The Hospital Standardized Mortality Ratio Fallacy

A Narrative Review

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Background: Outcome measures, like hospital standardized mortality ratios (HSMRs), are increasingly used to assess quality of care. The validity of HSMRs and their accuracy to reflect quality of care is heavily contested.

Objective: We explored apparent and potential shortcomings and adverse effects of the HSMR in the assessment of quality of care.

Research Design and Methods: For this narrative review, relevant articles were collected from Medline databases using the following search terms: "hospital standardized mortality ratio," "standardized mortality ratio," "HSMR," "quality of care," and "in-hospital mortality." In addition, other important articles were subtracted from the reference lists of the primary articles.

Results: The current literature exhibits important shortcomings of the HSMR that in particular affect hospitals providing specialized care of a certain level of complexity. Because of the lack or insufficiency of data concerning case-mix, coding variation between hospitals, disease severity, referral bias, end-of-life care, and place of death, the current HSMR model is not able to adjust adequately for these aspects. This leads to incomparability of HSMRs between hospitals. Instead of separate aspects of continuity of care, all factors contributing to quality of care should be considered.

Conclusions: Given the several shortcomings, use of the HSMR as an indicator of quality of care can be considered as a fallacy. Publication of the HSMR is not likely to lead to improvement of quality of care and might harm both hospitals and patients.

Key Words: hospital standardized mortality ratio, outcome, process, structure, quality of care

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Quality of care has become a major topic in health care policy since the 1970s. Increasing interest has arisen from the patients, health care providers, politics, researchers and media in transparency, and proclamation of hospital care. Measuring quality of care supposedly leads to improvements of care; areas in which care providers underperform could be identified and consequently be improved. Besides this internal use, quality-of-care assessment could also be used for benchmarking.

Quality of care varies widely between hospitals,[1–3] but it is difficult to assess quality and to compare hospitals. In addition, there remains considerable debate about which measures should be used to reflect quality of care.[4] The most common framework is that of Donabedian who conceptualized 3 quality-of-care dimensions, that is structure, process, and outcome.[5] Structural measures are related to the organization of care, such as procedure volumes. Process measures describe the care that patients actually receive and were introduced as a result of guideline development. It reflects whether patients are treated as recommended. Direct outcome measures such as morbidity and mortality are most appealing to use for the evaluation of quality of care. Although outcome measures are related to structure and process measures, many initiatives only focused on outcome indicators. The idea is that comparing hospital mortality rates could provide patients with information on (differences in) quality of care so they can choose the hospital that best fits their needs. The ultimate example of an outcome measure is the hospital standardized mortality ratio (HSMR).[6]

Since the late 1990s, in several countries such as Canada, the United Kingdom, the United States, Sweden, France, and Australia HSMRs are used to assess hospital mortality with the aim to improve quality of care and to monitor performance over time.[7] At present, numerous Dutch hospitals use the HSMR scores for internal use. The introduction of the new health insurance system in The Netherlands in 2006 was a further incentive for hospitals to use quality measures in the negotiation process with insurance companies and the growing desire of patients to choose their health care providers. Aiming at more transparency of care, the Dutch government decided to make the HSMR of each hospital public in 2011.

However, several concerns have arisen regarding the validity of the current HSMR calculation and the accuracy of reflecting quality of care.[8] One of the most important misperceptions is the assumption that greater-than-expected mortality indicates avoidable deaths. The consequences of making invalid measures public could provoke an unjustified good or bad hospital reputation, groundless sanctions or

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rewards, disturbed collaborations between health care providers as well as damage to the public confidence. The HSMR calculation should, therefore, be sufficiently valid and accurate before making results public or incorporating in policy decision making. The purpose of this paper is to highlight some important shortcomings regarding use of the HSMR for the assessment of quality of care.

SEARCH STRATEGY AND SELECTION CRITERIA

Data for this narrative review were identified by searches of Medline, Current Contents, PubMed, and references from relevant articles using the search terms "hospital standardized mortality ratio," "standardized mortality ratio," "HSMR," "quality of care," and "in-hospital mortality." As aforementioned, hospital mortality rates are increasingly used as indicators of quality of care and could have significant consequences when the results are made public. This emphasizes the importance to make, in particular, an overview of apparent and potential shortcomings of HSMRs as outlined in this narrative review. The different categories of possible sources of bias that we discuss in the present paper emerged from the literature review.

HSMR

This ultimate outcome measure of quality of care was initiated and introduced by Jarman in 1999.[6] The HSMR is calculated by dividing the number of observed deaths in a given hospital by the number of patients that would be expected to die there. The national HSMR reference value is 100, hospitals with a higher score are supposed to have performed worse, whereas the reverse would be true below 100. The HSMR is a hospital-wide measurement including several diagnosis (50 for the Dutch model) that are responsible for 80% of the in-hospital mortality for the concerning country. For each diagnostic group, a separate standardized mortality ratio (SMR) is calculated. The different SMR results could be interpreted and used separately or aggregated to create the overall hospital HSMR. In the Dutch hospital-wide HSMR model, expected mortality is based on age, sex, primary diagnosis, urgency of admission, Charlson-comorbidity index, month of admission, year of discharge, social deprivation, and source of referral (Table 1)[9] However, continuous refinements are made yearly to the included variables in the HSMR model.[7]

DISEASE SEVERITY

The HSMR adjustment model includes the Charlson-comorbidity index to correct for the presence of underlying comorbidity. However, the model does not fully adjust for the severity of the disease, which is evidently related to mortality. This could lead to several difficulties as presented in Table 2. For example, the severity of chronic lung disease, renal failure, heart failure, and cancer is not included when HSMRs or SMRs are calculated, whereas patients with an advanced stage of one of these diseases are known to have an increased mortality risk. A recent study by Friese et al[10] showed that disease severity of cancer patients varies significantly across hospitals; accordingly, accurate adjustment is crucial to compare outcome. In addition, this study showed favorable mortality rates for less severely ill patients. Hence, hospitals admitting less severely ill patients will have lower adjusted mortality rates than hospitals which admit patients with more advanced disease. Consequently, paradoxical results could be obtained when HSMRs of hospitals serving as a center of excellence are compared with HSMRs of hospitals providing usual care. Hospitals which are specialized in the treatment of a certain (complex) disease or particular treatment are more likely to have higher HSMRs while they might provide good quality of care. In addition, patients with chronic diseases frequently have multiple readmissions that effect the in-hospital mortality risk.[11] To provide a more accurate HSMR, additional adjustments should be made for the admission frequency as is done in Great Britain.[8,11]

TABLE 1. Variables Included in the Dutch Hospital Standardized Mortality Ratio Model

Case-mix Variables
Age
Sex
Primary diagnosis
Urgency of admission
Charlson-comorbidity index
Month of admission
Year of discharge
Social deprivation
Source of referral

REFERRAL BIAS

The adjustment for referral source (home, nursing home, general hospital, or academic hospital) in the HSMR calculation, is not sufficient to prevent referral bias. The current adjustment model only includes the latest referral source, but no preceding sources, whereas a significant number of patients will not be replaced from 1 hospital to another but sent home first for some time. The referral source of these patients will be coded as "home," whereas the actual referral source is the first hospital they were admitted to. Hospitals serving as tertiary referral center—frequently accepting severely ill patients—are likely to have increased hospital mortality rates compared with referring centers.[12,13] However, a restrictive admission policy by accepting only the relatively healthy patients or transfer of critically ill patients[14] could reduce the in-hospital mortality rates. Several studies, mostly including patients admitted to the intensive care unit, have investigated the existence of referral bias and the effect on outcome. These studies demonstrated that after full adjustment for case-mix and severity of disease, patients who lived outside the local community who were referred to a tertiary center were sicker, had higher mortality rates, and longer length of hospital stay than directly admitted patients.[13,15–17] Consequently, even transfer of 1 patient per month could make an important difference to the hospital outcome.[14] In addition, a simulation study showed that a hospital with an admission rate of 25% medical intensive care unit transfer patients compared with a hospital with a 0% admission rate would have 14 excess deaths per 1000 admissions.[12]

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TABLE 2. Summary of HSMR Shortcomings Leading to Incomparability

Shortcomings	Causes Bias or Confounding	Leads to Incorrect Estimation Expected Mortality	May Lead to Change in Admission and Discharge Policies
Disease severity			
Insufficient adjustment of disease severity	X	X	
Referral bias			
Incorrect referral source (eg, home instead of hospital)	X	X	
No. transfer patients (higher risk) varies across hospitals			X
No sufficient adjustment for transfer patients (higher risk)	X		X
Place of death and end-of-life care			
Differential reason of admission	X		
Percentages in-hospital mortality differs between hospitals			X
Case-mix and coding			
Unmeasured variables	X	X	
Constant risk fallacy	X		
Missing/incorrect comorbidity data	X	X	
Coding variation across hospitals (ie, urgency, primary diagnosis, comorbidity)	X		

X indicates an association.

Different reasons for referral exist. Referral patterns can be based on regional collaboration. However, tertiary referral centers could also serve as last resort for critically ill patients. Either way, hospitals that admit transferred patients will be "punished" when a patient dies during the hospital stay. The HSMR of such a hospital will be negatively affected, whereas the referring hospital is given a positive score (the patient leaves that hospital still alive). Therefore, in Great Britain, hospital transfers are linked so that mortality is allocated to all hospitals the patient was admitted to.[18] To reduce the referral bias, intention-to-treat analysis should be considered. The patients' outcome will then count for the first hospital he/she was admitted in, regardless of whether patients are transferred or not.

As referral of patients with poor health has great impact on the HSMR and SMR scores, this could have important consequences. Adjusted mortality rates have previously led to changes in admission thresholds and discharge policies.[19] Hospitals could be reluctant to admit seriously ill patients who are at increased risk of in-hospital mortality or patients with poor health could be discharged prematurely. As a result, HSMRs or SMRs could (partly) reflect variation in admission and discharge policies instead of quality of care. A partial solution might be to base the HSMR on 30-day mortality instead of in-hospital mortality.[20]

PLACE OF DEATH AND END-OF-LIFE CARE

A recent population-based study examined the proportion of deaths in hospitals in 6 European countries.[21] In 2003, of all deaths in Belgium, 52% occurred in a hospital, in The Netherlands 34%, in Scotland 59%, in England 58%, in Wales 63%, and 63% in Sweden in 2002.[21] In the United States, 41% of the population died in a hospital in 1998.[22] Although home is generally considered as the preferred place of death for ill patients,[23] several factors could influence the place of death (Table 3). People may die in the hospital because their death is less predictable or they require palliative care interventions provided by the hospital, such as active symptom control and/or end-of-life care. Although some of these patients might be referred to a hospice, many patients will instead be admitted to the hospital because they require complex medical care. For example, patients diagnosed with hematological cancers have increased risk of in-hospital death due to infection and/or bleeding, whereas patients diagnosed with breast and gynecological cancers are more likely to die elsewhere.[24] In addition, patients with colorectal cancer are more likely to die in a hospital or in-patient hospice setting than at home.[25] Notably, place of death may vary widely between regions due to differences in the availability of end-of-life care facilities.[20,23] Hospitals that admit many severely ill patients for end-of-life care will have higher in-hospital mortality rates than hospitals in which admissions are less often related to end-of-life care. As "reason of admission" is not considered in the current HSMR calculation, the HSMR scores may unjustifiably be increased in hospitals which admit patients for palliative care (Table 2). It is, therefore, important that physicians report if patients were admitted for end-of-life care. However, these data are frequently missing[20,26] and hospitals which do report deaths as end-of-life care often have a large underscore. A recent audit of recorded death and coding conducted in Great Britain found that 37% of the patients should actually be recorded as admitted for end-of-life care, whereas 8% was coded as such.[26] As a result, the risk-adjusted mortality score

TABLE 3. Factors Affecting Place of Death

Patient needs end-of-life care
Patients' death is less predictable
Patient has a complex disease
Availability of regional hospices/ end-of-life care facilities
Hospitals' admission and discharge policies
Religious, cultural and socioeconomic characteristics of local population

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decreased from 105 to 68 when place of death was taken into account. The current HSMR calculation is based on a variety of admissions such as admissions due to a diagnostic test, due to treatment, or due to palliative care; therefore, it is difficult to interpret the in-hospital mortality rates as quality of care measures. In Canada, HSMR scores are provided excluding cases identified by hospitals as having received palliative care.[27] These HSMR scores will be more accurate in reflecting quality of care than scores based on data including cases admitted for end-of-life care. However, the question is whether only patients who require palliative care at time of admission should be excluded from the analysis, or also those who became palliative during the admission. The latter could result in important differences in coding policies between hospitals. As suggested by others, patients should be labeled palliative only if this diagnosis became apparent after minimal investigation.[28] In addition, a palliative status label should be used consistently and by trained personnel.

As described above, in-hospital mortality is influenced by the admission of severely ill patients. In addition to admission of severely ill patients, the place of death might also depend on religious, cultural, and socioeconomic characteristics of the local population and may be most important, the availability of alternative forms of end-of-life care such as hospices and community palliative services.[23] British investigators have previously highlighted the importance of adjustment for different facilities for dying in the area of the hospital when mortality rates are calculated.[29] They demonstrated that place of death in the catchment area of the hospital is highly associated with the HSMR. After adjustment for geographic differences in the percentages of deaths occurring in hospital in the hospitals' catchment areas, the HSMRs of 20 hospitals were brought closer together and closer to 100. For example, the calculated HSMR of a British hospital was initially 126, whereas after adjustment for place of death the score decreased to 110.

CASE-MIX AND CODING

Besides the aforementioned shortcomings, unmeasured case-mix variation and coding inconsistencies are at least partly responsible for the unexplained variance in outcome within and between hospitals (Table 3). Hence, the assumption that after the adjustment for case-mix variables the unexplained variance is simply due to differences in quality of care is incorrect.[30–33] Full adjustment for non–treatment-related factors that might influence mortality is one of the fundaments of fair comparisons between hospitals. If case-mix adjustment is not sufficient, the HSMR might reflect patient characteristics instead of quality of care. Moreover, valid case-mix adjustment requires that the relation between the case-mix variables and mortality is similar across all hospitals. If this is not the case, the adjustment may even enlarge the bias that has been described as "the constant risk fallacy."[30,34] For example, the effect of Charlson-comorbidity index and urgency of admission are demonstrated to vary across hospitals on in-hospital mortality. This is shown by a significant interaction effect between these variables and hospital when in-hospital mortality is predicted.[30] Although, different hospital results might be attributable to better quality of care at some hospitals dealing with high-risk patients, it is likely that the effect of systematic differences in coding is substantial as well. In addition, data on comorbidity are frequently missing and often contain errors[35] as they should be based on a thorough diagnostic evaluation. In view of the increasingly large proportion of elderly patients who frequently have concomitant diseases,[36,37] it is of large importance that comorbidity is accurately reported and coded so that it can be useful for case-mix adjustment. In general, inconsistency in coding and discrepancy of definitions can be large between doctors and hospitals.[32,38] As a result, differences in coding frequently occur that is recognized as a major problem regarding benchmarking of mortality rates.[2,38] A recent study emphasizes the importance of uniform coding of the variables that are included in the HSMR model.[38] This study conducted in 6 Dutch hospitals providing highly specialized medical care, showed considerable coding differences for urgency of admission, primary diagnosis and comorbidities.[38] In 1 hospital, urgent admissions were coded as such in 34% compared with other hospitals coding nearly 100% of the acute admissions as urgent.[38] Large variation was also observed for coding of the primary diagnoses. Whether an admission will be included in the HSMR calculation is based on this primary diagnosis. Consequently, the possibility exists that 1 hospital includes a certain admission for the HSMR calculation, whereas another hospital would exclude an identical admission. Therefore, use of the code "diagnosis unknown" should be avoided when the primary diagnosis is established. Moreover, differences in coding of comorbidity were found between the Dutch hospitals. Hospitals with extensive coding for comorbidity had an artificially lower HSMR compared with hospitals with less intensive coding.[38] Consequently, the need and desire for a low HSMR has already led to fraud in data collection[19] that will often remain undocumented. As structural misclassifications and under classifications of patient characteristics could significantly affect the HSMR, adequate and uniform coding is warranted.

FUTURE PERSPECTIVES

Despite the fact that the association between adjusted mortality rates and quality of care is inadequate, adjusted mortality rates will probably be continuously used. Policy makers and health care organizations support the use of HSMRs, as it is easy to use and the data that are included in the calculation are widely available at a low price. Moreover, advocates of HSMRs claim that publication and subsequent discussion prompts high scoring hospitals to improve their quality of care. Some have demonstrated that use of HSMRs may reduce in-hospital mortality by supporting improvement initiatives for reducing hospital mortality with reduced HSMRs as a result.[39–43] Nevertheless, as discussed in this report, many others have previously demonstrated that the HSMR is not a reliable measurement of quality of care,[2,8,11,20,30–33,35,44–48] with the most important shortcomings summarized in Table 2. Besides, hospitals might try to lower the HSMR, although it is not even proven yet that a lower HSMR is an indicator of good quality. Also, hospitals with an incorrectly low HSMR might conclude that their quality of care is of a sufficient level, and will not pay

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full attention to areas that actually require it. Given the large numbers available, it is appealing to calculate hospital mortality rates. However, this overall score is hard to interpret for the general public. Because the HSMR is the mean score of numerous SMRs of different diagnosis (areas), the "best" hospital for a specific patient with a specific disease cannot be identified by the public.[49] Similarly, hospitals cannot identify their specific problems and the areas where the quality of care needs to be improved. Well-performed care might compensate poor care resulting in a respectable HSMR score, whereas underlying problems might be present. Consequently, use of condition-specific mortality rates will be more informative compared with hospital-wide mortality rates.[48] However, as the underlying adjustment model still has several uncertainties, the SMRs for specific conditions may still reflect other aspects than quality of care.[48]

We found several shortcomings of the HSMR especially affecting hospital providing specialized care. These centers frequently admit many referred patients who are often seen with a more advanced disease stage. As a result, these hospitals might have higher mortality rates, whereas they actually perform well. Given these referral patterns, quality of care should be considered on a regional level instead of hospital level.

In addition to the HSMR as initiated by Jarman et al,[6] several other methods calculating observed versus expected in-hospital mortality are used to assess quality of care, with substantially different results. When 4 common methods were considered to assess quality of care, in-hospital mortality ranged from 2.0% to 5.9%. Almost half of the 28 hospitals with higher than expected mortality rates had lower than expected mortality rates when another method was used.[47] The discrepant results might be due to the methodological differences between the 4 methods as well as due to a lack of standardized inclusion and exclusion criteria for patients, diagnosis, and hospital types leading to an inconsistent patient selection.[47]

The creators of the HSMR claim that the score should reflect avoidable death. However, the HSMR is based on the diagnoses with the most deaths instead of the diagnoses with the most avoidable deaths. As mentioned previously, the assumption that greater-than-expected mortality indicates avoidable deaths is incorrect. More detailed data and sophisticated analyses are needed to disclose preventable mortality.[50]

The largest criticism on outcome measures like mortality is that it is highly inaccurate to identify poor quality hospitals.[45,51] As suggested by Donabedian, the best hospital performance measures are those that include elements of structure, process and outcomes assessed in a population-based study.[5,52] Consequently, process measures and outcomes other than death are at least equally appropriate for the assessment of quality of care. Also, as outcome measures like mortality are less useful for assessing quality of low-risk operations that frequently aim to improve health-related quality of life.[4] For example, the complication rate after surgery, readmission rate, waiting times, length of hospital stay, guideline adherence, and patient satisfaction may be considered as these factors give more adequate information about quality of care than mortality rates only. Such performance measures including elements of structure, process, and outcome can be analyzed using more advanced statistical methods including composite endpoint analysis or multivariate models. Although process measures are also susceptible for bias and do not capture all of the hospitals' variation as shown among patients with cardiac disease,[53–55] they may be of additional value to outcome measures. Process measures are less affected by case-mix bias, they avoid stigma (not "you are bad" but "improve X"), prompt wider action and are useful for delayed events.[49] It has been shown for heart attack that differences in quality of care could only explain half of the observed variance mortality between hospitals.[56] The investigators found process measures to be able to detect relevant differences between hospitals that would not have been identified by comparing hospital specific mortality. Similar findings have been reported for stroke.[57] However, process measures require more intensive data collection than outcome measures like mortality data that are accessible for every patient. In addition, as discussed in this report, structure elements such as hospital type, the availability of specific technologies/ treatment options, and the presence of health facilities (like hospices) in the hospital area may have significant impact on in-hospital outcome as it results in the admission or discharge of specific patients. This is indirectly measured by the HSMR while not related with poor quality of care. Consequently, this type of structure measures should be included in the HSMR adjustment model.

CONCLUSIONS

The HSMR, which is increasingly used as an indicator of quality of care, has so many uncorrectable shortcomings including insufficient adjustment for case-mix and disease severity, coding variation between hospitals, referral bias, and differences in end-of-life care and place of death that it cannot be used as an indicator of quality of care. It should thus not be used in the comparison of hospital performance. It is likely that publication of the HSMR will cause more harm than good for hospitals as well as for patients. Well-performing hospitals that score low can too easily be unjustifiably labeled as poor performers and vice versa, and patients could be denied from admission to medical centers supplying the specialized care they require. Adequate coding and case-mix adjustment is required for the assessment of quality of care with outcome measures. The adjustment model should take into account differences in disease severity, referral patterns, the reason of admission, and place of death. Given the increasing regionalization of specialized care, quality of care may be considered on a regional level that is also a basis for more widespread clinical data sources. In addition, advanced statistical analyses are needed to provide valid and accurate results. Until then, the HSMR-fallacy should not be used for the assessment of quality of care.

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