

International HSMRs Academy Working Group Report to Professor Sir Bruce Keogh

February 2015

Executive Summary

Background

At the end of 2013 Professor Sir Bruce Keogh asked for an independent view from the Academy on behalf of the medical profession on how they see the data on UK and USA hospital death rates based on HSMRs produced by Professor Sir Brian Jarman.

The Academy brought together a distinguished group of clinicians from Colleges with an understanding of these issues along with expert advisors to consider and discuss the data. Professor Jarman was engaged throughout the process and his input sought although the report is the product of the Academy group alone.

The full report of the working group is attached as Annex A and the membership of the group as Annex B.

Conclusions

The question asked of the Academy was whether HSMR can be relied upon to make comparisons between hospitals in the NHS and between hospitals in other countries.

Following the detailed consideration and discussion it was the clear view that HSMR in its own right is subject to a number of limitations.

Furthermore, without the full data set that Sir Brian Jarman has utilised in his analysis being subject to independent peer review to see how much these variables affect the HSMR in making comparisons, it cannot be concluded that the quality of care in an American hospital is superior to that of an NHS hospital.

Differences in US and UK healthcare

We identified a number of differences that represent considerable challenges to compare US hospital and UK Hospital mortality rates. They are summarised here but a more detailed analysis is covered in the full report.

These include:

- Differences in diagnostic practices: use of lower risk diagnoses in England patients are less likely to be assigned high risk in England as opposed to the USA. The most striking example is the use of 'septicaemia' as the primary diagnosis: in England it is 4.5 per 10 000 admissions but in the USA it is about 8-fold higher at 35 per 10000.

This trend in the USA is thought to be driven by reimbursement considerations where there are greater financial incentives to place patients in a higher risk which would skew the HSMR as lower in the USA.

The impact of differences in diagnostic practice will have a dramatic effect on the HSMR

- Difference in number of secondary diagnoses: fewer recorded in England. There are again discrepancies in the recording of secondary diagnoses. There has always been a serious under recording of secondary diagnoses (co-morbidity) in HES in England. In contrast, in the USA where there are financial incentives to include co-morbidities in the hospital information system, a third of admissions have 10 or more recorded. As a result, patients in England appear to be at much lower risk of death than those in the USA which again will skew the results towards a worse HSMR in the UK.

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- Differences in severity: patients in England may be sicker. Comparisons based upon administrative data (HES and NIS) are not able to provide any information on the severity of patients' primary condition. But there is some evidence that on admission patients in England are more severely ill than in the USA and thus at higher risk of death.
 - Proportion of population deaths in acute hospitals: The proportion of patients who die in acute hospitals is higher in England and Wales (56%) than in the USA (45%). This matters because higher proportions of deaths occurring in hospital are known to be associated, albeit weakly, with higher HSMRs.¹⁰

Choice of statistical methods

In addition to the aforementioned differences in the data used to compare England and the USA, further uncertainty arises from the choice of statistical methods used for estimating HSMRs from these data. The relative HSMRs for England and for the USA will depend on the risk adjustment model used. There are four concerns:

- Choice of factors included in the risk adjustment model.
- Choice of data used to derive the model
- Choice of hospitals included from each country
- Choice of assuming same level of underlying risk in both countries

These are explained in detail in the full report.

How might valid comparisons be made?

That is not to say that HSMR cannot ever be useful. Where there are outliers and particularly high mortality rates in hospital it could serve as a useful tool for further investigation and evaluation i.e. HSMR should be used as a "smoke detector" to generate a signal, not as the definitive answer.

There are also a number of other areas that were brought to the attention of the group from the existing literature on HSMR during the review which merit consideration moving forward. There is little correlation between how well a hospital performs on one standard of safe effective care and how well it performs on another. This is reviewed in a 2010 BMJ analysis paper "differences in quality of care within hospitals themselves are much greater than differences between hospitals".¹

Hospitals are more likely to fail on specifics - pathology in Liverpool, paediatric cardiac surgery in Bristol for example.^{2,3}

Sir Brian has cooperated fully with the review in responding to all the questions posed. Although he agrees that numerous variables will influence his HSMR calculations, he feels this will be of a small magnitude that wouldn't make a major difference to his conclusions. There are two limitations to this. The first is that only Sir Brian Jarman has access to the raw data which he is obliged to keep confidential which hinders independent scrutiny. We recognise that he has signed confidentiality agreements and are not expecting him to breach those. The second is that there is already in existence extensive literature that highlights that HSMR is only one marker of health care quality and does not have primacy.

To move forward, we would recommend that studies are commissioned to establish whether there are systematic differences in the quality of hospital care between the two countries. Perhaps the focus should shift towards outcomes (other than hospital mortality) and clinical processes. This would require detailed comparisons of matched sets of patients with the same primary diagnosis in both the UK (or England) and the USA (or another first world comparator country). This would be more useful to NHS England than broad HSMR comparisons because of the methodological concerns set out in more detail in the appendix.

Comparison of HSMRs for England and USA

On 11 September 2013, Professor Sir Brian Jarman stated in the media that the likelihood of dying in NHS hospitals in England was higher than in hospitals in the USA. Specifically, he stated that risk-adjusted mortality was 45% higher in 2012. Based on the data he made publicly available, augmented by methodological information he provided in response to our requests, we have carefully considered the scientific basis of his claims.

The comparisons he made were based on routine hospital data publicly available in each country: in England the Hospital Episode Statistics (HES)¹ and for the USA the Nationwide Inpatient Sample (NIS)² - a 20% stratified sample of community hospitals (short-term non-federal hospitals, accounting for 97% of all acute admissions in the USA).

In a meeting with Mike Campbell and Terence Stephenson, Sir Brian Jarman acknowledged the problem arising from his confidentiality agreements which precluded scrutiny of the data and peer review.

We have considered two key aspects of the comparisons: the accuracy and comparability of the two datasets; and the choice of statistical method (the risk adjustment model).

Comparability of the English and US data

HSMR is a ratio and depends on dividing actual numbers of deaths by expected numbers of deaths. Therefore, a lower HSMR might be a reflection of genuine lower mortality (the numerator) but also could be due to a higher predicted mortality (the denominator). An apparent lower HSMR in another country could arise because not all deaths are counted in the same way or because of a higher predicted mortality. This could arise because the risks of death for a particular diagnostic group for admitted patients are different since the model for calculating this depends heavily on coding which can vary between countries.

There are four reasons why a comparison of England and the USA based on the data sources HES and NIS seems likely to erroneously lead to estimates of HSMRs that are higher in England.

Differences in diagnostic practices: use of lower risk diagnoses in England

Patients in England are less likely to be assigned a high-risk diagnosis than in the USA. The most striking example is the use of 'septicaemia' as the primary diagnosis: in England it is 4.5 per 10,000 admissions but in the USA it is about 8-fold higher at 35 per 10,000.^{1,2}

The impact of differences in diagnostic practice will have a dramatic effect on the HSMR, as is illustrated in the Appendix. For example, suppose there were no actual differences in mortality between the two countries. Then those patients who were classified as having septicaemia in the USA but would not have been given this diagnosis had they been in England, have the same outcomes but appear to be higher-risk in the USA. Even a three-fold higher use of septicaemia in the USA can be shown to result in the HSMR in England being 1.24 compared to 1.00 in the USA.

Over the past decade, the tendency in the USA to use high-risk categories has increased ('up-coding'): from 1997 to 2011 septicaemia rose by 132%.³ This was achieved by less use of lower risk diagnoses: between 2003 and 2009 pneumonia decreased by 28% while septicaemia with a secondary diagnosis of pneumonia increased by 178%.

This trend in the USA is thought to be driven by reimbursement considerations; between 2001 and 2010 use of higher paid diagnostic categories (which also have a higher risk of death) increased from 27% to 48%.^{4,5}

In a meeting with Mike Campbell and Terence Stephenson, Sir Brian Jarman acknowledged there were differences in coding practices between the USA and the UK. In particular, he agreed that the diagnosis of septicaemia was used more frequently in the USA than the UK. However, his view was that this would make little difference to the overall HSMR. Figures that Sir Brian gave suggested that admissions for septicaemia (except in labour) were 21 per 10,000 for the UK and 117 per 10,000 for the USA, which differ from the data in references 1 & 2 quoted above (the difference was unexplained) but still show a big variation in the two countries which is unlikely to be due to a difference in the true prevalence of the disease. Sir Brian's data show that the percentage of deaths due to septicaemia is 50% greater in the US, but what is needed is the death rate. From the ratio of death rates to admission $(3.07/1.97) / (1.17/0.21) = 0.28$ which suggests a patient has about one quarter the risk of dying from septicaemia in the USA compared to UK, suggesting a different severity for this label in the UK. It seems unlikely that all of this is due to poorer care in the UK and is more likely that 5 out of 6 people diagnosed with septicaemia in the US would not have been given this diagnosis in the UK.

Difference in number of secondary diagnoses: fewer recorded in England

There has always been a serious under recording of secondary diagnoses (comorbidity) in HES in England. Despite some improvement over time⁶, in 2009-12 HES reported that only 27% of patients undergoing hip replacement surgery had any secondary diagnoses compared with 78% according to patients' own reports:

Number of comorbidities	Proportion of patients in HES	Proportion of patients in PROMs ⁷
0	78	22
1	22	53
2	4	19
3 or more	0.7	6

Although using a similar information system in Scotland, it was found in 2007 that only 58% of people known to have diabetes had that diagnosis recorded in their hospital admission record.⁸

In contrast, in the USA where there are financial incentives to include comorbidities in the hospital information system, a third of admissions have 10 or more recorded. As a result, patients in England appear to be at much lower risk of death than those in the USA:

Number of secondary diagnoses recorded	Proportion of patients in USA 2011 (NIS)	Proportion of patients in England 2010-11 (HES)
None	4.2	23.7
1	8.5	22.1
2-3	15.5	26.3
4-6	20.2	18.6
7-9	18.8	6.4
10 or more	32.8	2.9

In England, under the Payment by Results tariff, there is also an incentive for NHS Trusts to increase their income by coding conditions in more detail and as more severe. However, this potential for 'gaming' the system does not seem to have had the same effect as it has in the USA. This might be because in the USA it may actually affect physicians' salaries in a way it does not in the UK but this is speculation.

In a meeting with Mike Campbell and Terence Stephenson, Sir Brian Jarman agreed that more co-morbidities were coded in the USA than the UK. However, his view was that the major patient determinants of HSMR were age, emergency vs elective and primary diagnosis and that co-morbidities made much less of a difference.

It is true that comorbidity as such does not contribute much to total HSMR. However changes in coding can have an effect. In a recent paper (Jacques RM, Fotheringham J, Campbell MJ, Nicholl JP (2013) Did hospital mortality in England change from 2005 to 2010? A retrospective cohort analysis. BMC Health Services Research, 13, 216) it was shown that over a 5 year period the Summary Hospital-level Mortality Indicator (SHMI) fell by 24% when adjusted for comorbidity and only 18% when not adjusted for comorbidity.

Differences in severity: patients in England may be sicker

Comparisons based on administrative data (HES and NIS) are unable to provide any information on the severity of a patient's primary condition, despite this being a key determinant of their level of risk of death. For example, a diagnosis of pneumonia does not distinguish between an early mild condition with a low risk of death and established severe disease with considerable risk of death.

This wouldn't matter if the severity of patients admitted was the same in the two countries. But there is evidence that on admission patients in England are more severely ill than in the USA, partly due to less provision of services in England. For example, patients admitted to critical care in England are much sicker.⁹

- Acute Physiology Score 16.7 in England compared with 10.6 in the USA
- Proportion ventilated within 24 hours: 68% in England v 27% in USA

Two administrative or funding reasons that contribute to patients in hospital in England included in the analyses being sicker and thus at higher risk of death than those in the USA are:

- HES does not include English patients who chose to pay for treatment by private providers (approximately 450 000 a year, excluding day cases) who are likely to be less severely ill and at low risk of death. In contrast, US data includes all patients and providers regardless of funder.
- Among NHS funded patients, those treated by private providers (independent hospitals; independent sector treatment centres) are less likely to be included in HES, particularly in earlier years. Again, these patients are likely to be less severely ill; in the case of Independent Sector Treatment Centres reflecting a deliberate policy. According to The King's Fund, 13 per cent of all elective surgery (non-emergency surgery) on UK residents was privately funded in 2011.

In a meeting with Mike Campbell and Terence Stephenson, Sir Brian Jarman said that we simply do not know whether UK patients are more sick or less sick. Only Japan records a measure of severity at admission (a measure of Activities of Daily Living). Given that health insurance is not universal in the USA, and therefore the financial deterrent to presenting to hospital early, he argued that patients in the USA could be sicker at admission.

Proportion of population deaths in acute hospitals: higher in England

This is another possible contributor. While in both countries acute hospitals have become places where patients go to die, a higher proportion of people die in hospital in England & Wales (56%) than in the USA (45%).¹¹ This matters because higher proportions of deaths occurring in hospital are known to be weakly associated with higher HSMRs.¹⁰

One reason for a higher proportion of deaths in hospital in England is the relative lack of alternative, more appropriate, provision.¹¹ Whereas in England only 5% of patients in acute hospitals are transferred to alternative care facilities (eg. domiciliary care, hospices, and intermediate care), this occurs for 30% in the USA.

Between 1997 and 2010, increases in discharges to intermediate care (by 37%) and home health care (by 79%) in the USA, were responsible for a 13% decline in the proportion dying in acute hospitals. A key contribution has been the increase in number of 'long-term acute hospitals' which rose from 192 to 408 (8.8% pa) between 1997-2006. These facilities do not just accept patients who require rehabilitation and general nursing care but also patients directly from critical care facilities which rose from 38.1 to 99.7 per 100 000 transfers. This increasingly high risk group is reflected in the rising number of co-morbidities (average of 5.0 to 5.8) and the proportion who still required mechanical ventilation (rose from 16.4% to 29.8%). Not surprisingly, their one year mortality is high and rose over that period from 50.7% to 52.2%.¹²

In a meeting with Mike Campbell and Terence Stephenson, Sir Brian Jarman said that the three major system determinants of HSMR were the number of hospital doctors per thousand hospital spells, the number of doctors per 1000 population and percentage of deaths which occurred in hospital. However, in relation to the latter, when he adjusted his model so that the percentage of deaths in hospital in the UK was the same as in the USA, this made less than 5% difference to HSMR.

Sir Brian Jarman has kindly sent Mike Campbell his analysis. Based on 147 Trusts in England he found an unweighted average of 58% of deaths occurring in hospital. He did a weighted linear regression of HSMR versus the three independent variables. He found that the coefficient associated with the proportion of deaths in hospital was 0.48 and used the fact that according to the preliminary report, there was a difference of 11% between the UK and the US in percentage of deaths in hospital to conclude that the difference in the UK and US would account for only 5% ($0.48 \times 0.11 \times 100$) of the HSMR. However, the range of proportions of deaths in hospital from hospital trusts in England ranged from 47% to 72%, which excludes the US average. It is extremely dangerous to extrapolate beyond the data, particularly to a different data set.

Finally, it is easy for the public to misinterpret HSMR as equating to risk of death overall. The public may not be aware that in both the USA and UK, only around half of all deaths occur in hospital. ONS data shows that at all ages up to 75, the chance of an individual dying is less in the UK than the USA. It is only over the age of 75 that the chance of dying in the UK exceeds the USA.

Death rates per 1000 by age group in 2004 for UK and USA (source ONS/CDC)

Number of comorbidities	Age group					
	35-44	35-44	55-64	65-74	75-84	85+
UK	1.2	3.0	7.3	20.1	57.2	160.4
USA	1.9	4.3	9.1	21.6	52.8	128.2

Choice of statistical methods

In addition to the aforementioned differences in the data used to compare England and the USA, further uncertainty arises from the choice of statistical methods used for estimating HSMRs from these data. The relative HSMRs for England and for the USA will depend on the risk adjustment model used.

There are four concerns:

Choice of factors included in the risk adjustment model

The factors included were patients': age; sex; emergency/elective admission; co-morbidity (Charlson Index); diagnosis (259 CCS groups) and sub-diagnoses. Three factors known to be associated with the risk of hospital mortality that were not included are: the severity or acuity of the patient on admission; the patients' level of social deprivation; and the readmission rate.¹³

In a meeting with Mike Campbell and Terence Stephenson, Sir Brian Jarman said that we simply do not know whether UK patients are more sick or less sick than in the USA. Using a different dataset from self-selected, large medical centres in the USA, UK and one other country, the re-admission rate had little impact on HSMR.

Choice of data used to derive the model

The risk-adjustment model was derived from data from seven countries for 2004, only two of which are identified (England and USA). A different choice of countries could lead to a different model and, as a result, different estimates of HSMR for England and the USA.

The contribution that each of the seven countries made to the 2004 data on which the model was based differed due to differences in the volume of patients admitted. Weighting the data to take this into account could affect the results.

In a meeting with Mike Campbell and Terence Stephenson, Sir Brian Jarman said that weighting did not make much difference, but in view of the disparate sizes of the countries involved (we were permitted to see some of the other countries involved but not divulge their names) this seems unlikely but without actual numbers one cannot tell.

Choice of hospitals included from each country

The types of patients included in each of the seven countries that contributed to the model varied considerably suggesting that either the type of hospitals included in each country was not consistent (eg proportion of those aged 0 - 4 years 0.0 - 14.2%; aged 85 or above 4.6 - 10.1%; male 41.8 - 58.9%) or the way admissions were defined varied (eg emergency admissions 29.4 - 80.8%). In a meeting with Mike Campbell and Terence Stephenson, Sir Brian Jarman said that given that his model has such a high c-statistic (a measure of how well a model discriminates between countries) that these differences are allowed for. However, a c-statistic has a number of problems as a measure of goodness of fit¹⁶. At its simplest a c-statistic measures the probability that a randomly chosen patient who dies will have a higher score than a randomly chosen patient who does not die. If the incidence of deaths is low, this will still mean that there are many more patients who do not die with scores higher than patients who do die.

Choice of assuming same level of underlying risk in both countries

The model uses indirect standardisation which assumes a constant risk across countries. For example, to compute the expected values it is assumed that a 60 year old British man, all other things being equal, has the same risk of death as a 60 year old American man. This assumption is known as the 'constant risk fallacy' and may affect the relative HSMRs derived for the two countries as shown in the Appendix.¹⁴

The impact that these choices can have was demonstrated when four models for deriving standardised mortality ratios were applied to hospitals in Massachusetts. Twelve of 28 hospitals that had higher-than-expected hospital-wide mortality when classified by one method had lower-than-expected mortality when classified by one or more of the other methods.¹⁵

In a meeting with Mike Campbell and Terence Stephenson, Sir Brian Jarman referred to earlier work, which showed that using direct standardisation, which avoids the constant risk fallacy, and indirect standardisation which is what the HSMR uses show similar results. Work on the SHMI also showed them to be comparable. However, this is a within country comparison, and is no guarantee that it is valid between countries. Standardisation tries to allow for the fact that different groups will have different proportions of subjects in each of the risk categories. However the crucial assumption, which is required for indirect standardisation is that within a category (eg age/sex/diagnosis) the risks are the same between groups. This has been shown to be false for septicaemia, and is unknown for other diagnoses. Both methods also require that all possible confounders are measured and used in the standardisation, which as we have seen, is an unlikely proposition.

How might valid comparisons be made?

We do not believe that the comparisons are valid because of the reasons we have given. More rigorous analyses using more clinically sophisticated data need to be used. This reflects the conclusion of a recent paper from the Dr Foster Unit which stated: 'There are considerable challenges in combining administrative databases across countries, with decisions to be made regarding definitions of inpatient admissions and diagnosis and procedure groups. Interpreting the resulting case mix-adjusted in-hospital outcome rates across international boundaries is hampered by differing discharge policies and intermediate care facilities. Standard statistical models cannot take account of this without valid and complete post discharge information'.

One of the key issues is that we have no measure of the uncertainty attached to the estimate of 45%. On a simplistic level, it is quite accurate because it is based on large numbers, but uncertainty in almost all the key assumptions used in its derivation mean that we cannot have much credence that this estimate is even close to the actual value.

We would advocate comparisons of outcomes of care for specific conditions or interventions based on high quality clinical data that enables adequate risk adjustment. Such comparisons are difficult as they require data from the two countries that are sufficiently similar as regards variable definitions, patient inclusion criteria, similar professional judgement regarding diagnostic labelling etc. Despite these challenges we would recommend that some studies be commissioned to establish if there are systematic differences in the quality of hospital care between the two countries.

References (Executive summary)

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Academy international HSMR working group membership

Professor Terence Stephenson (Chair)	Academy of Medical Royal Colleges	Chair AoMRC Nuffield Professor of Child Health UCL
Dr Kenneth Fleming	Royal College of Pathologists	Virginia Swanson Fellow in Pathology at Green Templeton College, Oxford, Honorary Consultant in Pathology, Oxford Radcliffe Hospitals NHS Trust
Professor Steve Goodacre	College of Emergency Medicine	Professor of Emergency Medicine, University of Sheffield
Mr Peter Holt	Royal College of Surgeons England	Senior lecturer at St George's, University of London and honorary consultant in vascular surgery at St George's Vascular Institute
Professor Jimmy Hutchison	Royal College of Surgeons of Edinburgh	Professor of Surgery Aberdeen. Vice President RCSE
Dr Azeem Majeed	RCGP	Professor of Primary Care Imperial College
Dr Aseem Malhotra	AoMRC	Consultant Clinical Associate
Professor Martin McKee	Faculty of Public Health	Professor of European Public Health at the London School of Hygiene and Tropical Medicine
Professor Monty Mythen	Royal College of Anaesthetists	Professor of Anaesthesia and Critical Care UCL
Dr Kevin Stewart	Royal College of Physicians, England	Clinical Director, Clinical Effectiveness and Evaluation Unit
Dr Diana Tait	Royal College of Radiologists	Vice President Clinical Oncology
Sir Richard Thompson	Royal College of Physicians, London	President

Advisors

Professor David Spiegelhalter	Statistical Laboratory, University of Cambridge	Winton Professor of the Public Understanding of Risk
Professor Nick Black	London School Hygiene and Tropical Medicine	Professor of Health Services Research
Professor Mike Campbell	University of Sheffield	Professor of Medical Statistics

Academy of Medical Royal Colleges
10 Dallington Street
London
EC1V 0DB
United Kingdom

Telephone

+44 (0)20 7490 6810

Facsimile

+44 (0)20 7470 6811

Email

academy@aomrc.org.uk

Website

www.aomrc.org.uk

Registered Charity Number

1056565

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