Do Hospital Standardized Mortality Ratios Measure Patient Safety?

Robert B. Penfold, Stafford Dean, Ward Flemons and Michael Moffatt

Commentary from Sten Ardal, Michael Baker, Robert Bell, Susan E. Brien, Shauna Figler, Cara Flemming, William A. Ghali, Debbie Gibson, Sir Brian Jarman, John MacNaughton, John McKinley, Carolyn Sandoval, Samuel B. Sheps, Greg Webster, Eugene Wen, Catherine Zahn and Jennifer Zelmer
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About the cover: “Our life is made by the death of others” is a quote from Leonardo Da Vinci. Our cover shows his study of “Drapery for a Seated Figure.”
Longwoods journals are published in partnership with our readers, our editors, our advisory boards, our authors as well as healthcare organizations and their suppliers of solutions and services. We value this participation in and dedication to leadership and knowledge. They enable us to present new ideas, policies and best practices essential to healthcare management, practice, education, research and innovation. It is a measure of their support for learning. Nothing can be more fundamental to the progress of healthcare.
This issue of Healthcare Papers examines the validity of the hospital standardized mortality ratio (HSMR) measurement tool and the implications of its use in Canadian hospitals. The lead article, titled “Do Hospital Standardized Mortality Ratios Measure Patient Safety? HSMRs in the Winnipeg Regional Health Authority,” questions the tool’s ease of use and whether or not it is consistent across different facilities. Authors Robert B. Penfold, Stafford Dean, Ward Flemons and Michael Moffatt note that the goal of the HSMR is to reduce “preventable” deaths – to motivate hospital administrators to examine in-hospital mortality rates and to reduce them. It discusses how, to date, a peer-reviewed study validating the HSMR as an indicator of the occurrence of adverse events does not exist.

In response, John McKinley, Debbie Gibson and Sten Ardal, in “Hospital Standardized Mortality Ratio: The Way Forward in Ontario,” note the importance of reporting HSMRs to highlight the need to improve the quality of healthcare. They discuss how the HSMR debate has focused too much on the measure’s shortcomings and not enough on what it brings to the healthcare field. They note that while the HSMR does not provide a specific measure of adverse events, its usefulness in tracking the impact of quality improvement initiatives over time cannot be negated. Finally, they point out the need to better educate the public to facilitate an accurate interpretation of the HSMR data.

Shauna Figler’s article notes that “the rationale presented fails to address the real issue found within the Winnipeg Health Authority.” She discusses how a hands-on approach to sorting through the data can reveal internal issues and create improvement in quality of care. Figler discusses that the HSMR is not meant to provide a comparison between different facilities; instead, it allows an individual facility to assess its own performance. She notes how a facility can identify areas needing performance improvement by tracking the HSMR over time.

This interesting debate continues in “CIHI’s Hospital Standardized Mortality Ratio: Friend or Foe?” by Susan E. Brien and William A. Ghali. Their commentary echoes the concerns of Penfold et al. in the lead essay but also comments on the importance of the HSMR. Brien and Ghali point out that, despite its limitations, the HSMR stimulated the lead authors to probe factors that may have influenced mortality rates, which shows the merit of HSMR reporting and the types of insight and knowledge likely gained by using this or similar evaluations.

In “Hospital Standardized Mortality Ratio Is a Useful Burning Platform,” Catherine Zahn, Michael Baker, John MacNaughton, Cara Flemming and Robert Bell discuss the HSMR as an important indicator of hospital performance that can...
be used immediately for improvements. The authors cite benefits of using the HSMR, including how it serves as a useful measure readily understood by healthcare professionals and by the public. These authors applaud the tool while agreeing that limitations exist. They note that while it is imperfect, the HSMR “serves as a compelling instrument to use in engaging staff in a culture change that will stimulate improvements in hospital safety.”

Samuel B. Sheps supports the findings of Penfold et al. in “Measure for Measure? The Challenge of New Thinking about Patient Safety.” Sheps agrees with points raised regarding the impact that a high number of deaths of terminally ill patients has on the HSMR measurement, as well as the variations between facility policies, specifically regarding discharge. Sheps discusses the need to rethink what it takes to achieve patient safety from a systems perspective.

In “Understanding and Using the Hospital Standardized Mortality Ratio in Canada: Challenges and Opportunities,” Eugene Wen, Carolyn Sandoval, Jennifer Zelmer and Greg Webster maintain that the HSMR, despite its limitations, remains an important tool for hospitals to help focus their efforts for patient safety and quality improvement, monitor the provision of care over time and identify opportunities for improvement.

The debate over the HSMR is sure to continue – enjoy this issue’s enlightening discussion as the authors examine this tool’s uses and its pros and cons.

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Do Hospital Standardized Mortality Ratios Measure Patient Safety? HSMRs in the Winnipeg Regional Health Authority

INVITED ESSAY

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ABSTRACT

The Canadian Institute for Health Information began publishing hospital standardized mortality ratio (HSMR) data for select Canadian hospitals in November 2007. This paper describes the experience of the Winnipeg Regional Health Authority in assessing the validity of the HSMR through statistical analysis, coding definitions and chart audits. We found a lack of empirical evidence supporting the use of the HSMR in measuring reductions in preventable deaths. We also found that limitations in standardization as well as differences in palliative care coding and place of death make inter-facility comparisons of HSMRs invalid. The results of our chart audit show that the HSMR is not a sensitive measure of adverse events as defined by “unexpected death” in the Canadian Adverse Events Study. It should not be viewed as an important indicator of patient safety or quality of care. We discuss the cumulative sum statistic as an alternative to the HSMR in monitoring in-hospital mortality.

Some in-hospital deaths that are judged to have been avoidable result from a complex series of contributing factors; some of these factors include errors of omission or commission made by healthcare providers, while others are latent conditions existing within an organization – often as a result of the policies that it establishes. One of the goals of the Safer Health Care Now! campaign (www.saferhealthcarenow.ca) is to reduce avoidable deaths in Canadian hospitals. The hospital standardized mortality ratio (HSMR) is a central tool in this campaign. Developing tools and processes to monitor and prevent these deaths is imperative. However, identifying which in-hospital deaths are preventable and which are expected is a non-trivial task. Aggregating all the deaths at a facility into a valid, informative safety measure is even more difficult. How then should this aspect of patient safety be monitored and improved?

There is a substantial body of literature that discusses the relative merits of using risk-adjusted mortality rates and standardized mortality ratios to monitor and evaluate the quality of care in hospitals (Austin et al. 2004; Baker et al. 2002; Jarman et al. 2005; Wright et al. 2006). It is well known that different statistical approaches to standardization have a measurable impact on hospital scores and ranks (Delong et al. 1997; Glance et al. 2006; Goldman and Brender 2000; Julious et al. 2001; Li et al. 2007). The creator of the HSMR has also argued that several significant predictors of in-hospital mortality are outside the control of hospital policy (Jarman et al. 1999). Others have found that differences in in-hospital mortality are usually not related to differences in quality of care (Iezzoni et al. 1996; Park et al. 1990; Thomas and Hofer 1999). Moreover, hospital administrators often have difficulty using the mortality measures because the data are too aggregate (Mehrotra et al. 2003) – limiting their utility with respect to quality improvement.

In November 2007, the Canadian Institute for Health Information (CIHI) began publishing HSMRs for hospitals with more than 2,500 HSMR cases in each of the fiscal years 2004–2005, 2005–2006 and 2006–2007. This initiative follows similar projects in Britain and the United States, where publishing HSMRs motivated administrators to examine in-hospital mortality more closely and to introduce interventions to try and reduce HSMRs. However, publishing in-hospital mortality data has also been followed by increases in 30-day mortality in some cases – hypothesized to be the result of differences in discharge rates. This high-
lights the importance of understanding how the HSMR is derived and the need to disentangle the discharge rate from the mortality rate (Austin et al. 2004; Farsi and Ridder 2006). Publishing Canadian HSMRs will presumably motivate hospital administrators to examine in-hospital mortality, with similar pressure to reduce it as was seen in other countries; however, whether this will actually lead to a wise investment of time and attention by healthcare leaders – with the ultimate goal of reducing ‘preventable’ deaths – remains an open question.

This paper describes the experience of the Winnipeg Regional Health Authority (WRHA) in assessing the validity of the HSMR through statistical analysis, coding definitions and chart audits. The first section of this paper evaluates the rationale for using the HSMR and the empirical evidence in support of using the HSMR as a tool to learn from in-hospital death. The following section presents HSMRs for comparable facilities in Winnipeg and Calgary during the development phase of the Canadian HSMR and the results of a WRHA chart audit. In the final section, we discuss caveats for facility and regional administrators in using the HSMR to make decisions. We also revisit the cumulative sum statistic as a method of learning from deaths that involves patient-level statistical analysis.

**Rationale for Monitoring and Publishing HSMRs in Canada**

The HSMR is thought to be an indicator of patient safety and hospital quality of care (Institute for Healthcare Improvement [IHI] 2003). It is also argued that death is a “definite event” – presumably making “safety” easier to define, measure and monitor. Leeb et al. (2005) state that the HSMR provides a means for hospitals to track changes in adverse events. As such, it is meant to be an indicator of avoidable deaths, that is, deaths that could have been prevented if different (higher-quality, safer) care were given.

Adverse events are not directly incorporated into calculating the HSMR. The number of avoidable deaths is inferred from “excess” mortality – the number of deaths that would be prevented if a facility were to have the same distribution of deaths that occurs nationally. Logistic regression is used to model the likelihood of death for all patients in Canada, limited to the 65 disease codes that account for 80% of in-hospital mortality. The national model controls for age, sex, length of stay, admission category, Charlson index and patient transfer. Patient risk factors within diagnostic groups (e.g., Acute Physiology and Chronic Health Evaluation [APACHE] scores for patients in intensive care) are not modelled. The results of the logistic modelling are then used to derive the number of expected deaths at each hospital given the patient characteristics mentioned. The HSMR is simply the ratio of observed (actual) deaths to expected deaths, multiplied by 100.

\[
\text{HSMR} = \left( \frac{\text{observed number of deaths}}{\text{expected number of deaths}} \right) \times 100
\]

For example, the observed number of deaths at Health Sciences Centre (HSC) in Winnipeg in the fiscal year 2006–2007 was 231. The expected number of deaths (derived from logistic modelling) was 312. Thus, the HSMR is 231/312 \times 100 = 74. CIHI also produces 95% confidence intervals for the HSMR.

Administrators in facilities with an HSMR >100 (the national benchmark) are encouraged to investigate the reasons why their HSMR is above average. It is further argued that monitoring the HSMR over time allows a facility to measure the effectiveness of initiatives to improve quality of care or reduce
the occurrence of adverse events.

To date, there are no peer-reviewed studies validating the HSMR as an indicator of the occurrence of adverse events. Two published studies in Britain have examined predictors of changes (decreases) in HSMRs over time (Jarman et al. 2005; Wright et al. 2006) and concluded that policy interventions reduced in-hospital mortality. Other studies lead to similar conclusions (Leeb et al. 2005). No robust rule for predicting an individual hospital’s HSMR could be found in an American study (Whittington et al. 2005). It is also important to note that none of these studies specifically examined adverse events. Nevertheless, these studies are provided as examples of how the HSMR is effective in monitoring patient safety.

**Evidence Supporting the HSMR as a Quality Monitoring Tool**

Closer examination of the data that are used to justify using the HSMR reveals that evidence of their utility is weak. Figure 1 shows HSMRs for the Walsall NHS Trust facility between 1996 and 2006. The data up to 2004 have been presented as evidence that improvements starting in 2000 reduced

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**Figure 1. Walsall Hospitals NHS Trust HSMRs, 1996–2006**

HSMR = hospital standardized mortality ratio.
Source: Based on data from http://www.bmj.com/cgi/data/330/7487/329/DC1/1 and Dr. Foster Intelligence (2005, 2007).
in-hospital mortality for this facility from 130 in 2000 to 92.8 in 2004; a discussion of the period from 1996 to 1999 is absent. While there are certainly five years of declining values beginning in 2000, the first three years of this trend seem to return the HSMR to an average level. The conclusion that these changes are associated with improved quality of care or a reduction in adverse events appears unwarranted when the 1996 (pre-intervention) and 2003 (post-intervention) HSMRs are statistically identical. Moreover, the Walsall HSMRs returned to average in 2005 and 2006, further eroding the contention that changes in 2000 led to any improvement in patient safety that is measurable with the HSMR. As Wright et al. (2006) acknowledge, the observed trend could be due to chance, regression to the mean, coding changes, different discharge policies or referral of complicated patients to other facilities (i.e., a change in admission policies). It could also be true that the HSMR does not measure avoidable deaths but, rather, trends in overall mortality.

Some evidence of this latter point may be found in Wright et al. (2006). For the facility they discuss, Figure 2 shows the HSMRs between 1996 and 2005. The authors argue that the mortality reduction program, begun in 2002, was responsible for a decrease in mortality at that facility. The data in Figure 2 show that mortality had been decreasing at this facility for at least two years prior to the mortality reduction program. Indeed, the rate of decrease between 2002 and 2004 is similar to the rate of reduction in the 1996–1998 period, when no program was in place. Further still, Figure 3 shows that the quarterly HSMRs were virtually unchanged between 1996 and 2005 (the 95% CIs overlap).
Applying common heuristics (Hart and Hart 2002; Hart et al. 2003, 2004) of statistical process control to Figures 1 and 2, there is preliminary evidence that mortality is “under control” at both facilities. Nearly all the observations lie within the three standard deviation control limits. In other words, the annual HSMRs are fluctuating around the facility average, and we observe the annual variation one would expect to occur randomly. However, these annual data may only be considered preliminary since there are not enough observations to establish reliable control limits (25 observations are needed) (Lee and McGreevey 2002).

Assuming that the mortality process is stable, only one data point (the HSMR for 2005 in Figure 2) lies outside the three sigma limits ordinarily used to identify an “out of control” process. Figure 2 does show evidence of a trend (seven consecutive falling values), but this trend starts three years before the mortality reduction program. As such, it is unclear whether the HSMR is actually measuring avoidable deaths.

**HSMR Development**

WRHA managers, researchers, auditors, analysts and clinicians participated in the development of the HSMR with CIHI. WRHA’s participation involved three versions of HSMR. Definitions, coding, inclusion criteria, statistical methodology and validation occurred for each version of the HSMR.
Standardization and Coding

CIHI’s HSMR version 3.0 selects cases based on 65 diagnosis groups (most responsible diagnosis) accounting for the top 80% of in-hospital deaths in Canada (CIHI 2007b). This definition is important because the methodology selects cases based on the diagnoses for which the most deaths occur rather than the diagnoses for which the most avoidable deaths occur.

An interesting example of the difference can be found in the version 3.0 HSMR compared with previous versions. Version 3.0 excludes “neonates less than 750 grams.” This change arose from findings in WRHA that these deaths were almost always planned terminations. The decision to exclude these cases is appropriate but demonstrates that a collection of diagnoses that accounts for 80% of deaths does not account for 80% of avoidable deaths.

A second important issue that arose during consultation with WRHA involved the inclusion and exclusion criteria around patients receiving palliative care (also known as comfort care). Notably, IHI in the United States specifically excludes all patients receiving comfort care [Boxes 1 and 2 in Figure 1 of Whittington et. Al. (2005)] from HSMR follow-up with their global trigger tool (Whittington et al. 2005). This is important because an above-average HSMR for a facility may be a signal that this facility has more adverse events, but it may also signal a higher propensity to admit patients to manage the dying process (Seagroatt and Goldacre 2004). WRHA (recognizing the IHI methodology in the United States) argued that patients receiving palliative care should be excluded from the HSMR calculation since these deaths were expected and the patients involved usually had a designation of alternate level of care or withdrawal of treatment. It is not a failure in patient safety when these patients expire. Many patients included in the HSMR were terminally ill. High HSMR levels may in fact represent a failure to reorient the healthcare system to facilitate more home and hospice deaths.

CIHI now produces separate HSMRs: one that includes patients receiving palliative care and one that excludes these patients. Separate logistical models are used to calculate expected deaths. However, this approach does not entirely solve the problem because there are wide discrepancies in the coding of palliative care. It is well known that measures of hospital performance are influenced by variable coding (Austin et al. 2005). A new palliative care coding standard is currently in place, but the HSMRs for 2004–2005 are not calculated based on this standard. Fiscal year 2004–2005 is the reference year for facilities to monitor their HSMR. All standardization (logistic modelling) was performed using 2004–2005 national data.

An example of what happens when this standard is applied is shown in Figure 4. Figure 4 illustrates the HSMRs at HSC before and after the coding change. The coding of palliative care has an enormous impact on facility HSMR. The HSMR goes from 148 in the fourth quarter of fiscal year 2004–2005 to 49 in the first quarter of fiscal year 2005–2006. Looking at fiscal year 2005–2006, the HSMR with palliative care is 118 (unchanged from 2004–2005) and 55 without palliative care. It is unclear whether HSC is 18% worse or 45% better than the national average.

The coding problem becomes more prominent when comparing other facilities in Winnipeg. In fiscal year 2004–2005, all the HSMRs with palliative care are lower than those that exclude palliative care. In fiscal year 2006–2007, all the HSMRs with palliative care are higher than those that exclude palliative care. In fiscal year 2005–2006, the HSMRs with palliative care in four of six facilities are lower than the HSMRs without
palliative care (but higher in the two teaching facilities). This is an example of how both temporal and inter-facility differences in admission for end-of-life care or differences in coding make comparisons of HSMRs difficult.

A coding issue separate from the national standard is the timing of a palliative designation. For example, should the HSMR exclude only those patients who are admitted with a palliative care designation or should it exclude anyone who is palliative at any time during an admission? If the latter criterion is chosen, when is the palliative designation valid? If a patient initially receives all possible life-saving measures and subsequently has care withdrawn, should this patient be included in the HSMR under “with palliative care” or “without palliative care”? Should this line be drawn at 72 hours? One week? One month? Clinical decisions concerning alternate levels of care have been shown to vary between Canadian cities (Cook et al. 2001). In any of these cases, clinical discretion (which is arguably desirable) regarding the withdrawal of care seriously undermines the validity of the HSMR in measuring avoidable deaths.

There are two remaining arguments against using the HSMR as a marker of “definite” mortality events. First, discharge decisions and policies vary regionally. Thus, it is unclear whether in-hospital mortality or 30-day mortality is a better measure of quality and safety. The arbitrariness of the decision to discharge means that “death” is not defi-
nite because it is associated with a particular place (the hospital). There is some evidence to suggest that regional differences in the proportion of people who die in hospital affect HSMR calculations (Harley 2004; Seagroatt and Goldacre 2004). As such, the HSMR is very likely an indicator of the degree to which death management is performed in hospital versus elsewhere.

Finally, it is well known that patients within a diagnostic group are not homogeneous with respect to the likelihood of dying; yet, the HSMR does not adequately standardize for within-diagnosis variation. For example, the CIHI 30-day acute myocardial infarction (AMI) in-hospital mortality indicator calculates expected deaths using parameters for age, sex, shock, diabetes, heart failure, cancer, cerebrovascular disease, pulmonary edema, acute renal disease, chronic renal disease and cardiac dysrhythmias. All of these elements affect the likelihood of death due to AMI, but none are used in the standardization of International Classification of Diseases Tenth Revision code I21 (AMI) – a diagnostic group included in the HSMR calculations. Instead, the expectations of death are derived from the national average of deaths in this category. This uncontrolled between-patient variability is compounded across 65 diagnostic categories when calculating HSMR. Interhospital comparisons would only be valid if the mortality rates across the 65 diagnostic strata had a consistent relationship (i.e., all 65 mortality rates at one facility were a scalar multiple of those at the comparison facility and this scalar were approximately constant across diagnostic groups) (Breslow and Day 1987; Wolfenden 1923).

Inter-hospital Comparisons

CIHI has been clear to point out that inter-hospital comparisons of HSMRs are not valid (personal communication, June 21, 2006). CIHI does not want to produce hospital rankings as has been done in other countries. Further evidence showing that HSMRs are not adequately standardized to make inter-hospital comparisons comes from consideration of the patient populations at HSC in Winnipeg and Foothills Medical Centre in Calgary. Both of these facilities provide tertiary level care and are the university medical centres for large urban and rural populations. However, in 2004–2005 the HSMR (without palliative care) for Foothills Medical Centre was 60 (95% CI 54–67) while the HSMR for HSC was 125 (95% CI 113–137).

Table 1 shows the counts and distribution of HSMR cases for fiscal year 2005–2006 at these two facilities. The HSC cases do not include any patients in age categories one (zero to four) or two (five to 14). (Note that the version 3.0 methodology uses age in years at time of admission, not age categories.) This means that people <15 years of age are excluded from the mortality rates at HSC. (A children’s hospital is administratively part of HSC but is considered a separate pediatric facility for purposes of CIHI administrative data, and pediatric facilities are excluded.)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>FMC n</th>
<th>%</th>
<th>HSC n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>979</td>
<td>5.13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5–14</td>
<td>556</td>
<td>2.92</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15–44</td>
<td>3,016</td>
<td>15.82</td>
<td>1,843</td>
<td>10.8</td>
</tr>
<tr>
<td>45–64</td>
<td>4,487</td>
<td>23.53</td>
<td>3,938</td>
<td>23.2</td>
</tr>
<tr>
<td>65–74</td>
<td>3,227</td>
<td>16.92</td>
<td>3,293</td>
<td>19.4</td>
</tr>
<tr>
<td>75–84</td>
<td>4,345</td>
<td>22.79</td>
<td>4,904</td>
<td>28.8</td>
</tr>
<tr>
<td>85–120</td>
<td>2,457</td>
<td>12.89</td>
<td>2,972</td>
<td>17.5</td>
</tr>
</tbody>
</table>

FMC = Foothills Medical Centre (Calgary); HSC = Health Sciences Centre (Winnipeg); HSMR = hospital standardized mortality ratio.
However, this subpopulation makes up >8% of cases at Foothills Medical Centre. Since the national model of expected mortality includes people 14 and under, there is serious mis-specification error associated with expected deaths at HSC, and two otherwise highly comparable facilities have incomparable HSMRs. This is because the age distributions of the two facilities, and therefore the distributions of expected numbers of deaths, are disparate (Breslow and Day 1987). The inconsistency of mortality rates across population subgroups (and therefore insufficient standardization of HSMRs) is one reason that Sir Brian Jarman has avoided making comparisons of HSMRs between UK and US hospitals (personal communication, June 2, 2006). Facility HSMRs are not comparable internationally. 

Further evidence that HSMRs in Calgary and Winnipeg are not comparable comes from a comparison of place of death. Seagroatt and Goldacre (2004) found that hospitals with the highest HSMRs were in regions where a large percentage of people died in hospital. Hospitals with the lowest HSMRs tended to be in regions where the percentage of people dying in hospital was low. In-hospital death ranged from 45% in Plymouth to more than 60% in Walsall.

Table 2. Distribution of place of death in the Calgary and Winnipeg Health Regions

<table>
<thead>
<tr>
<th>Place of Death</th>
<th>Calgary %</th>
<th>Winnipeg %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute care hospital</td>
<td>35.3</td>
<td>54.6</td>
</tr>
<tr>
<td>Palliative hospital</td>
<td>20.5</td>
<td>13.6</td>
</tr>
<tr>
<td>Long-term care facility</td>
<td>22.1</td>
<td>19.1</td>
</tr>
<tr>
<td>Home</td>
<td>18.3</td>
<td>11.3</td>
</tr>
<tr>
<td>Other locations</td>
<td>3.8</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Source: Canadian Institute for Health Information (2007a).

Table 2 shows the distributions of place of death for the Calgary and Winnipeg Health Regions in fiscal year 2003–2004 (CIHI 2007a). Nearly 20% more deaths occurred in hospital in Winnipeg than in Calgary, and these figures are comparable to differences found in Britain.

Audit Results

WRHA conducted a chart audit of fourth quarter HSMR cases in 2005–2006 to learn from these deaths and to determine whether the HSMRs were truly indicating that a higher than average number of preventable deaths was occurring in Winnipeg hospitals. In phase one of the HSMR audit, 553 charts from six hospitals were identified for pre-screening. Of the 553, 245 were selected to be audited in phase two. A chart was selected if a patient was categorized as receiving non-comfort care based on two sets of criteria. First, the patient was not in the process of being panelled (scheduled for transfer to a personal care/nursing home), did not have an alternate level of care designated, was not transferred from a Winnipeg personal care home (nursing home) and was under 75 or admitted to an intensive care unit (ICU) during the stay. Second, the auditor designated a patient as receiving comfort care if anywhere in the chart any of the terms comfort care, poor prognosis or informal palliative appeared or if there was any documented conversations with the family regarding palliation, comfort care or withdrawal of treatment. A patient may also have been designated as receiving comfort care if he or she had an advance care plan (ACP1, ACP2 or ACP3; see Appendix for WRHA definitions). The 245 patients selected for phase two of the audit were those receiving non-comfort care, according to at least one of the definitions. Of the 245 cases, 55 (22%) met both definitions of non-comfort care and 190 (78%) met at least one definition.
Level of Care

Of the 245 patients, 144 (59%) died on the ward and 76 (31%) died in the ICU. The remaining 25 deaths (10%) occurred in the following locations: ward transfer from ICU (nine), emergency room (five), observation (three) and other (eight). A do not resuscitate (DNR) order was in place for 190 (78%) of the 245 patients. Eighty-three (44%) of the 190 patients with DNR orders were located on the ward when the DNR was ordered. Twelve percent of the patients with a DNR order had it in place before being admitted to the hospital. Sixty-three (33%) patients had a DNR order on the day of or previous to admission. One hundred thirty-six (72%) of the 190 patients with DNR orders were designated DNR by the end of the third day of their hospital stay. Of the 53 patients with DNR orders after three days of admission, 30 (57%) had cancer. Twelve percent of the patients with a DNR order had it in place before being admitted to the hospital. Sixty-three (33%) patients had a DNR order on the day of or previous to admission. One hundred thirty-six (72%) of the 190 patients with DNR orders were designated DNR by the end of the third day of their hospital stay. Of the 53 patients with DNR orders after three days of admission, 30 (57%) had cancer. Twelve percent of the patients with a DNR order had it in place before being admitted to the hospital. Sixty-three (33%) patients had a DNR order on the day of or previous to admission. One hundred thirty-six (72%) of the 190 patients with DNR orders were designated DNR by the end of the third day of their hospital stay. Of the 53 patients with DNR orders after three days of admission, 30 (57%) had cancer. Twelve percent of the patients with a DNR order had it in place before being admitted to the hospital. Sixty-three (33%) patients had a DNR order on the day of or previous to admission. One hundred thirty-six (72%) of the 190 patients with DNR orders were designated DNR by the end of the third day of their hospital stay. Of the 53 patients with DNR orders after three days of admission, 30 (57%) had cancer. Twelve percent of the patients with a DNR order had it in place before being admitted to the hospital. Sixty-three (33%) patients had a DNR order on the day of or previous to admission. One hundred thirty-six (72%) of the 190 patients with DNR orders were designated DNR by the end of the third day of their hospital stay. Of the 53 patients with DNR orders after three days of admission, 30 (57%) had cancer.

Treatment Withdrawn

Fifty-one (21%) of the 245 patients had their treatment withdrawn. At HSC, 45% of patients had their treatment withdrawn. Forty-one (80%) of the 51 patients had a DNR order. The average age of patients who had their treatment withdrawn was 70 years. Of the 51 patients, 18 (35%) had their treatment withdrawn for the reason of poor prognosis or poor status.

One hundred thirty (53%) of the 245 patients were informally palliative. The informal designation of a patient being considered palliative occurred if any of the terms palliative, comfort care or poor prognosis was used in the physician’s or nurse’s progress notes. This could also include patients taking a turn for the worse or discussions with the family regarding withdrawing treatment. Eighty-one percent of Victoria Hospital patients were informally palliative.

There was anticipation of death within 72 hours of death noted for 82 (33%) of the 245 patients. For 45% of HSC patients and 43% of St. Boniface patients, concerns about death were documented within 72 hours prior to death occurring.

Global Triggers

The Canadian Adverse Events Study (CAES) (Baker et al. 2004) refined 18 screening criteria for detecting adverse events. The study was designed to describe the frequency and type of adverse events in patients admitted to Canadian acute care hospitals and to compare the rate of these adverse events across types of hospitals and between medical and surgical care. One of the screening criteria is “unexpected death.” Of the 3,745 cases in the study, 75 (2%) were flagged as unexpected death. A modified version of the CAES tool was applied to the 245 HSMR cases audited (we added several dozen other screening criteria). If many of the deaths in these cases were preventable, we would expect the proportion of unexpected death triggers to be high. In the sample of 553 charts in Winnipeg, 1.8% (10 of 553) of cases had an unexpected death trigger. Of these, three involved unwitnessed arrests and six involved sepsis. The proportion of unexpected deaths is similar to that in the CAES study; thus, the HSMR does not appear to be a sensitive tool for detecting unexpected death.

The results of the audit performed in WRHA indicate that most of the deaths used in calculating HSMRs were expected rather than preventable. Over half of the patients had an alternate level of care, and death was anticipated in one third of cases. Further, only
1.8% of patients had a patient safety concern. The adverse event trigger tool provides some confirmation that unexpected death was rare, given that death in 1.8% of the 553 cases reviewed was classified as unexpected. This is not to argue that 1.8% is an acceptable number but, rather, that the HSMR is not a sensitive tool for detecting the occurrence of adverse events or unexpected death.

**How Can Administrators Best Learn from Deaths?**

The HSMR should not be viewed as an important indicator of patient safety or quality of care for several reasons. The indicator is highly aggregate and difficult to adequately standardize given the large number of diagnosis groups. This makes inter-hospital comparisons invalid. The definition of palliative care and differences in discharge rates make in-hospital and out-of-hospital mortality difficult to distinguish. Many changes in policy unrelated to patient safety could significantly change a facility’s HSMR. As we have seen in the case of HSC, when the intended use is to compare one facility’s HSMRs over time, the choice of reference year makes interpretation difficult and cause-effect relationships between the HSMRs and patient safety programs even more difficult. How then can facilities best learn from in-hospital mortality?

Use of the cumulative sum (CUSUM) statistic is a better approach to monitoring in-hospital deaths. It has been used both by Jarman et al. (2005) and Wright et al. (2006) to monitor mortality over time. The CUSUM statistic allows one to differentiate between variations in performance that are due to chance and variations that are greater than what would be expected from a random process and therefore a possible cause for concern (Yap et al. 2007). The measure can be risk-adjusted in a variety of ways (Steiner et al. 2000) and involves recording instances of “failures” (deaths) and comparing the likelihood of this failure to the likelihood of death in all patients from the beginning of the time series (hence the name cumulative sum). The main advantage of the CUSUM over quarterly or annual HSMRs is that the CUSUM statistic is calculated for each patient. As such, it allows administrators to focus on a subset of patients within a narrow time frame in which deaths were occurring at a higher rate than expected. Armed with this information on a small number of patients (as opposed to all patients at a hospital within a given fiscal quarter), auditors or mortality review committees can focus their attention on what may have been happening during this period of elevated mortality. The CUSUM approach also provides “signal alarms” that sound when mortality is occurring at a higher-than-expected rate within a given time frame. Thus, it can be used relatively silently until a problem arises.

Following Steiner et al. (2000), use of the CUSUM statistic involves setting an odds of death “alarm” rate, \( R_A \). For example, \( R_A \) would be set at 2 if administrators desired to detect a doubling in the odds of death. Defining \( R_0 \) as the current odds of death (usually set at 1), the CUSUM sequentially tests (for each patient) \( H_0 : \text{odds ratio} = R_0 \) versus the alternative, \( H_A : \text{odds ratio} = R_A \). CUSUM scores are then calculated based on the individual risk factors of each patient (likelihood of death based on prior risk factors such as severity of illness), the alarm odds ratio and the current odds ratio. The CUSUM scores are added with each discharge and an “alarm” signals when the sum of these scores is greater than a predefined control limit. The control limits varies depending on the data characteristics at each hospital.

Both Jarman et al. (2005) and Wright et al. (2006) use the odds ratio version of the CUSUM statistic to measure changes in...
mortality. Jarman et al. (2005) set their graph to detect a doubling in the odds of death ($R_\lambda = 2$; a rising CUSUM is bad news). Wright et al. (2006) set their graph to detect a halving in the odds of death ($R_\lambda = 0.5$; a falling CUSUM is bad news). These authors set an alarm at approximately 4.5; thus, each time the graph crossed this line, there was sufficient evidence to conclude that a new level of mortality had been reached (e.g., the odds of death had doubled).

The CUSUM statistic detects changes in mortality when the HSMR does not. Whereas the quarterly HSMRs in Figure 3 do not show much change in observed mortality compared with expected mortality, the CUSUM (Figure 2 in Wright et al. 2006) shows that in-hospital mortality was, in fact, lower after. As such, the CUSUM is a more effective tool for monitoring changes in mortality rates over time.

As noted above, use of the CUSUM statistic does not avoid the need to adjust for individual patient risk factors beyond diagnosis, age, sex, length of stay and comorbid conditions. For example, Steiner et al. (2000) use the Parsonnet score to control for illness severity when calculating the CUSUM statistic. A variety of other risk-adjustment methods are available to control for the generic severity of illness, such as scores on the Duke University Severity of Illness (DUSOI) scale and APACHE. One study found that a patient’s first APACHE III score explained 90% of the variations in hospital mortality among critically ill patients (Knaus et al. 1991). One way to interpret this finding is that 10% of in-hospital mortality is related to errors, quality of care or other factors.

Of the 245 charts audited, 43.7% (107 of 245) involved an admission to ICU and an APACHE score. As of 2006, four of the six hospitals in the Winnipeg Health Region have calculated APACHE scores for patients when they are admitted to the Department of Medicine. When ICU patients are included, approximately 70–80% of patients admitted to these four hospitals have at least one APACHE score. Use of APACHE scores to derive expected deaths would significantly improve the ability to control for between-patient (within-diagnosis) variations in the risk of death. A limitation of using APACHE scores is that these scores are not included in the discharge abstract database. However, the data are routinely collected in databases and could easily be linked to the HSMR data.

A weakness of the CUSUM approach is that, like the HSMR, it does not provide a reason for why mortality might be higher. More detailed investigations of deaths are still required since the CUSUM is only an indicator or signal. However, a major advantage of the CUSUM approach is that administrators would be able to identify small groups of patients and short time frames in which patients expired at a higher rate than expected (as opposed to having one HSMR for the fiscal quarter). Narrowing the field of patient deaths that are contributing to higher-than-expected deaths would permit more focused chart audits and process evaluations.

**Policy Implications in WRHA**

In the absence of better standardization of coding for palliative care and within-diagnostic group variations in level of illness, we reiterate our contention that HSMRs cannot be fairly compared between hospitals. As such, the argument for publishing HSMRs in tables that facilitate such comparisons is weak. Further, there is pressure on administrators to decrease their HSMRs in the absence of detailed and actionable data to do so. This may encourage “gaming” through admission and discharge policies. Such games might include discharging a patient multiple times to inflate the number of “live” discharges in a
diagnostic group, recoding patients as palliative, discharging patients to long-term care more quickly or refusing to admit critically ill patients from personal care homes. These examples, though perverse, illustrate the ease with which HSMRs can be manipulated when there is an incentive to do so.

Even if the HSMR is eventually shown to be a valid, sensitive and specific indicator for unrecorded adverse events or deficiencies in quality of care, it is not clear that focusing attention on death is the best route to improving patient safety or hospital quality. The vast majority of patients who experience adverse events do not die from their injury. Thus, focusing on death as a means of improving quality is highly inefficient. Data regarding deaths is simply convenient because they cannot go unreported. Since mortality has been chosen as the pathway to improving quality, efforts would be better focused on measuring safety and quality at the sub-hospital level. For example, hospital administrators in the United Kingdom are provided (monthly) adjusted standardized mortality ratios for 78 diagnostic groups and 128 procedures, including CUSUM charts and mortality odds ratios (B. Jarman, personal communication, 2007). This information is highly actionable – giving administrators a much better sense of where problems might exist. CIHI should consider developing similar data to augment the distribution of HSMRs. The experience in WRHA is that identifying specific problems via HSMRs is difficult and costly.

Because problem areas are difficult to identify, WRHA is making extraordinary efforts to investigate deaths. The new WRHA Mortality Diagnostic Process involves rapid screening of all deaths by a nurse auditor and referral of obvious problems directly to the Critical Incident Review Process and/or the Chief Medical Officer. Periodically, groups of questionable cases are referred to an interdisciplinary diagnostic team in which two members perform a more detailed review of a chart. The budget for the Mortality Diagnostic Process is $125,000. A comprehensive formative evaluation of the entire process will be conducted by the Research and Evaluation Unit at WRHA, and in a year or two there will be detailed information about the value of such a process and the learning that has occurred.

Conclusion

CIHI and the Canadian Patient Safety Institute should be commended for bringing heightened awareness and scrutiny to in-hospital mortality in Canada. They are clearly concerned about the welfare of Canadians and improving patient safety. Most hospitals are now reviewing, resurrecting or re-designing death review processes. However, the HSMR must be interpreted and used with caution; it is difficult to interpret without better patient, hospital and regional level risk stratification. Our chart audit found that the HSMR does not appear to be a sensitive measure of adverse events or unexpected death. Further, the measure is difficult to use because the information is too aggregate. While the CUSUM approach also has weaknesses, it provides a much better starting place for auditors and administrators. Mortality data by diagnostic group and procedure would be even more helpful.

The publication of HSMRs from facilities across Canada will inevitably lead to continued public (media) comparisons between different hospitals across the country. We hope the arguments presented here will reinforce CIHI’s stated caveat that these comparisons should be avoided. It is simply not a valid conclusion that differences in HSMRs are due to differences in quality of care. Such comparisons are also not a useful way for patients to choose a hospital for care. The usefulness of
the HSMR lies entirely in promoting facilities to investigate deaths and make incremental improvements over time. But it must be kept in mind that even tracking trends over time is complicated by the use of a baseline year that precedes the development of a palliative care coding guideline.

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Do Hospital Standardized Mortality Ratios Measure Patient Safety?

Appendix 1. Definitions for Levels in the Winnipeg Regional Health Authority's Advance Care Plan

Advance Care Plan 1

Advance care plan 1 is often referred to as palliative or comfort care. It focuses on aggressive relief of pain and discomfort. There is no cardiopulmonary resuscitation (CPR – intubation, assisted ventilation, defibrillation, chest compressions or advanced life support medications) performed. There are also no life-sustaining or curative treatments, such as intensive care, tube feedings, transfusions, dialysis, intravenous (IV) hookups and certain medications. All available tests and treatments necessary for palliation are done, including medications and transfer to hospital if necessary.

Advance Care Plan 2

Advance care plan 2 provides palliative and comfort care, as above, but also allows for treatment of reversible conditions (e.g., pneumonia, blood clot) that may have devel-
oped. There is no CPR (intubation, assisted ventilation, defibrillation, chest compressions, advanced life support medications). Intensive care, all available tests and treatments for reversible conditions are offered, based on medical assessment, except for CPR. Certain tests and treatments for any reversible conditions (e.g., tube feedings, dialysis, intensive care, transfusions, IV hookups, certain medications, certain tests, transfer to hospital, etc.) may be refused based on the patient's values.

**Advance Care Plan 3**
Advance care plan 3 provides any necessary palliative and comfort care, as above, plus available treatment of all conditions, both reversible and nonreversible, with no restrictions, except for CPR. There is no CPR (intubation, assisted ventilation, defibrillation, chest compressions, advanced life support medications). As above, a person may elect to refuse any tests or treatments for both nonreversible and reversible conditions. If so, these should be listed.

**Advance Care Plan 4**
Advance care plan 4 provides for all available treatment of all conditions, and includes full CPR.

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Understanding and Using the Hospital Standardized Mortality Ratio in Canada: Challenges and Opportunities

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ABSTRACT

In 2005, the Canadian Institute for Health Information (CIHI) began a methodological journey to develop a Canadian version of the hospital standardized mortality ratio (HSMR). For two years, CIHI worked with hospitals, regional authorities and measurement experts to define the most appropriate methodology given Canadian datasets and systems of care. In November 2007, we made the findings publicly available for regional health authorities and larger facilities. In their lead article,
Penfold et al. discuss their views regarding some methodological issues and potential limitations of the HSMR to monitor quality of care and, in particular, as a patient safety indicator. Here we respond to their specific concerns and maintain that the HSMR remains an important tool in the arsenal of information hospitals can use to focus the discussion of patient safety/quality improvement, monitor the provision of care over time and identify opportunities for improvement.

Delivering safer and the highest-quality care is high on the agenda of healthcare settings. Having relevant and timely information to inform decisions is invaluable to supporting these improvement efforts. However, to improve the safety and quality of care being delivered, different measures are needed by various decision-makers. For example, hospital-based clinical teams often need immediate and detailed information to assess and monitor progress in specific areas. In contrast, hospital board and executive team members may focus on higher-level summary measures to evaluate quality of care from a more institutional perspective. These summary measures are sometimes called “big dot” measures.

The hospital standardized mortality ratio (HSMR) is an example of a big dot measure that has been used internationally to help support efforts to improve quality of care in hospitals (IHI 2003, 2007; Whittington et al. 2005; Wright et al. 2006). Typically, hospitals review and analyze their mortality rates, and then develop targeted strategies aimed at reducing mortality in identified areas. In this context, the HSMR has been used as an important tool for monitoring changes in overall mortality and, in conjunction with other measures, has helped to inform quality improvement efforts within hospitals.

In 2005, at the request of health regions and the patient safety community in Canada, the Canadian Institute for Health Information (CIHI) was asked to develop an HSMR for use in Canada. Since December of 2005, annual and quarterly HSMR reports have been sent to hospitals for verification. In November 2007, HSMR results for larger institutions and health regions were made publicly available (CIHI 2007). Since the availability of facility level HSMR values, many hospitals, health regions and ministries have continued to monitor their HSMRs on a quarterly or even monthly basis.

In their lead article, Penfold et al. discuss the challenges that they faced in interpreting HSMR results in Winnipeg and thereby dispute its utility as a measure for informing efforts to improve quality of care. We share their view on the importance of sound measurement to guide quality improvement efforts but not their overall conclusion. Feedback that we have received from many hospitals, health regions, patient safety experts and others across the country (reflected in a number of other papers in this issue) suggests that HSMRs can be a useful addition to a set of measures used to monitor and guide improvements in care. The key is that the HSMR is intended as a starting point to better understand trends in mortality for a given facility or region rather than a way to rank order the performance of hospitals across the country. It is designed to be used in conjunction with other macro- and micro-level outcome and process measures.

Here we assert that the HSMR remains an important tool for monitoring fluctuations in hospital mortality over time. We acknowledge that limitations with the methodology exist and provide answers to questions about their impact.
The Canadian HSMR

As originally developed in the United Kingdom by Sir Brian Jarman (Jarman et al. 1999), the HSMR compares the actual number of deaths in a hospital with the average national experience after adjusting for the types of patients treated. This HSMR is based on diagnosis groups that account for approximately 80% of deaths in acute care hospitals and is adjusted for several factors that may affect in-hospital mortality rates (e.g., age, sex and admission status of patients).

The HSMR is simply a ratio of observed over expected deaths multiplied by 100. For the purpose of definition, the term expected death is derived from a statistical perspective, using the overall (national) level as a reference and does not refer to expected death in a clinical sense. An HSMR greater or less than 100 suggests that a local mortality rate is higher or lower than that of the national experience.

The Canadian HSMR is based on the UK methodology but was adapted to take into account disease patterns and data availability issues specific to Canada. Over a two-year period, CIHI worked to develop and refine the methodology. Consultations with many experts in quality measurement and patient safety, as well as hospital teams, were conducted, and through these consultations hospitals and health regions provided valuable feedback that helped ensure that the final HSMR methodology is meaningful in the Canadian context.

Briefly, the HSMR methodology for Canada is based on the 65 diagnosis groups that together account for about 80% of in-hospital deaths, after excluding patients identified by hospitals as having received palliative care (PC). Using a logistic regression model (which is based on data from fiscal year 2004–2005 as the reference and includes all acute care facilities that submit to CIHI’s Discharge Abstract Database [DAD]), the HSMR is adjusted for several factors that affect in-hospital mortality: age, sex, LOS, admission category, diagnosis group, comorbidity and transfer from another acute care institution.

HSMR Methodology: Addressing Questions and Potential Concerns

In their article, Penfold et al. challenge the utility of the HSMR on methodological grounds. They provide results of in-depth analyses conducted within their own regional health authority as they investigated the factors driving HSMR results within their region. While their criticisms are methodological in nature, they conclude that the HSMR methodology is not a sensitive measure of “unexpected deaths resulting from adverse events,” that it is not a sensitive measure of “avoidable or preventable deaths” and that variations in coding practice and patient population make the HSMR unsuitable for inter-hospital comparisons.

In this section, we provide answers to the concerns raised by Penfold et al. as well as answers to other questions that arose during the development of the HSMR methodology over the two-year period.

Can HSMR Measure the Reduction of Deaths Due to Adverse Events?

As a big dot indicator, the HSMR can be used to track the overall change in mortality resulting from a broad range of factors. More specific tools, such as the Institute for Healthcare Improvement (IHI) global trigger tool (Griffin and Resar 2007) and the Canadian Adverse Events Study tool (Baker et al. 2004), are better suited to delve into greater detail regarding adverse event–related deaths. In their landmark study of 2004, Baker et al. identified that annually approximately 7% of Canadians experience an adverse in-hospital event; “unexpected death” was flagged in 2% (75) of the 3,745 charts reviewed. The
Canadian HSMR methodology is based on 65 diagnosis groups that account for 80% of in-hospital deaths. Deaths due to adverse events are not explicitly identified. In their article, Penfold et al. inaccurately cite a paper by Leeb et al. (2005), suggesting that it advocates that hospitals can use HSMRs as a means of tracking changes in adverse events. A careful reading of the paper indicates that this is not what is stated. We reiterate that the HSMR was never developed to monitor deaths due to adverse events specifically. Overall changes in hospital mortality can be influenced by many factors, including changes in both the quality of care and the safety of care delivered. For example, improving quality of care through implementing new evidence-based clinical guidelines, more timely responses, improved patient flow and reducing the number of deaths due to adverse events can all contribute to improved healthcare outcomes, including overall reductions in deaths.

**Does the Provision of PC Services at My Hospital Affect the Interpretation of Our HSMR?**

There are three types of patients who receive PC services in acute care hospitals:

A. Patients who were admitted to hospital for the purpose of PC
B. Patients who were admitted as acute care cases (e.g., for acute myocardial infarction [AMI] or hip fracture) but were changed to a PC treatment plan, which then accounted for the largest portion of their length of stay (LOS)
C. Patients who were admitted as acute care cases (e.g., for AMI or hip fracture) but received PC services at the end of their hospitalization; for these patients, PC did not represent the largest portion of their LOS

Due to unavailability of information on PC status at time of admission, a limitation pointed out by Penfold et al., CIHI calculated two HSMRs for hospitals. Patients with a most responsible diagnosis of PC (i.e., those in groups A and B) were not included in either HSMR. The “HSMR all-cases” covers patients from 65 diagnosis groups and includes patients that fall into group C. The “HSMR excluding PC” results do not cover cases that fall into group C. As a result, among the PC cases identified in acute care discharge abstracts in 2006–2007, approximately 59% of them are excluded from the HSMR all-cases.

When the HSMR methodology was being developed, there was no national coding standard for PC, which meant that hospitals coded their PC cases in different ways. In order to improve the quality and comparability of PC data, CIHI developed coding guidelines in June 2006 and updated them in 2007. The coding standard was in effect as of 2008, and hospitals are now using it. For many hospitals, this PC standard did not affect their coding practices. For these hospitals, both the HSMR all-cases and the HSMR excluding PC reflect actual changes in hospital mortality. For some hospitals, however, implementing the PC standard resulted in major changes in their coding practices. Many cases not previously coded as PC are now being coded as PC, resulting in an increased number of coded PC cases. Data analysis showed that the majority of this increase involved cases that fall into group C above. For these hospitals, changes in the HSMR excluding PC reflect more of a coding practice change than an actual change in mortality. The HSMR all-cases still reflects the actual change in mortality, and hospitals can use it to monitor their mortality as long as there is no major change in their hospital service programs (e.g., adding a new PC unit and receiving additional cases).
Does the Fact That the Methodology Limits Inter-hospital Comparisons Diminish the Usefulness of the HSMR?

Penfold et al. caution against the use of the HSMR for inter-hospital comparisons. The HSMR is not intended for inter-hospital comparisons but, rather, to provide hospitals with a big dot indication of their mortality trends over time – CIHI has repeatedly highlighted this point. Use of this type of measure in this way is supported from a methodological standpoint (Breslow and Day 1987). In cases where hospitals have similar enough profiles to satisfy the methodological requirements highlighted by Breslow and Day (1987), HSMRs can be validly used for inter-hospital comparisons. When making these types of comparisons, statistical differences need to be tested using different methods (Breslow and Day 1987).

While it would be unwise to assume that a hospital with a ratio of 105 delivers lower-quality care than one with a ratio of 100, regardless of the stated methodology limitations, it would also be unwise to assume that the difference between 60 and 130 is wholly attributable to methodological inconsistencies or data quality issues. Like any other measure and data set, the more it is used, discussed, debated and refined, the better the HSMR will become. It is true that the HSMR is best used for within-hospital than between-hospital comparisons. But regardless of the comparisons being made, it should be used less to judge and more as a catalyst to examine, understand and improve.

Does Having a Higher Proportion of Patients Who Die in Hospital or Stay in Hospital Longer Affect My HSMR?

The HSMR adjusts for patients’ LOSs so that
hospitals with patients who have longer LOSs would have a higher-than-expected mortality. CIHI does not have the capacity to fully assess the impact of out-of-hospital deaths. Instead, to estimate the impact of out-of-hospital deaths, we examined the relationship between the percentage of in-hospital deaths and HSMRs for 16 regions in Western Canada (Figure 1). The correlation with the HSMR all-cases was not strong ($r^2 = 0.25$; for HSMRs excluding PC, $r^2 = 0.26$). Research from England suggests that statistically adjusting for the percentage of in-hospital deaths in hospitals’ catchment areas may move at least some outlier hospitals closer to the average (Seagroatt and Goldacre 2004). On the other hand, data for all hospitals (not just outliers) in 2000–2001 were poorly correlated, with the percentage of deaths occurring in National Health Service hospitals in seven regions in England ($r^2 = 0.02–0.20$), except for the West Midlands ($r^2 = 0.50$) (Harley and Mohammed 2004). Likewise, Scottish standardized mortality ratios based on deaths in and outside of hospital within 30 days of admission to hospital were highly correlated with HSMRs that only included in-hospital deaths (Jarman et al. 2004).

**Does Having Sicker Patients at My Hospital Affect My HSMR?**

Patient sickness can be reflected by measures of acuity and complexity. Patient acuity and severity of illness can be captured using observational clinical measurement tools, such as the Acute Physiology and Chronic Health Evaluation (APACHE) score. These types of data, gathered through bedside monitoring and most commonly collected for patients in the intensive care unit, are not currently available nationally and, as such, were not included in the HSMR adjustment. However, the type of admission is available and can give an indication of patient sickness. Given that cases admitted as emergency or urgent have a higher expected mortality than those admitted as elective, the HSMR is adjusted for a patient’s admission category, that is, emergency/urgent versus elective. Using their own in-house data, hospitals can investigate cases further with APACHE scores. The HSMR can provide the starting point, but hospitals are in the better position to look at more detailed data and link to their local context.

Complexity can be partially accounted for by looking at comorbidities as patients with more comorbid conditions tend to be more
complex. Our analyses revealed that patients with three or more Charlson Index comorbidities are more than three times as likely to die than those with no Charlson Index comorbidities recorded (odds ratio [OR] 3.44, 95% confidence interval [CI] 3.32–3.56), and this is adjusted for in the HSMR methodology. (The Charlson Index is an overall comorbidity index shown to be highly associated with in-hospital mortality and has been widely used in clinical research.)

**Does Having Older Patients in My Hospital Affect My HSMR?**

Our analysis has confirmed that crude in-hospital mortality rates increase as patient age increases (Figure 2). All else being equal, patients in general have a 5% higher risk of dying in hospital for each additional year of age (OR 1.05, 95% CI 1.050–1.052), and this is adjusted for in the HSMR methodology.

**Does Serving a Low-Income Community Affect My HSMR?**

Previous studies have found that Canadians living in lower-income neighbourhoods are more likely to report being in poor health and to be admitted to hospital than the population as a whole (Booth and Hux 2003; Carrie and Kozyński 2006). We assessed the effect of income on in-hospital mortality by adding neighbourhood income quintile as a covariate in the HSMR logistic regression model. While the neighbourhood income quintile variable was statistically significant at the patient level ($p < .05$), there was little difference between hospital-level results that were adjusted for neighbourhood income quintile and those that were not ($r = 0.99$) (Figure 3). (In addition, there was no difference in the C statistic when neighbourhood income was added to the logistic regression model.) Jarman et al. (1999) also reported that socioeconomic deprivation did not explain significant variations in hospital-specific HSMR results.

**Do the Types of Patients My Hospital Treats Affect My HSMR?**

Patients with different diagnoses have a different chance of dying during their hospital...
stay. The HSMR is based on each patient’s expected chance of dying in hospital and whether the patient died during or was discharged from that hospitalization. For the 65 diagnosis groups included in the HSMR calculation, each group was assigned its own level of risk of death based on the overall death rate for all patients with the same diagnosis (based on eligible cases in DAD 2004–2005). For example, our analysis showed that patients with stroke have a higher risk of dying than patients with pneumonia. So, a hospital that treats more stroke cases has a higher expected mortality than one that treats more pneumonia cases (assuming that both hospitals treat a similar volume of patients for all other HSMR-eligible conditions). Patient diagnosis grouping was the most influential contributor among all risk factors included, as revealed by the logistic regression analysis.

What Is the Impact of Receiving More Transferred Cases on My HSMR?
Transferred patients may have higher risks of in-hospital mortality because their care needs may only be available at particular facilities due to their complexities. As a result, the HSMR methodology adjusts for transfers from another acute care institution, and hospitals that receive more of these cases would be assigned a higher expected mortality. Our analysis showed that patients transferred from another acute care hospital generally have a 35% higher risk of dying than those patients not transferred (OR 1.35, 95% CI 1.30–1.41).

Does Incomplete Physician Documentation at My Hospital Affect My HSMR?
The current analysis is based on data submitted by hospitals to the DAD. CIHI’s re-abstraction studies do show that most conditions are accurately coded to the level used in the HSMR. The quality of the clinical data depends on accurate and comprehensive physician documentation as well as chart coding in Health Records department. Incomplete coding can influence HSMR results. For example, if comorbidities are under-coded, the true HSMR may be different from those reported by CIHI. Initiatives aimed at engaging physicians in addressing documentation issues are already under way in some jurisdictions.

More Work to Be Done
Despite the limitations, many hospitals and health regions (including some respondent authors included in this issue) indicate the utility of the HSMR as one of a group of important indicators used to monitor overall quality of care and to evaluate the impact of care improvement initiatives. CIHI remains committed to working with hospitals and regions to further their and our understanding of the strengths and limitations of the HSMR methodology and to develop more tools to help hospitals identify factors affecting their mortality rates. This includes providing electronic tools to help support analytical capacity in hospitals and regions (e.g., cases validation tool and e-HSMR). Another tool we are currently piloting is the CUSUM, or cumulative sum, methodology. Since the early stages of HSMR development, CIHI has been investigating the CUSUM methodology and its usefulness and practicality in clinical settings.

As indicated by Penfold et al., CUSUM has been used to monitor hospital performance in the United Kingdom (Jarman et al. 2005). This graphic method involves sequential monitoring over time and can provide a sensitive early warning of increases in mortality such that hospitals can target a specific period of time or group of cases for chart audits (Figure 4). However, notwithstanding the fact that CUSUM is calculated based on the same administrative data as the HSMR (and is
therefore prone to the same data limitations as the HSMR), it too is not without limitations.

While changes in performance can be detected by a CUSUM graph, the cause of these changes, as with the changes in HSMRs, can only be determined through further analysis at the hospital and program level. To date, the literature is mixed with respect to the usefulness and application of CUSUM in healthcare settings (Aylin et al. 2003; Biau et al. 2007; Burns et al. 2005; Sibanda and Sibanda 2007). For example, a major challenge with CUSUM reflected in the literature is the need to carefully select chart limits to minimize high false-positive rates (Billett and Kendall 2003; Buchan et al. 2003; Hurwitz and Beaumont 2003). In their paper, Penfold et al. offer CUSUM as an alternative tool for understanding hospital mortality. We believe that there is potential for CUSUM to be used as a complementary measure to the HSMR, and CIHI has now begun to work with a few hospitals to examine whether CUSUM monitoring can be used to detect patterns of mortality that need further investigation. In light of the limitations associated with CUSUM, we do not agree with Penfold et al.’s recommendation that the HSMR should be replaced with CUSUM; rather, we view Penfold’s recommendation as further validation that the HSMR is the most useful big dot measure available for use in Canada.

Conclusion

Many hospitals and regions in Canada are now tracking their HSMRs over time. Internationally, this is also the case. Like most high-level or big dot indicators, the tracking of HSMRs and noting of their variations over time can be used as a screening tool for initiating further investigations or as a monitoring tool to evaluate the impact of quality improvement initiatives. While the HSMR provides a mountaintop view of hospital mortality, its true value is most evident when hospitals go beyond their number and conduct analyses on their own data to gain a true understanding of the value of such an indicator.

For most hospitals or health regions, specific strategies aimed at reducing mortality may involve one or more interventions such as changes in clinical practices, policy interven-
tions and documentation practices. Further investigation into the factors driving HSMR results may help to inform the focus of these strategies. And, there is evidence to suggest that reducing overall mortality can motivate further changes within the organization that lead to other improvements in the quality of care delivered to patients (IHI 2003).

The nature of a big dot measure is to track progress on a broad outcome at a system level. The purpose of the HSMR is to show the overall picture of mortality change for an organization. Hospital management teams have been using aggregate indicators (e.g., average LOS or bed occupancy rate) in conjunction with more specific indicators (e.g., 30-day in-hospital AMI mortality or maternal adverse events) as part of their arsenal of information in examining their overall organizational performance for many years. The HSMR adds to this arsenal of information.

CIHI continues to work with our partners to further refine and develop our methodology regarding the HSMR. Further improvements to the measure will probably be borne only with additional improvements in data availability. In the meantime, interested hospitals, regional health authorities and ministries can use the HSMR to monitor their provision of care over time.

Penfold et al. raise questions and concerns about the HSMR methodology. Their concerns rest on assumptions about coding variations regarding the provision of PC and the utility of the HSMR to directly monitor deaths due to adverse events. They conclude by suggesting that the CUSUM statistic may be a better measure for monitoring changes in mortality over time. In this response, we suggest that coding differences in the provision of PC are less problematic with the introduction of new coding standards and further work at CIHI to improve data quality. We assert that the HSMR is a measure designed to monitor overall changes in mortality and was not designed to focus specifically on adverse event–related mortality. We conclude, as do several others, that the HSMR remains a robust global indicator of quality of care and a flag for hospitals to initiate investigations if their HSMRs increase over time.

References


In Defence of the Hospital Standardized Mortality Ratio

COMMENTARY

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ABSTRACT

This commentary addresses many of the points made by Penfold and colleagues in the lead article of this issue of Healthcare Papers, including the relationships between hospital standardized mortality ratios (HSMRs) and adverse event reporting, hospital policy and discharge rates. It also discusses what the HSMR is intended to measure, the various analyses and cumulative sum statistic data that my colleagues and I provide to hospitals, interpretation of the results and the inclusion or exclusion of patients receiving comfort or palliative care. It should be noted that my colleagues and I still have the attitude that if anyone can make improvements in our methodologies, we are happy to adopt these improvements as long as they are statistically sound.

We feel strongly that if a hospital has a high HSMR, then further investigation is merited to exclude or identify quality-of-care issues; this approach can result in a useful insight into mortality at the institution, which can be associated with a decrease in mortality.

My thanks to Rob Penfold and colleagues for their article on the hospital standardized mortality ratio (HSMR). I have a few comments that I would like to add to this discussion.

Quality-of-Care Programs and HSMRs

To begin, I would like to point out that two of the papers that Penfold et al. discuss – Wright et al. (2006) and Jarman et al. (2005) – do give published examples of quality-of-care
programs specifically designed to reduce hospital mortality that have shown measured reductions in HSMRs (about 300 fewer observed – expected deaths per year after about three or four years). Similar examples have occurred in the United States (unpublished).

**Adverse Event Reporting and HSMRs**

Regarding the association between HSMRs and adverse event reporting, my view is that of Charles Vincent, who is a recognized expert on the recording of adverse events. He has pointed out that there is almost no relationship between events detected by a record review and those that are reported (Sari et al. 2007; Vincent 2007). My colleagues and I did a study (as yet unpublished) of US hospital data that indicated that hospitals that record more secondary diagnoses are more likely to record complications of treatment. There is also an indication that hospitals with higher death rates are less likely to record complications of treatment. I understand from Gene Gaffney (personal communication), from Vanderbilt, that there are higher levels of adverse event reporting in Swedish hospitals that have lower death rates.

A second problem is the inability to distinguish between diagnoses present on admission and those developed during hospitalization. A good example of this involves decubitus ulcers; my colleagues and I found in a recent study of 20 hospitals that 40% of the decubitus ulcers we had recorded were present on admission. In the United States, Medicare will require, as of October 2008, that hospitals record whether diagnoses were present on admission. The conclusion of the Bristol Royal Infirmary Inquiry (2001) regarding reporting morbidity/adverse event rates was this: “As well as examining rates of mortality, our Experts also examined the available statistical data on levels of morbidity following PCS [pediatric cardiac surgery] in Bristol in relation to other specialist centres. Their overall conclusion was that the ‘sources of routine data which are available do not serve as an appropriate basis for drawing any firm conclusions concerning morbidity.’”

The level of adverse event recording may reflect the quality and quantity of coding at each hospital and the vigilance of a hospital in terms of the degree of attention that it gives to questions of reporting quality of care. A high level of reporting might represent either a high number of incidents or greater vigilance and a better quality of recording of adverse events. I was recently at a meeting in Copenhagen at which the people from Missouri Baptist Medical Center in St. Louis, Missouri, described their program to reduce their HSMRs. They found that the number of adverse events reported went up immediately by about three times its previous level once they started taking quality improvements seriously. The adverse events reporting level gradually came down over subsequent years.

Overall, from the above considerations, we would expect that adverse event reporting would probably tend, overall, to be lower in the hospitals with higher death rates. HSMRs are, of course, for the reasons that I have stated, in no way meant to be an indicator of the level of adverse events recorded.

**Hospital Policy and HSMRs**

Penfold and colleagues state that in our 1999 paper (Jarman et al. 1999, with Lisa Iezzoni as one of the co-authors), we “also argued that several significant predictors of in-hospital mortality are outside the control of hospital policy.” This quotation was a comment on the variation of the HSMRs as found in the multiple regression analysis using HSMRs as the dependent variable and a range of independent variables to find which best explained the variation of HSMRs. Therefore, the comment only applies to the factors that explain the
variation of the HSMRs. Readers of the lead paper could incorrectly interpret the comment as meaning that we think that hospital staff cannot influence hospital mortality.

Analyses Provided to Hospitals
Penfold et al. argue that “hospital administrators often have difficulty using the mortality measures because the data are too aggregate.” However, they fail to point out that we supply, on a monthly basis via the web, to hospital administrators and clinicians a detailed analysis of the adjusted SMRs of 78 Clinical Classifications Software (CCS) diagnostic groups and 128 procedures, including cumulative sum (CUSUM) charts and log (odds ratio) statistics based on the Steiner (2000) article that the authors quote. About 80% of English hospitals receive these monthly analyses. We (Paul Aylin, the deputy director of our unit at Imperial College, and I) also write a letter to the chief executive of any hospital (or “trust,” as we call them) when there is a >99% chance that it is double the national death rate in the past year for any of these conditions (which cover 90% of hospital deaths). See, for example, the methodology published in an article by Aylin et al. (2007) and other articles published in *BMJ*, such as the 2005 article about the Walsall NHS Trust facility (“Dr. Foster’s Case Notes” 2005).

Interpretation of the Results Seen at Walsall NHS Trust
In Penfold et al.’s discussion of the Walsall results, they state that the “1996 (pre-intervention) and 2003 (post-intervention) HSMRs are statistically identical.” As my colleagues and I have indicated, the quality of care improvement interventions took place directly after our publication of the Walsall HSMRs in January 2001, and from that point their death rates dropped steeply. (This is shown, for example, by the CUSUM data presented in a graph in the web pages of the Walsall paper [“Dr. Foster’s Case Notes” 2005], an article that used the Steiner methodology.)

What Does the HSMR Measure?
The authors of the lead paper comment that “It could also be true that the HSMR does not measure avoidable deaths but, rather, trends in overall mortality.” Certainly, as explained above, the HSMR does not measure avoidable deaths recorded as such. It does measure the trend in overall adjusted mortality at a hospital (for the diagnoses giving rise to 80% of deaths nationally) compared with the national trend. It is an overall hospital measure, using a national baseline for comparison: hospitals have to go to individual diagnostic group or procedure analyses for detailed data.

Inclusion or Exclusion of Patients Receiving Comfort Care
In the lead article, the authors state that “the IHI [Institute for Healthcare Improvement] in the United States specifically excludes all patients receiving comfort care from HSMR follow-up … (Whittington et al. 2005).” This applies to the four-by-four analyses of the last 50 deaths, which I think John Whittington was probably meaning, and that would be true in that in their detailed analyses with their four-by-four studies, they excluded the patients receiving comfort care. I do all the HSMR analyses that IHI uses, and I also supply John with monthly HSMR analyses for his hospitals in the OSF group. Penfold et al.’s statement is just untrue regarding the way that I do the HSMR calculation for IHI and for John’s own hospital group.

Inclusion or Exclusion of Patients Receiving Palliative Care
Penfold et al. argue that “patients receiving palliative care should be excluded from the HSMR calculation since these deaths were
expected and the patients involved usually had a designation of alternate level of care or withdrawal of treatment.” I think that the situation in Canada is different from that in the other countries that I have studied in that a much higher proportion of patients receiving palliative care were included in the original data, and I believe that the Canadian Institute for Health Information (CIHI) has detailed protocols to exclude them. In the United Kingdom, we do include palliative care as one of the 2 variables in the SMR analyses that I have referred to, and this is significant in some (but only the usual variables are significant at the overall HSMR level). Also, it may be worth noting that removal of all neoplastic diseases (carcinomas and lymphomas) from the HSMR diagnoses hardly changes the HSMRs.

**Discharge Rates and HSMRs**

Penfold and colleagues state that “differences in discharge rates make in-hospital and out-of-hospital mortality difficult to distinguish.” In the data that we have presented at various meetings (soon to be published), we have shown that the HSMRs do not change a great deal between the “normal” in-hospital HSMRs and those that include patients up to 30 days from discharge, and that the main changes seen occur in hospitals that have “non-average” case mixes. As we are trying to measure in-hospital mortality, I think it is best to give the normal HSMRs plus show the effect on the HSMRs of the percentage discharged to various forms of intermediate care and also the effect of the availability of this type of care in the community (see Jarman et al. 1999). There is also not much difference between normal HSMRs based on all admissions and those based on only one (e.g., the last) admission in a year. To do these analyses, we have to link the in-hospital deaths with all registered deaths in the country and also all admissions of patients from 1996 to the current time. Overall, the hospitals that have high HSMRs calculated by the normal methods tend to be high by the other methods, especially if specialist hospitals are excluded (and we exclude specialist or non-average case-mix hospitals from our comparisons).

**Use of the CUSUM Statistic**

Finally, Penfold et al. assert that “use of the cumulative sum (CUSUM) statistic is a better approach to monitoring in-hospital deaths. … The CUSUM statistic allows one to differentiate between variations in performance that are due to chance and variations that are greater than what would be expected from a random process and therefore a possible cause for concern (Yap et al. 2007). The measure can be risk-adjusted in a variety of ways (Steiner et al. 2000).” But, Penfold and colleagues do not seem to acknowledge that we agree with them, as has been shown by several of our publications, and make the detailed information using this methodology available to 80% of English hospitals monthly via the web. We believe that it is also valuable to give hospitals their HSMRs and SMRs (and a great deal of other information) as well as their CUSUM data, so that is what we do in England. I would not be surprised if CIHI were to consider similar data analyses for Canada in future. Those interested can see the small part of our analyses that can be anonymized for dummy hospitals (real hospitals randomly selected and the data anonymized and altered) by logging on to https://da.drfoster.co.uk/, with “drfosterdummyaccess” as both the user name and password.

**Conclusion**

Do not forget that it has taken us more than 10 years to develop the analytical methods that we use in the United Kingdom, starting with HSMRs some years before our 1999 paper (Jarman et al. 1999). For Canada, it is relatively
early days. Analyzing and publishing adjusted hospital mortalities is a difficult subject, and there will be opposition from clinicians, managers and statisticians. I was on the Bristol Royal Infirmary Inquiry, the only medical member of the inquiry (see http://www.bristol-inquiry.org.uk/). We felt that these types of analyses should be done and, where appropriate, made available to the public. We had available to us the best statisticians that we knew of (we did not want to be judicially reviewed), and we still have the attitude that if anyone can make improvements in our methodologies, we are happy to adopt these improvements as long as they are statistically sound. However, I always have borne in mind that at Bristol the clinicians looked at their data every month for about 10 years and took no action (rationalizing that the problems were due to their higher proportion of patients with Down syndrome, even though patients with Down syndrome have a lower-than-average death rate for PCS). It was not until the data were published that action was taken (there were many problems at Bristol), and then mortality for PCS under one year dropped from 28 to 8% in one year and then to 3.5%. Two thirds of those children need not have died.

I should also point out that the calculation of the English and Dutch HSMRs has been modified over the past two years (since I first worked with CIHI to calculate the Canadian HSMRs in 2005) through the development of a more complex logistic regression model using more variables but still covering the diagnoses that make up 80% of all hospital deaths. The factors involved in the model are age group, comorbidity (Charlson index of comorbidity), socio-economic deprivation, length of stay group, month of admission, year of admission, sex, year, urgency of admission, palliative care and the Agency for Healthcare Research and Quality CCS diagnostic groups that lead to 80% of all deaths nationally.

Adjustments are made for diagnosis subgroups (at the three-digit International Classification of Diseases 9 level) within each of the diagnosis groups. Work looking at similarly complex case-mix models based on administrative data suggests they are comparable or in some cases superior to models derived from clinical databases (Aylin et al. 2007) and are certainly better than crude non-adjusted mortality. Models for individual CCS groups enable hospitals to drill down to finer detail than HSMR analyses, which are designed to give an overview of case-mix adjusted mortality at the hospital level.

HSMRs could potentially be affected by a number of factors, including data quality, admission thresholds, discharge strategies and underlying levels of morbidity within the population, but quality of care must also be considered as a contributing factor. Where a hospital has a high HSMR, then further investigation is merited in order to exclude or identify quality-of-care issues. Hospitals that have taken this approach in the United States, United Kingdom and other countries have gained a useful insight into mortality at their institution, and this has been associated with documented falls in mortality.

References


Notes
Letter from Sir Brian Jarman to Penfold et al. 2007.
Hospital Standardized Mortality Ratio: The Way Forward in Ontario

COMMENTARY

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ABSTRACT

Variations in quality of care persist despite an increased understanding of optimal practice and an improved ability to monitor outcomes. The reporting of hospital standardized mortality ratios (HSMRs) is an important step in highlighting the need to improve quality; but, as with most measures, the HSMR is not without flaws. Intense debate in the United Kingdom and the United States, and now here in Canada, has focused too much on the shortcomings of this measure and not enough on the issue at hand. The Ontario Ministry of Health and Long-Term Care – assuming our commitment to steward the healthcare system – embraces the themes of transparency and accountability as key tools in focusing attention on system performance and quality. The analysis of HSMRs in Ontario has indicated limitations to its interpretation, similar to those observed in the Winnipeg Regional Health Authority. The HSMR may not be a specific measure of adverse events, but this does not negate its
The public release of Canadian hospital standardized mortality ratios (HSMRs) in November 2007 by the Canadian Institute for Health Information (CIHI) brought national attention to quality and patient safety in healthcare. Proponents and detractors have debated the “usefulness” or “uselessness” of the HSMR as a statistic for measuring and tracking the quality of medical care. These debates in Canada were predictable since the previous public release of the HSMR in other countries, including the United Kingdom and the United States, resulted in similar responses from stakeholders, including researchers, government, media and the public.

From the United Kingdom to the United States to Canada, the biggest questions about the HSMR remain the same: Is it a good measure of quality and patient safety? What can it tell you, and what can it not tell you? Is the information useful to the public, or is it likely to be misinterpreted? In their article “Do Hospital Standardized Mortality Ratios Measure Patient Safety? HSMRs in the Winnipeg Regional Health Authority,” Penfold et al. conclude that the HSMR is not a good measure of patient safety and quality of care. The article emphasizes the unsurprising limitations of the HSMR, with analyses of factors previously reported to impact its range. Analyses of Ontario data uncover similar limitations, including the poor quality of palliative care coding.

With this being said, why then should we publicly report HSMRs? The answer is that there is sufficient value in measuring and reporting HSMRs. Penfold et al. make a strong case for the lack of validity of the HSMR as a sensitive comparative measure of adverse events or unexpected death. But if we look beyond this very specific use, we may begin to see the value in reporting the HSMR as a broad-based quality indicator: namely, that the HSMR can be a valuable tool along with other measures or indicators of quality and safety to understand how well systems are delivering and continuously improving quality healthcare. Last, but not any less important, kick-starting the process in a way that ignites activity, in this case from healthcare providers and government (i.e., the stewards), can in the long run only do more good than harm.

The HSMR in Ontario
Numerous newspaper articles, television and radio reports and questions in the legislature attest to the generous amount of attention garnered by the public release of Canadian HSMRs. Ontario received a large share of this attention because a significant number of the individual hospitals identified in CIHI’s report were from Ontario, and considerable variation was observed in HSMRs across the province’s institutions.

Exploratory analysis was done at the Ontario Ministry of Health and Long-Term Care (MOHLTC) to understand the variation within the province. Concerns had been raised, particularly around factors that had the potential to impact the range of HSMRs, including death outside the hospital setting, discharge policies and patterns and coding quality of CIHI’s discharge abstract database (DAD). Our analysis looked at whether there was any evidence of an impact on HSMRs from such factors.
Palliative Care Coding Also an Issue in Ontario Data

Not unlike the results presented by Penfold et al. for the Winnipeg Regional Health Authority, we found that the coding of palliative care in the DAD had a significant impact on a hospital’s HSMR. In Winnipeg, HSMRs with palliative care were lower than those without palliative care in four of six facilities for fiscal year 2005–2006. Conversely, in their two teaching facilities, HSMRs with palliative care were higher than those without palliative care for the same period. Similarly, in Ontario facilities, HSMRs calculated with palliative care are lower in some hospitals (but higher in others) compared with HSMRs calculated without palliative care for fiscal year 2006–2007 (Figure 1). No consistent relationship is observed when palliative care cases are excluded from calculations of HSMR, which makes it difficult to interpret the results and highlights the variation in the coding of these data in Ontario hospitals.

Discharges to Community Services Impact HSMRs in Ontario

Penfold et al. state that “discharge decisions and policies vary regionally” and that “the arbitrariness of the decision to discharge” means that death is not a definite event within hospital. Death as an outcome event has been reported as a definitive event – an outcome that is less subject to reporting bias (CIHI 2007). Therefore, the argument is that the HSMR as a measure is not biased by “the underreporting of events,” as is possible when calculating measures based on less defined events, for example, morbidity or disease data. MOHLTC found that HSMRs were lower for a group of hospitals that discharged more patients to community services, including long-term care, palliative care and home with

Figure 1. Percent change in annual 2006–2007 HSMRs with and without palliative care cases in Ontario hospitals

Bars on the graph represent hospitals with at least 3,000 annual HSMR cases and teaching hospitals. HSMR = hospital standardized mortality ratio.
support services, than for a group of hospitals where these types of discharges were fewer (Figure 2). This result highlights the importance of understanding the role of community services, including the effect of discharge patterns for patients who are more likely in an “end-of-life” situation, when interpreting HSMRs. If these patients die outside the hospital setting, the cases are not included as an event in the calculation of the HSMR.

**Transparency Dictates Public Reporting, Benefits Follow**

In light of these results and other arguments referring to the less-than-ideal information provided by the HSMR, there remains support in Ontario for the use and public release of HSMRs. Much of this support derives from the fundamental theme that strengthening accountability is central in our policy initiatives regarding quality healthcare. This follows recommendations for transparency and accountability made in recent studies on the future of healthcare (Brown et al. 2005).

Clearly, it makes no sense to evaluate an individual, institution or other group on the basis of a single numerical indicator. Our position is that we do not need to continue to poke holes in the HSMR; rather, we need to develop better statistics, including better data and measurement frameworks, and to educate the public to improve interpretation instead of reacting by suppressing information because it is imperfect. Transparency and accountability dictate that information such as HSMRs be made available, irrespective of the risk of
misinterpretation by the media and public. With the release of the HSMRs, CIHI made tremendous efforts toward educating the public by having media proactively briefed on how to interpret the findings in the report. Also, through the process of developing the methodology, recommendations were made for strengthening the comparable collection of palliative care information in acute care facilities across the country. These two activities are benefits that may not have been realized without the work around the development and release of the HSMRs.

Moving Beyond the Question of Whether the HSMR Is a Good Measure

If we look beyond the strict use of the HSMR as a sensitive, comparative, “one-stop-shopping” measure of patient safety, we may see that when situated within a framework of balanced quality indicators, the HSMR can be a useful measurement tool.

Measurement for Monitoring versus System-Level Management and Accountability

The HSMR is a “big dot” indicator, and, as has been suggested, tracking this dot can help us understand whether patient safety and quality initiatives are impacting patient outcomes (CIHI 2007). Penfold et al. state that if excess mortality is observed based on a higher-than-average HSMR, the suggestion is that an institution should drill down into its data to identify where problems related to excess mortality may exist. The challenge, however, is determining what exactly contributes to the observed movement of the HSMR over time. As such, using the HSMR in this way may not be an appropriate or efficient use of resources. Penfold et al. highlight this limitation and suggest the use of the cumulative sum (CUSUM) statistic instead because it offers a better approach to monitoring in-hospital death. The CUSUM can provide “signal alarms” for a limited group of patients who may contribute to increased deaths during a specified time frame. They point out that this statistic can focus chart audits and evaluations in a way that using the HSMR cannot.

This difference between the HSMR and CUSUM may highlight a distinction between measurement for system-level management and accountability and measurement for daily operations or monitoring. It has been suggested that measurements for these purposes differ (Adair et al. 2006). The HSMR included in a complementary set of indicators based on a framework representing the direct and indirect relationships of the system’s structure, process and outcomes may shed stronger light on an institution’s quality initiatives. When tracked over time, the HSMR used in this context may be an accurate indication of a big dot indicator. Providing a wide perspective, the HSMR may be a tool for healthcare quality management and accountability at the system or institution-level for tracking trends (CIHI 2007) instead of a day-to-day tool for spotting where specific changes may be made that can impact preventable death.

Quality Measurement Frameworks

Since the 1990s, quality or performance reporting has increasingly focused on the use of balanced formats or complementary sets of indicators (Brown et al. 2005). However, the evidence on the value of this type of quality reporting continues to be limited, which is most likely a reflection of the complexity of the task (Fung et al. 2008). The significant challenge is that healthcare quality is a multidimensional construct, and developing a framework for measurement is not simple. The approach includes the development of multiple indicators, each providing insights into different domains of quality (Figure 3).
Figure 3. Domains of a quality healthcare system (or institution)

Each attribute of the health system can be conceptualized by various domains. Measures of a domain can help to provide information for assessing an attribute. Measures or indicators can be thought of as structure, process or outcomes measures. Structure, process and outcome in healthcare are related and impact quality. Improvements in quality lead to improved patient outcomes. Assessing the quality or performance of the health system involves many measures or indicators of the various attributes of the health care system.

**HSMR** = hospital standardized mortality ratio.

Source: The quality frame
Institute for Clinical Evaluative Services collaborative high-performing health system for Ontario.

Donabedian (1966) likened this to “borings in a geological survey which yield sufficient information about the parts to permit reconstruction of the whole.” Emphasis on assessments of single indicators without an added focus on a contextual framework will not provide the mechanisms for addressing the complex undertaking of developing and publishing suites of indicators that can assess outcomes of the quality of care. Work is needed in this area as issues of too much versus too little information (i.e., what indicators for which domains) currently generate much discussion among those producing quality reports (Verrall et al. 2008).

**The Way Forward**
Information in healthcare quality measurement and improvement has been hidden (or shrouded) from the public for too long. The public release of HSMRs in Canada has brought quality measurement and provider
accountability to the forefront of the public consciousness. With this, most providers will make investments in change to improve quality and safety; research has shown that activities are increased in quality improvement in response to reporting (Brown et al. 2005). This is not lost on Penfold et al. who, in their conclusion, commend CIHI for “bringing heightened awareness and scrutiny to in-hospital mortality in Canada” and state, “Most hospitals are now reviewing, resurrecting or re-designing death review processes.” As we continue to transform the Ontario Ministry of Health and Long-Term Care toward a stewardship role, measurement and reporting of the issues that impact quality will drive improvements in practice, quality and patients’ experiences.

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Hospital Standardized Mortality Ratio Is a Useful Burning Platform

COMMENTARY

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ABSTRACT

Hospital Standardized Mortality Ratio (HSMR) is an important indicator of hospital performance that can be immediately used by quality improvement teams. As described by Penfold et al., the indicator is not perfect. However, it does serve as a useful measure that is readily understood by healthcare professionals and the public. Engaging hospital staff in quality improvement work can be challenging and requires understandable quality measures. The Canadian Institute for Healthcare Information deserves our thanks for making this indicator available.
We are pleased to have the opportunity to provide our views on the article by Robert Penfold et al. They have provided an excellent analysis of the limitations of the hospital standardized mortality ratio (HSMR) but have come to an inaccurate conclusion about its utility. As governance, management and clinical leaders of a large academic health science centre, we support their call for better outcome measurement and acknowledge the imperfections of the HSMR as a quality and safety measurement. However, we argue that the HSMR is useful right now, and we strongly advocate for its continuing use in the Canadian hospital system.

**Where We Agree**

Penfold and his colleagues have made a valuable contribution to the analysis of the HSMR, outlining the strengths and weaknesses of the measurement and providing data resulting from an extensive chart audit to illustrate their points. We endorse the viewpoint that deaths in a hospital deserve understanding and analysis, and we have also observed that truly unexpected deaths are fortunately very uncommon in our hospitals. The authors correctly point out that hospital death rates depend on many factors aside from quality and safety of care, including admission and discharge practices, coding definitions and regional variations in palliative care and long-term care resources. The HSMR is accurately described as an overarching summary of these factors, susceptible to variation from chance alone. These limitations need to be understood but do not invalidate the use of the HSMR as a useful quality monitoring and quality improvement tool.

The authors have provided many good arguments for the use of the HSMR internally by hospitals themselves, rather than for inter-hospital comparisons, only after several data points are collected, with suitable sample size and over a significant time period. These very points were stressed by the Canadian Institute for Health Information (CIHI) when the HSMRs were released, and we are in complete agreement with them. However, these facts can be lost on the general public and in the media. It is tempting for institutions with apparently favourable HSMRs to lose sight of the limitations of these data when congratulated publicly. Individual organizations and the system at large must be vocal in educating all stakeholders surrounding the need for both robust quality and safety improvement initiatives and more meaningful data.

**Where We Differ**

The limitations of the HSMR described by the authors are legitimate, and Penfold et al. are persuasive in arguing that more precise and actionable outcomes should be pursued. However, most aspects of clinical quality improvement as currently practised lack a robust evidence base. The distinctions between common quality management tools such as rapid cycle improvement and formal research initiatives are usually explicit and accepted as legitimate in the world of healthcare quality and safety. Similarly, we have allowed small-scale process measures and intermediate outcomes to satisfy demands for quality improvement, claiming necessity due to a lack of perfect outcome measures. We must afford the HSMR the same leeway during this transitional period. The HSMR is an important and bold move from decades of process measurement to a frank look at outcomes. While imperfect, it is currently available.

In the short term, the HSMR serves as a compelling instrument to use in engaging staff in a culture change that will stimulate improvements in hospital safety. Despite its flaws, the HSMR does measure the incontrovertible outcome of death, which is of interest to all stakeholders: patients, government payers and clinicians. As a Canadian institu-
tion with a mission to develop data that will improve quality in publicly funded healthcare, CIHI should be applauded for its introduction of the HSMR. CIHI’s further work in providing specific analyses of mortality for case mix groups within an institution will serve as an important element for improving hospital performance.

All clinical investigators recognize the strengths and weaknesses of administrative databases in detecting regional differences in care and testing high-level hypotheses about value for money within the healthcare system. Although the statistical appeal of the HSMR may improve with many more data points considered in the formula, the addition of further measures of co-morbidity (e.g., Acute Physiology and Chronic Health Evaluation [APACHE] scores) would add considerable complexity and expense to the calculation. There is no reason to believe that it would render the measurement more useful.

The authors propose a calculated cumulative sum (CUSUM) statistic to replace the HSMR. The importance of studying performance over time is the rationale for this suggestion. The debate of “CUSUM versus HSMR” is focused on the issue of how best to detect change, and it leads to a discussion of derivatives and calculus. It is difficult to evaluate raw data (and the HSMR, for all of its standardization, is a raw representation of the “death data” within a hospital over time) to establish whether changes are real or simply “noise” on a background of random variation. To detect real change, the first derivative (or instantaneous derivation of the “slope”) of the mortality data plotted against time can be used.

This first derivative function (or odds ratio) of mortality is the CUSUM statistic. A rise in the first derivative or odds ratio would be more sensitive in detecting significant change and would be best used as an early warning system in detecting a high-impact cause of new deaths, for example, a point source for an infectious disease outbreak. However, the CUSUM would be calculated on the same, inadequately standardized raw data that is used for the HSMR and would not advance the quality of the measurement for the reason that it was intended.

A sustained trend in HSMRs, whether up or down, or a sustained ratio that is higher or lower than 100, is cause for careful analysis by the hospital in question. It is highly likely that the quality and safety of patient care in an institution would have a measurable effect on such sustained results, even though other factors play a role. It is also fair to expect that a consistent change in a quality and safety practice (e.g., universal handwashing or computerized physician order entry of medications) will have a long-term beneficial effect on mortality and will be reflected in the HSMRs.

We are particularly passionate about the positive impact that HSMR measurements have had on our culture of safety. A crucial element in improving quality is changing the culture of front-line staff so that every clinician is involved in assessing practice and outcomes. Thus, the intersection of organizational accountability and individual practitioner responsibility supports the highest quality of patient care and patient safety.

The University Health Network Board of Trustees is strongly committed to ensuring sustained improvement in our quality of patient care and has seen the HSMR release as highly beneficial to this aim. We are very fortunate to have board members with an excellent understanding of quality from their business and community experience, and they are pleased with the heightened awareness that the HSMR has brought to this topic.

We are also strongly in favour of public disclosure of our quality and safety measurements, including HSMRs (and raw mortality data). Canadian hospitals have not kept pace
with the public disclosure of quality and safety data seen in other countries, and the release of the HSMRs last year was the first time that a broad national debate on this topic was joined by the professionals and public alike.

In our opinion, it’s time that hospital quality and safety programs move beyond incremental improvement initiatives and develop major strategic initiatives that require culture change. A paradigm shift toward a focus on outcomes is best served by indicators that can be honestly explained in a room of front-line health workers. For all of its flaws, the HSMR is simple to explain and interpret and is well suited to engagement of staff in quality improvement and patient safety initiatives. The warts of the data can be explained carefully in order to avoid long-term disenchantment with the difficult course of improving patient outcomes over time.

In releasing the HSMRs to the public, CIHI has floated a burning platform onto the sometimes too-placid lake of Canadian hospital care. CIHI has stimulated emotions about quality and safety in healthcare in a responsible way and should be applauded for introducing the HSMR to our system. We endorse this release, we consider it a very successful contribution to the quality and safety agenda, and we look forward to contributing to the improvement of and response to further data of this type.
Data May Reveal Real Issues

COMMENTARY

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ABSTRACT

In the lead article, Penfold et al. question whether the hospital standardized mortality rate (HSMR) is a valid indicator for hospitals to use in addressing patient safety. Their article attempts to show that the HSMR is flawed and should not be used as an indicator for patient safety; however, the rationale presented fails to address the real issue found within the Winnipeg Health Authority. A hands-on approach to sorting through the data can reveal internal issues and spur quality improvement.

In this commentary, I respond to the article “Do Hospital Standardized Mortality Ratios Measure Patient Safety? HSMRs in the Winnipeg Regional Health Authority.” The lead article questions whether the hospital standardized mortality rate (HSMR) is a valid indicator for hospitals to use in addressing patient safety. The article attempts to show that the HSMR is flawed and should not be used as an indicator for patient safety; however, the rationale presented fails to address the real issue found within the Winnipeg Health Authority.

HSMR results in Canada and elsewhere are based on methods developed by Sir Brian Jarman. All use similar data and calculation
methods and adjust for similar factors, including age, sex, length of stay and admission category. Each country’s HSMR results are calibrated based on their national mortality experience. In Canada, HSMR calculations are (1) based on the ratio of actual to expected deaths in acute care hospitals, (2) based on the diagnosis groups that account for 80% of deaths and (3) adjusted for factors affecting mortality (e.g., mix of diagnoses, age, sex and length of stay).

The HSMR is a ratio of observed to expected deaths multiplied by 100. A ratio equal to 100 suggests that there is no difference between the hospital’s mortality rate and the average national rate; greater than 100 suggests that the hospital’s mortality rate is higher than the average national rate, and less than 100 suggests that the hospital’s mortality rate is lower than the average national rate. Agreeing to have the HSMR calculated is a voluntary process that some health institutions in Canada have decided not to undertake.

In 2006, the Canadian Patient Safety Institute decided that the HSMR would be one of the indicators that they would endorse to monitor patient safety on a national basis through the Safer Healthcare Now! campaign. The HSMR is not intended to serve as a comparison between health regions and facilities but is meant to allow hospitals and regions to track their own progress over time. The HSMR was not created to measure rapid changes in mortality rates but, rather, to provide a straightforward means of understanding mortality rate changes over time.

By tracking the HSMR over time, a facility, health authority or province can identify areas for performance improvement. On the other hand, if the facility, health authority or province does not take the time to delve into the participating factors and diagnostic codes feeding into the HSMR, it will find little value in the number. By examining trends in data, facilities, health authorities and provinces can identify problems, develop solutions and design quality improvement initiatives that will lead to improved care and substantially decrease preventable deaths.

Penfold et al. have pointed out that differences in palliative care coding make inter-facility comparisons of HSMRs invalid. However, national guidelines that have been established on palliative coding, if used properly, would allow for the ability to compare facilities not only within a health authority or province but within Canada. Yet, in the chart audit involved in their study, the researchers have not used these guidelines in identifying which cases were palliative care; therefore, the results they have cited cannot be considered accurate or comparable and do not provide the reader with a true picture. A closer look within the health authority shows that the issue is actually not with the HSMR but, rather, with improper coding of palliative care. The solution should not be to exclude the HSMR as an indicator but to address those issues that have resulted in incorrect coding. By correcting the issue through education and follow-up chart audits, the health authority would be able to draw the comparisons they are looking for in the HSMRs and provide the standardization that the researchers identified was missing.

Like the Winnipeg Regional Health Authority, when the Department of Health in New Brunswick began to analyze the HSMR in 2006 for its eight regional health authorities and their facilities, we were surprised at what we found: deaths attributed to the wrong facility and HSMRs for small facilities that were falsely high. We decided that we would take a hands-on approach to sorting through the data. We worked closely with Canadian Institute for Health Information (CIHI) in identifying data that were incorrect.

As a result of our work with CIHI, it was determined that a minimum number
of admissions/cases were required for the HSMR to be considered statistically valid and that producing HSMRs for many small facilities in New Brunswick would have no benefit. As a result, CIHI decided that across Canada, facilities must have a minimum of 2,500 cases in each quarter to have the HSMR calculated. We realized through analyzing the data that we needed to take responsibility and that in order for the HSMR to work for us, facilities would have to follow standardized guidelines.

As we analyzed the HSMR in the fall of 2007, we realized that palliative care coding was still an issue in one of the eight health authorities. Consequently, the health authority undertook an audit of 500 charts and established a quality of assurance program that has education at its core to address the issue. More importantly, while analyzing the data, we were able to see a trend in the number of people in a particular diagnostic group who were admitted to hospital and died. Further review of the data showed that in one facility, several nursing home residents with dementia had been admitted with aspiration pneumonia. We were able to work with the department responsible for nursing homes to follow up with the nursing home involved. The nursing home arranged to have staff receive additional training on feeding cognitively impaired residents and will ensure that all staff receive the training on an ongoing basis. If we had not spent the additional time to see past the palliative care coding issue and look for trends in data, the feeding issue would not have been addressed.

I would challenge other facilities, health authorities and provinces to identify what they perceive as wrong with the measurement and fix internal issues such as coding. By doing so, they will be able to use the HSMRs over time to spur quality improvements that can lead to a reduction in preventable deaths.

“I never teach my pupils; I only attempt to provide the conditions in which they can learn.”
- Albert Einstein

Albert Einstein is an honorary member of the HealthcareBoard, a Longwoods learning initiative

www.longwoods.com
Hospital standardized mortality ratios (HSMRs) for acute care hospitals across Canada (excluding Quebec) were released in November 2007 by the Canadian Institute for Health Information. Since the release, some hospitals have undertaken in-depth analyses of their HSMRs to make sense of their results. In this issue of Healthcare Papers, Penfold et al. describe their experiences with the measure, pointing out shortcomings with using such a highly aggregated measure of hospital performance. We echo their concerns with the HSMR and highlight the caveats to interpreting this measure. However, we also point out that, despite its limitations, the HSMR stimulated the authors to probe, on behalf of their institution, factors that may have influenced mortality rates. This probing underlines the merit of HSMR reporting and the types of insights and knowledge that are likely to be gained if other institutions undertake similar evaluations.
In November 2007, the Canadian Institute for Health Information (CIHI) publicly released its report *HSMR: A New Approach for Measuring Hospital Mortality Trends in Canada* (CIHI 2007b) that contained pan-Canadian data on acute in-hospital mortality described by the hospital standardized mortality ratio, or HSMR. The publication was endorsed by the Canadian Patient Safety Institute as a means of improving patient safety. The release of the report gained national media attention, with a particular focus on those hospitals with poor results, that is, high HSMRs. In this issue of *Healthcare Papers*, Penfold et al. present an elegant description of the experiences of the Winnipeg Regional Health Authority in assessing the validity of the HSMR through an in-depth examination of the HSMR data for the Health Sciences Centre and a comparison with those of an acute care facility in Calgary. The authors also provide a detailed discussion of the rationale behind using the HSMR and the ability of the measure to be a catalyst for quality improvement.

The HSMR was first developed in the United Kingdom as a tool for hospitals to decrease in-hospital mortality rates (Jarman et al. 1999). The HSMR calculated by CIHI compares the *actual* number of deaths among 65 diagnoses (CIHI 2007a) accounting for 80% of in-patient mortality with the *expected* mortality based on the sum of the probabilities of in-hospital death. The expected in-hospital mortality rates were determined using a logistic regression model based on case mix (i.e., age, sex, duration of stay in hospital, reason for admission to hospital, diagnosis, co-morbidities and hospital transfers) (CIHI 2007c). The data were collected from all acute care hospitals in Canada, excluding Quebec, with an annual number of expected deaths ≥20, between April 2004 and March 2007 (CIHI 2007c). Hospitals were provided with the opportunity to validate their data in advance of the November 2007 public release of the report that presented the HSMRs – with and without patients receiving palliative care – on a yearly basis by hospital, hospital corporation and health region. Somewhat more detailed confidential reports were distributed to hospitals in addition to the public report, containing HSMRs broken down quarterly and calculated for medical and surgical programs and intensive care unit cases. Hospitals were also provided with ranges of hospital peer group data and resources describing starting points for identifying areas of improvement within their facility.

In their article, Penfold and colleagues examine many aspects of the HSMR and rightly point out limitations of this particular measure. They discuss the aggregate nature of the measure and the difficulty with standardization given the numerous diagnosis groups, which make it invalid to compare HSMRs across hospitals. They compare more detailed data on the Winnipeg Regional Health Authority’s Health Sciences Centre HSMR by age group with those of Foothills Medical Centre in the Calgary Health Region to prove the incomparability of data across facilities.

Penfold et al. also point out the numerous downfalls associated with using administrative data to calculate HSMRs, including variations in coding palliative care admissions and mortalities, discharge rates and transfers. The palliative care coding issue was of particular concern to the Winnipeg Regional Health Authority as through the data-validation process, several important considerations were revealed. The region argued that patients receiving palliative care should be excluded from the HSMR as their inclusion skews the calculation of expected mortality. CIHI responded by calculating HSMRs including and excluding these patients. However, the logistic regression model developed by CIHI to exclude such patients does not take into
consideration discrepancies in palliative care coding or the timing of designating palliative care, thus producing HSMR values that vary widely between the inclusion and exclusion of patients receiving palliative care. The authors provide a clear example of the impact of these discrepancies on the HSMRs for the Health Sciences Centre in 2005–2006, where the HSMR including palliative care was 118 and excluding palliative care was 55. The authors point to the obvious conundrum in interpreting these two values: is the HSMR in the Health Sciences Centre 18% worse than the national average or 45% better?

For the most part, we agree with Penfold and colleagues with regard to the limitations of the HSMR measure. It is a macro-level measure that provides little actionable information. That is, it is difficult to determine from such a broad measure specifically where problems may be occurring within a facility. It also does not take into account complexities of care within a hospital or inter-institutional variations in care. The HSMR is an outcome measure that is entirely focused on mortality. It does not consider other important outcomes of care (e.g., readmission), nor does it link the mortality outcome to the process of care. These characteristics make it difficult for administrators, providers and policy makers to interpret HSMRs and implement meaningful change. Indeed, the HSMR would be more useful to stakeholders if it were presented with additional data such as condition-specific outcomes and processes of care, and outcomes linked to processes of care. For example, data regarding beta blocker administration after acute myocardial infarction and rates of mortality would greatly improve insight into a facility’s care of patients with acute myocardial infarction and provide a starting point for quality improvement initiatives if care was not at the level of evidence-based guidelines.

Penfold et al. repeatedly mention that the HSMR should not be interpreted as a measure of avoidable deaths or adverse events. For all its intents and purposes, the HSMR remains true to its definition: it compares the actual mortality observed within an institution (e.g., hospital) with that of the expected mortality rate in that institution given the particular case mix of patients within the facility. It has been inferred that the greater-than-expected mortality rate is an indicator of “avoidable deaths or adverse events” (i.e., deaths occurring due to error in treatment) (Safer Healthcare Now! and Canadian Patient Safety Institute 2007). However, this is an erroneous inference as the actual calculation of adverse events (Baker et al. 2004) or avoidable mortality (McDonald et al. 1991) requires more detailed data and sophisticated analyses than that provided by the HSMR. Rather, the HSMR simply indicates that given the particular patient population treated within the facility, a particular number are expected to die given their conditions, and that should the actual number of patient deaths exceed that number, a greater-than-expected mortality rate exists within that facility. Penfold and colleagues extensively argue the inability of the HSMR to measure adverse events and avoidable deaths, and demonstrate this through an internal chart audit of the Health Sciences Centre in the Winnipeg Regional Health Authority. Yet, our point is to suggest that the measure was never intended to serve as a tool for identifying and pinpointing avoidable events. The HSMR merely tallies observed deaths and presents them relative to a case mix–derived estimate of expected deaths.

The latter point aside, we agree with Penfold and colleagues’ arguments regarding the HSMR’s shortcomings and related misconceptions. The HSMR alone is not likely to help much in quality improvement. For hospitals to make meaningful improvements, there is a requirement for more detailed
approaches to quality measurement, such as condition-specific data, process measures, process measures linked to outcomes, chart reviews, cause-of-death reviews, analyses of patient transfers and place of death; and more sophisticated analyses such as the cumulative sum statistic. Penfold et al. undertook many of these activities in their exploration of HSMRs in the Health Sciences Centre, and were able to create for themselves more detailed analyses of the underlying factors contributing to their HSMRs and the cumulative sum of in-hospital mortality. This in-depth examination ultimately made the HSMR more meaningful to the health region auditors and administrators in terms of quality improvement initiatives. We recognize that the work undertaken by this Winnipeg team is likely to have been a time- and resource-intensive exercise that required a certain level of methodological expertise that may not be available to all facilities. Thus, for facilities unable to undertake the investigative work done by Penfold et al., the HSMR will most likely remain a number with little actionable information.

These considerations beg the question, Should HSMR reporting continue despite the shortcomings of the measure, or should it be scrapped? Penfold et al. commend CIHI for bringing heightened awareness to in-hospital mortality in Canada through the HSMR initiative. We agree with this commendation and also concur that CIHI has done well to take a first attempt at producing a pan-Canadian measure of in-hospital mortality rates. Information, regardless of its imperfections, is better than no information; the HSMR, despite its flaws and cautions for interpretation, has prompted some hospitals and health regions to take a more in-depth look at their acute care in-hospital mortality data. Case in point: the Winnipeg Regional Health Authority’s meticulous examination of in-hospital mortality in the Health Sciences Centre facility by Penfold et al. In this regard, the HSMR is clearly more friend than foe as it has catalyzed an evaluation that yields insights for the providers and administrators of the hospital and health region.

We conclude that, overall, the CIHI HSMR reporting was a worthy exercise despite the measure’s shortcomings: it puts a lens on quality and has been a catalyst for hospitals to start looking at their data and take an interest in the hospital outcomes presented in a pan-Canadian perspective. However, it remains difficult to discern where problems lie with such a global measure. Future HSMR reports will be more powerful if they are coupled with more condition-specific measures and process measures, to allow for more targeted quality improvement interventions.

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Measure for Measure? The Challenge of New Thinking about Patient Safety

COMMENTARY
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ABSTRACT
Penfold and colleagues, in this issue of Healthcare Papers, provide a comprehensive and substantive critique of the hospital standardized mortality ratio (HSMR) as a measure of patient safety, and suggest a useful alternative. However, although measurement is not trivial, new thinking about patient safety presents a much greater challenge than just issues related to measurement. The measurement issue highlights the need for a re-conceptualization of what it takes, from a systems perspective, to achieve safety. This commentary first reviews Penfold et al.’s arguments (agreeing with their conclusions regarding the HSMR). It then presents some key elements of the new thinking about patient safety, particularly the emerging concepts of resilience and resonance, and notes how and why these are beginning to be applied in healthcare. Finally, it considers a number of reasons why a more comprehensive adoption of these new perspectives may be prolonged and notes that, while difficult, the journey is worth taking.

Einstein observed, “Not everything that can be counted counts, and not everything that counts can be counted.” Moreover, it is generally believed that what is counted attracts attention and sometimes action. Penfold et al., in this issue of Healthcare Papers, provide an insightful and substantive critique of the hospital standardized...
mortality ratio (HSMR), a patient safety indicator the Canadian Institute for Health Information (CIHI) began publishing in 2007 and that is also reported in the United States and England. Their critique, based on a synthesis of the literature as well as data from the Winnipeg Regional Health Authority (WRHA), is comprehensive and well argued. In addition, they provide an alternative metric— the cumulative sum (CUSUM) statistic, a standardized mortality risk estimate calculated on each patient. The CUSUM, though it has its own limitations, is intuitively appealing for identifying time-limited sharp increases in hospital mortality that might be more easily investigated; it thus has better utility as a patient safety indicator for understanding the underlying dynamics of “excess” or “unexpected” hospital deaths. This would in turn be useful for developing preventive strategies.

The Arguments Regarding the HSMR as a Tool

Penfold et al. review the rationale for using the HSMR and identify a number of key issues making its interpretation as a measure of safety dubious. First, they note that adverse events preceding death do not inform HSMR calculations, a problem for any patient safety measure. They also present evidence from England demonstrating a disconnect between HSMR decreases and initiatives to address high ratios, and provide WRHA data confirming this disconnect. Additionally, the important notion of preventability is not considered—a particularly telling point. Although HSMRs are based on 65 diagnostic groups accounting for the top 80% of in-hospital deaths, they tell one nothing about avoidable deaths, and this information is critical for understanding safety or quality problems. The issue of preventability is further illustrated by the inclusion of palliative care admissions (and neonatal deaths in infants <750 g) in the HSMR calculation. The initial inclusion of patients receiving palliative care—now corrected—is also problematic because of variabilities in coding. Both of these issues suggest an overestimation of HSMRs in hospitals with a high proportion of palliative cases, and this is elegantly confirmed in the comparison of WRHA and Calgary data. As Penfold et al. observe, “Many patients included in the HSMR were terminally ill. High HSMR levels may in fact [and likely do in my view] represent a failure to reorient the healthcare system to facilitate more home and hospice deaths.” Similar points were recently made by Holland (2007) based on experience in the United Kingdom.

If the above are not enough to give one pause, three additional issues are raised. First, discharge policies and decisions are highly variable across hospitals; thus, it is unclear which measure, in-hospital or 30-day post-discharge mortality, is appropriate. Second, there is a lack of standardization, and thus high variability, in the mortality risks within the 65 diagnoses used in calculating the HSMRs. And, third, CIHI itself has been very clear that HSMRs lack validity for inter-hospital comparisons. This last point, while legitimate, will most likely be ignored since it is natural for a metric as dramatic as hospital mortality to be a point of comparison between hospitals and, if low, a demonstration of a comparative advantage in “competitive” healthcare markets. Penfold et al. demonstrate the comparison problem using data from Calgary and Winnipeg as well as from an in-depth audit of deaths in Winnipeg. The audit found, using the Canadian Adverse Events Study (CAES) trigger tool (Baker et al. 2004), that most of the deaths were “expected” and that only 1.8% (a figure almost the same as that found in the CAES) could be related to what is termed “a patient safety concern.”

Having provided a thorough review of
critical issues in the conceptualization, calculation and potential misinterpretation of the HSMR, Penfold et al. describe the CUSUM metric. It adjusts for a number of relevant patient factors (co-morbidity, age, gender, etc.) and importantly for patients' disease severity using Acute Physiology and Chronic Health Evaluation (APACHE) scores; these factors are found to account for almost all the variability of in-hospital mortality.

**New Thinking about Patient Safety**

So, what is a healthcare administrator to do with a measure that purports to provide an assessment of patient safety or quality issues but provides, as Penfold et al. note, neither an understanding of how either is implicated (i.e., no “actionable data”) nor consequently any capacity for developing solutions?

To begin, it is useful to reconsider the framework in which patient safety is conceptualized. When patients seek care, we make two implicit but important promises to them: first, we promise to provide them with excellent care; and, second, we promise not to hurt them (Reinertsen and Clancy 2006).

Thus, there is a difference between quality and safety. This distinction, in the worst instance, often ignored in healthcare or, only marginally better, significantly conflated. Quality and safety are often seen as overlapping goals; following from this is the notion that achieving quality will also enhance safety.

The Institute of Medicine considers safety to be the first of the six domains or attributes of quality (Institute of Medicine 2001). However, in other risk-critical industries (e.g., aviation, nuclear power and petrochemical industries), safety and quality are distinctly conceptualized attributes achieved through different means: improving quality is not sufficient and may not even be necessary to achieve safety (Dekker 2006). Moreover, it is, in part, through this distinction that these industries have, over time, become highly reliable – they manage production goals, yet incidents that destroy production capacity or harm people (whether workers, passengers or the general public) are extremely rare.

In many high-reliability industries, accidents are very public events (there is generally wreckage) and often the human toll is high. With exceptions, individual critical incidents in healthcare are neither public nor dramatic, although when aggregated the numbers do become striking and hard to ignore. The response to accidents in risk-critical high-reliability industries has been a long ongoing process of mitigation and prevention, building defenses in depth and an understanding that many factors latent in their processes may combine (with each other and/or with external events) in unforeseen ways to produce problems. This perspective sees accidents as both “normal” (Perrow 1989) and inherent in getting work done, despite structured approaches to regulations and standardized production processes. Thus, targeted regulations, unambiguous communications, clear procedures and standardization were important to the early achievement of high reliability though insufficient to sustain safety, particularly once industries became ultra-safe (<10−6). A new perspective is required to maintain ultra-safe production, specifically a deeper level of understanding about safety as an emergent phenomenon of complex systems, involving concepts of resilience, vigilance and anticipation and cognitive patterns of thinking reflecting these ideas (Hollnagel et al. 2006). Moreover, in high-reliability industries, structures are in place to support investigation, reporting and learning from critical incidents (accidents and near misses), such as safety management systems providing ongoing linkage between leadership (senior execu-
tives and the board) and front-line workers that keep the discussion of organizational risks and hazards alive – a feature of resilient organizations (Dijkstra 2007; Sidney Dekker, personal communication, 2007; Terrance Kelly, personal communication, 2006).

Healthcare remains firmly within a high-reliability conceptual paradigm despite evidence, including tacit knowledge, that this is insufficient. Penfold et al.’s critique of the HSMR is a case in point since this tool has been endorsed by the Safer Health Care Now! initiative of the Canadian Patient Safety Institute and the 5 Million Lives Campaign of the Institute for Health Improvement (IHI).

Several reasons can be advanced for slow progress in rethinking approaches to healthcare safety. First, cultural change is slow, and it is still relatively early days for the patient safety movement; thus, structured communications, team building, executive engagement and simulation are just beginning to be talked about and applied. However, with concerted effort, healthcare might achieve high reliability more quickly if, in thinking about safety, it takes advantage of and embraces the concepts of resilience and resonance at an earlier stage than did other risk critical industries.

Second, the above notwithstanding, the conflation of quality with safety creates a preference for continuing reliance on high-reliability solutions and linear investigative models (e.g., root-cause analysis). These have reached their limit to explain, or address, latent system factors (design flaws in technology, procedures, competing/conflicting goals), the impact of the unexpected and the resonance between inexhaustible combinations of these in healthcare organizations. Moreover, critical incidents are generally a surprise to those involved (patients and professionals), highlighting the need for totally different approaches than those required to enhance quality that, after all, should not be a surprise.

Third, healthcare is labour intensive. People are almost always in temporal and physical proximity to incidents, and although focusing on “human” error as a causal explanation is easy, more important is the investigation of incidents to understand the context in which they occur – why it made sense for people to do what they did, given that context.

Fourth, from a psychological perspective, the notion that failure is “normal” is deeply disturbing, particularly among highly trained professionals. In contrast, high-reliability thinking is a positive, action-oriented “can do” spirit more congenial to (if misleading about) professional self-image. This point is related to the importance of assessing organizational safety culture (or climate – they are not the same) with regard to the penchant for blaming those in close proximity to an incident.

Fifth, and related to the third and fourth points, critical incidents that arise within a context of “normal people doing normal work in normal environments” are perplexing and at odds with the concepts of quality and risk management. It is at odds with the former because healthcare has been addressing quality issues for decades, yet “surprising” adverse events still occur. The latter, with its legalistic framework, looks for rules violated and sees standards, protocols and guidelines as means to control the “unreliable operator” at the sharp end of care (Dekker 2002). However, increasing the number of rigid controls itself creates the need for additional sharp end “workarounds,” adaptations and other adjustments to maintain care processes and satisfy competing organizational goals.

These five points taken together illustrate a critical issue: if one achieves a reasonably high level of care quality – “everyone does the right things to the right people at the right...
times” – aspects of the organization and its rules (indeed the same rules and standards meant to achieve quality and in many cases assumed also to produce safety) may, given the influence of unforeseen or anticipated events, produce patient injury and death.

Healthcare will likely continue to struggle with sorting out the difference between quality and safety, and its reliance on high-reliability thinking for some time. But there are positive signs of change. Resar (cited in Sheps and Cardiff 2008), a patient safety consultant with IHI, recently noted that IHI is moving in a new direction since it determined that relying solely on a rules- or standards-based approach to minimize uncertainty (an underlying facet of critical incident generation) is of limited utility in complex socio-technical systems. There are indications that IHI is moving toward conceptualizing risk as a non-linear phenomenon, an approach developed from an understanding of resilience thinking. Similarly, Bagian (cited in Sheps and Cardiff 2008), a safety expert with the US Veterans Health Administration, has observed that while the 100,000 Lives Campaign (now the 5 Million Lives Campaign) is a useful start, it has limited future value since its specific activities are often undertaken in isolation, tend to be clinically targeted, do not fully engage senior management and have not been applied in a context (e.g., an organizationally oriented interdisciplinary safety management system) critical for cross-organizational learning.

Recognizing the limitations of current efforts to achieve patient safety is the beginning of insight regarding the need for new approaches to and ways of thinking about patient safety. Penfold et al.’s paper provides an example, in the measurement sphere, of why fairly crude metrics will not take us farther in understanding how critical incidents occur or safety is created. Their critique is timely and illustrative of the changes required to move the patient safety agenda forward. This will not be easy since concepts such as resilience and resonance are not yet well understood. Moreover, although not fully operationalized for quantitative measurement, these concepts provide a solid conceptual base to go beyond a mindset of promoting “solutions” through more rules, procedures and standards and/or the adoption of new technology. Thus, education in the form of exhortations to “wash your hands” to prevent hospital-acquired infections is a prescriptive rule telling people what they already know instead of stimulating new learning.

A workshop discussing regulation for safety in England (London School of Economics 2005) made it clear that education alone was not sufficient; training of staff to lead them to a new conception of what safety culture means cannot be limited to rules but must involve reflecting on how work is actually done, with sensitivity to weak signals regarding problems arising in “normal” work processes, and thus adjusting behaviour and thinking accordingly. Moreover, Nathanael and Marmaris (2007) comment on the “interplay between prescription and flexibility” in complex organizations, arguing that it is important for senior management to be aware that (1) work done is actually often different from what they imagine it to be and (2) rules, procedures and standards can be flexibly integrated with processes through which work is actually accomplished. This is radical thinking. Understanding competing pressures and constraints as part of normal work – sometimes leading front-line staff to not do what they know to be “textbook practice” – is an important insight that, along with an organizational culture that supports such adaptations, creates safety. Similarly, using questionable metrics to understand when safety issues exist is a dubious pursuit, in part because safety issues are always inherent in the
healthcare delivery process.

Moving Forward
Those interested in moving the patient safety agenda forward owe Penfold et al. both careful attention and gratitude for providing a powerful assessment of the HSMR’s limitations and for pointing us in directions that will surely prove more fruitful.

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Notes
1 Figure, as used in safety, refers to fewer than 1 event per million.
Follow the Big Dots?

THE AUTHORS RESPOND

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ABSTRACT

A number of interesting arguments have been made about the utility of the hospital standardized mortality ratio (HSMR) as a “big dot,” broad-based safety indicator that is useful for initiating change and measuring change over time. This rejoinder examines these arguments. Section one briefly revisits issues of measurement related to the HSMR. Section two discusses whether and how big dots should be used. Section three addresses problems with using HSMRs to track changes in mortality for a facility over time. The final section describes issues with the indirect effects of HSMR and engaging staff.

The public release of hospital standardized mortality ratios (HSMRs) was intended to be a catalyst for change. A number of interesting arguments have been made about the utility of the HSMR as a “big dot,” broad-based safety indicator that is useful for instigating and measuring change over time. This rejoinder examines these arguments.

Measurement and Standardization

A valid indicator actually measures what it is intended to measure. It seems clear that the HSMR was developed with the assumption that it would measure preventable deaths related to deficiencies in the safety of care provided. Indeed, the Canadian Institute for Health Information (CIHI) HSMR press
release of November 29, 2007, reiterated this commonly held assumption: “In recent years, many hospitals, health regions and clinical teams have implemented strategies to reduce the harm and deaths related to adverse events, such as infections and medication incidents, and to improve quality of care overall,” says Phil Hassen, CEO of the Canadian Patient Safety Institute and Chair of the Safer Healthcare Now! campaign. ‘It’s promising to see that these efforts are paying off, and to be able to measure this progress in a tangible way’ (CIHI 2007b).”

The sincere desire to have a big dot measure that would capture the impact of important efforts such as Safer Healthcare Now! and the Institute of Healthcare Improvement’s 100,000 Lives Campaign to improve outcomes for patients as captured in the following quotation from Leeb et al. is understandable:

Additional initiatives are also emerging. For example “Safer Healthcare Now!”, a grassroots patient safety campaign aimed at reducing preventable complications and deaths, is testing the use of intervention-specific process and outcome measures, as well as broad-based safety indicators. Originally developed in the United Kingdom, Hospital Standardized Mortality Ratios (HSMRs) compare observed versus expected deaths on a hospital-specific basis, adjusted for the age, sex, diagnoses, and admission status of its patients (Jarman et al. 2005). The Institute for Healthcare Improvement in the United States is now using this measure to track the success of its 100,000 Lives patient safety campaign, and it will be a core measure for the Canadian Safer Healthcare Now! campaign. (Leeb et al. 2005:88)

Our lead paper used adverse events as a means of testing the validity of the HSMR vis-à-vis preventable deaths. We chose this approach as a means of differentiating in-hospital deaths related to gaps in safety from other deaths. Adverse events were identified via the Canadian Adverse Events Study tool and not by tallying adverse events recorded in charts, as suggested by Jarman. In our lead article, we show that HSMRs in Winnipeg are not sensitive to the “unexpected death” trigger. As a big dot, the HSMR does not assist in understanding trends in unexpected deaths in Winnipeg. That is, changes in the number of unexpected deaths in Winnipeg will not change the HSMR to a degree that would initiate further investigation. While this is only one aspect of patient safety, it is an important one.

The lead article does not fully address the bigger question of validity that is emphasized in the commentaries: is the HSMR a useful indicator of high-level practices or policies that can be modified to reduce excess mortality? Recent research suggests it is not. Heijink et al. (2008) assess differences between hospitals in the Netherlands that might explain differences in HSMRs. The authors found that general practitioners per 10,000 inhabitants in the hospital region, academic versus non-academic hospital type and the year were significantly associated with HSMRs (none of which are within the control of hospital administrators). There was no multivariate association between hospital inputs and HSMRs (e.g., doctors per bed, nurses per bed, bed occupancy rate or discharge procedures). Similar work in Canada has not been attempted, so the degree to which HSMRs are associated with system-level differences between hospitals (or within hospitals over time) is unknown. Any contention that HSMRs are useful for this purpose in Canada is speculative and not based on
any published evidence of a link between system-level choices and HSMRs. On the contrary, the published evidence suggests that it is only after a “drill down” into very narrow areas (e.g., aspiration pneumonia) that safety improvements can occur. If administrators must first dismantle HSMRs to understand what circumstances are driving their numbers, what value does aggregating add?

We raised a number of methodological issues associated with the HSMR, including the structure of the standardization model, controlling for within-diagnosis differences in risk of mortality, palliative care coding, regional differences in place of death, the timeliness of HSMR reporting and the high level of aggregation. Among these issues, controlling for within-diagnosis variation in risk is the most serious. There are a multitude of known risk factors specific to each diagnostic group that affect mortality, and none of these are accounted for in HSMR standardization. The second most important factor is regional differences in place of death. We present further evidence of this below.

It is untrue that adoption of the palliative care coding guideline will improve the utility of the HSMR, particularly in monitoring the progress of a single facility over time. Indeed, changing coding practices will only serve to make historical comparisons less useful. Facilities will be unable to distinguish reductions in HSMRs due to changes in coding from those due to changes in safety.

Contrary to Wen et al., we find evidence in Canada that the regional distribution of place of death is associated with HSMRs. The bivariate association between the proportion of acute hospital deaths and HSMRs is actually quite strong ($r = 0.50, r^2 = 0.25$) in the context of other research. For example, Heijink et al. (2008) found bivariate correlations of 0.26 between hospital type and HSMRs ($r^2 = 0.068$), −0.25 between bed days

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**Figure 1. Percent palliative hospital deaths versus HSMRs for regions in Western Canada**

![Graph showing the relationship between percent palliative hospital deaths and HSMRs](image)

Sources: Canadian Institute for Health Information (2007a, 2007c).
for day cases and HSMRs \( (r^2 = 0.063) \), 0.18 between hospital size and HSMRs \( (r^2 = 0.032) \) and −0.17 for general practitioners per 10,000 inhabitants and HSMRs \( (r^2 = 0.029) \). The bivariate association found by Wen et al. is between three and eight times the size of the association found for hospital-level characteristics in Heijink et al. (2008). The association between the proportion of palliative hospital deaths and HSMRs in Western Canada is also quite strong \( (r = -0.556, r^2 = 0.31) \) and in the expected direction (Figure 1). The proportion of palliative hospital deaths in western Canadian regions explains 31% of the regional variance in HSMRs. These data reinforce our argument in the lead paper that the HSMR measures the failure of a region to reorient the system to more palliative care deaths. The HSMR does not measure patient safety.

**Big Dots**

The lead article does not fully address the question of whether and how big dots should be used. There does not seem to be agreement among experts. McKinley et al. argue that the HSMR, as a big dot, is useful for system-level management and accountability. The results of Heijink et al. (2008) contradict this argument as they found no multivariate association between management-level variables and HSMRs in a cross-section of Dutch hospitals. On the other hand, Zahn et al. argue that HSMRs are appropriate to monitor changes in safety practice for daily operations such as universal handwashing and computerized physician order entry of medications. While there is face validity to this latter argument, there is no evidence to show how strongly these safety characteristics are related to HSMRs. That is, reductions in HSMRs by increasing handwashing may be obliterated by changes in the case mix of a hospital over time – such as a trend toward more elderly patients.

We find the concept of a big dot problematic. A good indicator has three basic properties: (1) it is easy to understand, (2) it defines a small number of system-level measures to focus attention and (3) it readily flags changes leading to questions for further investigation of processes, communications and practices (Norton 2008, April 1). Crampton et al. (2004) suggest a much longer list, requiring that an indicator be precisely defined, be easily quantifiable, be feasible to collect and report, comply with national processes of data definitions, be based on reliable and valid information, reflect important aspects of health status, be attributable to healthcare, be linked to health outcomes, be sensitive to change, be sensitive to and discriminate between organisations, reflect a variety of dimensions of care, be understood by people who need to act, be relevant to policy and practice, not be vulnerable to random fluctuation associated with rare events and minimize perverse incentives.

As a big dot, the Canadian HSMR does not define any system-level safety measures or correlates on which to focus attention. The HSMR also aggregates deaths across 65 diagnosis codes into one measure (stretching the definition of “focus”). HSMRs must first be disaggregated into 65 diagnosis components in order to identify a set of patients who might have a systemic safety problem in common. In this sense, the HSMR obfuscates safety issues rather than clarifying them. While it is true that the HSMR is only one indicator in a tool kit (we never argued that it should be used as a sole indicator or that proponents of the HSMR thought it should be used this way), it is unclear what, if anything, the HSMR adds to understanding patient safety.

Neither does the HSMR readily flag changes in excess mortality. The results of Wright et al. (2006) demonstrate that moni-
toring quarterly HSMRs will sometimes show no change in mortality when, in fact, reductions in mortality have occurred. This could happen if decreases in mortality in one population of patients are offset by increases elsewhere – occurring through a shift in hospital resources to high-mortality areas. Conversely, increases in mortality among a defined population may be offset by general decreases. Under this scenario, HSMRs change little and prompt no investigation of increases in mortality in specific areas.

Standardizing the big dot to a national average is also questionable. While it is desirable to have an external (comparative) measure to evaluate safety, it is not clear why the national average should be used instead of the best performers. There is, by definition, too much mortality in Canadian hospitals. Thus, the national average is unacceptable. Identifying the facilities with the lowest crude mortality rates and attempting to identify how these facilities are different from the average or poor performers would tell us more about how to reduce mortality. Valid pair-wise comparisons between hospitals could be made by standardizing to the case mix of the best performers.

**Tracking Improvements over Time**
Understanding how HSMRs mask temporal trends is critical to understanding that it is fatally flawed, and not merely imperfect, for the purpose of tracking changes in the safety of care over time. First, as we have argued above, the HSMR hides trends among the diagnostic groups with respect to mortality. Second, the HSMR is a relative measure of performance, not an absolute measure. The HSMR reflects an excess or absence of mortality compared with expected mortality nationwide in the baseline year. Thus, each facility can track its change in HSMRs as long as the baseline year remains fixed. Otherwise, a facility must decrease mortality at the same rate as the national average simply to maintain its HSMR at the same level. Overall, HSMRs in Canada declined 6% between fiscal years 2004–2005 and 2006–2007 (CIHI 2007c). Facilities that decreased mortality at a slower rate during this period will see their HSMR increase when the baseline year changes (e.g., after five years). That is, facilities whose efforts decreased mortality but not as fast as the national average will see their HSMR go up despite the fact that they have lower crude death rates compared with five years earlier. This perverse feature of the HSMR makes the indicator difficult to understand and makes it hard for an institution to track its own progress over time.

Third, changes in HSMRs over time may be related to changes in patient mix and clinical improvements in treatment (e.g., related to new technology) in addition to safety improvements. Over time, the standardization model becomes increasingly out of date with respect to patient mix and risk because the standardization model is created using baseline year data. Over the medium term (e.g., four years), the expected number of deaths generated by the standardization model will be more than that using a model based on current fiscal year data. HSMRs fall across the board as a result. It is impossible for facilities to know how much change in their HSMR is due to this systematic downward drift and how much is due to safety efforts.

**Engaging Staff and Being a Catalyst for Change**
The HSMR appears to have already served as a powerful catalyst for initiating change. It is arguable that the validity of the HSMR is relatively unimportant if making these data public instigates meaningful reflection and
process improvement. But this argument has hidden traps.

Front-line healthcare staff are intelligent: they are (rightly) sceptical of performance measures based on administrative data because these data are frequently of low quality or applicability. The first question from most healthcare providers when presented with evidence that mortality is higher at their facility would likely be, “Are our patients sicker?” The honest response is, “We don’t know,” because within-diagnosis (between patient) variation is not controlled or standardized in HSMR calculations. Interested readers should refer to Shahian and Normand (2008) for an excellent discussion of how to do effective risk adjustment for hospital outcomes.

Second, the validity of the HSMR as a measure of success of hospital safety initiatives is unknown. There are a limited number of times that one can launch “burning platforms” fuelled by measures with questionable statistical and theoretical support. What should be said to hospital executives, board members and front-line healthcare providers when the dedicated efforts to improve handwashing, acute myocardial infarction mortality, ventilator-associated pneumonia rates and other safety improvement initiatives fail to substantially change an organization’s HSMR? It is more likely than not that the “signal” from excellent initiatives such as these will not be strong enough to be heard over the “noise” that is inherent in the HSMR, that is, the sensitivity of the HSMR to detect clinically important change over time is predicted to be quite low. Practitioners are increasingly expected to make evidence-based clinical decisions. Practitioners should demand valid, robust, evidence-based indicators from researchers and administrators. Eventually, front-line staff will stop listening if they feel goaded into action.

Third, much has been made of the positive, unintended consequences of publicly releasing HSMRs. Discussions concerning data quality and coding practices have led to real improvements. However, the negative, unintended consequences of releasing HSMRs have not received much consideration. How many people will bypass their community hospital (based on its HSMR) in an emergent situation and expire due to a delay in receiving care? A more tangible account of negative outcomes may be found in an article by Ettinger et al. (2008). One of the more serious effects of being proclaimed a “high mortality hospital” was that the facility they discuss lost its resident training program for coronary artery bypass graft procedures.

Conclusion
We would like to thank the contributors to this issue for their thoughtful and thorough comments. Readers might find it reassuring to know that HSMRs are by no means the only hotly contested safety indicators. Using the Agency for Healthcare Research and Quality Patient Safety Indicators, Bahl et al. (2008) found that a large percentage of “adverse events” are actually conditions present on admission. Accounting for conditions present on admission reduced the number of “failure to rescue” cases by 54%.

We disagree that HSMRs are useful for measuring a hospital’s progress in reducing mortality over time. First, no clear relationship has been established between system-level hospital changes and reductions in mortality. Prospective studies comparing hospitals matched with controls that implement a well-defined safety improvement measure are needed in order to determine how well the HSMR measures changes associated with these improvements. Various complementary outcome measures should be used simultane-
ously to determine what the HSMR contributes to understanding. Second, variability in the rate of reducing in-hospital mortality over time leads to the perverse situation where crude mortality decreases and standardized mortality increases. Finally, medium-term changes in patient mix and clinical risk relative to the baseline year make within-hospital temporal comparisons difficult.

We agree that the HSMR is only one measure among many that could be used, and that multiple measures of safety should be used. That being said, Sheps makes a compelling argument for changing the way patient safety is conceptualized and actively advanced. Focusing on resonance, resilience, vigilance and anticipation as well as building structures found in high-reliability industries is a quantum leap from monitoring big dots. While these concepts may be difficult to operationalize, it is likely that front-line staff will find this approach more engaging.

References

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