CHKS
Insight for better healthcare

Hospital mortality measures

Comparison of HSMR, SHMI and RAMI

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2 About CHKS

CHKS is a leading provider of healthcare intelligence and quality improvement products and services. Over the last 27 years our team of NHS data experts, clinicians and quality managers have worked with more than 400 healthcare organisations around the world to improve population health.

We enable providers and commissioners to make better decisions at patient, service, organisation and population levels, and deliver sustainable improvements in care quality, patient outcomes and service efficiency along the entire patient pathway.

Our services include:

- **Healthcare benchmarking and analytics** – we identify what to improve and model the impact of change at patient, organisation and population levels
- **Clinical coding, data quality and costing services** – we ensure data is used for payment and decision making, and accurately reflects the care delivered
- **Care quality, assurance and accreditation** – we work to the latest international standards of best practice within a proven framework of continuous improvement.

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3 Executive summary

Three hospital mortality measures are in use in England, and the methods underpinning each are different. For many information managers, chief information officers and medical directors mortality measurement has become a complex task. When the board asks: 'Which mortality measure should we be looking at?', a nuanced answer is often not enough to assure the board that it is taking the right action, particularly since the CQC and NHS Improvement may take a different view.

Interpreting the results of any one measure, and understanding the differences between the three, requires clarity as to what is, and what is not, taken into account in each case, and to a lesser extent, the methodology employed.

This document aims to clarify the individual strengths of each measure or indicator, and how they differ in their respective calculation of 'expected deaths'. An explanation of each calculation is provided to allow users to understand them and then use them in the most effective way.

You should consider using SHMI when:

- Some discharges may have been premature. Only SHMI captures deaths after discharge and is, therefore, the only measure sensitive to cases where the patient was potentially discharged early and then died after discharge.
- Community service provision is unequal. To some extent, counting out of hospital deaths may also compensate for where community services (e.g. hospice provision) differ between regions.
- The CQC also monitors the SHMI within its CQC Insight tool.
- Hospitals need to be able to respond to published performance figures and associated media interest.
- Risks of death are changing quickly so a relatively short but recent observation period is required.

You should consider using RAMI when:

- Reference data should be as general as possible, including Wales and Northern Ireland as well as just England, and specialists as well as general hospitals.
- Greater confidence (specificity) is required as to which comorbid conditions have been included (excluded) in the uplift of risk (than is implied by the Charlson comorbidity index).
- Understanding how the expected deaths figure has been calculated is as important as the result itself.
- Local lengths of stay are systematically different from the average for some conditions.

You should consider using HSMR when:

- Case mix within CCS groups (i.e. between CCS sub groups) may be significantly different from the average. By including sub group as a starting variable, HSMR effectively further sub divides some or all of its CCS groups into sub categories. Other models don't do this.
- Patient deprivation is different from the average, and is something that should legitimately be taken into account when calculating risks.

- Palliative care is assigned to patients locally in accordance with national guidance and norms, is consistent with the average assignment in peer trusts, and is a reflection of the patient's condition only on admission.
- Taking into account seasonality is necessary (e.g. when monitoring a period that is not a whole number of years).
- The number of previous admissions and/or the source of admission both systematically and significantly affect the risk of death.

All three measures have their own limitations and as a result should be used as part of a toolkit to establish the true picture. There are times when it will be more appropriate to use one measure instead of another. As circumstances change either at trust level, or within departments, there will need to be a reassessment as to whether the same measure can be relied on to highlight what is happening on wards. Measures can be used together and in some cases a variation between them will reveal where action needs to be taken.

Dr Charles Young, Senior Medical Officer, Capita plc., says:

"By clearly explaining the way that each mortality measure is calculated, we provide crucial insight which can be used by Clinicians and Executives to ensure that the most appropriate mortality assessment is being made. This insight is critical to service review and planning."

4 Mortality measurement

4.1 Context

All risk-adjusted hospital mortality measures take into account case mix, that is, the nature and degree of illness within the patient group. The complex 'expected death' calculation is expressed simply as an 'expected' number of deaths. Actual deaths can then be expressed as a percentage of 'expected', taking into account case mix, and to provide a result that is easy to understand: A score higher than 100 per cent suggests more deaths than expected.

Selecting the factors to be taken into account is not straight forward. Experts agree that age, sex, admission type, diagnosis and comorbidity are fundamentally important. Beyond that, however, a variety of other questions might be considered.

- Are five factors enough – is anything more needed?
- Are these factors that demonstrably and consistently increase the risk of death?
- Should only the most reliable data items be used?
- Should only those factors that the hospital cannot control be included?
- Should only those factors that reflect the patient's status on admission be included?
- Should all other fields in administrative data that might affect the risk be included?

There is no single correct answer. All of the above may be 'right' for one purpose, but for a different analysis, one may have overriding importance.

4.2 Common limitations of all models

Whilst useful as a very broad check on patient care in the long term, two important limitations apply to the use of any risk-adjusted mortality model. Users need to understand both of these before reaching any conclusions.

Severity of condition – the missing factor

Severity of the condition is an extremely important factor in estimating risk of death. For example, two stroke patients of the same age and sex may have very different clinical presentations (extent of paralysis, state of consciousness, cognition, etc.) and, thus, different risk of death. Yet these differences are not recorded in administrative data.

A lack of information on severity represents a major limitation of all risk-adjusted mortality models, particularly at individual patient level. In using any of the models at trust level, the implied assumption is that differences in each condition's severity 'average out', and/or that thresholds for admission in terms of severity, are the same across all hospitals. The user needs to be aware that, in the context of their particular analysis, this assumption about severity may or may not be reasonable.

Significance – 1,000 deaths required

Indicators that count events such as death suffer from huge uncertainty. To be confident of a rate (to within 10 percentage points) approximately 1,000 deaths must be included in the dataset. Many smaller hospital trusts have fewer than this number of deaths in a whole year, and analysis of a smaller subgroup of deaths (a specific condition, for example) would require proportionately more years of data before an acceptable degree of confidence about the underlying rate can be reached.

For this reason, mortality rates should never be relied upon as an 'early warning' on their own. In addition, they should always be presented with correctly calculated confidence intervals, such as a funnel plot or equivalent cumulative sum (parabolic) chart.

4.3 Common features of all models

Despite the differences presented and discussed below, there is a high degree of commonality between the three models. All three models take into account the well-established and evidenced primary determinants of risk of death, namely:

- Age (though numbers of groups vary)
- Admission type (elective or non-elective)
- Diagnosis (numbers of groups vary, but all now use CCS[1] as basis)
- Sex (M/F)
- Comorbidity (albeit different methods).

[1] Clinical Classifications System: Also known as Clinical Classification Software. A system of aggregation of detailed diagnosis codes into 260 clinically meaningful summary groups developed in the United States Agency for Healthcare Research and Quality but now adopted worldwide.

4.4 Summary of the three calculations

The table below describes the main features of each model for ease of comparison.

Attribute \ Model	HSMR	SHMI	RAMI
Deaths included (% hospital inpatients)	83%	100% + 30 days after discharge (out of hospital deaths)	100%
Deaths and activity excluded	• Smaller CCS groups • Day cases	• Day cases • Regular attenders • Still births	
Currency	• Super-spells	• Spells	• Spells • Bed days
Coefficient determination	Backward stepwise logistic regression	Backward stepwise logistic regression	Direct measurement of rates per admission and per bed day
Reference data	10 years + England	3 years England (acute excluding specialists)	5 years England, Wales, NI and specialists
Factors included	• Age • Admission • Diagnosis (56 CCS) • Diagnosis sub group • Sex • Comorbidity (Charlson continuous) • Deprivation Carstairs • Palliative care flag • Previous admissions • Year • Month • Admission source	• Age • Admission • Diagnosis (150 combined CCS) • Sex • Comorbidity (Charlson 3-cat) • Year	• Age • Admission • Diagnosis (all 260 CCS) • Sex • Comorbidity (most sig ICD) • Length of stay (chronic condx)
Factors ignored	• Length of stay	• Length of stay • Palliative care flag • Deprivation • Month	• Palliative care flag • Deprivation • Month • Year
Re-based	Annually (2014 spec, though now believed to be quarterly)	Quarterly	Annually

5 HSMR

5.1 HSMR discussion

HSMR (Hospital Standardised Mortality Ratio) is a generic term but is commonly used to refer to the approach taken by Dr Foster®[2]. With Professor Brian Jarman of Imperial College London, Dr Foster® developed and refined the measure that helped identify poor care at Mid-Staffordshire around 2007. It still provides HSMR data to the CQC, which monitors the indicator alongside a much wider suite of indicators related to quality in hospitals. The CQC's current monitoring tool is called CQC Insight, which replaced intelligent monitoring.

CHKS has created a version of HSMR using Dr Foster's® published specification, together with approximately five years of Hospital Episode Statistics (HES) data to which CHKS has access. The CHKS version of HSMR may differ in detail from Dr Foster's® calculated values, particularly at patient level. For more detail on the CHKS HSMR, see the separate document 'CHKS HSMR Description V1 May 2018'.

Key distinguishing features of HSMR:

- Includes more starting variables than the other models. It is the only model to consider:
  - diagnosis sub-group
  - patient deprivation (Carstairs method)
  - whether the patient received a palliative care code during their stay
  - which month of the year the patient was admitted in
  - how many times during the previous 12 months the patient had been admitted
  - the patient's source of admission.
- Covers fewer deaths than the other two models. The method covers 56 major CCS groups out of 260, and consequently includes 83 per cent of all hospital deaths.
- Aggregates provider spells into a single super-spell if patients are transferred to other providers before calculating risks. If death occurs, it is counted against each provider.

You should consider using HSMR when:

- Case mix within CCS groups (i.e. between CCS sub groups) may be significantly different from the average. By including sub group as a starting variable, HSMR effectively further sub divides some or all of its CCS groups into sub categories. Other models don't do this.
- Patient deprivation is different from the average, and is something that should legitimately be taken into account when calculating risks.
- Palliative care is assigned to patients locally in accordance with national guidance and norms, is consistent with the average assignment in peer trusts, and is a reflection of the patient's condition only on admission.
- Taking into account seasonality is necessary (e.g. when monitoring a period that is not a whole number of years).
- The number of previous admissions and/or the source of admission both systematically and significantly affect the risk of death.

[2] Developing the measure - Jarman B, Gault S, Alves B, et al. Explaining differences in English hospital death rates using routinely collected data. BMJ 1999;318:1515–20.
Poor care at Mid-Staffordshire – Carter P, Jarman B Who knew what, and when, at Mid Staffs? BMJ 2013;346:f726

6 SHMI

6.1 SHMI discussion

SHMI (Summary Hospital-level Mortality Indicator) was developed by a cross-industry group of experts (including Dr Foster® and CHKS) to try to agree a single measure of mortality that all stakeholders would support. Despite this, several years on from its introduction, the two other models are still demanded by trusts.

SHMI reports on mortality at trust level across the NHS in England using a standard and transparent methodology. It is produced and published quarterly as an official statistic by NHS Digital.

Key distinguishing features of SHMI:

- Counts more deaths than other models. Deaths are counted even when they occur up to 30 days after the patient has been discharged from hospital. These deaths are attributed to the condition of the patient in the last hospital admission, irrespective of the actual cause of death.
- The official measure: Developed and maintained by the government for the NHS England.
- Results published by NHS England every quarter, counting deaths from the previous 12 months.
- Trusts have to wait for official results to be published (so cannot monitor themselves in real time).
- Uses a shorter reference period (three years) than the other models, so is based on fewer observations. Coefficients are therefore slightly more up-to date.

You should consider using SHMI when:

- Some discharges may have been premature. Only SHMI captures deaths after discharge and is, therefore, the only measure sensitive to cases where the patient was potentially discharged early and then died after discharge.
- Community service provision is unequal. To some extent, counting out of hospital deaths may also compensate for where community services (e.g. hospice provision) differ between regions.
- The CQC also monitors the SHMI within its CQC Insight tool.
- Hospitals need to be able to respond to published performance figures and associated media interest.
- Risks of death are changing quickly so a relatively short but recent observation period is required.

7 RAMI

7.1 RAMI discussion

RAMI (Risk Adjusted Mortality Index) is CHKS's approach to measuring hospital mortality. It was re-designed in 2017 specifically to avoid sources of inconsistency in the calculation of expected deaths. It does this by disallowing exclusions, ignoring certain known inconsistently coded attributes, and focusing on relatively noiseless attributes such as patient age, sex, admission type and length of stay. As it no longer uses logistic regression, its coefficients can be expressed simply as meaningful measures in their own right.

Key distinguishing features of RAMI:

- No exclusions – all inpatients and deaths are included.
- Includes occupied bed days as a currency in addition to the number of spells, to consider length of stay for chronic conditions. Integrated care providers, for example, keep such patients for longer, and only RAMI makes an appropriate adjustment for this.
- Measures risks directly from the proportion of patients who died in the reference group. Uses forward stepwise modelling so that most important and consistently known factors are considered before anything else.
- Uses reference data from Wales and Northern Ireland in addition to England.
- Has a selective approach to comorbidity. Individual secondary diagnoses are scanned for the most significant. Palliative care and other secondary diagnoses, which may indicate cause of death rather than condition on admission, are ignored.

You should consider using RAMI when:

- Reference data should be as general as possible, including Wales and Northern Ireland as well as just England, and specialists as well as general hospitals.
- Greater confidence (specificity) is required as to which comorbid conditions have been included (excluded) in the uplift of risk (than is implied by the Charlson comorbidity index).
- Understanding how the expected deaths figure has been calculated is as important as the result itself.
- Local lengths of stay are systematically different from the average for some conditions.