

Studies in Health Care Policy



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A Comparative Analysis of Mortality Rates Associated with Coronary Artery Bypass Graft (CABG) Surgery in Ontario and Select US States

by Michael Walker, Maureen Hazel, and Nadeem Esmail





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Executive summary

The purpose of this study is threefold: first, to ascertain whether there are differences between mortality rates associated with coronary artery bypass graft (CABG) surgery in Ontario hospitals that perform such surgeries; second, to test whether the aggregate CABG mortality rate in Ontario is changing; and, third, to test whether the aggregate CABG mortality rate in Ontario is different than the aggregate CABG mortality rate in US states for which comparative data are available.

The coronary artery bypass graft surgery mortality rate is a widely used health outcome measure, since the surgery is performed in high volumes, requires complex surgical and perioperative care, and has easily measurable rates of adverse effects. Comparing coronary artery bypass graft mortality rates within and across jurisdictions can assist patients in making decisions related to their health and may improve outcomes from treatment in underperforming facilities or regions.

This study relies on the fact that mortality rates for CABG surgery have been calculated in a standard way in a 2008 report by the US Agency for Healthcare Research and Quality (AHRQ) for a number of jurisdictions in the United States and most recently in Canada by the Fraser Institute.^[1] The methodology used for calculating bypass surgery mortality rates was developed by AHRQ in conjunction with Stanford University. This measure has been shown to reflect the quality of care in hospitals where better processes of care may lead to lower mortality rates (AHRQ, 2006).

Data are available for 31 US states for the years 2003 and 2004, with data for one additional state available for 2004 (AHRQ, 2008). Data for Ontario were extracted from the Fraser Institute's hospital report cards for Ontario, published at www.hospitalreportcards.ca, which use the AHRQ methodology also employed for the aforementioned US states (Esmail and Hazel, 2008; Mullins et al., 2006).

¹ Both the Fraser Institute report and the AHRQ report use the AHRQ's Inpatient Quality Indicator #12 (using version 2.1 of the AHRQ Inpatient Quality Indicators software) to calculate the CABG mortality rate for individuals over the age of 40 without transfers to another institution.

We find considerable hospital-by-hospital variation in risk-adjusted [2] mortality rates in Ontario. This variation is large enough to make a material difference in the likelihood of mortality for a patient of a given risk-adjusted health status. Over the period of 2002/2003 to 2004/2005, the University of Ottawa Heart Institute and St. Mary's General Hospital were found to have the lowest risk-adjusted mortality rates in Ontario, while Sunnybrook and Women's College Health Sciences Centre and Anonymous Hospital 104 [3] were found to have the highest rates in Ontario.

We also found that the risk-adjusted CABG mortality rate in Ontario increased from 3.38% in 2002/2003 to 3.60% in 2003/2004, and to 4.00% in 2004/2005, though this increase was not statistically significant.

According to the comparison of mortality rates associated with CABG in Ontario and selected US states, patients seeking to minimize risk of death would be better off having surgery in all but five of the 32 identified US states in preference to Ontario in 2004. Further, 20 of the 32 identified US states had risk-adjusted mortality rates that were statistically lower than Ontario's in 2004. [4] There is also an increasing gap between the performance of hospitals in Ontario and many US states.

A comparison of hospital mortality rates in Ontario reveals material differences in the mortality rates experienced by patients, depending on where they were treated. While the data cannot explain why hospitals experienced different mortality rates, it is clear that changing providers can have a significant impact on the likelihood of mortality for a given patient. There are also notable differences in the mortality experiences of different jurisdictions.

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- 2 The comparisons in this study are based on risk-adjusted measures in order to account for differences in relative risk levels between facilities and jurisdictions. In both the Fraser Institute report and the AHRQ report, the indicators are adjusted by age, gender, age-gender interactions, and the 3M™ APR-DRG risk of mortality score.
 - 3 Hospitals that consented to be identified alongside their results in the Fraser Institute's Hospital Report Card (43 out of 136 hospitals, representing 41% of inpatient records in Ontario in 2004/2005) are named; the identities of other institutions that did not consent to be identified were encrypted by the CIHI prior to delivery and assigned an arbitrary number in the full report.
 - 4 CABG mortality rates are measured in terms of calendar year by AHRQ, and in terms of fiscal year by the Fraser Institute. However, given that rates remain relatively constant (as shown in table 8, rates significantly changed for only two US states between 2003 and 2004), the comparison can be considered to be accurate.

Introduction

The purpose of this study is threefold: first, to ascertain whether there are differences between mortality rates associated with coronary artery bypass graft (CABG) surgery in Ontario hospitals that perform such surgeries; second, to test whether the aggregate CABG mortality rate in Ontario is changing; and, third, to test whether the aggregate CABG mortality rate in Ontario is different than the aggregate CABG mortality rate in US states for which comparative data are available.

Background

Why study coronary artery bypass graft surgery?

The coronary artery bypass graft (CABG) surgery mortality rate is a widely used health outcome measure since the surgery is performed in high numbers, requires complex surgical and perioperative care, and has easily measurable rates of adverse events. In the 1990s, New York and Pennsylvania led the way in constructing CABG outcome reports by publishing statistics on state-wide CABG surgery outcomes. Following the publication of these reports, a marked decline in CABG mortality rates in those two states was noted (Hannan et al., 1994; PHC4, 1998).

Studies of CABG in Ontario

A number of studies have also looked at CABG surgery outcomes in Ontario. For example, a study by Tu et al. (1996) used the clinical information contained in the adult Cardiac Care Network (CCN) of Ontario database and linked it to outcomes and co-morbidity data contained in the Canadian Institute for Health Information's (CIHI) Discharge Abstract Database (DAD) for 1991/1992 to 1993/1994. The authors calculated the three-year risk-adjusted [5] CABG mortality rate in Ontario to be 3.01%; this rate declined from 3.17% in 1991/1992 to 2.93% in 1993/1994. In this study, individual hospitals were not named and no hospital was found to be a high outlier hospital.

Naylor et al. (1999) performed a follow up study with data from 1994/1995 to 1996/1997. In this study, however, all nine cardiac centres in existence during this period were named alongside their results. The authors found that the overall in-hospital risk-adjusted isolated CABG mortality rate in Ontario went from 2.75% in 1994/1995 to 2.19% in 1995/1996 [6] and to 2.23% in 1996/1997. [7] Their results also showed that in 1994/1995 only St. Michael's hospital had a significantly higher mortality rate relative to the provincial average (4.34%, compared to 2.75%). In 1995/1996, the Kingston

5 Since more specialized hospitals may treat more high-risk patients and some patients arrive at hospitals sicker than others, it is important to risk adjust the raw data in order to compare hospital death rates for patients with the same condition but a different health status.

6 Significantly different than provincial average in 1994/1995 ($p < 0.05$).

7 Significantly different than provincial average in 1994/1995 ($p < 0.05$).

General Hospital's risk-adjusted mortality rate was significantly lower than the provincial average (0.29%, compared to 2.19%), and University Hospital (now University Campus, London Health Sciences Centre) demonstrated a significantly higher mortality rate (4.74%, compared to 2.19%). By 1996/1997, no institution had a mortality rate that was significantly higher or lower than the provincial average.

A third follow-up study by Guru et al. (2006) reported data on the 11 cardiac surgical centres that existed in Ontario between the 2002 fiscal year and the 2004 fiscal year. The authors found that the in-hospital risk-adjusted isolated CABG mortality rates in Ontario increased from 1.05% in 2002 to 1.26% in 2003, [8] and to 1.33% in 2004. [9] The study also found that Hôpital Régional de Sudbury/Sudbury Regional Hospital had a significantly higher risk-adjusted mortality rate than the provincial average in 2002 (2.96%, compared to 1.05%). All other hospitals were found not to differ significantly from the provincial average. In 2003, Kingston General Hospital (2.37%) and Sunnybrook and Women's College Health Sciences Centre (2.67%) performed significantly worse than the provincial risk-adjusted mortality rate (1.26%); and in 2004, Southlake Regional Health Centre (4.32%) and Sunnybrook and Women's College Health Sciences Centre (2.82%) performed significantly worse than the provincial average (1.33%). In 2004, the University Health Network performed significantly better than the provincial average (0.54%, compared to 1.33%).

A recent study by Spencer et al. (2008) reported data on the same 11 cardiac surgical centres for 2005/2006 and 2006/2007. The authors found that the in-hospital risk-adjusted isolated CABG mortality rates in Ontario increased from 1.08% in 2005/2006 to 1.2% in 2006/2007, though this difference was not statistically significant. In 2005/2006, Sunnybrook Health Science Centre (2.44%) performed significantly worse than the provincial average. In 2006/2007, no hospital's performance was significantly different from the provincial average.

Canada-wide studies of CABG

Ghali et al. (1998) compared in-hospital CABG mortality rates in British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, New Brunswick, Nova Scotia, and Newfoundland & Labrador from 1992/1993 to 1995/1996. The authors used data on CABG procedures contained in the Canadian Institute for Health Information's Discharge Abstract Database. The authors found that wide variation existed among the provinces; risk-adjusted mortality rates

8 Not significantly different than provincial average in 2002 ($p < 0.05$).

9 Not significantly different than provincial average in 2002 ($p < 0.05$).

ranged from 2.4% in Nova Scotia to 4.3% in Alberta. The study also found that Alberta, Ontario, and Newfoundland & Labrador had higher risk-adjusted death rates (4.3%, 3.9%, and 3.9%, respectively) than the other provinces for the years studied. Finally, the authors calculated the national death rate for the four-year period to be 3.6%, and noted a trend of decreasing mortality rates from 3.8% to 3.2% between 1992/1993 and 1995/1996.

Subsequently, two of the same researchers with other co-authors increased the scope of their study to include data on Canada-wide, in-hospital risk-adjusted mortality rates for isolated CABG surgery for the 1992 to 2000 fiscal years (Ghali et al., 2003). The authors found that the overall nine-year risk-adjusted CABG mortality rate in Canada was 2.6%, but that it varied significantly across provinces, ranging from 2.0% in Nova Scotia and Manitoba to 3.3% in Newfoundland & Labrador. Further, the national risk-adjusted rate decreased significantly from 3.5% in the 1992 fiscal year to 2.0% in the 2000 fiscal year. In Ontario, the nine-year risk-adjusted CABG mortality rate was 2.8%, similarly decreasing from 3.7% in 1992 to 2.3% in 2000.

Methodology

This study relies on the fact that mortality rates for CABG surgery have been calculated in a standard way in a 2008 report by the US Agency for Healthcare Research and Quality (AHRQ) for a number of jurisdictions in the United States and most recently in Canada by the Fraser Institute. [10] The methodology used for calculating bypass surgery mortality rates was developed by the AHRQ in conjunction with Stanford University. This measure has been shown to reflect the quality of care inside hospitals where better processes of care may lead to lower mortality rates (AHRQ, 2006). Data are available for 31 US states for the years 2003 and 2004, with data for one additional US state available for 2004 (AHRQ, 2008). [11]

Data for Ontario were extracted from the Fraser Institute's Hospital Report Card for Ontario, which uses the AHRQ methodology also employed for the aforementioned US states (Esmail and Hazel, 2008; and Mullins et al., 2006). All data analyzed in the Fraser Institute's Hospital Report Card were taken from the Canadian Institute for Health Information's Discharge Abstract Database (DAD) over a nine-year period from April 1st, 1997 to March 31st, 2006. The DAD, which was purchased from the Canadian Institute for Health Information (CIHI), contains over 9.5 million patient records for the specified period. Hospitals that consented to be identified alongside their results are named; the identities of the institutions that did not consent to be identified were encrypted by the CIHI prior to delivery, and assigned an arbitrary number. [12] Data from April 1st, 2003 to March 31st, 2005 [13] (covering fiscal

10 Both the Fraser Institute report and the AHRQ report use the AHRQ's Inpatient Quality Indicator #12 (using version 2.1 of the AHRQ Inpatient Quality Indicators software) to calculate the coronary artery bypass graft mortality rate for individuals over the age of 40 without transfers to another institution.

11 The AHRQ provides estimates for the following states: Arizona, Arkansas (2004 only), California, Colorado, Florida, Georgia, Illinois, Iowa, Kansas, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, Nevada, New Hampshire, New Jersey, New York, North Carolina, Oregon, Rhode Island, South Carolina, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, and Wisconsin.

12 Forty-three out of 136 hospitals, representing 41% of inpatient records in Ontario, agreed to have their institution identified in 2004/2005.

13 The *Hospital Report Card: Ontario 2008* also presents CABG mortality rates for 2005/2006. These are not examined in this study since the latest US data from AHRQ is for 2004.

years 2003/2004 and 2004/2005) were extracted and compared to 2003 and 2004 data from the AHRQ report. [14]

Since more specialized hospitals may treat more high-risk patients and some patients arrive at hospitals sicker than others, it is important to risk adjust the raw data in order to compare hospital death rates for patients with the same condition but a different health status. The international standard for classifying risk factors, the 3M™ APR-DRG classification system, was employed by the AHRQ to calculate risk-adjustment factors which are applied to the data to correct for differences in patients' age and gender, and the presence of co-morbidities (other significant health conditions). Therefore, a hospital with a sicker patient mix is not penalized for a potentially higher mortality rate, while a hospital that treats less ill patients inappropriately is not rewarded for a lower mortality rate.

The technical features of the calculations, along with the limitations and accuracy of the data acquired from CIHI, are presented in the Fraser Institute publication noted above. Readers of this report are strongly urged to consult that larger, more detailed report for information regarding methodology and data accuracy.

Validation of the Fraser Institute's findings for Ontario

A key difference between the Fraser Institute study and the other studies surveyed above is the fact that the Fraser Institute study uses the standard AHRQ definition of CABG. The Canadian studies discussed in the preceding sections focus on isolated cardiac artery bypass graft (ICABG)—CABG that does not involve valve repair or other interventions. The Fraser Institute's Hospital Report Card looks at all CABG surgeries.

The focus of the Fraser Institute's Hospital Report Card allows the comparison of hospitals within Canada and between Canada and the United States, using similar definitions, methods, and risk adjustment. Consequently, this study assesses all CABG surgery mortality rates (and not only ICABG mortality rates) since comparable data are available for a number of US states for this definition of CABG surgeries. In addition to making Canada-US comparisons possible, comprehensive measurement ensures that all types of CABG competency are assessed. The use of broad, identical samples for the calculation of risk adjustment parameters reduces the possibility that

14 CABG mortality rates are measured in terms of calendar year by AHRQ, and in terms of fiscal year by the Fraser Institute. However, given that rates remain relatively constant (as shown in table 8, rates significantly changed for only two states between 2003 and 2004), the comparison can be considered to be accurate.

comparisons might be distorted by different rates of risk adjustment for the different jurisdictions. [15]

The study performed by Guru et al. (2006) establishes a ranking for Ontario hospitals focusing on ICABG. This ranking can be used as a comparator for the ranking focusing on CABG. In general, we would expect to find a lower mortality rate for ICABG than for CABG since ICABG is the least complicated form of the procedure. However, the ranking of the hospitals around the mean outcome should be similar, unless competency to perform ICABG is not an accurate predictor of an institution's ability to perform more complicated CABG procedures.

The results of the Fraser Institute's Hospital Report Card for Ontario are similar to those described in the study performed by Guru et al. (2006), where both studies looked at data from the same time period. Both studies found that variation in outcomes exists among acute care hospitals in Ontario. Additionally, both found that the risk-adjusted CABG mortality rates in Ontario increased between 2002 and 2004. As shown in table 1, other similarities exist, including the relative ordering of St. Mary's General Hospital, Trillium Health Centre, Hamilton Health Sciences Corporation, and Sunnybrook and Women's College Health Sciences Centre (four of the six hospitals that could be compared) relative to the calculated provincial mean in each study in the last year of data. The reasons for the differences in the ordering of the London Health Sciences Centre and the University of Ottawa Heart Institute are unclear, but they may be caused by differences in risk adjustment models or differences in CABG performance in general when compared to ICABG, as noted above. Unfortunately, we cannot agree or disagree with Guru et al.'s (2006) findings on Hôpital Régional de Sudbury/Sudbury Regional Hospital, Kingston General Hospital, Southlake Regional Health Centre, St. Michael's Hospital, or the University Health Network's performance since these hospitals did not agree to be identified in the Fraser Institute report.

The broad concurrence of the extant literature and the Fraser Institute's Hospital Report Card using the AHRQ standard CABG classification gives evidence that the various comparisons of hospital performance are an accurate representation of hospital performance with respect to CABG in Ontario, and a reasonable guide to differences in salient performance characteristics in the jurisdictions examined.

15 The comparisons in this study are based on risk-adjusted measures in order to account for differences in relative risk levels between facilities and jurisdictions. In both the Fraser Institute report and the AHRQ report, the indicators are adjusted by age, gender, age-gender interactions, and the 3M™ APR-DRG risk of mortality score.

Table 1: Calculated risk-adjusted CABG mortality rates in Guru et al. (2006) and in the Fraser Institute's Ontario Hospital Report Card, 2004

Guru et al.	Risk-adjusted mortality rate	Order	Fraser Institute	Risk-adjusted mortality rate	Order
St. Mary's General Hospital	0.29	1	St. Mary's General Hospital	2.18	1
University Health Network	0.54	2	University of Ottawa Heart Institute	2.27	2
London Health Sciences Centre	0.74	3	Hospital 10	3.28	3
Hôpital Régional de Sudbury / Sudbury Regional Hospital	0.81	4	Hospital 50	3.55	4
Trillium Health Centre	0.82	5	Trillium Health Centre	3.99	5
Ontario Average	1.33	6	Ontario Average	4.00	6
Hamilton Health Sciences Corporation	1.44	7	Hamilton Health Sciences Corporation	4.25	7
St. Michael's Hospital	1.55	8	Hospital 109	4.29	8
University of Ottawa Heart Institute	1.62	9	Hospital 8	4.50	9
Kingston General Hospital	1.89	10	London Health Sciences Centre	4.55	10
Sunnybrook and Women's College Health Sciences Centre	2.82	11	Sunnybrook and Women's College Health Sciences Centre	5.52	11
Southlake Regional Health Centre	4.32	12	Hospital 104	6.27	12

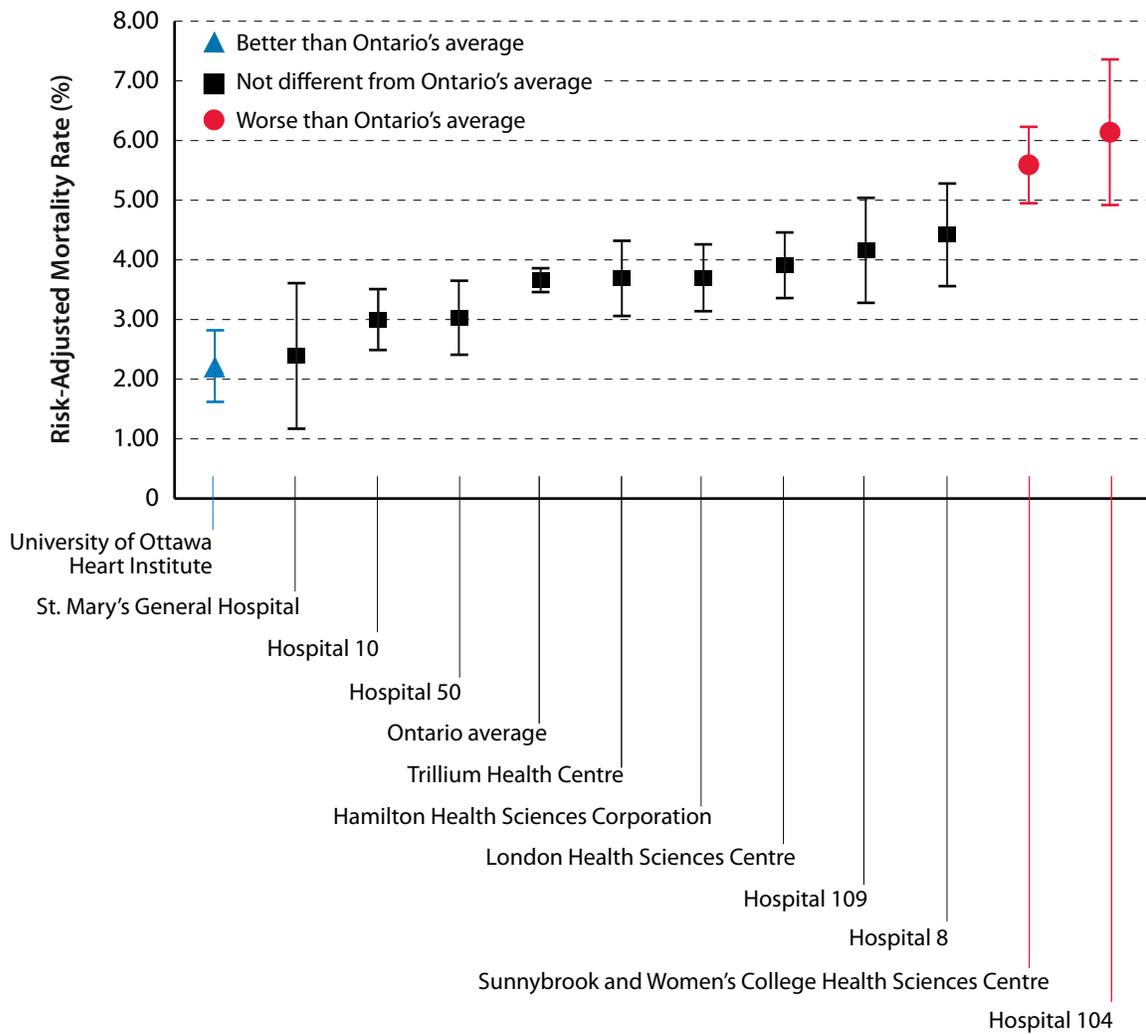
Sources: Guru et al., 2006; Esmail and Hazel, 2008.

Findings

Is there a significant difference in the mortality rates among hospitals in Ontario?

Figure 1, which presents the mortality rates aggregated for fiscal years 2002/2003 to 2004/2005, shows that there is considerable variation around the mean provincial mortality rate. Some hospitals have mortality rates that

Figure 1: Three-year risk-adjusted CABG mortality rates in Ontario, 2002/2003-2004/2005



Note: St. Mary's General Hospital was not performing CABG surgeries in the 2002 fiscal year. Hospital 104 did not exist in 2002.
 Source: Mullins et al., 2006, special data extract.

Table 2: Maximum probable risk-adjusted mortality rate for three-year pooled data (2002/2003-2004/2005) for Ontario

	Maximum probable upper limit	Minimum probable lower limit	Average
University of Ottawa Heart Institute	2.82	1.62	2.22
Hospital 10	3.51	2.49	3.00
St. Mary's General Hospital*	3.61	1.17	2.39
Hospital 50	3.65	2.41	3.03
Ontario average	3.86	3.46	3.66
Trillium Health Centre	4.32	3.06	3.69
Hamilton Health Sciences Corporation	4.26	3.14	3.70
London Health Sciences Centre	4.46	3.36	3.91
Hospital 109	5.04	3.28	4.16
Hospital 8	5.28	3.56	4.42
Sunnybrook and Women's College Health Sciences Centre	6.23	4.95	5.59
Hospital 104**	7.36	4.92	6.14

* St. Mary's General Hospital was not performing CABG surgeries in the 2002 fiscal year.

** This institution did not exist in 2002.

Source: Mullins et al., 2006, special data extract.

are indistinguishable from the provincial aggregate, some are higher, and some are lower. Since all of the patient information used to calculate the rates is adjusted for risk, the variations amongst hospitals can be taken to imply the variations in risk a patient would encounter by choosing a particular hospital relative to the average risk in the province. [16]

For a patient actually choosing an institution at which to have surgery, the main objective is to minimize risk. Minimizing risk means avoiding hospitals that have high rates of risk-adjusted mortality. Since the estimates that are calculated for the hospitals have a range, avoiding risk means choosing the hospital that has the lowest maximum probable mortality rate.

In Ontario, the University of Ottawa Heart Institute, which had a maximum probable risk-adjusted mortality rate of 2.82% over the three-year period, is overall the least risky hospital for CABG surgery (table 2). Hospital 10, St. Mary's General, and Hospital 50, which have risk-adjusted mortality rates of

16 The comparisons in this study are based on risk-adjusted measures in order to account for underlying differences in risk levels between facilities and jurisdictions.

3.51%, 3.61%, and 3.65%, respectively, are also less risky, while Sunnybrook and Women's College Health Sciences Centre and Hospital 104, with probable mortality rates as high as 6.23% and 7.36%, respectively, are the most risky.

Of course, though we are measuring institutional performance, it is possible that within each institution there is variance among surgeons. Also, this comparison of hospitals assumes that each patient has the standard risk features for which all patient records are adjusted. To the extent that a potential patient has knowledge of the internal variance among surgeons, or how their own risk factors differ from the standard ones used in the risk adjustment, it may be possible for them to have a less risky procedure at a higher risk institution. Mortality rates for individual surgeons are recorded, but not made available by the CIHI; consequently, they could not be calculated in this study. The risk of going to any particular hospital is calculated on the basis of the standard risk factors, and, as noted, a particular patient with particular risks may do better at some hospitals than others.

As can be seen in tables 3, 4, and 5, the assessment of the maximum probable risk-adjusted mortality rate does not change if, instead of pooling

Table 3: Maximum probable risk-adjusted mortality rate in Ontario, 2002/2003

	Maximum probable upper limit	Minimum probable lower limit	Average
University of Ottawa Heart Institute	3.31	1.29	2.30
Hospital 10	3.53	1.81	2.67
Ontario average	3.73	3.03	3.38
Hospital 50	3.92	1.88	2.90
London Health Sciences	4.38	2.56	3.47
Hamilton Health Sciences	4.40	2.48	3.44
Trillium Health Centre	4.85	2.55	3.70
Hospital 8	5.46	2.46	3.96
Sunnybrook and Women's College Health Sciences Centre	5.71	3.63	4.67
Hospital 109	6.16	3.28	4.72
St. Mary's General Hospital*	—	—	—
Hospital 104**	—	—	—

* St. Mary's General Hospital was not performing CABG surgeries in the 2002 fiscal year.

** This institution did not exist in 2002.

Source: Esmail and Hazel, 2008, special data extract.

Table 4: Maximum probable risk-adjusted mortality rate in Ontario, 2003/2004

	Maximum probable upper limit	Minimum probable lower limit	Average
University of Ottawa Heart Institute	3.11	1.05	2.08
Hospital 50	3.76	1.50	2.63
Ontario average	3.95	3.25	3.60
Hospital 10	3.97	2.17	3.07
Hamilton Health Sciences Corporation	4.43	2.47	3.45
Trillium Health Centre	4.44	2.34	3.39
St. Mary's General Hospital	4.54	0.82	2.68
London Health Sciences Centre	4.77	2.89	3.83
Hospital 109	4.96	1.92	3.44
Hospital 8	6.24	3.30	4.77
Sunnybrook and Women's College Health Sciences Centre	7.73	5.55	6.64
Hospital 104	8.60	2.10	5.35

Source: Esmail and Hazel, 2008, special data extract.

Table 5: Maximum probable risk-adjusted mortality rate in Ontario, 2004/2005

	Maximum probable upper limit	Minimum probable lower limit	Average
University of Ottawa Heart Institute	3.32	1.22	2.27
St. Mary's General Hospital	3.80	0.56	2.18
Hospital 10	4.18	2.38	3.28
Ontario average	4.35	3.65	4.00
Hospital 50	4.62	2.48	3.55
Trillium Health Centre	5.06	2.92	3.99
Hamilton Health Sciences Corporation	5.24	3.26	4.25
London Health Sciences Centre	5.57	3.53	4.55
Hospital 109	5.92	2.66	4.29
Hospital 8	5.98	3.02	4.50
Sunnybrook and Women's College Health Sciences Centre	6.70	4.34	5.52
Hospital 104	7.59	4.95	6.27

Source: Esmail and Hazel, 2008, special data extract.

all three years, the years are examined individually. University of Ottawa Heart Institute is the least risky hospital for all three years, while Hospital 104 (only ranked for two years since this institution did not exist in 2002) and Sunnybrook and Women's College Health Sciences Centre are among the two most risky in each year examined.

Are mortality rates for patients undergoing CABG surgery the same in Ontario as they are in the United States?

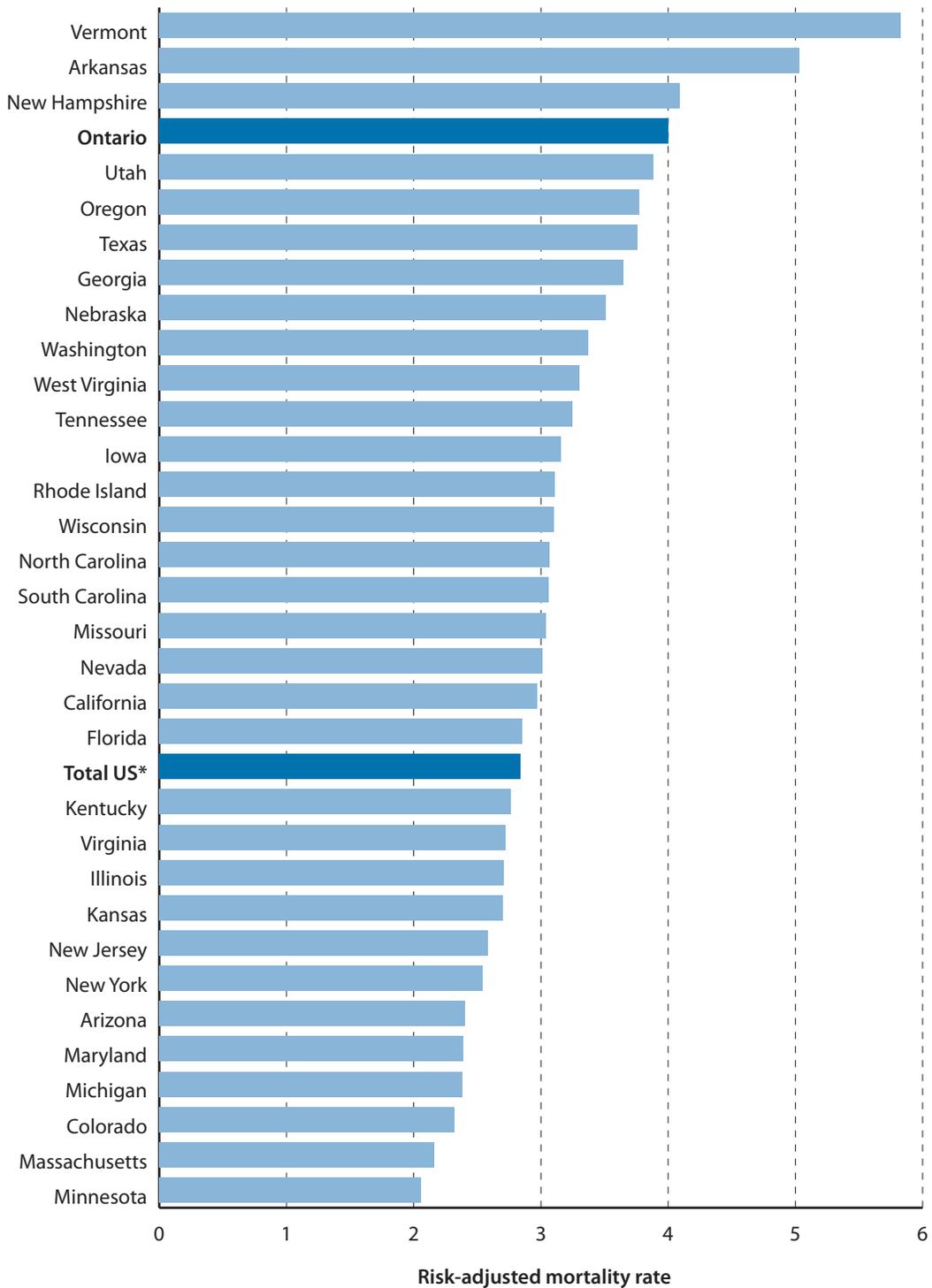
An examination of the risk-adjusted mortality rates for the 32 US states in 2004 reveals that mortality rates vary between jurisdictions. Of these 32 states, only Vermont, Arkansas, and New Hampshire have a risk-adjusted mortality rate that is equal to or greater than that found in Ontario (figure 2).

Table 6 presents the data along with the confidence intervals for the estimates of the risk-adjusted mortality rates for the 32 US jurisdictions and for Ontario; it also presents a mortality rate estimate for the United States as a whole. Using the estimated confidence intervals, the data shows that nearly two thirds (20) of the US states studied have risk-adjusted mortality rates that are statistically lower than Ontario's rate.

Using the same logic as was applied in the case of a patient seeking the least risky hospital in Ontario, a patient seeking the least risky hospital in this collection of jurisdictions would select the jurisdiction with the lowest maximum probable mortality rate. In 2004, a patient seeking to avoid risk would have preferred all but five of the states examined over Ontario. In the cases of Minnesota and Massachusetts, an Ontario patient seeking CABG surgery would, by going to an average Minnesota or Massachusetts hospital for CABG surgery, reduce their probable upper limit risk of mortality by about 41% since the average probable upper limit mortality rates at the cardiac surgery centres in those states are on average only 59% of the average probable upper limit rate in Ontario.

These comparisons demonstrate that patients who wish to minimize their risk by avoiding hospitals with high maximum probable mortality rates would choose a hospital in most of the US states measured over one in Ontario. And this is true both for states like New York, which performs this procedure on 865 people per million of its population, and Colorado, which performs the procedure on only 504 people per million of its population; in Ontario, this rate is 755 procedures per million population (table 7).

Figure 2: CABG mortality rates in Ontario and select US states, 2004



* The Total US measure is an estimate constructed from the Nationwide Inpatient Sample and is not a simple average of the individual state measures shown here (AHRQ, 2008).
Sources: AHRQ, 2008; Esmail and Hazel, 2008.

Table 6: CABG mortality rates in Ontario and select US states, 2004

	Average	Probable Upper Limit	Probable Lower Limit
Vermont	5.83	7.44	4.22
Arkansas	5.03	5.60	4.46
New Hampshire	4.09	4.99	3.19
Ontario	4.00	4.35	3.65
Utah	3.88	4.64	3.12
Oregon	3.77	4.36	3.18
Texas	3.76	3.98	3.54
Georgia	3.65	4.06	3.24
Nebraska	3.51	4.27	2.75
Washington	3.37	3.82	2.92
West Virginia	3.30	3.95	2.65
Tennessee	3.25	3.58	2.92
Iowa	3.16	3.83	2.49
Rhode Island	3.11	4.15	2.07
Wisconsin	3.10	3.49	2.71
North Carolina	3.07	3.44	2.70
South Carolina	3.06	3.57	2.55
Missouri	3.04	3.37	2.71
Nevada	3.01	3.62	2.40
California	2.97	3.17	2.77
Florida	2.85	3.03	2.67
Total US*	2.84	2.90	2.78
Kentucky	2.76	3.13	2.39
Virginia	2.72	3.13	2.31
Illinois	2.71	2.98	2.44
Kansas	2.70	3.31	2.09
New Jersey	2.58	2.91	2.25
New York	2.54	2.78	2.30
Arizona	2.40	2.77	2.03
Maryland	2.39	2.80	1.98
Michigan	2.38	2.65	2.11
Colorado	2.32	2.89	1.75
Massachusetts	2.16	2.57	1.75
Minnesota	2.06	2.55	1.57

* The Total US measure is an estimate constructed from the Nationwide Inpatient Sample and is not a simple average of the individual state measures shown here (AHRQ, 2008).

Sources: AHRQ, 2008; Esmail and Hazel, 2008, special data extract; calculations by authors.

Table 7: Number of cardiac bypass surgeries performed in Colorado, Oregon, Ontario, New York, and Texas, per million population, 2004

	Number of procedures	Population (thousands)	Procedure rate (procedures/million)
Colorado	2,324	4,609	504
Oregon	3,248	3,583	906
Ontario	9,378	12,420	755
New York	16,658	19,258	865
Texas	22,232	22,455	990

Sources:

US data: US Census Bureau, 2008; New York State Hospital Report Card, <<http://www.myhealthfinder.com>>; Indicators of Inpatient Care in Texas Hospitals, <<http://www.dshs.state.tx.us/thcic/publications/hospitals/HospitalReports.shtm>>; Colorado Hospital Report Card, <<http://www.cohospitalquality.org/index.php>>; Oregon Hospital Quality Indicators, <<http://www.oregon.gov/OHPPR/HQ/index.shtml>>.

Ontario data: Statistics Canada, undated; Esmail and Hazel, 2008.

Calculations by authors.

Are mortality rates for patients undergoing CABG surgery improving or deteriorating in Ontario and the United States?

To answer this question it is necessary to construct confidence limits for the mean mortality rate in a given year and then observe whether the confidence limit for the mean mortality rate in the subsequent year overlaps or not. Because data were available for 31 US states and for Ontario for two consecutive years, 2003 and 2004, a test could be performed for these jurisdictions.

The results (table 8) indicate that there was a statistically significant change between the two measured years for only three of the jurisdictions (two US states and the US national measure) shown in the table. [17] The mean estimates were higher for 2004 than they were in 2003 for only nine jurisdictions. Ontario's mortality rate estimate increased between 2003 and 2004. This increase caused the gap between the performance of hospitals in Ontario and of those in many US jurisdictions to widen markedly between 2003 and 2004. For example, Minnesota's mortality rate as a proportion of Ontario's rate went from 69% to 52%.

17 The confidence intervals for the risk-adjusted rate give probable lower and upper limits. For example, in 2004, the mortality rate in Minnesota could, statistically speaking, be as low as 1.57% or as high as 2.55%.

Table 8: CABG mortality rates in Ontario and select US states, 2003 and 2004

	2003		2004	
	Risk adjusted mortality rate (%)	95% Confidence interval	Risk adjusted mortality rate (%)	95% Confidence interval
Minnesota	2.49	1.98, 3.00	2.06	1.57, 2.55
Massachusetts	2.55	2.14, 2.96	2.16	1.75, 2.57
Colorado	2.74	2.17, 3.31	2.32	1.75, 2.89
Michigan	2.56	2.29, 2.83	2.38	2.11, 2.65
Maryland	2.61	2.18, 3.04	2.39	1.98, 2.80
Arizona	3.04	2.63, 3.45	2.40	2.03, 2.77
New York	2.84	2.60, 3.08	2.54	2.30, 2.78
New Jersey	2.94	2.61, 3.27	2.58	2.25, 2.91
Kansas	3.45	2.84, 4.06	2.70	2.09, 3.31
Illinois	3.13	2.86, 3.40	2.71	2.44, 2.98
Virginia	3.16	2.71, 3.61	2.72	2.31, 3.13
Kentucky	3.04	2.65, 3.43	2.76	2.39, 3.13
Florida	3.04	2.86, 3.22	2.85	2.67, 3.03
California	2.94	2.74, 3.14	2.97	2.77, 3.17
Nevada	4.01	3.38, 4.64	3.01	2.40, 3.62
Missouri	2.99	2.66, 3.32	3.04	2.71, 3.37
South Carolina	3.60	3.09, 4.11	3.06	2.55, 3.57
North Carolina	3.98	3.61, 4.35	3.07*	2.70, 3.44
Wisconsin	3.08	2.71, 3.45	3.10	2.71, 3.49
Rhode Island	4.36	3.40, 5.32	3.11	2.07, 4.15
Iowa	3.00	2.29, 3.71	3.16	2.49, 3.83
Tennessee	3.68	3.33, 4.03	3.25	2.92, 3.58
West Virginia	3.69	2.98, 4.40	3.30	2.65, 3.95
Washington	3.88	3.43, 4.33	3.37	2.92, 3.82
Nebraska	3.03	2.34, 3.72	3.51	2.75, 4.27
Georgia	4.22	3.79, 4.65	3.65	3.24, 4.06
Texas	4.72	4.48, 4.96	3.76*	3.54, 3.98
Oregon	3.36	2.77, 3.95	3.77	3.18, 4.36
Utah	3.06	2.30, 3.82	3.88	3.12, 4.64
Ontario	3.60	3.25, 3.95	4.00	3.65, 4.35
New Hampshire	4.21	3.35, 5.07	4.09	3.19, 4.99
Arkansas	N/A	N/A	5.03	4.46, 5.60
Vermont	3.27	1.64, 4.90	5.83	4.22, 7.44
Total US**	3.22	3.16, 3.28	2.84*	2.78, 2.90

* Change from 2003 to 2004 was statistically significant.

** The Total US measure is an estimate constructed from the Nationwide Inpatient Sample and is not a simple average of the individual state measures shown here (AHRQ, 2008).

Sources: AHRQ, 2008; Esmail and Hazel, 2008, special data extract; calculations by authors.

Discussion

A comparison of hospital mortality rates in Ontario reveals material differences in the CABG mortality rates in different hospitals. While the data cannot explain why hospitals had different mortality experiences, it is clear that changing providers could have a significant impact on the likelihood of mortality for a given patient.

There are also notable differences in the mortality experiences of different jurisdictions. A comparison of CABG mortality rate data, computed using the AHRQ methodology, for 33 jurisdictions (32 American states, one Canadian province), reveals that Ontario has one of the highest measured risk-adjusted mortality rates. Using the estimated confidence intervals, 20 US states were found to have mortality rates that were statistically lower than Ontario's rate in 2004. This was also true for the Total US measure. Moreover, the analysis in this study reveals that, in 2004, a patient seeking to avoid risk would statistically prefer all but five of the states examined over Ontario.

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