Medical Registration dataset, the Netherlands • ICD-9
Settings **Participants** **Reporting period**	• Dutch hospitals: 15 hospitals' data did not meet necessary quality and were excluded from the analysis. Total included hospitals n=65 • Reporting period: 2005 to 2007
Selection of subjects	• All inpatient and day case admissions • "Vague or undetermined diagnoses" were removed • Diagnostic groups contributing 80% mortality (50 groups based on AHRQ's Clinical Classification System (CCS)) were included
Risk adjustment and /or other variables of interest	• Variables included in risk adjustment included; age, sex. LOS, comorbidity (Charlson Index), urgency of admission, month of admission, social deprivation, referral source • Other variables of interest included; year, diagnostic group
Statistical methods **Data presentation**	• Logistic regression models were fitted to each diagnostic group to generate an expected risk of death for each individual. The HSMR is derived from the sum of the observed and expected deaths. • Specific calculations, including scaling up or down, were undertaken for 'non-average' hospitals with a case-mix very different from the national average. • The model performance was assessed by c-statistic (area under the receiver operating characteristic curve) • Outlier status was presented using a funnel plot exhibiting 95% and 98% confidence intervals.
Main findings	• There were 2,363,332 admissions (90,873 deaths, crude rate 3.85%) included in the analysis (the proportion of total admissions was not stated). • Dutch HSMRs vary widely between hospitals. • The chance of dying in the hospital with the highest HSMR is 2.3 times that for the hospital with the lowest HSMR. • The c-statistic of the model was 0.91, across all groups it was between 0.68 (CHF non hypertensive) to 0.96 (breast cancer). • Predictive factors included; age, sex, admission urgency, LOS, Charlson Comorbidity Index, area-level social deprivation, month of admission, type of organisation that made the referral and CCS subgroup.
Authors' conclusion	• The authors consider the HSMR for the Netherlands is a statistically robust model that can be used to improve quality of care, given a hospital has more than 100 deaths per year, and an average casemix; however random variation and coding quality issues need to be considered when interpreting the results. • The authors suggest HSMRs can be used to track impact of interventions. • The authors refer to the demand for HSMR methodology emanating from hospitals in the Netherlands, with a number of applications for internal use being sought that include; profiling performance across low and high risk areas, use of Dr Foster's RTM tool for early warning and continuous monitoring, use of HSMRs in combination with clinical audits to drill down to the level of individual patient mortality risk. • The authors also discuss the use of administrative data and/or clinical data to predict risk, and to their previous work suggesting models based on either data source are comparable. • The limitations of the study are discussed, including the potential benefit of linking data to

	identify numbers of previous admissions and other healthcare system factors that could influence HSMRs; admission thresholds, proportion of patients in area dying in hospital, discharge policies, underlying disease rates in the catchment area. Further they acknowledge that it can be debated whether or not LOS and procedure group are part of the case-mix or determine quality as they relate both to patient illness and treatment.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This study outlines the adaptation of HSMR methodology for the Netherlands and demonstrates good model performance for predicting deaths. However, as with other such articles it does not address the issue of residual variation in relation to proven quality of care issues and whilst the authors suggest the data can be used for improvement and to track effectiveness of interventions, they provide no supporting evidence for these statements. • The study only partially defines methods for HSMR and variables included in the risk adjustment model and does not discuss issues such as transfers, definition of in-hospital/30-day mortality, or statistical alternative modelling options • The funnel plot provided indicates that, using 95% CI, there are many outliers both above and below the mean HSMR. Even with 98% CI there remain many outliers thus raising questions about the clinical significance of the variation identified and the degree to which such variation is likely to be related to quality of care issues. • The authors indicate the need for organisations to investigate data quality issues to separate issues of bias and real quality of care differences, but do not discuss the tradeoff between unnecessary investigation due to potentially high false positive alarms and associated opportunity costs.

Kernisan LP, 2009, USA

Study title	Association between hospital-reported Leapfrog safe practice scores and inpatient mortality
Study objective(s)	To determine the relationship between hospital's Safe Practice Score (SPS) and risk-adjusted inpatient mortality rates.
Study type	Observational analysis of discharge data
HMI definition **Data sources**	• Inpatient risk-adjusted mortality • Leapfrog Hospital Survey • National Inpatient Sample (NIS)
Setting **Participants** **Reporting period**	• USA • 155 urban hospitals • Reporting period: 2005
Selection of subjects	• 155 hospitals were selected from the Nationwide Inpatient Sample (N = 1054), located within 24 USA states that allow release of hospital-identifying information and had completed the Safe Practices Survey. • Exclusion criteria: patients < 18 years, oncology patients, recipients of solid organ transplants, patients transferred to or from another acute care facility. • Mortality risk data obtained from the Nationwide Inpatient Sample (NIS), for 400 hospitals located within the 24 states that allow the release of data (3,672,146 discharges).
Risk adjustment and /or other variables of interest	• Hierarchical logistic regression was used to determine the relationship between quartiles of Safe Practice Score and risk-adjusted inpatient mortality, after adjusting for hospital discharge volume and teaching status. • Subgroup analyses were performed using data from patients older than 65 years and patients with 5% greater mortality risk.
Statistical issues	• The Leapfrog survey is self-reported and the distribution of survey scores is skewed, with most hospitals scoring above 770 (of a possible 1000). Concerns re validity of the Leapfrog survey i.e. does it actually measure what it needs to measure. • Mortality risk appears to have been adjusted for DRG only, unclear if hospital characteristics were factored into the mortality ratio. • Results related to 14% of hospitals participating in the Leapfrog survey, limiting generalisability.
Report presentation / Feedback	Not applicable
Management of outliers	Not applicable
Main findings	• Of 1075 hospitals completing the 2006 Safe Practices Survey, 155 (14%) were identifiable in the NIS (1,772,064 discharges). • Raw observed mortality rate in the primary sample (whole of 2005) was 2.09%. • Quartiles of SPS were not a significant predictor of mortality. • Fully adjusted mortality rates, from SPS quartile 1-4, were 1.97% (95% CI, 1.78% - 2.18%), 2.04% (95% CI, 1.84% - 2.25%), 1.96% (95% CI, 1.77% - 2.16%), and 2.00% (95% CI, 1.80% - 2.22%); p value=0.99 for linear trend. • Results were similar in the subgroup analyses. None of the 3 alternative survey scores was associated with risk-adjusted inpatient mortality, although P values for linear trends were lower (0.80, 0.20, and 0.11).
Authors' conclusion	In this sample of hospitals that completed the 2006 Safe Practices Survey, survey scores were not significantly associated with risk-adjusted inpatient mortality.

Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ The study addresses an appropriate and clearly focused question ☐☐☐ Clear and explicit definition of the study population and participation rate ☐☐☐ The outcomes are clearly defined ☐☐☐ Data quality adequately described ☐☐☐ Statistical analysis (OR, CI) ☐☐☐ Study limitations discussed
Reviewer comments / relevance to Australian setting	• An American study aimed at comparing the Leapfrog Safe Practice Scores with mortality rates calculated using the National Inpatient Sample. • Much of the paper focussed on discussing the Leapfrog Safe Practice Survey and changes that are required to better measure quality practices. • Additionally, there was little emphasis on the calculation of the mortality ratios and its validity.

Kipnis P, 2010, USA

Study title	Effect of choice of estimation method in inter-hospital mortality rate comparisons
Study objective(s)	To evaluate and compare the use of 6 different methods for calculating expected mortality rates and SMRs when performing inter-hospital mortality rate comparisons.
Study type	Cross-sectional study
HMI definition **Data sources**	• HSMR • Northern California Kaiser Permanente Medical Care program (KPMCP) data • Data type uncertain – ?mixed administrative/clinical
Settings **Participants** **Reporting period**	• 17 KPMCP hospitals in California USA • 118,698 patients; age ≥ 15years • Reporting period: 1/7/2004 - 30/6/2005
Selection of subjects	• Obstetrics excluded; patients aged 15 years and above
Risk adjustment and /or other variables of interest	• Risk model included pre-admission; sex, age, admission type, admission diagnosis, laboratory based physiological score, comorbidity score (c-statistic 0.88 for hospital death)
Statistical methods **Data presentation**	• Transfer deaths attributed to admitting rather than 'linked' hospital. • Patients assigned to highest frequency hospital. • 500 simulated datasets developed; labelled 1-17 and correspond to KPMCP hospitals A to Q, with randomly generated number of hospitalisations and illness severity for patients. • 2 scenarios created – unaltered (set to expected mortality rate in real KPMCP data) and altered (each hospital's mortality rate was increased or decreased by -2.3 to + 7.0 percentage points across the 17 hospitals). • 6 methods used to create SMRs; 3 fixed effects and 3 random effects. • 2 sets of analyses were undertaken to determine the effect of choice of estimation method on SMR characteristics, and sensitivity and specificity evaluation using simulated data to assess the ability of different estimation methods to detect differences in O/E mortality rates across hospitals with true low, average or high rates.
Main findings	• The crude mortality rate was 3.4% across 17 hospitals. For the predictive model, the mortality rate was 3.5%. • Increasing illness severity was associated with higher crude mortality rate, correlation 0.55. • The fixed effects models identified (flagged outliers) hospitals as significant (8/17) more often than random effects (3/17) models. Confidence intervals wider for random effects models. • The methods closely agreed (log (SMR)) on hospital ranks – lowest correlation 0.91. • Random effects models had the highest specificity (98.3-100%) • The sensitivity of all methods increases as the change in mortality rate increases in magnitude. • Random effects models have substantially lower sensitivity for changes in mortality rates of no greater than 1.2% points but have equal sensitivity when the change is greater than 1.2% points. • The aggregate level fixed effects model had greatest sensitivity close to a zero change, 89% probability of identifying a hospital with a true 0.5% point increase change in mortality rate and 90% probability for identifying a 0.5% point change decrease. • The sensitivity and specificity of each method are a function of the bias and the variance of SMR estimates from each model.
Authors' conclusion	• The authors also point out that even small changes in actual mortality eg 3.7% versus 3.2% expected in the altered scenario approximates to 15% higher than expected and therefore may be worthwhile further investigation.

Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This study adds to knowledge about the influence of statistical SMR estimation models on sensitivity and specificity for identifying change in SMR scores. • There was a high correlation between methods and log (SMR) values and hospital ranks however the authors note that this may not be observed in settings where admissions/hospital are lower. • Of interest, whilst specificity was lower (therefore more prone to false positive alarms) for fixed effects models, they were more sensitive to detecting small changes in mortality and this needs to be further tested on longitudinal data. Overall the aggregate level fixed effects model had the highest sensitivity and specificity. • This study included only a small number of hospitals thus limiting generalisation and also included physiological scores which are not included within the Australian HMI program specifications.

Kristoffersen DT, 2012, Norway

Study title	Comparing hospital mortality - how to count does matter for patients hospitalized for acute myocardial infarction (AMI), stroke and hip fracture
Study objective(s)	• To summarise time, place and cause of death for first time AMI, stroke and hip fracture. • To compare case-mix adjusted 30-day mortality measures based on in-hospital deaths and in-and-out-of hospital deaths, with and without patients transferred to other hospitals.
Study type	Cross-sectional study
HMI definition **Data sources**	• First time AMI HMI; Stroke HMI; Hip fracture HMI. • Death defined as: o Death within 30-days after first day of admission in and out of hospital, weighting transferred patient by time spent in each hospital **(W30D**) o Death within 30-days after first day of admission in and out of hospital for patients admitted to single hospital **(S30D)** o Death within 30-days after first day of admission occurring in-hospital only **(IH30).** • Norwegian hospital data, the patient administration system (PAS) of each hospital and The National Population register and Norwegian Causes of Death Register. A unique PIN for each resident was used to link data sets.
Settings **Participants** **Reporting period**	• 66 Norwegian acute care hospitals (16 large, 45 small) • Specific condition populations were defined by ICD-9 between 1997-1999 and after by ICD-10 • Reporting period: 1997 to 2001
Selection of subjects	• First admissions for each year were selected (lookback to 1994 to ensure first AMI) • Excluded; hospitals <20 admissions yearly, patients <18 years for AMI, stroke and <65 years for hip fracture, dead on arrival, non-acute case, readmission or admission for rehabilitation • Different models accounted for transfers differently; exclusion (S30D), both hospital attributed to the outcome (IH30D), weighting (W30D)
Risk adjustment and /or other variables of interest	• Variables of interest; hospital, age, sex, stage of disease • Missing data 2.7% - excluded
Statistical methods **Data presentation**	• Adjusted mortality calculated using logistic regression model (hospital, age, sex, stage of disease). • Hospital regression coefficients estimated as deviations from the mean of all hospitals. • Ranks of S30D and IH30D were compared to W30D using Spearman rank correlation and by numbers of hospitals shifting rank. • Difference in ranks between hospitals based on size investigated using analysis of variance (ANOVA). • Model predictive value assessed by area under the curve (AUC), c-statistic.
Main findings	• 144, 190 patients with 174,527 records were included in the analysis • 48030 AMI from 55 hospitals, 47854 Stroke from 59 hospitals, 40142 hip fracture from 58 hospitals. • AMI largest group with shortest length of stay (LOS), fewer females and younger patients. • Hip fracture patients had the largest proportion females and were older. • Stroke had longest LOS, 50% females. • Deaths within 30-days: AMI 19.1%, stroke 17.6%, hip fracture 7.8%. • Of patients dying within 30-days, hip fracture 51%, stroke 16.5%, and AMI 11.1%. • Of those dying within 1 year, AMI 60.5%, hip fracture 15.9%. • Cause of death remained similar for all three groups at 30-days and for AMI. (58.1%)/stroke (73.5%) at 1 year but was lower for hip fracture (37.9%). • Transfers for AMI were small to large hospitals and for stroke and hip fracture large to small hospitals.

	• Mean LOS for transfers was longer for all three conditions at subsequent hospitals. • Variation in unadjusted mortality rates was large between hospitals for all conditions and all mortality measures. • Adjusted mortality measures were highly correlated for AMI (0.82≤r≤0.94), and stroke (0.78≤r≤0.91). • The correlations between mortality and LOS was strongest for hip fracture, W30D (r=-0.54) and S30D (r=-0.35). • Ranking was highly influenced by method of counting deaths. • For comparisons of adjusted mortality, no altered rank seen in 5-9%. • Most shifts minor for comparing W30D and S30D. • For IH30D versus W 30D 14% AMI, 17% stroke, 43% hip fracture had major shift (>10) in rank. • One stroke hospital had low mortality W30D and high mortality S30D. • For hip fracture, no high or low mortality hospital was identified by S30D but 9/14 shifted from high mortality (W30D) to medium mortality (IH30D). • C-statistics; AMI (0.726-0.729), Stroke (0.700-0.713), hip fracture (0.678-0.694). • Size of hospitals had little effect on difference between mortality measures.
Authors' conclusion	• Major shifts in hospital ranking and outlier detection occurred when different case-mix adjusted mortality measures were applied to the same hospital and national Register data. • For diseases with a high proportion of deaths within 30-days (AMI/stroke) there is little change when using a model including post-discharge deaths, however, for hip fracture there is a larger shift which may reflect variation in quality of follow up care. • The authors suggest including all cause deaths within the 30day models as identifying the cause of death can be difficult. • There are differences in transfers between conditions, AMI transfer being primarily from small to large hospitals probably for interventional management, whilst the opposite is seen for stroke and hip fracture most likely for rehabilitation. The authors suggest an approach of weighting to account for transfers rather than omission or double counting. • The authors acknowledge the value of a unique PIN enabling robust data linkage and there was a very low level of missing data based on PIN (0.85%) • The strength of the study lies in its coverage of all Norwegian hospitals • The authors note the criticism of ranking but found use of ranking lists and shifts in ranking was useful in comparing mortality measures.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• Different methods of counting deaths resulted in major shifts in hospital rankings in this study – even for AMI/stroke where a high proportion of deaths within 30-days occur and the difference between IH30D might be expected to be similar to W30D or S30D. • Of note, the proportion of hip fracture deaths within 30-days was much lower for hip fracture than AMI/Stroke and changes in rank and outlier status higher. • The study raises the issue of transfers and the authors discuss use of weighting. This issue deserves further investigation • Of interest, in this study there was little effect on shifts attributed to adjusted versus unadjusted data suggesting casemix had no major impact on the comparisons. This is in contrast to other studies.

Kroch EA, 2010, USA

Study title	Making hospital mortality measurement more meaningful: incorporating advance directives and palliative care designations
Study objective(s)	To evaluate the benefits and caveats of incorporating care-limiting orders, such as do not resuscitate (DNR) and palliative care (PC) directives, in a general multivariate model of mortality risk, wherein the unit of observation is the patient episode of hospital care. 1. What are the demographic and clinical characteristics of patients who were flagged as DNR or had received PC during the study period? 2. How are DNR and PC related? 3. How are DNR and PC jointly and separately related to inpatient mortality? 4. Does the timing of a DNR order or beginning of PC with respect to patient admission or discharge influence the observed relationship between mortality outcomes? 5. Should indicators be used in risk adjustment that would identify DNR patients or those receiving PC?
Study type	Retrospective, cross-sectional analysis
HMI definition **Data sources**	• Mortality rate as per the CareScience risk-assessment methodology • CareScience customer database, ICD-9-CM • Manually collected patient level data
Settings **Participants** **Reporting period**	• Oklahoma City, USA • Mercy Health Centre • Reporting Period: 1/11/2005 – 30/10/2006
Selection of subjects	• 10,092 discharges, final sample 9,197 matched to the CareScience calibration database. • Patients were excluded from specific analysis if they had insufficient data to adequately calculate the outcome of interest. • Patients classified PC based on ICD-9 PC code (V66.7) and compared to manual data, which showed all clients receiving palliative care were not coded as V66.7 due to coding practice that stated a written order alone for palliative care was not coded. DNR orders were identified from electronic health records and the date captured from manual chart review. DNR orders can occur at any time during the admission.
Risk adjustment and /or other variables of interest	• CareScience risk-assessment methodology was used to calculate mortality rate. • Patient level data manually extracted: DNR flag, palliative care flag, admission date, discharge date, DNR date.
Statistical issues	• Coding accuracy, capturing both palliative care status and do not resuscitate orders manually.
Report presentation / Feedback	Descriptive statistics re DNR and PC status, by service, mortality rates and time.
Management of outliers	Not applicable
Main findings	• The prevalence of care-limiting orders varies markedly between services, being low (PC 1% or less) for surgical services and higher (PC approximately 7%) for oncology and pulmonary services. • Patients with care limiting orders have higher risk of mortality than the general inpatient population, however most DNR patient survive the episode (65%) whereas most PC patients do not (73%) • The later in the hospital stay that the DNR order is written, the higher the risk of death (27% for orders made on day 1 to 59% for orders after day 5) • Mortality rates for patients with PC/DNR orders are higher than expected - the 'mortality rate-risk gap' and is much higher for Pc (42%) than for DNR only patients (8%) ie PC enhances risk models especially. • Mortality deviations (observed-expected) are greatest for DNR in patients <60 years

	• Mortality deviations are smaller for services where care limitation orders are higher eg general medicine/pulmonary and higher for services with low levels of orders eg cardiology, surgery, gastroenterology • The mortality gap is higher for those with DNA orders written later in the hospital stay • Including DNR within the baseline risk model increases explanatory power by approximately 10%. • In a simple model of the mortality gap, DNR explained between 8%-24% of the gap variation depending upon the disease. PC designation identifies patients whose risk of dying is between 9%-57% greater than that predicted by the standard model.
Authors' conclusion	• This study's findings indicate that addition of palliative care and DNR orders to the baseline risk mortality model has value in estimating mortality risk, especially when the DNR order comes early in the hospital stay. • More than two thirds of DNR patients are not PC patients. • Restricting the use of the DNR indicator to cases for which the order is given at or shortly after admission has the potential to improve mortality prediction even after taking PC status into account. • Further study of DNR practices and coding could be valuable in refining mortality risk models.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ The study addresses an appropriate and clearly focused question ☐☐☐ Clear and explicit definition of the study population and participation rate ☐☐☐ The outcomes are clearly defined ☐☐☐ Data quality adequately described ☐☐☐ Statistical analysis (OR, CI) ☐☐☐ Study limitations discussed
Reviewer comments / relevance to Australian setting	• Despite methodological limitations this study adds useful information about incorporating PC and DNR status into mortality risk models. • The main limitation of the study for Australia is general lack of electronic medical records that accurately capture DNR status and timing although this may be a future option. • This study is not generalisable as it relates to one hospital in USA, and there are no details of the hospitals characteristics. • The wide range of documentation and coding practices create limitations for using palliative care / do not resuscitate orders to assist with estimating mortality risk • Flagging all cases with DNR orders, especially if associated with the later stages of hospital care, may exclude cases in which the patient's death was the result of a medical error, which masks opportunities to improve care for certain types of patients.

Miyata H, 2008, Japan

Study title	Performance of in-hospital mortality prediction models for acute hospitalization: Hospital standardized mortality ratio in Japan
Study objective(s)	To develop a new in-hospital mortality prediction model for in-hospital mortality
Study type	Cross-sectional study
HMI definition **Data sources**	• HSMR: used Canadian HSMR methods • Ministry of Health, Labor and Welfare dataset including hospital administrative and clinical information • Diagnosis Procedure Combination (DPC) classification system. • ICD-10
Settings **Participants** **Reporting period**	• 82 Japanese hospitals • Reporting period - 1/7/2002 to 31/10/2002
Selection of subjects	• Excluded major diagnostic categories with mortality rates <0.5%
Risk adjustment and /or other variables of interest	• Model 1 variables; age (under 60, 60-69,70-79, 80-89, 90+), gender, ambulance at admission, emergency admission status, length of stay (LOS), Major diagnosis, Charlson Comorbidity Index (CCI) 5 categories. • Model 2 – excluded LOS.
Statistical methods **Data presentation**	• Split data randomly to development (80%, 179,156 records), validation (20%, 45,051 records). • A multivariate logistic regression analysis was performed to predict in-hospital mortality using the development dataset. • Model performance tested; prediction accuracy (c-statistic), calibration was assessed by plotting observed versus predicted deaths based on risk.
Main findings	• Development and validation cohorts demonstrated similar patient characteristics and casemix. • In-hospital mortality development (2.68%), validation (2.76%) • Odds ratios for model 2 variables were of similar statistical significance to model 1. • The models performed well with c-statistics for model 1, 0.841 and model 2, 0.869. • Using a model with more comorbidities resulted in a higher c-statistic.
Authors' conclusion	• The authors reflect on the better performance of their risk prediction model to a previous model and suggest inclusion of comorbidities is essential when using administrative data to measure clinical outcomes. • They acknowledge the limitation of excluding low frequency major diagnostic categories.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This paper provides evidence relating to development of a model to derive HSMRs within Japanese hospitals and supports in depth comorbidity coding but does not add a great deal of additional knowledge about model development. • Including or excluding LOS did not influence the models performance greatly. • The models were based on previously reported HSMR methods (Canada and UK), however there was no formal testing of the derived models with existing models nor testing for variation in derived HSMRs between hospitals in the dataset.

Mohammed MA, 2009, UK

Study title	Evidence of methodological bias in hospital standardised mortality ratios: retrospective database study of English hospitals
Study objective(s)	To assess the validity of casemix adjustment methods used to derive SMRs for hospitals by examining the consistency of relationships between risk factors and mortality across hospitals Study rationale – Constant Risk Fallacy – "casemix adjustment can create biased comparisons when underlying relations between casemix variables and outcome are not the same in all the comparison groups". This can be due to differential measurement error or inconsistent proxy measures of risk.
Study type	Retrospective longitudinal cohort study with cross-sectional analysis of SMRs at different time points
HMI definition **Data sources**	• HSMR • Routinely collected hospital episode data • ICD-10
Settings **Participants** **Reporting period**	• England • 4 NHS hospitals purposively selected based on wide range of published casemix adjusted Dr Foster Unit SMRs – George Eliot Hospital, GEH (SMR143), Mid Staffordshire Hospital, MSH (SMR 127), University Hospitals Coventry and Warwickshire, UHC (SMR 123), University Hospital North Staffordshire, UHN (SMR 88). Included 2 large teaching hospitals (UHN, UHC) and 2 medium sized acute hospitals (MSH, GEH) • Reporting period: April 2005-March 2006
Selection of subjects	• Palliative care excluded • <1.5% data was missing
Risk adjustment and /or other variables of interest	• Variables tested: Charlson comorbidity index (CCI) (range 0-6), age (10 year bands), sex, deprivation (quintiles), primary diagnosis (1 of 56), emergency admission status, number of admissions within previous year
Statistical methods **Data presentation**	• Logistic regression models to test interactions that would support potential for 'constant risk fallacy'. • Interaction terms leading to odds ratio (OR) close to 1 indicated a constant relationship.

Main findings	• No interaction identified between 'sex' or 'deprivation' and hospitals
	• Significant interactions were identified between remaining variables:
	  ○ CCI had significant interactions Year 1, Year 2, not Year 3 – across full range of CCI. This equated to increase in odds of death of 50% or decreases of 39%.
	  ○ For emergency admission in all years across all hospitals. The effect sizes ranged from 38% to 355% increases in odds of death above those of Dr Foster.
	• Hospitals with lowest SMR had highest mean CCI.
	• Coding depth increased over the years in all hospitals during which time the interaction between CCI and hospitals became smaller.
	• UHN had highest CCI and higher deprivation but paradoxically lower mortality rate, 'emergency' admissions and lower length of stay (LOS).
	• There were large variations in proportions of emergency/non-emergency patients with zero LOS indicating systematic different admission policies across hospitals.

Authors' conclusion	• The authors indicate that there is a critical and previously overlooked methodological issue - the constant risk fallacy - that cannot be overcome by statistical correction. Therefore the only safe variables they identified were age, sex and deprivation score. In particular, Charlson comorbidity score and emergency status were prone to the constant risk fallacy caused by systematic differences in clinical coding (particularly depth of coding) and admission practices across hospitals. • The authors acknowledge the limitations of the study being confined to a subset of hospitals in the West Midlands of England. The authors suggest further examination of these issues. • The authors conclude that the current Dr Foster Unit method is prone to bias and that identified variations are "less than credible".

Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described	☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This paper adds to the discussion about constancy of casemix between hospitals and over time, as well as the influence of interactions between risk prediction variables that may influence derivation of SMRs. • As the interaction between casemix and hospitals reduced over time as presumably hospitals optimize their casemix coding practices this should result in greater stability of comorbidity as a risk model variable. • The utility of the variable 'emergency/non-emergency' is more questionable as it appears highly prone to inaccuracies. • Further, as the authors point out, there are systematic differences in admission policies that may influence adoption of these descriptors, increase variability in use and increase likelihood of the constant risk fallacy.	

Mohammed MA, 2013, UK

Study title	A simple insightful approach to investigating a hospital standardised mortality ratio: an illustrative case-study
Study objective(s)	To illustrate how to investigate increase / decrease in hospital standardised mortality ratio (HSMR).
Study type	Retrospective analysis of routinely collected hospital admissions data.
HMI definition **Data sources**	• HSMR: Dr Foster methodology • Dr Foster Real Time Monitoring computer system • ICD-10
Settings **Participants** **Reporting period**	• England • Shropshire and Telford NHS Trust Hospital, • April 2007 – March 2010
Selection of subjects	• Shropshire and Telford NHS Trust Hospitals admissions data (n = 74,860)
Risk adjustment and /or other variables of interest	• Dr Foster methodology to derive HSMR • Coding depth: a derived measure of completeness of the clinical coding process was obtained by calculating the number if ICD-10 codes (excluding the primary diagnosis) per admission
Statistical issues	• Changes in coding practices had an impact on the HSMR • There was no overall discussion about the quality of the data within the database, other than looking at coding depth
Report presentation / Feedback	• Plotted observed and expected deaths as mean centred (to aid visualisation) run charts over the 36 months where a run of seven consecutive points above / below zero as unusual. • Plots by Shropshire and Telford NHS Trust Hospital and Princes Royal Hospital and Royal Shewsbury Hospital separately.
Management of outliers	Not applicable
Main findings	• In 2008/09 the Dr Foster HSMR for Shropshire and Telford NHS Trust Hospitals was 99, but in 2009/10 this jumped to 118 (19% increase). • The increase in the HSMR was primarily located in Princes Royal Hospital (109 to 130 vs. 105 to 118 at Royal Shewsbury Hospital). • Disentangling the HSMR by plotting run charts of observed and expected deaths showed that observed deaths were stable in Royal Shewsbury Hospital and Princes Royal Hospital but expected deaths, especially at Princes Royal Hospital, had fallen. • The fall in expected deaths has two possible explanations – genuinely lower risk admissions or that the case-mix adjustment model is underestimating the risk of admissions perhaps because of inadequate clinical coding. • There was no evidence that the case-mix profile of admissions had changed but there was considerable evidence that clinical coding process at PRH was producing a lower depth of coding resulting in lower expected mortality.
Authors' conclusion	• The fall in expected deaths has two possible explanations – genuinely lower risk admissions or that the case-mix adjustment model is underestimating the risk of admissions perhaps because of inadequate clinical coding • Knowing whether the change (increase / decrease) in HSMR is driven by the numerator or the denominator is a pivotal first step in understanding a given HSMR and so such information should be an integral part of the HSMR reporting methodology.

Critical analysis ☐ Good ☐Adequate ☐Poor/None	☐☐☐ The study addresses an appropriate and clearly focused question ☐☐☐ Clear and explicit definition of the study population and participation rate ☐☐☐ The outcomes are clearly defined ☐☐☐ Data quality adequately described ☐☐☐ Statistical analysis (OR, CI) ☐☐☐ Study limitations discussed
Reviewer comments / relevance to Australian setting	• Useful paper demonstrating the importance of plotting both numerator and denominator to understand the component parts that makes up the HSMR. • The use of simple run charts to visualise the data provides health services with useful information to assist with investigation. • The paper makes reference to the Queensland Pyramid Model of Investigation.

Morsi E, 2012, USA

Study title	Primary care physicians' use of publicly reported quality data in hospital referral decisions
Study objective(s)	To characterise factors that influence primary care physicians' hospital referral choices.
Study type	Web-based physician survey using Survey Monkey
HMI definition **Data sources**	Not applicable
Setting **Participants** **Reporting period**	• Massachusetts, USA • 3 acute care hospitals; 92 primary care physicians • June – September 2009
Selection of subjects	• Email list obtained from all area hospitals of primary care physicians within 10-mile radius. 192 physicians contacted via email and asked to participate anonymously. • 92 (47%) physicians responded. • Participants were given two follow up email reminders and respondents who completed the entire survey received a $15 gift card.
Risk adjustment and /or other variables of interest	• Measures: physician demographics, familiarity with public reporting, opinions about which factors would influence hospital referral decision for an elderly patient with pneumonia. Specifically asked about awareness of 4 websites publicly reporting hospital quality data. • Participants were asked to state using a 3-point scale (agree, disagree, neutral), their level of agreement with the following statements: o risk-adjusted methods are inadequate to compare hospitals fairly o mortality rates are an incomplete indication of quality of a hospital's care o hospitals can manipulate the data o ratings are inaccurate for hospitals with small caseloads." • Factors associated with physicians' knowledge of publicly reported data were analysed with bivariate analysis.
Statistical issues	• Small sample size, less than 50% response rate, limited to one jurisdiction and the findings may not be representative beyond this jurisdiction. • Use of one case study to assess the physicians' decision-making, findings might have been different for alternative cases.
Report presentation / Feedback	Not applicable
Management of outliers	Not applicable
Main findings	• Although 93% of the primary care physicians who responded maintained admitting privileges only 20% admitted patients. • The following were considered "very" important in referral decisions: "familiarity with the hospital" (70%), "patient preference" (62%), and "admitting arrangements with a hospitalist group" (62%). • "Publicly available quality measures" were not at all important to 42% of respondents. • Only 61% were aware of hospital quality reporting; 16% were familiar with Hospital Compare, a Centres for Medicare and Medicaid Services (CMS) web site. • No physicians reported ever using quality information to make a referral decision or discussing it with patients. • No physician factors were associated with awareness of publicly reported data. • Primary Care Physicians identified the following factors as being "very" important in determining the quality of pneumonia care: antibiotics within 6 hours of arrival (66%), appropriate initial antibiotic (63%), and blood cultures performed prior to the administration of antibiotics (51%).

Authors' conclusion	• 61% of respondents were aware of web sites that report hospital quality. • None of the physicians surveyed reported having used publicly reported quality information when making a referral decision or having discussed such data with their patients. However, 49% stated that publicly reported performance data was "somewhat" and 10% "very" important to decisions regarding the medical care they receive. • When asked about limitations of publicly reported performance data, 42% "agreed" that risk-adjusted methods were inadequate to compare hospitals fairly, 76% "agreed" that mortality rates were an incomplete indication of quality of hospital care, 62% "agreed" that hospitals could manipulate data, and 72% "agreed" that the ratings were inaccurate for hospitals with small caseloads.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ The study addresses an appropriate and clearly focused question ☐☐☐ Clear and explicit definition of the study population and participation rate ☐☐☐ The outcomes are clearly defined ☐☐☐ Data quality adequately described ☐☐☐ Statistical analysis (OR, CI) ☐☐☐ Study limitations discussed
Reviewer comments / relevance to Australian setting	An American study exploring primary care physicians' use of publicly reported data and found it did not influence referral patterns. Unable to be generalised to the Australian setting due to differences in the health care systems and quality indicator reporting. However, the finding is not surprising, as anecdotally, general practitioners generally use the same referral paths based on knowledge and relationships.

Palmer WL, 2013, UK

Study title	Meeting the ambition of measuring the quality of hospital's stroke care using routinely collected administrative data: a feasibility study
Study objective(s)	To evaluate: 1. the hospital-level variation in the measures, in terms of statistical outliers 2. The influence of bias introduced by commonly cited variations in the coding of the underlying data 3. convergent validity in terms of the degree to which theoretically similar measures correlate with one another
Study type	Retrospective cohort study
HMI definition **Data sources**	• Six stroke indicators spanning hospital care pathway, from timely access to brain scans to emergency readmissions following discharge after stroke. Chosen indicators were based on a literature review to identify indicators that could be measured using administrative data. • Included 30-day in-hospital mortality • Hospital Episodes Statistics (HES) data • ICD-10 used for diagnostic coding • Office of Population Censuses and Survey's classification of Surgical Operations and Procedures, fourth edition (OPCS-4) for coding of procedures
Settings **Participants** **Reporting period**	• The analysis compared rates of outcomes of the indicators across all NHS hospitals and looked for correlations between measures • All NHS hospitals in England • Reporting period: 1 April 2009-31 March 2010
Selection of subjects	• Stroke episodes- classified within major subgroups using ICD-10 • Where there was more than one episode of care during treatment (FCE) the episodes were grouped into a 'superspell' • Where transfers occurred the corresponding performance measure was scored against the first hospital
Risk adjustment and /or other variables of interest	• Variables considered were; age, sex, social deprivation quintile, number previous admissions, Charlson Index for comorbidities, month of discharge, ethnic group, source of admission (elective/emergency), stroke type (4-digit ICD-10) • Other variables not included in risk adjustment (potential quality related explanatory variables) were brain scanning and thrombolysis process measures
Statistical methods **Data presentation**	• Calculated crude unadjusted and adjusted rates for every NHS hospital across each measure (details provided in supplementary data). • For adjusted data, a logistic regression analysis was undertaken to calculate expected numbers of numerator events based on the casemix for each hospital. • Investigation of different coding practice at the hospital level was investigated in sensitivity analyses – fitting generalised linear models with a hospital-level variable: o 'coding depth' – the average number of distinct diagnosis codes per admission o use of the ICD-10 diagnosis code I64 "unspecified stroke" – hypothesised that this would be associated with lower scanning rates as scans used to subgroup stroke type. • Inter-measure correlations were investigated using statistical significance of the correlation coefficient (Pearson's correlation coefficient r). For example; scanning and thrombolysis/scanning and mortality. • Crude and adjusted rates were plotted using funnel plots with 95% and 99.8% control limits to identify outliers.
Main findings	• There were 91,936 stroke admissions across 147 NHS hospitals. • 2522 (2.7%) deaths on the day of admission. • 15,846 (17.2%) deaths within 30-days of admission, 19,721 (21.5%) before discharge. • 69.7% scanned within 1 day admission.

	• 2.6% received thrombolysis. • 5.3% aspiration pneumonia. • 72.8% discharged to usual place of residence. • 11% readmitted as emergency within 30-days of discharge. • Each stroke associated with average 2.3 (FCEs). • Less than 13.7% received care in more than one hospital. • All indicators (except readmissions) associated with at least one outlier (99.8% CI). • Average number of distinct codes ranged from 5.0-10.7. There was a weak correlation between coding depth and aspiration pneumonia (r-0.26, p=0.002). • Of 25 hospitals flagged as outliers for aspiration pneumonia, 20 (80%) also flagged when coding depth included in the regression analysis. • The proportion of strokes diagnosed as ICD-10 code I64 (unspecified stroke) varied from 0.2-42.6%; but negligible correlation with mortality outcomes (p=0.12). • Statistically significant (weak) association between scanning rates and use of I64 (r=-0.17, p=0.04). • Overall six pairs of indicators had significant correlations at 95% CI and 2 at the 99.8% CI (aspiration pneumonia and discharge to usual abode, same day scan and next day scan).
Authors' conclusion	• The results indicate the potential for using administratively derived indicators to identify quality of care for stroke. • There are no guidelines for 'acceptability' of measure performance except for scanning • There are a number of limitations. • Some significant factors for stroke outcome are not included; stroke severity and pre stroke function. Therefore residual variation may relate to these case-mix factors. • Differential care type of hospitals eg acute/rehabilitation. • Data collection differences-few studies that have investigated the accuracy of coding stroke care. • Changing in coding quality eg introduction of scanning recent therefore may be initial underuse. • Unexpected inverse correlations – for example positive correlation between same day scanning (good) with aspiration pneumonia (bad) – possibly due to better coding practices of the hospital • Potential improvement in stroke quality with introduction of real time process of care auditing program (Stroke National Improvement Programme). • The data forms the basis for a debate about use of HES data.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• A high quality study that demonstrates variation (albeit limited at 99.8% control level) in outcomes between NHS hospitals. There were only 2 hospitals outside these limits for 30-day mortality and as the authors indicate there is no adjustment for stroke severity and pre stroke function. • None of the process measures correlated with 30-day in-hospital mortality therefore questioning the utility of measuring mortality if no actioning can be made based on the measure. • The study is very relevant to the Australian setting where similar analysis could be undertaken and potentially linked to real time stroke audit data.

Popowich J, 2011, Canada

Study title	Hospital Standardized Mortality Ratios: a tale of two sites. Lessons learned from the United Kingdom; Canada catches up.
Study objective(s)	To outline the use of mortality data, both in raw and standardised form, in two Caritas Health Group (CHG) acute care community hospitals in the Edmonton area, Canada. • To provide executive, administrators, physicians and the quality departments with information to guide improvement.
Study type	Descriptive study
HMI definition **Data sources**	• HSMR: CIHI based on Dr Foster methodology (monthly) • Canadian Institute of Health Information (CIHI) • Chart reviews
Setting **Participants** **Reporting period**	• Canada • 2 acute care hospitals (327 beds; 294 beds) • Reporting Period: 2005 -2008 (chart review process)
Selection of subjects	• Chart review was targeted for areas with high HSMR e.g. medicine, surgery, intensive care
Risk adjustment and /or other variables of interest	• CIHI methodology and raw data was also analysed in SPSS Version 14.0 • Variables: admission / discharge data and location, age, sex visit number, triage (if applicable), transfer status, ICD10, length of stay (in days and / or hours for those dying within 24 hours of admission) and comorbidities.
Statistical issues	Not described.
Report presentation / Feedback	• CIHI e-portal providing HSMRs per diagnostic category, site and previous regional as well as provincial roll-ups in addition to monthly and quarterly results and peer to peer comparisons. Access is available to a range of standardised reports. • HSMRs were provided monthly to each site as an aggregate as well as for surgical, medicine and ICU, enabling interpretation in the context of care. • If HSMR were inconsistent with raw data, the next step was patient chart review.
Management of outliers	• Clinical areas with high HSMR triggered further investigation as per the "If high, why" initiative.
Main findings	• The HSMR remains a positive first step in comparative mortality measurement. • An elevating HSMR trend does not always indicate underlying problems in standards of care but it does warrant careful exploration.
Authors' conclusion	Encouraging a deeper understanding within a hospital, region or nation of the HSMR in terms of the underlying raw demographic data could eventually facilitate improvement and sharing of best practice comparisons between related sites.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ The study addresses an appropriate and clearly focused question ☐☐☐ Clear and explicit definition of the study population and participation rate ☐☐☐ The outcomes are clearly defined ☐☐☐ Data quality adequately described ☐☐☐ Statistical analysis (OR, CI) ☐☐☐ Study limitations discussed
Reviewer comments / relevance to Australian setting	• This paper describes the development of a quality improvement initiative "If high, why?" using raw data (via CIHI portal) to identify target areas, random sample of patient charts for review and more extensive peer review using Healthcare Improvement (IHI) Global trigger Tools (GTT). The initial development of the initiative resulted in the introduction of the "Safer HealthCare Now" bundles of care. • A key component of the initiative is the HSMR committee, which supports a standardised process for the analysis and review of the raw monthly mortality data and subsequently, the introduction local improvements.

	• This paper reflects a practical approach for investigating and using the HSMR for quality improvement purposes, including a flow chart. The approach is aimed at minimising unnecessary chart review, however, there is no discussion regarding the resource burden associated with the process or the effect of the initiatives on the HSMRs or overall quality.

Pouw ME, 2013, Netherlands

Study title	Hospital standardized mortality ratio: consequences of adjusting hospital mortality with indirect standardization
Study objective(s)	To assess the validity and applicability of directly and indirectly standardised hospital mortality ratios.
Study type	Cross-sectional study
HMI definition **Data sources**	• HSMR • Dutch National Registration Database – routinely collected hospital episodes statistics • ICD version not stated
Settings **Participants** **Reporting period**	• 61 Dutch hospitals • Reporting period: 2006-2009
Selection of subjects	Not described in detail, used similar or same methods to Dr Foster
Risk adjustment and /or other variables of interest	• The Dutch HSMR developed in close collaboration with Dr Foster Intelligence, UK. A reference is provided but limited details are provided in this study; o 50 diagnostic groups chosen which accounted for 80% mortality o For each group a logistic regression was fitted using predictors; age, gender, urgency of admission, Charlson Comorbidity Index (CCI), diagnosis and social deprivation to generate an expected mortality risk for each admitted patient o Interactions tested between hospital and urgency • HSMR = ∑of observed mortalities in 50 groups/∑ expected mortalities
Statistical methods **Data presentation**	• Firstly calculated HSMR (see above) according to regular indirect standardisation method. • Scenarios 1-4 (S1-S4) stratified patients into urgent/non urgent and calculated observed and expected mortality rate. Then they replaced the original distribution of urgent and non urgent admissions by; the 'average case-mix' distribution of 61 Dutch hospitals (S1), the original distribution of a single hospital (S2), calculating case-mix over 3 years not 1 year (S3), calculating case-mix each year over the 3 years (S4). • Scenarios 5-8 (S5-S8) repeated scenarios using CCI instead of urgency of admission. • Data for outliers was presented as a funnel plot, dividing the hospital into 3 groups using 95% control limits
Main findings	• Funnel plot of HSMRs in 2009 showed significant variation between hospitals. • There was interaction between variables "urgency" and 'CCI' in 19/50 prediction models ($p<0.05$). • In 7/50 there was evidence of interaction between hospitals and CCI. • In S2 for 10 (16.4%) hospitals, use of another hospital's casemix distribution changed the category in the funnel plot. • S3 - no change in HSMR for 2009 when casemix distribution changed to that of 2006-8. • S4 - one hospital in 2008 and one in 2006 significantly changed category, no change for 2007. • Repeating scenarios with CCI was associated with increase in differences between original and simulated HSMRs.
Authors' conclusion	• Based on their results, the authors recommend caution when interpreting variation between hospitals or within a single hospital over time. However, major changes in HSMR only occurred with substantial changes in casemix distribution.

Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described	☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This study highlights the problems associated with unstable casemix distributions on indirect standardisation methods and raises the issue of interactions between risk prediction variables. • The degree of change in HSMRs is related to choice of casemix variables – with greater variation noted with CCI – possibly due to greater variability in the distribution of this index between hospitals. • Variation over time was also noted for CCI within some hospitals suggesting possibly changes in coding practice. • The authors have only addressed possible interactions between two variables and further investigation into other potential interactions seems warranted.	

Scott I, 2008, Australia

Study title	Comparing risk-prediction methods using administrative or clinical data in assessing excess in-hospital mortality in patients with acute myocardial infarction.
Study objective(s)	To compare results of statistical process-control analyses, using Variable Life-Adjusted Display (VLAD) of in-hospital deaths of patients with acute myocardial infarction (AMI) by using either administrative or clinical data sources, and prediction models, and to assess variation in results according to selected patient characteristics.
Study type	Retrospective, cross sectional study
HMI definition **Data sources**	• In-hospital AMI deaths: statistical estimates of cumulative lives gained or lost in excess of those predicted at the end of the study period. • Queensland Health administrative data • National registry for clinical data • ICD-10-AM
Settings **Participants** **Reporting period**	• Queensland, Australia • Tertiary teaching hospital • Reporting period: 1/7/2003 to 31/3/2006
Selection of subjects	• 467 consecutive patients admitted with a coded discharge diagnosis of acute myocardial infarction. • Inclusion criteria: age 30-89 years, hospital stay <30-days, Queensland resident, acute admission via emergency department, not transferred to another hospital.
Risk adjustment and /or other variables of interest	• Comparison of VLAD curves derived by using administrative or clinical predictive models applied to a single patient sample. • An Administrative risk prediction model was developed using multivariate logistic regression analysis of data from 7491 patients admitted to Queensland hospitals (four tertiary, 27 other) between 1 July 2003 and 30 June 2006 with coded discharge diagnosis of AMI. 11 independent risk predictors: gender, age, comorbidities (9). The model exhibited good discrimination (c statistic =0.80) and compared well to a very similar Canadian model (c statistic =0.77) • A clinical risk prediction model was developed using logistic regression based on eight clinical variables from a large national registry of 11,389 patients with clinician verified diagnoses of acute coronary events, including AMI. The model exhibited good discrimination within two study cohorts [c statistic = 0.83 (derivation) and between 0.79-0.84 (validation)]. The clinical diagnosis of AMI was based on international criteria (elevated troponin level and presence of ischaemic chest pain or unequivocal ECG changes). Coded diagnoses ascertained by review of medical records, and for deaths review of death certificates. • Coders and investigator were blinded to the purpose of the study • Interim feedback to senior hospital clinicians led to additional undertaking of sensitivity analyses to exclude patients whose high mortality risk was independent of hospital quality of care (misclassified cases, out-of-hospital / ambulance cardiac arrests or deaths in ED within 30 minutes of presentation), complicated patients transferred in from community hospitals whose mortality risk may be under-estimated by risk prediction models, patients with end-stage or terminal co-morbidities who warranted a conservative/palliative care approach and patients residing in nursing homes whose care had not already been classified as palliative. • Interim feedback also recommended a third model which included only patients admitted to tertiary hospitals, rather than all Queensland hospitals.
Statistical issues	• VLAD plot was designed to have upper and lower control limits (based on the sequential probability ratio test), which corresponded to a real 30% decrease or a real 30% increase in mortality (95% confidence intervals (CI)) when a breach occurred. With each breach the control limits were reset, with the breach point taken as the new baseline. • Comparisons between variables and mortality were assessed using x^2 and were expressed as odds ratios with 95% CI. • Independent predictors were determined by multivariate logistic regression models and attributes of discrimination (c statistic) and goodness of fit (Hosmer-Lemshow x^2 test)

Report presentation / Feedback	VLAD
Management of outliers	Not applicable
Main findings	• The two prediction models, when applied to all patients, generated almost identical VLAD curves, showing a steadily increasing excess mortality over the study period, culminating in an estimated 11 excess deaths. • Risk estimates for individual patients from each model were significantly correlated (r=0.46, P<0.001) • After exclusion of misclassified cases, out-of-hospital cardiac arrests and deaths within 30 minutes of presentation, replotting the curves reversed the mortality trend and yielded, depending on the model, a net gain of three or seven lives. After further exclusion of transfers in from other hospitals and patients whose care had a palliative or conservative intent, the net gain increased to seven or 10 lives. • The Hosmer-Lemeshow Goodness of Fit test was initially low but increased after patient deselection without a decrease in model discrimination.
Authors' conclusion	• Appropriate patient selection is more important than choice of dataset or risk-prediction model when statistical process-control methods are used to flag unfavourable mortality trends suggestive of suboptimal hospital care. • VLADs and related tools do not, in themselves, provide definitive proof of, or explanations for, lower quality care. Their results should not be used in interhospital comparisons for purposes of ranking, but to monitor outcomes within single institutions over time. If excess mortality is found, then in-depth, clinician-led investigations should be initiated to identify and remedy system-of-care problems (including inadequate resourcing) or impaired professional performance. • Limitation re incomplete ascertainment of all cases of AMI in the original administrative dataset, because of misdiagnosis by clinicians or error by coders, corresponding to a sampling fraction of 45%
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ The study addresses an appropriate and clearly focused question ☐☐☐ Clear and explicit definition of the study population and participation rate ☐☐☐ The outcomes are clearly defined ☐☐☐ Data quality adequately described ☐☐☐ Statistical analysis (OR, CI) ☐☐☐ Study limitations discussed
Reviewer comments / relevance to Australian setting	• This is a high quality study that adds useful information about the issue of patient population selection and ways in which variation due to potentially preventable quality sensitive issues can be isolated from the general 'noise' of death, for instance by excluding those deaths that bear no relation to the quality of in-hospital care but what of the impact on the overall HSMR e.g. reference was made to misdiagnoses. • It demonstrates the utility of including senior hospital clinicians in data interpretation. • As the authors point out, VLAD methodology provides a feasible, low cost method of 'real-time' reporting that can be further optimised through consideration of appropriate patient population selection.

Shahian DM, 2010, USA

Study title	Variability in the measurement of hospital-wide mortality rates
Study objective(s)	To assess and compare 4 risk-adjustment methods used to calculate hospital wide mortality measures.
Study type	Cross-sectional comparative study
HMI definition **Data sources**	• HSMR, in-hospital mortality rates • Massachusetts Division of Health Care Finance and Policy (DHCFP); N=2,528,624
Settings **Participants** **Reporting period**	• Massachusetts, USA • General acute care hospitals • Reporting period: 1/10/2004-30/9/2007 4 methods of calculating hospital-wide mortality were provided by 5 commercial vendors to the DHCFP 1. Health Information Systems (3M) 2. Dr Foster 3. Thomson Reuters (TR) 4. University HealthSystem Consortium (UHC-Premier)
Selection of subjects	• Data on all discharges from acute care general hospitals were provided, including demographic information, admission source and type, up to 15 discharge diagnoses, 15 procedure codes, indicators of vital status (alive or dead) at discharge. • Excluded; no information about previous hospitalisations, outcomes after discharge.
Risk adjustment and /or other variables of interest	• Variables provided are listed above. The way in which these were applied differed for each model with details accessible in supplementary materials at journal (NEJM) website
Statistical methods **Data presentation**	• Based on each method the researchers calculated numbers of discharges and hospitals included in each model according to fiscal year/over the 3 year period. • Compared attributes of each patient population. • Calculated Pearson correlation coefficients for individual discharge-level predicted probabilities of in-hospital death between pairs of methods. • Assessed agreement on hospital performance between methods using predicted/actual mortality, converting all measures to ratios, multiplying by 100 then examining pairwise correlations of ratios between methods using Pearson correlation coefficients. Three correlations were estimated; no weighting, weighted by smaller number of hospital discharges analysed by any two methods, weighted by larger number of discharges. • Consistency between methods was assessed by calculating the intra-class correlation coefficient (ICC) - using an analysis of variance procedure that modelled standardised mortality ratios as a function of mixed fixed effects and hospital random effects. • Hospitals were compared according to grouping as higher than expected mortality, as expected mortality and lower than expected mortality and outliers were based on p values of 0.05 (95% CI). The authors noted different methods used to assign outlier status and adopted Dr Foster annual estimates and SEs with p <0.05 significance (noting Dr Foster typically uses 99.8% control limits). • Agreement between method pairs was assessed using kappa statistics and strength of agreement using the Landis and Koch method.
Main findings	• Each method used different inclusion and exclusion criteria (patient, hospital-type, diagnoses). • Discharges included ranged from 28% (Model 4) - 95% (Model 1) depending on method used; 22% included in all methods. • There was a large variation in HSMR results depending on methods used. • Individual discharge level predicted probability of in-hospital death ranged form 0-0.999 for the 4 methods.

	• For individual-level mortality, pairwise predicted probabilities for the 22% common discharges ranged from 0.46 (TR vs Dr Foster) in 2005 to 0.70 for UHC-Premier vs 3M in 2005). • For hospital-level mortality, pairwise correlation of HSMR depended upon weighting of measures and ranged from 0.32-0.74. UHC-Premier and 3M had the strongest linear correlations, regardless of weightings. • ICC coefficients indicated consistency among methods in 2005 (0.73) and 2006 (0.80) but lower consistency in 2007 (0.45) • Kappa statistics indicated poor-to-substantial agreement between methods in classifying hospital mortality performance – depending upon the year and method pairs. • Hospital performance categorization was discordant in a number of cases; eg of 28 hospitals classified as having higher-than-expected mortality for one method 12 had lower-than-expected mortality for one or more other methods.
Authors' conclusion	• The authors discuss the reasons for measuring mortality and note that the methods tested in this study are already in commercial use in the industry to support internal quality improvement • They also reinforce the implications for broader use of these measures for comparing hospitals and the need for greater accuracy for public reporting or performance-based purchasing. • The authors comment on the large variation they have documented between the four methods and suggest this may be due to a number of factors; different inclusion/exclusion criteria for patients, diagnoses and hospital types as well as methodological differences in analysis and quantification of in-hospital risk of death. • The authors further comment that they cannot state which method best identifies potential quality problems as an observable benchmark for overall hospital quality does not exist, therefore they are observing convergence (agreement) between methods presumably measuring a similar construct which may or may not relate to quality of care. The divergence they identified suggests not all methods are indeed measuring the same construct. • Poor correlation between methods may reflect a number of issues including; absence of an association with quality of care, confounding effects of small samples, randomness, inadequate risk adjustment, coding problems or other method issues.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This is an Interesting study, which strongly questions the wisdom of using existing standardised mortality measures to benchmark performance between hospitals.

van den Bosch WF, 2011, Netherlands

Study title	Predicting hospital mortality among frequently readmitted patients: HSMR biased by readmission
Study objective(s)	To study the impact of readmissions on calculation of HSMR.
Study type	Cross-sectional analyses within a retrospective longitudinal dataset
HMI definition **Data sources**	• Dutch HSMR 2008 model (DHM-2008): 100 x (number of observed deaths/sum of predicted risks of deaths of all admissions) • SMRs of 50 Clinical Classification System (CCS) groups • Routinely collected hospital data in the National Medical Registration dataset (the LMR), the Netherlands • ICD-9
Settings **Participants** **Reporting period**	• Six large non-university teaching hospitals geographically spread over the Netherlands with a spread of high (poor) HSMRs (114) to low (favourable) HSMRs (65) • Hospitals included cover 10% of all Dutch hospitals in terms of admissions • Reporting period: 2003-2007
Selection of subjects	• DHM-2008 is the same as the Dr Foster model except for the following; use of days cases that are excluded in Dr Foster model, use of 50 CCS groups (ICD-9) compared to 56 CCS groups (ICD-10), and no adjustment in DHM-2008 for palliative care, source of admission or previous number of emergency admissions
Risk adjustment and /or other variables of interest	DHM-2008 was used in this study and accounts for 70% hospital mortality. • Variables included in risk adjustment included; age, sex. LOS, comorbidity (Charlson Comorbidity Index (CCI)), admission type (urgency), month of admission, social deprivation, referral source, year of discharge, CCS diagnostic group based on ICD-9 coding. • The dataset was grouped in 2 ways: Admission view (according to all first admissions (A1), all second admissions (A2) etc) and Patient view (according to admission frequency (Pm)) • Readmissions were defined as planned or unplanned readmission for the same problem or different problems over the study period of 5 years. The 'nth admission' was any admission occurring after the 6^{th} admission. Admission frequency was the number of times a patient was admitted during affixed time period. Readmission frequency was the number of times a patient was admitted after the initial admission.
Statistical methods **Data presentation**	• Calculations were made of crude mortality, predicted mortality (DHM-2008) and standardised mortality ratios (SMRs) by applying the HSMR formula for each class A(n) and (Pm), with 95% confidence intervals (CI). • Goodness of fit, and discrimination for both admission and patient views were calculated.
Main findings	• There were 240,662 patients (418,566 admissions). • 31% were admitted more than once accounted for 61% of total admissions. • The distribution of readmissions varied across classes, for example (P(m=1) varied from 29.3% to 45.3% and P(m=>20) varied from 0.6% to 9.2%. • Neoplasms, heart disease and respiratory diseases accounted for 2/3 all readmissions and the proportion of each varied between hospitals. For example there was a 3 fold difference for neoplasm readmissions across hospitals. • DHM-2008 predicts a reduction in mortality per admission, P(m=1)of 4.2% to P(m=>20) of 1.1%. A similar relationship but smaller effect was noted for the admission view. • The SMRs are presented graphically with 95% CI and demonstrate that the SMRs decline from 127 P(m=1) to 35 P(m=>20). For P(m=2) to P(m=>20), none of the SMR CI cross the expected overall HSMR of 93.0 (95%CI 91.5-94.5) and there is lack of model fit. • The Admission view SMRs fluctuate between 90 and 99 and all include the HSMR value of 93 indicating a good fit. • As readmissions increase the casemix changes as reflected by the combination of variations of 5 CCI casemix variables.
Authors' conclusion	• Patients admitted more frequently experience a lower risk of death per admission. • Comparing patient admissions using the current HSMR model commits the constant risk

	fallacy. • Misleading differences between hospitals requires analysis of over 3 years, but is in effect every day of the year; and as readmission rates were as high as 43% of all admissions the impact on HSMR for some hospitals could be substantial. • The authors discuss and cannot resolve the opposing views that frequently admitted patients are unexpectedly resilient, possibly in association with the reducing age of frequently admitted patients; however comorbidity increases indicating higher vulnerability. • In moving forwards, the authors suggest that an additional adjustment variable 'admission frequency' be used, although they acknowledge this could be difficult to implement. • The authors point out that readmissions, commonly thought to be associated with poor quality of care, in fact work in favour of those hospitals with patients experiencing multiple readmissions.
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This study clearly indicates the issues associated with accounting for multiple readmissions in deriving SMRs especially where the data is to be used for between hospital comparative data purposes. It would also be an issue for internal HSMR application where there are changes in admission/discharge policies or changes in the external environment facilitating fewer readmissions.

van den Bosch WF, 2012, Netherlands

Study title	Variations in hospital standardised mortality ratios (HSMR) as a result of frequent readmissions
Study objective(s)	To investigate the impact that variations in the frequency of readmissions has on HSMR.
Study type	Cross-sectional study
HMI definition **Data sources**	• Dutch 2010 HSMR model; and • SMRs of 50 Clinical Classifications System (CCS) diagnostic groups • Netherlands national medical registration data (LMR) from 70 Dutch hospitals; N=2,494,613 2005-2009 • ICD-9
Settings **Participants** **Reporting period**	• The Netherlands • 89 hospitals – 19 excluded due to insufficient data (N=70 hospitals) • Reporting period: 2005-2009
Selection of subjects	• As per Dutch 2010 HSMR model (Dr Foster model applied in Netherlands 2010); excluded day cases
Risk adjustment and /or other variables of interest	▪ Model 1 includes: age at admission, sex, diagnostic group, year of discharge, comorbidity (Charlson comorbidity index), admission type, social deprivation, month of admission, source of referral, and casemix on the primary diagnostic level. ▪ Model 2 - also includes adjustment for frequency of readmission (m) as those admitted more frequently have a lower mortality ratio/admission (m=number of times admitted within the five year period). 8 frequency categories; 1,2,3,4,5-6,7-9,10-20,>20.
Statistical methods **Data presentation**	• Statistical methods used to derive the HSMR and SMRs were not described in full. • Agreement between the SMR models was assessed by 'relative change' = the degree to which SMR (Model 1) differed from SMR (Model 2) for each diagnostic group, per hospital, and y 'significance scores' whereby hospitals with a significantly high SMR score according to Model 1 was not significantly high with Model 2. • Quality metrics of the models were assessed by discrimination (c-statistic), and calibration (Hosmer-Lemeshow test) and explanatory power (pseudo R^2). • Three scenarios of review (lookback) of 1 year, 2 years and 5 years were examined.
Main findings	• Model 2 with adjustment for frequency of readmissions: o produced different HSMR and SMRs outcomes compared to the reference model o showed more favourable quality metric characteristics (better discrimination and explanatory power) • Model 1 indicated 328 SMRs as 'higher than expected' of which with Model 2, 64 (19.5%) were not higher than expected.
Authors' conclusion	• There was significant disagreement between the two models. • The standard deviation (SD) of the frequency distribution of HSMR-change was equal to 4 HSMR points which the authors considered substantial compared to the SD of the HSMR-frequency distribution which amounted to 14 points. • Low SMR scores indicated susceptibility to adjustment for readmission. On average chronic diseases scored lower than acute diseases, the former being more associated with readmission. • Overall, all differences in HSMR/SMR outcomes between the two models cannot be attributed to differences in quality of care, nor to 'chance' but to the choice of model applied. • Use of a longer review period increases the ability to identify readmission sequences; however the UK model is restricted to a maximum review period of one year which is too short to see the readmission effect. The authors recommend a 3 year review period. • The study was limited by exclusion of 19 Dutch hospitals leaving 80% therefore generalisations to all hospitals limited. Further in-hospital mortality may favour hospitals with shorter length of stay.

Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described	☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• The general issues related to use of different models to derive HSMR/SMRs is relevant to other jurisdictions, including Australia as is the issue of accounting for readmissions.	

van Walraven C, 2010, Canada

Study title	The Kaiser Permanente inpatient risk adjustment methodology was valid in an external patient population
Study objective(s)	To externally validate the Kaiser Permanente (KP) inpatient risk adjustment methodology and to investigate different measures of chronic illness burden
Study type	Cross-sectional study
HMI definition **Data sources**	• HSMR: in-hospital (inpatient) mortality • ICD-9-CN (changed to ICD-10 later in 2002)
Settings **Participants** **Reporting period**	• The Ottawa Hospital (TOH), a publicly funded tertiary care teaching facility with 2 hospitals and 20,000 admissions annually. • Reporting period: January 1998 to April 2002.
Selection of subjects	• All hospital admissions including same day surgeries (reference to Escobar 2008) • Excluded age ≤ 15 years, delivery related obstetrical admissions, and transfers to or from other hospitals
Risk adjustment and /or other variables of interest	• Age, sex, admission urgency (elective/emergent), service (medical/surgical), admission diagnosis, severity of illness (Laboratory-based Acute Physiology Score (LAPS)), chronic comorbidities (Comorbidity point score (COPS))

Statistical methods
Data presentation
	• Unit of analysis is the hospitalisation
	• Data was divided into derivation (n=94,237) and validation (n=94,488) cohorts.
	• Logistic regression models created with age as squared natural spline
	• Interaction terms included: age, LAPS and COPS
	• Model performance tested included discrimination (c-statistic) and calibration (Hosmer-Lemeshow statistic)
	• KP methods were replicated in the study population with 2 exceptions:
	  ○ as no comorbidity data collected for outpatients they used diagnoses from previous hospitalisations and diagnoses for the current admission that were characterised as 'chronic'
	  ○ TOH uses troponin–T not troponin-I, therefore modified the LAPS
	• 4 models were developed:
	  ○ Model A – original model intercept and parameter estimates were multiplied by current parameter values
	  ○ Model B – same variables as Model A but parameter estimates calculated from the data of this study using logistic regression
	  ○ Model C and Model D – substituted COPS with Elixhauser (C) or total Charlson comorbidity score (D)

Main findings	• 188,724 admissions met inclusion criteria, mean age 55 years, 47% male, 64% emergent admissions, 29% surgical, 3.3% deaths. • The patient population differed from that in the original study – younger, lower acuity of illness, fewer documented chronic comorbidities, 80% did not have LAP score in the 24 hours before admission whereas, all patients in the original cohort did have this score, and there were differences in diagnostic groupings. • Discrimination results; original model 0.894 (0.891-0.898), Model B 0.915 (0.912-0.918), Model C 0.901 (0.898-0.904), Model D 0.894 (0.891-0.897). Models C and D retained discrimination, and Model B had better discrimination and improved calibration. • Expected mortality rates did not differ significantly from observed rates for any of the risk deciles, however did differ in the 0-10% and 60-79% risk strata.
Authors' conclusion	• The study externally validates the KP inpatient risk adjustment methods for inpatient mortality in this very different patient population. • It extends the KP model in that discrimination and calibration improved using data-driven parameter estimates.

	• The study also showed that the models work equally well regardless of comorbidity methods.

Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described	☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This paper provides supportive evidence for transfer of risk adjustment models from the population in which they are developed to an external and in this case different patient population. However the data are Canadian and would need to be tested in other settings such as Australia. • Of interest, modification of Illness severity (LAPS score) due to lack of data did not adversely impact on the models' performance.	

van Walraven C, 2011, Canada

Study title	The procedural index for mortality (PIMR): an index calculated using data to quantify the independent influence of procedures on risk of hospital death.
Study objective(s)	To quantify the independent association of all procedures with the risk of death in hospital.
Study type	Cross-sectional study
HMI definition **Data sources**	• In-hospital death • Administrative data • ICD-10
Settings **Participants** **Reporting period**	• The Ottawa Hospital, a tertiary-care teaching facility with 3 sites, averaging 20,000 admissions per year. • Reporting period: 1/4/2004-1/4/2009
Selection of subjects	• Included same-day surgical admissions. Excluded patients aged ≤ 15 years, delivery related obstetrical admissions, transfers to or from the Ottawa hospital
Risk adjustment and /or other variables of interest	• Used the Kaiser Permanente In-patient Risk Adjustment Model (KP-IRAM) – previously validated in this hospital. • It includes patient age and sex, admission urgency (elective/emergent), service (medical/surgical), admission diagnosis, illness severity (laboratory based acute physiology score), chronic comorbidities (Comorbidity point score). Hospitalisations are grouped into 'Primary conditions' based on admission diagnosis and separate logistic regression model created for each group. Interaction terms between age, severity score, comorbidity score included. Model discrimination excellent (c-statistic 0.88), calibration – Hosmer-Lemeshow statistic P value 0.66 for all-cause death in hospital. KP-IRAM modified for this study; ICD-9 to ICD-10, Elixhauser Index for comorbidities, calculated on day of procedure rather than day of admission. • There were 4013 hospital deaths therefore the logistic model could test a maximum of 400 procedures/surgeries (10 deaths/exposure) • Candidate procedures chosen using Canadian Classification of Intervention code (CCI), grouped using first 5 alphanumeric s of each code (anatomical area and intervention type). • Non elective procedures were defined as urgent irrespective of admission status eg cardiac resuscitation. • Overall 3984 unique procedure/urgency combinations – filters used to reduce to the required 400 – included only procedures occurring on day of principal procedure, procedures conducted at least once per month, P-value for association with death in hospital after adjustment <0.5.
Statistical methods **Data presentation**	• Unit of analysis was the hospitalisation. • Randomly assigned patients to derivation (50%)/validation (50%) groups. • Index day was day of procedure for those with procedures and day of admission for those without procedures. • Multiple binomial logistic regression used to derive the index. • Surgeries with 2-sided p value < 0.05 retained in the model. • Parameter estimates of regression model were modified into an index using methods of Sullivan. • Developed the Procedural Independent Mortality Risk (PIMR) for each person based on each coded procedure coded on the index day. • Validation data used to measure risk of PIMR with death in hospital- discrimination and calibration assessed. • KP-IRAM compared with and without PIMR using the Integrated Discrimination Improvement (IDI – greater than zero means improved discrimination) and Net Reclassification Improvement (NRI – correct reclassification means predicted risk moves upward to events and downwards for non-events) statistical measures.

Main findings	• Total admission 369,588, exclusions 93,971 (25.5%). • Validation and derivation groups were similar. • Total 1939 procedures, 1436 less than one/mth excluded. Remaining 503 included 938 procedure-urgency combinations. After adjusting for KP-IRAM death risk estimate, P value >0.5 for 736 which were then excluded., leaving total 212 procedure-urgency combinations (168 individual surgeries). • After adjustment, 56 combinations (52 individual procedures) were independently associated with in-hospital death, 37 emergent and 8 elective procedures. • In validation set, 22664 (16.4%) admissions with at least 1 PIMR procedure (83% within 3 days of hospitalisation). Strongest association with death – cardiac resuscitation, ventriculectomy, pericardial drainage, pelvic irradiation. • PIMR scores for individual procedures ranged from -7 to +11. • Risk of death in hospital strongly related to PIMR score. • PIMR score moderately predictive alone for risk of death: c-statistic 67.3% (95%CI 66.6-68.0%) • Total PIMR score changed expected risk of death beyond that estimated by KP-IRAM. Model discrimination improved from 0.929 [0.926-0.932] to 0.938 [0.935-0.941]., IDI improvement 0.04327 [0.0384-0.0493, p,0.0001]. • Model calibration did not change. • NRI showed that overall net proportion of correct reclassification was negative (-18.4%) but the overall net number of correct reclassifications was positive (+17923, 13% of the entire cohort)
Authors' conclusion	• The PIMR score adds predictive accuracy to the existing KP-IRAM risk index. • The discrimination achieved with KP-IRAM and PIMR is similar to clinical based models • A number of specific individual procedures associated with higher risk of in hospital death have been identified
Critical analysis ☐ Good ☐ Adequate ☐ Poor/None	☐☐☐ Clear and explicit definition of the patient and provider sample ☐☐☐ Variables of interest are well defined and summarised ☐☐☐ Mortality outcomes well defined ☐☐☐ Data quality adequately described ☐☐☐ Appropriate analytical approach ☐☐☐ Appropriate model development, validation and performance assessment methods described ☐☐☐ Key results reported well ☐☐☐ Model limitations discussed
Reviewer comments / relevance to Australian setting	• This study confirms the high performance attributes of risk models developed using administrative data only. • Reliance on Canadian surgical procedural classification limits generalisation to other jurisdictions • Overall this was a nicely developed and reported study, however the additional value of the PIMR was limited given the already high c-statistic associated with the KP-IRAM thus questioning the utility of the additional risk score, given the need to exclude a large number of admissions from the analysis and the limitations of coding outlined above.

APPENDIX 5 – Australian reports summaries

University of Western Sydney, June 2012

Report title	Deaths after admission to hospital: a NSW population-based data linkage study (Draft Report)
Report Commissioners	Clinical Excellence Commission ACSQHC NSW Bureau of Health Information (BHI)
Questions of Interest relevant to the current review	• What is the rate of in-hospital and 30 day mortality? • Should 'cause of death' information be used to identify deaths that are potentially related to health care when estimating in-hospital and 30 day mortality? • Does ranking of hospitals vary according to whether in-hospital or 30 day mortality is used?
Study type	Cross sectional data analysis

HMI definition
Data sources
	• Death definition
	  o Death in hospital (HSMR)
	  o 30-day post admission death
	  o 30-day SHMI death (in hospital or within 30 days of discharge)
	• The NSW Admitted Patient Data Collection (APDC) – includes records for all NSW public and private hospital separations and day procedures.
	• The NSW Emergency Department data Collection (EDDC)
	• The NSW Registry of Births, Deaths and Marriages (RBDM) –compiles NSW deaths
	• The Australian bureau of Statistics (ABS) – codes for principal and contributing causes of death are assigned according to ICD-10 classification (2000-2006)
	  o Linkage of data performed by the Centre for Health record Linkage (CHeReL) using probabilistic methods.
	• ICD-10-AM

Reporting period	1/7/2000 – 30/6/8
Selection of subjects	• NSW residents • Admission for acute care • Age 0-120 years • Gender recorded • LOS up to 365 consecutive days • Admission category emergency or elective Exclusions; discharged against medical advice, neonates (</=28 days), cadavers
Risk adjustment and /or other variables of interest and **Statistical methods**	• Independent variables included; age at admission, sex, LOS (categorical -1, 2, 3-9, 10-15, 16-21, 22-365), admission category, diagnosis group (those contributing to 80% and centiles based on first 3 digits of the principal diagnosis) and comorbidity category (Charlson score0, 1,2 or more). • Australian additions – transfer status (1=inward transfer, 0=no inward transfer) – for transfers death was assigned to all separations within 30 days • Probabilities of death were summed across all admissions • HSMR – calculated using the Canadian RACM logistic regression model and indirect standardisation with 95% confidence intervals. • Confidence intervals computed using Byar's approximation • Reference year 2004/5 for logistic regression coefficients because earlier years possibly less reliable additional diagnosis coding. • HSMRs computed for all hospitals, stratified public/private and hospital type assigned • Results were shown for peer group; principal referral, major, district, community and other • A death was considered 'related' to the hospital stay if there were agreement between principal and additional hospital diagnoses and underlying and contributing causes of

	death. • No comment was made about how readmissions were managed in the data analysis
Main findings	General Findings • There were 17,047,558 hospital admissions between 2000-2008 • 16.2-31.2% people were excluded from the HSMR calculations – predominantly for reasons; not acute care type, no urgency assigned category • Total included admissions were 14,285,320 (64% public) • 148,870 associated with death in hospital and a further 144,941 deaths up to 30 days post discharge • 96% private, 65% public hospital admissions were planned • in-hospital deaths 1% (1.5% public, 0.3% private) • deaths within 30 days admission 1.8% (2.4% public, 0.5% private) • Deaths within hospital or 30 days discharge 21% (2.8% public, 0.6% private) • Transfers occur for 3.1% (3.3% public, 2.9% private) • In-hospital deaths reduced between 2000-2008 from 955/100,000 to 747/100,000 (21.8%), with an 8% drop in 2004/5 • 30 day post-admission rates decreased from 1150 to 947/100,000 (17.7%) • 30 day SHMI rates reduced from 1306 to 1083/100,000 (17.1%) • 30 day post admission mortality rates were 20% higher than in-hospital rates (24% public, 35% private) Linking cause of death • There is a 2 year lag between death notification and ABS coding/linkage • Higher concordance for diagnoses for in-hospital records and cause of death were found for; in-hospital deaths, increasing numbers of diagnoses and causes of death, earlier years of data collection, certain chapters eg neoplasms, circulatory system, respiratory system • Higher odds of agreement were found for; older patients, public hospital admissions, specific disease systems described above, hospitals in specific geographic region Variation • Average in-hospital HSMRs were higher than for 30day admission or 30 day SHMI models, however the 30 day models were similar • Average in-hospital HSMRs were higher for private than public hospitals but no different for 30 day measures • There was a general reduction in HSMRs over time • Correlations between in-hospital HSMRs and 30day models were high (0.88 to 0.89) and were higher in private (0.91 versus public 0.87) • Agreement on outlier status between in-hospital HSMR and 30 day postadmission rates for public hospitals was k=0.5 (CI 0.36, 0.64), for private hospitals k= 0.64 (CI 0.43, 0.86) • Agreement on outlier status between in-hospital HSMR and 30day post admission rates for hospital type principal referral was k= 0.26 (0.00, 0.64), major hospital was k= 0.43 (CI 0.11,0.75), district hospitals was k= 0.52 (CI 0.27,0.77) and community hospitals k= 0.65 (CI 0.43,0.88) • Similar agreement was found for HSMR comparison to 30 day post discharge rates • Therefore, based on the above results, categorisation by performance groups (below average, average and above average) remained the same for *72% of 30 day post admission and 71% 30 day SHMI models*

Reviewer's comments	• The very large changes in mortality rates over time are unlikely to reflect quality sensitive changes in mortality rates, however there is no data provided for age and sex adjusted community mortality rate changes nor of coding changes or other factors that may have influenced the documented findings. • Whilst the correlation between in-hospital mortality rates and 30day rates are good, the finding that up to nearly 30% of hospitals change outlier category is concerning. It should be noted that confidence around these reported correlation coefficients are wide. • The lack of concordance between crude mortality rate differences for public and private hospitals (higher rates for public) and in-hospital HSMRs (higher for private hospitals) is of interest, particularly as there is a much higher rate if planned (surrogate for low risk) admissions to private hospitals, but is not discussed. • The long time delay between death and subsequent registration of cause of death currently limits the utility of this information.

Australian Institute of Health and Welfare (AIHW), March 2011

Report title	Use of in-hospital mortality risk-adjustment coefficients (Draft Report)
Report Commissioners	The ACSQHC
Questions of Interest relevant to the current review	• To analyse data collected through the National Hospital Morbidity Dataset (NHMD) from 2006-7 to 2008-9, in order to quantify the effects of in-hospital mortality rates for a certain year of using national risk-adjustment coefficients, from previous years.
Study type	Cross-sectional data analysis
HMI definition **Data sources**	• HMI for AMI, stroke, fractured neck of femur, pneumonia, heart failure • National Minimum Dataset • ICD-10-AM
Reporting period	2006-7 to 2008-9
Selection of subjects	• ACSQHC specifications • Hospitals that had more than 30 separations in the denominator

Methods	• In-hospital mortality rates and national risk-adjustment coefficients were calculated according to ACSQHC specifications (v5)
	• Modifications included; age included as a continuous variable not 5 yr groups, heart failure was not included in the risk-adjustment for HMI heart failure
	• A logistic model was fitted for each HMI and for each year, 2006-7, 2007-8, 2008-9
	• Non significant variables were kept in the model each year for consistency
	• Four analyses were undertaken
	  o 2006-6 coefficients used to generate expected deaths for the years 2007-8 and 2008-9
	  o 2007-8 coefficients were used to generate expected deaths for 2007-8 and 2008-9
	  o 2008-9 coefficients were used tp generate expected deaths for 2008-9
	• no analysis of using current years data for generating coefficients for previous years was undertaken
	• The authors document changes in coding ICD-10-AM during the study period which may some variables in the risk adjustment model varied by year have impacted on coding of some conditions
	• The authors note that there is no single method for determining the reliability of coefficients
	• Data dispersion was assessed using the coefficient of variation (CV) – a summary measure of data dispersion in relation to the mean
	• Hospitals were grouped by peers; A (principal referral and specialist women's and children's), B (large), C other (medium, small and other specialist)

Main findings	• The statistical significance of some variables in the risk adjustment model varied by year – in particular Alzheimer's disease was only significant for AMI in 2007-8. Sex was only significant for AMI in 2007-8 • There was little difference in the CV values, dispersion does not change significantly, regardless of coefficients used. • Using previous-year coefficients generally reduces in-hospital mortality rates (eg AMI reduced by 5%, fractured neck of femur approx 10%, heart failure approx 12%) • Using previous year coefficients decreases the number of hospitals flagged as high outliers compared to using current year's coefficients for most indicators but the changes are small. The most significant changes were seen for stroke in 2008-9 – 10 hospitals were identified as high outliers using same year coefficients and this reduced to 6 using 2006-7 coefficients and reduced to five using 2006-7 coefficients. • Using data from 2 years before has more impact than using data from the year before • There was some clustering according to peer grouping; eg for pneumonia using 2007-8 coefficients with 2008-9 data - peer A had lower rates and peer B and C had increased

	rates • The relative positions of hospitals were highly correlated when using different coefficients
Authors' conclusions	• The importance of the difference in rates associated with using different year coefficients should be considered in terms of the relative importance of comparison of hospitals with national confidence limits versus comparison of hospitals over time • Decisions about whether to sue 95% or 99.8% confidence intervals to determine outlier status would make more difference than choice of coefficients. • A feasible approach in Australia would be to use coefficients from the previous 2 years due to timing of NHMD updates and subsequent analyses. • 'Alzheimer's disease' and 'sex' may not be useful risk-adjustment variables
Reviewer's comments	• The key issue relating to choice of risk adjustment coefficients relates to the driving purpose for which the data is to be used – between hospital variation based on national average data or within hospital monitoring over mortality rates over time.

Australian Institute of Health and Welfare (AIHW), March 2011

Report title	Hospital Standardised Mortality Ratio indicator (Draft report)
Report Commissioners	ACSQHC
Questions of Interest relevant to the current review	• To investigate the HSMR indicator and artefactual causes of non-random variation in the indicator, and; o coding and classification practice and standards differences across jurisdictions o distribution of raw mortality rates across Australian hospitals o distribution of raw and risk-adjusted mortality rates across jurisdictions
Study type	
HMI definition **Data sources**	• The National Hospital Morbidity Data Collection (NHMD)
Reporting period	2006-7, 2007-8, 2008-9
Selection of subjects	6 Australian states (excluding territories and private sector)
Methods	• Utilisation of palliative care assessed using palliative care type, ICD-10-AM palliative care code Z51.5 as a secondary/additional diagnosis.
Main findings	• Utilisation of coded palliative care type varies across states, ranging 2006-7 (0.58% to 0.28%), 2007-8 (0.57% to 0.28%) and 2008-9 (0.62% to 0.27%) • The relative position of states mortality rates does not change significantly after removing palliative care types from the analysis – state level trends in mortality rates are not a consequence of deaths in coded palliative care services • Crude mortality rates are highly variable across states. Adding risk adjustment changes the relativities of states position little with only one state changing positions. • Age and sex standardisation has a significant impact on crude mortality rates increasing it in one state and reducing it in another. • Adding in the Charlson comorbidity index generally results in only a small impact in 4 states. It increased rates in 1 state (6.31 from 5.76) and decreased rates in another (2.40 to 2.39). • Adjusting for risk decile of principal diagnosis decreased the standardised mortality rate in 1 state (6.31 to 6.09), increased it in another (2.39 to 2.52) and had small impacts in other states. • There was modest impact of variables; transfer status, urgency of admission and length of stay
Authors' conclusion	• Although there were jurisdiction level differences in areas such as provision of palliative care, these are insufficient to explain substantial differences in raw mortality and risk adjusted mortality between jurisdictions • A number of further investigations are recommended related to; use of palliative care, further longitudinal analyses from 2004 to 2009, differences in jurisdictional coding practices
Reviewer's comments	• There were no major changes in proportions of palliative care coded separations over the three years of study. Whether this has remained stable over the last 4 years is uncertain and would be interesting to investigate, given results of studies in UK and Canada. • Australia lags behind other jurisdictions in use of standardised mortality measures. The variables investigated in these analyses need to be re-examined once the HMIs have been implemented and hospitals begin to respond to identified variation, particularly for variables such as palliative care type.

Australian Institute of Health and Welfare (AIHW), June 2011

Report title	Hospital transfers in Core, hospital-based outcome indicators (Draft report)
Report Commissioners	ACSQHC
Questions of Interest relevant to the current review	• To provide an overview of transfer activity in Australian hospitals, in particular o To ascertain if other similar indicators include/exclude separations where care began or ended in another hospital o To consider data elements and domain values that can be used to identify transfers o To perform data analyses to document the pattern of use of transfers in and out by hospital characteristics such as; sector, peer group, jurisdiction
Study type	Cross-sectional data analysis
HMI definition **Data sources**	• HSMR, condition specific HMIs for AMI, stroke, pneumonia, fractured neck of femur, heart failure, a variety of readmission indicators • Transfers in – definition includes; admitted from another hospital/ hospital transfers of care type characterised as 'statistical admission' • Transfers out defined as discharge/transfer to acute, residential aged care, psychiatric, other healthcare accommodation, statistical discharge type 'change' • Admitted patient care national minimum dataset
Reporting period	2008-2009
Selection of subjects	ACSQHC specifications for HMIs
Method	• Current specifications (ACSQHC, v 0.5.2) – HSMR (risk adjust for transfers in), LMDRG (no adjustment), AMI (exclude transfers out), stroke (exclude transfers out), fractured neck of femur (exclude transfers out), pneumonia (exclude transfers out) • Hospitals grouped by peers • Simple descriptive summaries stratified by jurisdictions and peer groups
Main findings	• There was a low level of transfers 3% private sector, 5% public sector • There was a small amount of variation in coding of transfers across jurisdictions • Public psychiatric hospitals had 42% admissions coded as transfers in • A small number of hospitals (n=25, mostly smaller peer groups E to G), including rehabilitation facilities had over 80% transfers in separations • There was variation in proportion of transferred in separations across jurisdictions reflecting different numbers of smaller (E to G peer) group hospitals. • Larger hospitals had fewer transfers out than smaller hospitals • The proportion of public hospitals with transfer out separations great then or equal to 20% differed across jurisdictions from 19% to 52% Core Indicators • For HSMRs transfer out separations (15%) were greater than transfers in (6%) • For LMDRG, the proportion of transfers in (3%) and transfers out (4%) is small. • Fractured neck of femur was associated with the highest proportion of transfer out separations 967%). If these were included the population selected for inclusion would be increased threefold and the proportion ending in death would be significantly reduced. • For almost all hospitals, including transfers out would lead to lower mortality rates, the largest difference being for fractured neck of femur and stroke • Excluding transfers in generally reduces numbers of in-hospital deaths by 9-10% and for fractured neck of femur by 16% • The effects of transfers on mortality rates varies by hospital and can be large for transfers out especially for stroke (peer groups A &B) and fractured neck of femur. Including transfers out would reduce in-hospital mortality rates by increasing the denominator.
Reviewer's comments	• The findings in this report parallel those reported in the literature in other jurisdictions

Australian Institute of Health and Welfare (AIHW), June 2011

Report title **Date**	Treatment of age in Core, hospital-based outcome indicators (Draft Report) June 2011
Report Commissioners	ACSQHC
Questions of Interest relevant to the current review	• What is the recommended approach for risk adjusting age for the core, hospital-based outcome indicators? Specifically, should age be used as a continuous or categorical variable? • What is the effect of applying the upper age limit of 120 years on the core, hospital-based outcome indicators?
Study type	Cross-sectional data analysis
HMI definition **Data sources**	• ACSQHC specifications • Core ACSQHC HMIs including those relevant to this review; HSMR, LMDRG, AMI, stroke, pneumonia and fractured neck of femur. • National Hospital Morbidity database (NHMD)
Reporting period	2008-2009
Selection of subjects	• Hospitals that included more than 30 separations in the denominator • ACSQHC specifications for patient population
Risk adjustment and /or other variables of interest and **Statistical methods**	• Logistic additive model – an extension of the logistic model that releases the assumption of linearity in generalised linear models and allow the relationship between the dependant variable and the independent variables to be examined non parametrically • Age enters the logistic additive model as a smooth function and the relationship between age and mortality is plotted graphically. The logistic additive model was therefore used to visualise how mortality changes by age and to find a parametric function that approximates smooth function of age well. • The generalised additive models are used as an exploratory tool to view relationship between variables while the logistic regression model is better for calculating expected deaths and their confidence intervals.
Main findings	• Review of other jurisdictional HMIs demonstrates variation in the way in which age is applied within risk adjustment models, and variation across indicators within sets. • Age distributions for HMIs indicate an older age profile (especially 75-94 years) with few younger separations • Age can be used as a continuous variable for risk-adjustment • The age separations were even across most age groups with smaller proportions among the elderly, however deaths in LMDRGs were much more likely amongst the elderly especially 75-99 years • Separations for AMI and stroke showed similar age distribution with pneumonia the only indicator with relatively high numbers of separations amongst younger age groups • In contrast to other condition specific HMIs, the average number of fractured neck of femur deaths is low across age groups. • The relationship between age and probability of death is best represented as a continuous variable as the lines are not flat and "stepped". The exception s pneumonia which has less smooth slope. • For indicators where the upper age limit is lower than 120 years, increasing the age limit, eg from 89 to 120 years, increase in-hospital mortality rates probably because of the increased risk of death in patients over the age of 90 years. • The increase in mortality rate relates to most but not all hospitals, with 17/90 hospitals exhibiting lower in-hospital mortality rates. • There were differences between HMIs in the impact of increasing the age limit.
Authors' conclusion	Increasing the age limit should not adversely affect hospitals as the indicators are risk-adjusted for age