Understanding Your Hospital Performance Metrics

What are RAMI, SHMI and HSMR and how they can support learning from deaths?

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Contents

Data provided by patients and collected by the NHS as part of their care and support. Where HES data is used, it is with the permission of NHS England.

CHKS

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We bring insight and expertise to help you deliver cost-effective, safe care and provide assurance that you are committed to the highest levels of quality and improvement.

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1 Executive Summary

1.1 Across the UK clinicians and hospital leaders need assurance that the number of patients who die in is not higher than would be expected. Simply counting the total number of patients who have died does not take account of how ill patients were before coming to hospital, or the nature of the treatments that they undergo while staying in hospital.

1.2 Board members, managers and clinicians should use risk adjusted mortality measures as tools to predict the number of patients you would expect to die and ensure that services are providing excellent care and not resulting in unexpected deaths.

1.3 In the UK there are three common measures in use which use historic data and statistical modelling in slightly different ways. These are:

- RAMI – Risk Adjusted Mortality Index
- SHMI – Summary Hospital-level Mortality Indicator
- HSMR – Hospital Standardised Mortality Ratio

What does each measure do and which one to use?

1.4 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 by each.

	RAMI	SHMI	HSMR
Reference data	▪ 5 years - all diagnoses	▪ 3 years - all diagnoses	▪ 5 or 10 years[1] – most diagnoses (80%)
Adjusted for	▪ Age / Sex / Admission method ▪ 262 diagnosis groups ▪ Comorbidity evidence-based on individual diagnoses ▪ Length of stay in hospital	▪ Age / Sex / Admission method ▪ 142 diagnosis groups ▪ Comorbidity based on cumulative Charlson score ▪ Year and month of stay ▪ Deaths 30 days after discharge	▪ Age / Sex / Admission method ▪ 56 diagnosis groups plus subgroups ▪ Comorbidity based on cumulative Charlson score ▪ Year and month of stay ▪ Deprivation ▪ Palliative care flag ▪ Previous admissions ▪ Source of admission

1.5 CHKS advise that monitoring all three measures through iCompare gives the best result to monitor mortality and support learning from deaths reviews.

RAMI good for…	SHMI good for…	HSMR good for…
Complex populations where the model of care varies between providers or expected deaths are sensitive to comorbidities.	Where deaths may be occurring after discharge, or the model of care has recently changed so needs a shorter reference period.	Some specific conditions where more detail on deprivation and admission type and history may impact the expected deaths.

[1] CHKS hold 5 years of data for HSMR, but the original measure was based on 10 years of data.

2 Introduction to risk adjusted mortality measures

2.1 Risk adjusted mortality measures are used to help hospital providers look at the number of deaths that occur in a hospital and compare this to the number that would be expected.

2.2 Crude mortality, typically expressed as number of deaths per 1,000 admissions, does not account for any differences between patients admitted to hospital and makes comparison between different hospitals or parts of a hospital difficult.

2.3 Instead of crude mortality risk adjusted mortality measures account for the variability of patients by looking at their diagnoses, their treatment and other risk factors to predict how likely they are to die during a stay in hospital. In the UK there are three risk adjusted mortality measures most commonly used; the methods underpinning each are different. The three measures are:

- RAMI – Risk Adjusted Mortality Index
- SHMI – Summary Hospital-level Mortality Indicator
- HSMR – Hospital Standardised Mortality Ratio

2.4 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. 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 statistical methodology employed.

2.5 This document aims to clarify the individual strengths of each measure or indicator and how they differ in their respective calculation of 'expected deaths', and how they do this, so users can use them in the most effective way.

2.6 All three risk adjusted measures have their own limitations and as a result all should be used as part of the local learning from deaths programme. 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 be a need to reassess whether the same measure can be relied on to highlight what is happening on wards. Measures can be used in combination and in most cases this will reveal more clearly where action needs to be taken.

2.7 By clearly explaining the way that each risk adjusted 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.

3 Using historic data to predict expected deaths

3.1 For any group of patients, it is quite straight forward to work out the death rate as the number of patients who died as a proportion of those admitted. This can be used to calculate the death rate for each year, or month and compare changes over time provided the patient group remains similar, as shown below.

$$\frac{Actual\ deaths}{Admitted\ patients} = Death\ rate$$

3.2 However, if you want to compare between different groups of patients, such as in different specialties or the same specialty from different hospitals, this simple method will not work as it does not account for the variation in the patient groups. For example, you would expect the number of patients who die while undergoing complex heart surgery to be higher than those who are admitted to hospital for a simpler diagnosis such as a hernia, or that a patient group with a greater number of elderly and infirm patients would have an increased death rate.

3.3 To compare death rates between different patient groups all three risk adjusted mortality measures predict the expected number of deaths for a patient group and compares this to the actual observed deaths to create a ratio using the method illustrated below:

$$\frac{Actual\ deaths}{Expected\ deaths} = Risk\ Adjusted\ Mortality\ Measure$$

3.4 This simple ratio makes comparison between quite different groups of patients easy to understand. RAMI and HSMR express this ratio as a number relative to 100, and SHMI bases the ratio as a decimal number relative to one. For example, if there were 110 actual deaths observed and the expected number of deaths was 100 then both RAMI and HSMR would return values of 110 and SHMI would return a value of 1.1.

3.5 These measures differ in the period and source of the data each uses to determine the number of expected deaths, the characteristics chosen to predict deaths (age, sex etc.) and the statistical methods used.

4 How risk adjusted mortality measures differ

4.1 All three common measures differ in the way they calculate the expected number of deaths around three principal features: reference data, patient characterisation and statistical method. These differences help define which measure might be best for specific uses and is outlined in the table below.

	RAMI	SHMI	HSMR
Reference data	▪ 5 years ▪ England, Wales & Northern Ireland	▪ 3 years ▪ England (excludes specialist hospitals and hospices)	▪ 10 years[2] ▪ England
	▪ 100% hospital deaths	▪ 100% hospital deaths + deaths in 30 days of discharge	▪ Approximately 80% hospital deaths (most common diagnoses)
	▪ Spells and bed days	▪ Spells	▪ Super spells[3]
	▪ Covid included	▪ Covid included	▪ Primary Covid diagnosis excluded
	▪ Excludes: ▪ None	▪ Excludes: ▪ Day cases, ▪ Regular attenders ▪ Still births	▪ Excludes: ▪ Smaller diagnostic groups ▪ Day cases
Patient Characterisation	▪ Age / Sex	▪ Age / Sex	▪ Age / Sex
	▪ Age / Sex	▪ Age / Sex	▪ Age / Sex
	▪ Admission Method	▪ Admission Method	▪ Admission Method
	▪ 100% patients - 262 CCS Diagnosis Groups[4]	▪ 100% patients – SHMI Groups (cluster of CCS groups)	▪ ≈ 80% patients – 56 diagnostic groups plus some subgroups
	▪ Comorbidity –based on diagnoses shown to increase mortality	▪ Comorbidity – based on Charlson Score	▪ Comorbidity – based on Charlson Comorbidity Index
	▪ Additional: ▪ Length of stay (adjusts for more bed days)	▪ Additional: ▪ Admission Year/Month ▪ Birthweight	▪ Additional: ▪ Deprivation ▪ Palliative care ▪ Previous admissions ▪ Source of admission ▪ Admission Year/Month
Statistical Method	▪ Actual mortality in patient groups adjusted for bed days	▪ Multiple variable logistic regression	▪ Multiple variable logistic regression

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2 HSMR was originally based on 10 years HES data, but only five years data is available for calculation

3 Super spells are based on continuous stays in hospital where a patient may be transferred between different providers

4 The diagnostic groups used are based on the primary diagnosis for the patient admission and may not be the cause of death

5 Understanding RAMI

5.1 RAMI (Risk Adjusted Mortality Index) is CHKS's approach to risk adjusted mortality monitoring which compensates for length of stay in hospital. Developed to support mortality monitoring across the UK and not just in England it is designed based on actual death rates in patient groups and avoids sources of inconsistency in the calculation of expected deaths. RAMI is the only measure to determine absolute risks and does not rely on logistic regression. RAMI does not exclude any patients or patient groups and focuses on relatively noiseless attributes such as patient age, sex, admission type and length of stay.

Key distinguishing features of RAMI

5.2 Predicts expected deaths directly from the proportion of patients who died in the past. Rather than using a statistical model to infer risk coefficients, RAMI groups patients according to their characteristics and predicts risk based directly by how many patients in the same group died in the reference period.

5.3 Includes bed days. Evidence shows that for some conditions the longer a patient is in hospital the greater their risk of dying. For example, some providers also have integrated care beds and will look after some groups of patients longer than other solely acute focussed providers. RAMI adjusts the number of expected deaths to compensate for this variation.

5.4 Effect of comorbidity calculated based on individual diagnosis evidence base. The impact of 99 comorbidity conditions has been calculated based on how these conditions have independently impacted on mortality. Rather than using an aggregate comorbidity score the impact of individual diagnoses are used to determine the expected number of deaths.[5]

You should consider using RAMI when:

- You need to understand mortality rates across all patients and diagnoses, and you need to quickly identify any anomalies or trends that require a detailed mortality review.
- Where length of stay is likely to have an impact on mortality, such as where the model of care is not the same as most other providers in the peer group.
- Understanding how the expected deaths figure has been calculated and the impact of comorbidities has been assessed based on individual conditions.
- You would like to compare data from Wales and Northern Ireland as well as England.

[5] Aggregated comorbidity scores cannot reflect the impact from individual conditions. For example, CHKS research has shown that a comorbidity diagnosis of hypertension can reduce the expected risk of death - contrary to the expected outcome.

6 Understanding SHMI

6.1 SHMI (Summary Hospital-level Mortality Indicator) was developed by a cross-industry group of experts (including CHKS) to try to agree a single measure of mortality that English stakeholders would support. Despite this, several years on from its introduction, the two other models are still in use with trusts due to their benefits. SHMI reports on mortality at trust level across the NHS in England using a standard and transparent methodology. It is produced and published monthly as an official statistic by NHS England.

Key distinguishing features of SHMI

6.2 Includes patients who die after discharge from a provider 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.

6.3 Results published by NHS England every month, counting deaths from the previous 12 months. SHMI relies on collation of additional data meaning Trusts cannot monitor performance until publication which is often three months after the other measures.[6]

6.4 Uses a shorter three-year reference period - so is based on fewer observations, but coefficients are slightly more up to date.

6.5 CQC monitors the SHMI - included in the CQC Insight tool.

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.
- 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.

[6] CHKS have developed an in Hospital SHMI which will calculate SHMI without post discharge deaths allowing Trusts to monitor SHMI in real time.

7 Understanding HSMR

7.1 HSMR (Hospital Standardised Mortality Ratio) is a generic term but is commonly used to refer to the approach initially developed and refined in 2009 by the Dr Foster Intelligence Unit at Imperial College.[7] CHKS have adopted this methodology based on the most recent five years of HES data.

Key distinguishing features of HSMR

7.2 Is the only model to include adjustments for:

- Deprivation – based on Carstairs method
- Recording of palliative care
- Source of admission
- Seasonality – which month of the year the admission occurs
- Number of previous admissions
- Diagnosis sub-group[8]

7.3 Uses data from fewer deaths than the other models. This method only includes deaths from 56 of the 262 diagnosis groups, approximately 80% of all deaths.

7.4 Groups risk at a super-spell level looking at time at multiple providers before calculating expected deaths (deaths are recorded against all providers in the super-spell).

You should consider using HSMR when:

- Deprivation has a significant impact on expected deaths and can be aggregated at a suitable level to allow comparison.
- Palliative care recording will have an impact on expected deaths and is recorded consistently in both the target and peer groups.
- The number of previous admissions and/or the source of admission both systematically and significantly affect the number of expected deaths.
- There is a particular sub-group of patients that you need to review.

[7] Aylin P, Bottle A, Jen M, Middleton S (2009) HSMR mortality indicators

[8] Using sub-groups can increase sensitivity for particular patient groups. For example, unlike the other measures HSMR uses subgroups to differentiate between vascular and ischaemic strokes allowing for closer monitoring for these patients.

8 Risk adjusted mortality measure limitations

8.1 Risk adjusted mortality measures provide a valuable tool in delivering a systematic approach to identifying those deaths requiring review and in ensuring that mortality reporting in relation to deaths, reviews, investigations and learning is regularly provided to hospital boards. However, these measures do not account for variation that is not built into their design and some significant predictors of mortality are not included in the hospital data that is used to create the tools. These are outlined in the table below.

Common limitations of risk adjusted mortality measures	
Accuracy of Clinical Coding	The data used to calculate risk adjusted mortality scores depend on accurate, compete and timely clinical coding, that is delivered to a high standard. All relevant clinical information must be accurately and consistently recorded in both target and peer data. For example, if some co-morbidities have not been recorded, the risk adjusted mortality measures will not accurately reflect the expected deaths.
Population Size	Risk adjusted mortality measures are designed to work across a large population, so when looking at smaller patient groups over relatively short periods of time a small number of random deaths could be highlighted as an anomaly. For example, if for a particular patient group there are 100 expected deaths it would be within the statistical confidence limits for the actual deaths to be between 70 and 130 deaths. The greater the sample group the greater the confidence in drawing any conclusion from mortality rates.
Statistical Method	Some data can have a significant impact on the expected death rate which is not collected in hospital episode statistics data. 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. Variables which have a significant impact but are not collected include: ▪ Severity of illness ▪ General health (fitness, nutrition, hydration, BMI, smoking status) ▪ Blood pressure ▪ Mental health
Models of Care	Hospitals and providers adopt slightly different care models this can lead to systemic differences entirely unrelated to the characteristics accounted for in the risk adjusted mortality measures. For example, providers delivering a fully integrated end of life pathway may have different outcomes to those providing only part of this pathway.
Independence of rare events	When observing rare events, the occurrence of one rare event has no impact on the likelihood of another occurrence in a short period of time. Therefore, it is possible to have a run of deaths in a particular patient group which has no underlying root cause. Over longer periods of time this will be regress to the mean, but random chance cannot be eliminated

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