



Surgical Outcomes:

A synopsis & commentary on
the *Cardiac Care Quality*

Indicators data

May 2019

*Prepared by the Canadian Cardiovascular Society
(CCS)/Canadian Society of Cardiac Surgeons (CSCS)
Cardiac Surgery Quality Working Group*



**Canadian Cardiovascular
Society**
Leadership. Knowledge. Community.

**Société canadienne
de cardiologie**
Communauté. Connaissances. Leadership.

Background

In 2011, the Canadian Institute for Health Information (CIHI) started measuring and reporting on pan-Canadian cardiac outcomes. Two years later, the Cardiac Surgery Quality Working Group of the Canadian Cardiovascular Society (CCS) Quality Project defined a suite of [quality indicators](#) in cardiac surgery for pan-Canadian reporting.

Mortality indicators were defined as mortality up to 30-days, in or out of hospital, from the index cardiac surgery, for the three most common cardiac surgical procedures—coronary artery bypass (CABG), aortic valve replacement (AVR); and combined AVR and CABG—as well as 30-day readmission rate after CABG¹. These indicators reflect the highest volume cardiac surgical procedures, which should be associated with consistent excellent results, and which lend themselves to reproducible systems and processes of care.

In 2016, the CCS and CIHI established a partnership that led to extensive cohort and methodologic refinement of these indicators. These refinements were driven by an expert advisory committee that included cardiac physicians and hospital administrators, as well as representatives from the CCS and key cardiac and research organizations across Canada. Since then, the CCQI data update has received increased recognition from clinicians and administrators across the country.

¹ The CCQI report from CIHI also contains data related to PCI, which is included in the tables and figures presented in this commentary.

The first public [Cardiac Care Quality Indicators \(CCQI\) report](#) was released in October 2017 based on the first three year cohort of pooled data for fiscal years 2013-2014, 2014-2015, and 2015-2016. As of 2019, five years of data are now available for fiscal years 2013-2014 to 2017-2018. The [updated risk-adjusted indicator results](#) are based on the last 3 years of pooled data to the end of fiscal year 2017-2018.

The annual measurement and public release of the data is intended to:

- Promote transparency in the system of care;
- Foster and stimulate quality improvement;
- Supplement local reviews by providing standardized, national outcome analysis and reporting for every hospital performing cardiac surgery.

This is particularly important due to inter-provincial variability in review and reporting processes that make it challenging to assess quality of care across jurisdictions. In addition, the high-quality data in clinical cardiac surgical databases across the country are rarely available for hospital chart abstraction and coding. Further, inter-provincial data sharing across provincial health care jurisdictions is challenging.

Despite the challenges that persist, the Cardiac Surgery Quality Working Group is committed to this annual reporting process. We are optimistic that teams of care providers will find the CCQI data useful for continuing to improve quality of care in centres across the country. We appreciate the engagement of all stakeholders in the Canadian cardiovascular community in these efforts.

We will be pleased to receive any feedback on the contents of the CCQI data, and any outcomes or actions taken as a result. This feedback may be directed to CIHI (cardiacquality@cihi.ca) and the CCS Quality Project (qualityproject@ccs.ca).

A note on methodology

Model specifications (coefficients, odds ratios and p-values) for the indicators were developed using logistic regression models based on three years of pooled data (2013-2014 to 2015-2016). The reported cohort includes data from the most recent three fiscal years, 2015-2016, 2016-2017, and 2017-2018. Note that only in-hospital mortality is reported and for hospital stays less than 30 days — this will underestimate true 30-day mortality as defined by the CCS [quality indicators](#).

The tables and figures contained in this commentary are numbered according to the CIHI release and are excerpted directly without editing.

CCQI crude and risk-adjusted results

Table 1 in the CIHI data update provides the crude, predicted, and risk-adjusted outcomes by province and hospital for 11 months of data from each fiscal year, totaling 33 months of data to the end of February 2018. The 11-month fiscal cohorts allow 30-day hospital readmission rates and 30-day mortality to fiscal year end to be reported for all patients discharged within the first 11 months of the fiscal year.

Crude rates are divided by predicted rate to get an observed over expected ratio (O/E) which is multiplied by the average outcome of the entire study cohort to obtain the risk-adjusted rate. O/E ratios above 1 reflect risk adjusted rates greater than the cohort mean, and similarly O/E ratios less than 1 reflect risk adjusted rates lower than the cohort mean.

Table 1 can be filtered by province, hospital, indicator, and year. Using the arrows at the top of each column allows filtering of the data by province, hospital, indicator, and year, and permits ordering of the rows. The data contained in Table 1 is also displayed in Figures 1 to 8.

National annual results for mortality indicators over five years are shown in Figure 1 (below).

Figure I. Canadian average mortality* rates by indicator and fiscal year, 2013–2014 to 2017–2018

| Fiscal year | 30-Day In-Hospital Mortality After Isolated [†] CABG | 30-Day In-Hospital Mortality After Isolated [†] AVR | 30-Day In-Hospital Mortality After CABG and AVR |
|-------------|---|--|---|
| 2013–2014 | 1.2 | 1.3 | 3.6 |
| 2014–2015 | 1.4 | 1.3 | 3.7 |
| 2015–2016 | 1.4 | 1.2 | 2.6 |
| 2016–2017 | 1.4 | 1.3 | 3.1 |
| 2017–2018 | 1.3 | 1.2 | 2.9 |

* Mortality indicators are based on in-hospital mortality only.

† Isolated means that no other cardiac surgeries, valve procedures or core concomitant procedures were performed during the hospitalization episode of care

Sources: Discharge Abstract Database, National Ambulatory Care Reporting System and Hospital Morbidity Database, 2013-2014, 2014-2015, 2015–2016, 2016–2017 and 2017–2018, Canadian Institute for Health Information.

There is a trend to decreasing mortality in the AVR + CABG cohort to less than 3.0%, with isolated CABG and isolated AVR mortality relatively constant at 1.3% each.

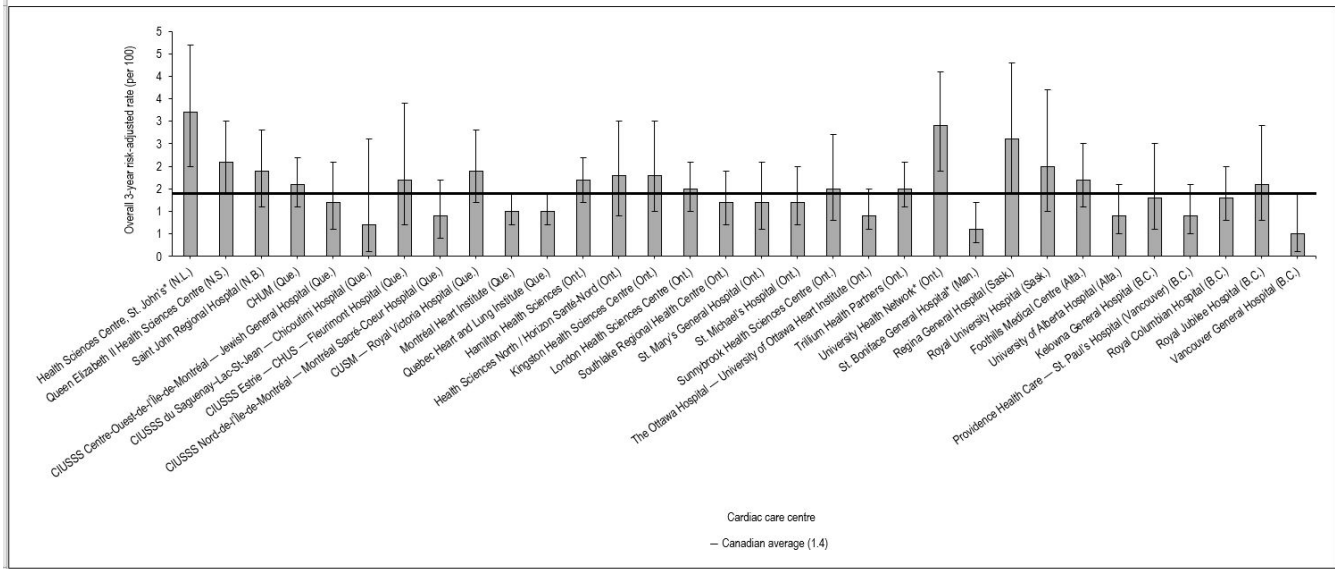
CIHI clients have private access to an Excel spreadsheet via [CIHI’s Data Preview for Indicators Tool](#) that contains the five individual year crude and risk adjusted rates for all indicators, as well as graphics of crude and predicted rates.

Care providers and hospital administrators are encouraged to contact these CIHI clients (known as **Designated Users**) from their organization to request access to the Excel spreadsheet in order to review this information.

INDICATOR: 30-Day In-Hospital Mortality After Isolated CABG

The 33-month cohort undergoing isolated CABG comprised 43,942 patients from 32 cardiac surgical centres nationally. Average annual in-hospital mortality after isolated CABG is 1.4%, as shown in Figure 4 below. This has been consistent year-over-year.

Figure 4. Cardiac care centre risk-adjusted results for 30-Day In-Hospital Mortality After Isolated CABG, 2015–2016 to 2017–2018 (3 years of pooled data)



| Organization | Risk-adjusted rate | 95% confidence interval: LCL | 95% confidence interval: UCL | Canadian average |
|---|--------------------|------------------------------|------------------------------|------------------|
| Health Sciences Centre, St. John's* (N.L.) | 3.2 | 2.0 | 4.7 | 1.4 |
| Queen Elizabeth II Health Sciences Centre (N.S.) | 2.1 | 1.4 | 3.0 | 1.4 |
| Saint John Regional Hospital (N.B.) | 1.9 | 1.1 | 2.8 | 1.4 |
| CHUM (Que.) | 1.6 | 1.1 | 2.2 | 1.4 |
| CIUSSS Centre-Ouest-de-l'Île-de-Montréal — Jewish General Hospital (Que.) | 1.2 | 0.6 | 2.1 | 1.4 |

| | | | | |
|---|-----|-----|-----|-----|
| CIUSSS du Saguenay–Lac-St-Jean — Chicoutimi Hospital (Que.) | 0.7 | 0.1 | 2.6 | 1.4 |
| CIUSSS Estrie — CHUS — Fleurimont Hospital (Que.) | 1.7 | 0.7 | 3.4 | 1.4 |
| CIUSSS Nord-de-l'Île-de-Montréal — Montréal Sacré-Coeur Hospital (Que.) | 0.9 | 0.4 | 1.7 | 1.4 |
| CUSM — Royal Victoria Hospital (Que.) | 1.9 | 1.2 | 2.8 | 1.4 |
| Montréal Heart Institute (Que.) | 1.0 | 0.7 | 1.4 | 1.4 |
| Quebec Heart and Lung Institute (Que.) | 1.0 | 0.7 | 1.4 | 1.4 |
| Hamilton Health Sciences (Ont.) | 1.7 | 1.2 | 2.2 | 1.4 |
| Health Sciences North / Horizon Santé-Nord (Ont.) | 1.8 | 0.9 | 3.0 | 1.4 |
| Kingston Health Sciences Centre (Ont.) | 1.8 | 1.0 | 3.0 | 1.4 |
| London Health Sciences Centre (Ont.) | 1.5 | 1.0 | 2.1 | 1.4 |
| Southlake Regional Health Centre (Ont.) | 1.2 | 0.7 | 1.9 | 1.4 |
| St. Mary's General Hospital (Ont.) | 1.2 | 0.6 | 2.1 | 1.4 |
| St. Michael's Hospital (Ont.) | 1.2 | 0.7 | 2.0 | 1.4 |
| Sunnybrook Health Sciences Centre (Ont.) | 1.5 | 0.8 | 2.7 | 1.4 |
| The Ottawa Hospital — University of Ottawa Heart Institute (Ont.) | 0.9 | 0.6 | 1.5 | 1.4 |
| Trillium Health Partners (Ont.) | 1.5 | 1.1 | 2.1 | 1.4 |
| University Health Network* (Ont.) | 2.9 | 1.9 | 4.1 | 1.4 |
| St. Boniface General Hospital* (Man.) | 0.6 | 0.3 | 1.2 | 1.4 |
| Regina General Hospital (Sask.) | 2.6 | 1.4 | 4.3 | 1.4 |
| Royal University Hospital (Sask.) | 2.0 | 1.0 | 3.7 | 1.4 |
| Foothills Medical Centre (Alta.) | 1.7 | 1.1 | 2.5 | 1.4 |
| University of Alberta Hospital (Alta.) | 0.9 | 0.5 | 1.6 | 1.4 |
| Kelowna General Hospital (B.C.) | 1.3 | 0.6 | 2.5 | 1.4 |
| Providence Health Care — St. Paul's Hospital (Vancouver) (B.C.) | 0.9 | 0.5 | 1.6 | 1.4 |
| Royal Columbian Hospital (B.C.) | 1.3 | 0.8 | 2.0 | 1.4 |
| Royal Jubilee Hospital (B.C.) | 1.6 | 0.8 | 2.9 | 1.4 |

| | | | | |
|-----------------------------------|-----|-----|-----|-----|
| Vancouver General Hospital (B.C.) | 0.5 | 0.1 | 1.4 | 1.4 |
|-----------------------------------|-----|-----|-----|-----|

Figure 4 shows average in-hospital risk-adjusted mortality over the 33-month time frame with 95% confidence limits. Risk-adjusted mortality ranged from 0.5% to 3.2%, nationally. Hospital mortality rates with 95% confidence limits not overlapping the national mean of 1.4% are significantly different from the national mean.

Risk factors for 30-Day in-hospital mortality after isolated CABG

Table 4 shows the numbers and percentages of patients in the 2015-17 cohort with model risk factors. Model risk factor coefficients, odds ratios and statistical significance for each of the risk factors that are included in the CABG model were developed from the 2013-2014 to 2015-2016 patient cohort.

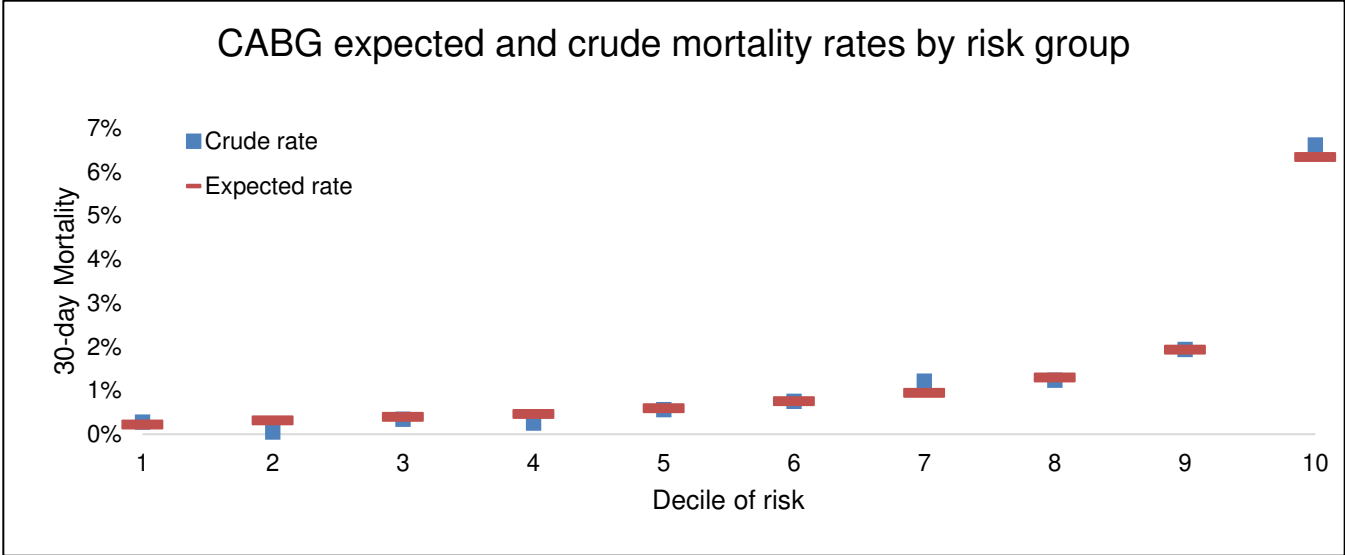
Table 4. Risk factors for 30-Day In-Hospital Mortality After Isolated CABG, 2015–2016 to 2017–2018 (3 years of pooled data)

| Risk factor | Number | Percentage | Coefficient | Odds ratio | Significance |
|---|--------|------------|-------------|------------|--------------|
| Intercept | n/a | n/a | -5.6 | n/a | <0.0001 |
| Age 18–49 (vs. 50–69) | 1,960 | 4.5 | 0.0 | 1.0 | 0.8659 |
| Age 70–79 (vs. 50–69) | 13,705 | 31.2 | 0.7 | 2.0 | <0.0001 |
| Age 80+ (vs. 50–69) | 3,011 | 6.9 | 1.3 | 3.7 | <0.0001 |
| Male (vs. female) | 35,517 | 80.8 | -0.5 | 0.6 | <0.0001 |
| Urgent/emergent admission | 22,313 | 50.8 | 0.4 | 1.5 | 0.0006 |
| Shock | 440 | 1.0 | 2.2 | 9.3 | <0.0001 |
| NSTEMI AMI/unspecified AMI (vs. stable CAD) | 13,667 | 31.1 | 0.5 | 1.6 | 0.0003 |
| STEMI AMI (vs. stable CAD) | 3,562 | 8.1 | 0.9 | 2.4 | <0.0001 |
| Unstable angina (vs. stable CAD) | 6,317 | 14.4 | 0.0 | 1.0 | 0.9243 |

| | | | | | |
|---|--------|------|------|-----|---------|
| Previous AMI | 3,167 | 7.2 | 0.1 | 1.1 | 0.3703 |
| Previous cardiac surgery | 18 | 0.0 | 0.7 | 2.1 | 0.5139 |
| Cardiac dysrhythmias (non-Quebec records) | 2,187 | 6.5 | 0.3 | 1.3 | 0.0526 |
| Cardiac dysrhythmias (Quebec records) | 1,608 | 15.3 | 0.2 | 1.2 | 0.3100 |
| Multiple cardiac interventions in same episode of care (PCI, CABG) | 1,719 | 3.9 | 0.7 | 1.9 | <0.0001 |
| Peripheral vascular disease (non-Quebec records) | 650 | 1.9 | 1.0 | 2.8 | <0.0001 |
| Peripheral vascular disease (Quebec records) | 1,911 | 18.2 | 0.7 | 1.9 | <0.0001 |
| Acute renal failure (non-Quebec records) | 769 | 2.3 | 0.3 | 1.4 | 0.1233 |
| Acute renal failure (Quebec records) | 588 | 5.6 | -0.1 | 0.9 | 0.5602 |
| Charlson group 1 (vs. 0) | 17,713 | 40.3 | 0.6 | 1.8 | <0.0001 |
| Charlson group 2 (vs. 0) | 3,335 | 7.6 | 1.4 | 4.0 | <0.0001 |

Age greater than 70, female sex, urgent hospital admission, shock, acute myocardial infarction, with and without ST-segment elevation, percutaneous coronary intervention within the same hospital episode of care, peripheral vascular disease, and a Charlson Comorbidity Index greater than 0 were all associated with increased mortality with the probability indicated by the odds ratios. The Charlson Comorbidity Index incorporates a number of preoperative comorbidities related to mortality such as congestive heart failure, dementia, chronic pulmonary disease, rheumatologic disease, liver disease, diabetes with organ failure, hemiplegia or paraplegia, renal disease, and HIV infection.

The ability of a logistic regression model to adequately predict the outcome and risk adjust, termed discrimination, is often assessed by the C-statistic. This is the area under the receiver operating curve for true positives vs false positives. The C-statistic for this model is excellent at 0.81. For perspective, the Society of Thoracic Surgery (STS) C-statistic for isolated CABG is 0.80 for the recently developed 2017 model². Goodness of fit, or calibration, is also commonly assessed by the agreement between predicted and observed outcomes at 10 deciles of risk. The excellent agreement of the CABG model is shown in the graph below at all deciles of observed risk:

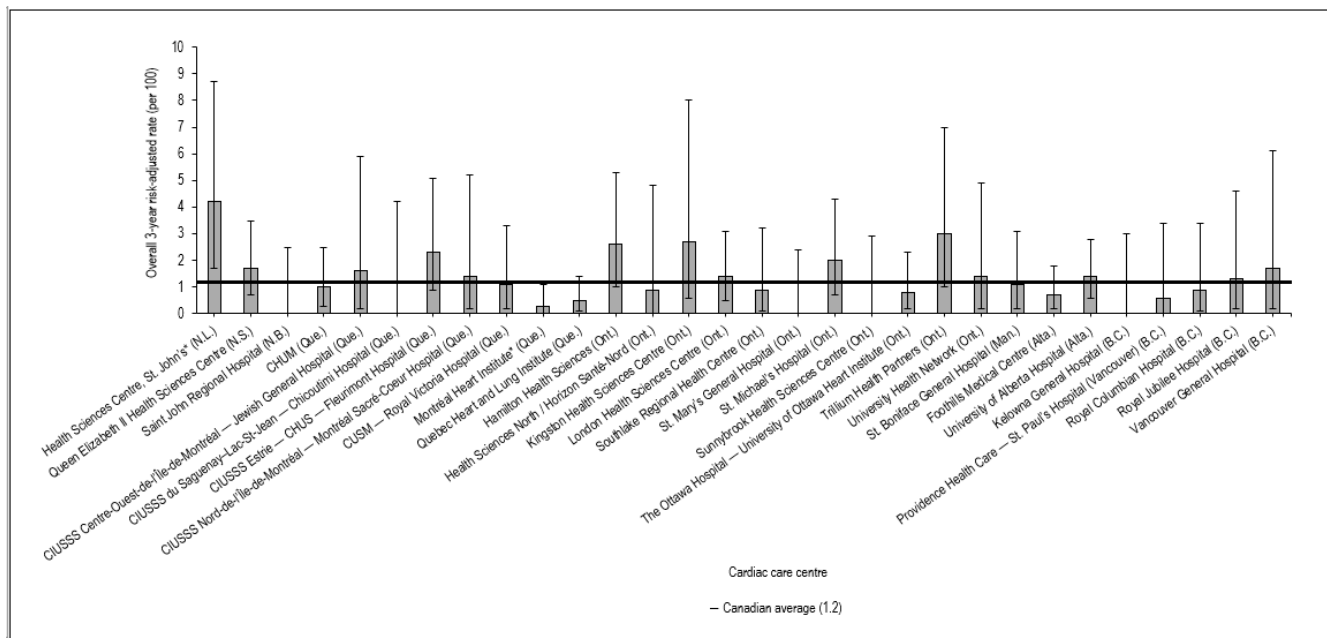


² O'Brien, SM et al. The Society of Thoracic Surgeons 2018 Adult Cardiac Surgery Risk Models: Part 2 —Statistical Methods and Results. *Ann Thorac Surg* 2018; 105:1419–28.

INDICATOR: 30-Day In-Hospital Mortality After Isolated AVR

The 33-month cohort analyzed, included 7,742 patients. Average national in-hospital mortality after isolated AVR over the last three years was low at 1.2%.

Figure 5. Cardiac care centre risk-adjusted results for 30-Day In-Hospital Mortality After AVR, 2015–2016 to 2017–2018 (3 years of pooled data)



| Organization | Risk-adjusted rate | 95% confidence interval: LCL | 95% confidence interval: UCL | Canadian average |
|---|--------------------|------------------------------|------------------------------|------------------|
| Health Sciences Centre, St. John's* (N.L.) | 4.2 | 1.7 | 8.7 | 1.2 |
| Queen Elizabeth II Health Sciences Centre (N.S.) | 1.7 | 0.7 | 3.5 | 1.2 |
| Saint John Regional Hospital (N.B.) | 0.0 | 0.0 | 2.5 | 1.2 |
| CHUM (Que.) | 1.0 | 0.3 | 2.5 | 1.2 |
| CIUSSS Centre-Ouest-de-l'Île-de-Montréal — Jewish General Hospital (Que.) | 1.6 | 0.2 | 5.9 | 1.2 |

| | | | | |
|---|-----|-----|-----|-----|
| CIUSSS du Saguenay–Lac-St-Jean — Chicoutimi Hospital (Que.) | 0.0 | 0.0 | 4.2 | 1.2 |
| CIUSSS Estrie — CHUS — Fleurimont Hospital (Que.) | 2.3 | 0.9 | 5.1 | 1.2 |
| CIUSSS Nord-de-l'Île-de-Montréal — Montréal Sacré-Coeur Hospital (Que.) | 1.4 | 0.2 | 5.2 | 1.2 |
| CUSM — Royal Victoria Hospital (Que.) | 1.1 | 0.2 | 3.3 | 1.2 |
| Montréal Heart Institute* (Que.) | 0.3 | 0.0 | 1.1 | 1.2 |
| Quebec Heart and Lung Institute (Que.) | 0.5 | 0.1 | 1.4 | 1.2 |
| Hamilton Health Sciences (Ont.) | 2.6 | 1.0 | 5.3 | 1.2 |
| Health Sciences North / Horizon Santé-Nord (Ont.) | 0.9 | 0.0 | 4.8 | 1.2 |
| Kingston Health Sciences Centre (Ont.) | 2.7 | 0.6 | 8.0 | 1.2 |
| London Health Sciences Centre (Ont.) | 1.4 | 0.5 | 3.1 | 1.2 |
| Southlake Regional Health Centre (Ont.) | 0.9 | 0.1 | 3.2 | 1.2 |
| St. Mary's General Hospital (Ont.) | 0.0 | 0.0 | 2.4 | 1.2 |
| St. Michael's Hospital (Ont.) | 2.0 | 0.7 | 4.3 | 1.2 |
| Sunnybrook Health Sciences Centre (Ont.) | 0.0 | 0.0 | 2.9 | 1.2 |
| The Ottawa Hospital — University of Ottawa Heart Institute (Ont.) | 0.8 | 0.2 | 2.3 | 1.2 |
| Trillium Health Partners (Ont.) | 3.0 | 1.0 | 7.0 | 1.2 |
| University Health Network (Ont.) | 1.4 | 0.2 | 4.9 | 1.2 |
| St. Boniface General Hospital (Man.) | 1.1 | 0.2 | 3.1 | 1.2 |
| Foothills Medical Centre (Alta.) | 0.7 | 0.2 | 1.8 | 1.2 |
| University of Alberta Hospital (Alta.) | 1.4 | 0.6 | 2.8 | 1.2 |
| Kelowna General Hospital (B.C.) | 0.0 | 0.0 | 3.0 | 1.2 |
| Providence Health Care — St. Paul's Hospital (Vancouver) (B.C.) | 0.6 | 0.0 | 3.4 | 1.2 |
| Royal Columbian Hospital (B.C.) | 0.9 | 0.1 | 3.4 | 1.2 |
| Royal Jubilee Hospital (B.C.) | 1.3 | 0.2 | 4.6 | 1.2 |
| Vancouver General Hospital (B.C.) | 1.7 | 0.2 | 6.1 | 1.2 |

Figure 5 shows average in-hospital risk-adjusted mortality over the 33-month time frame with 95% confidence limits. Risk-adjusted mortality ranged from 0 to 5.9%. Hospital mortality rates with 95% confidence limits not overlapping the national mean of 1.2% are significantly different from the national mean.

Risk factors for 30-Day In-Hospital Mortality After Isolated AVR

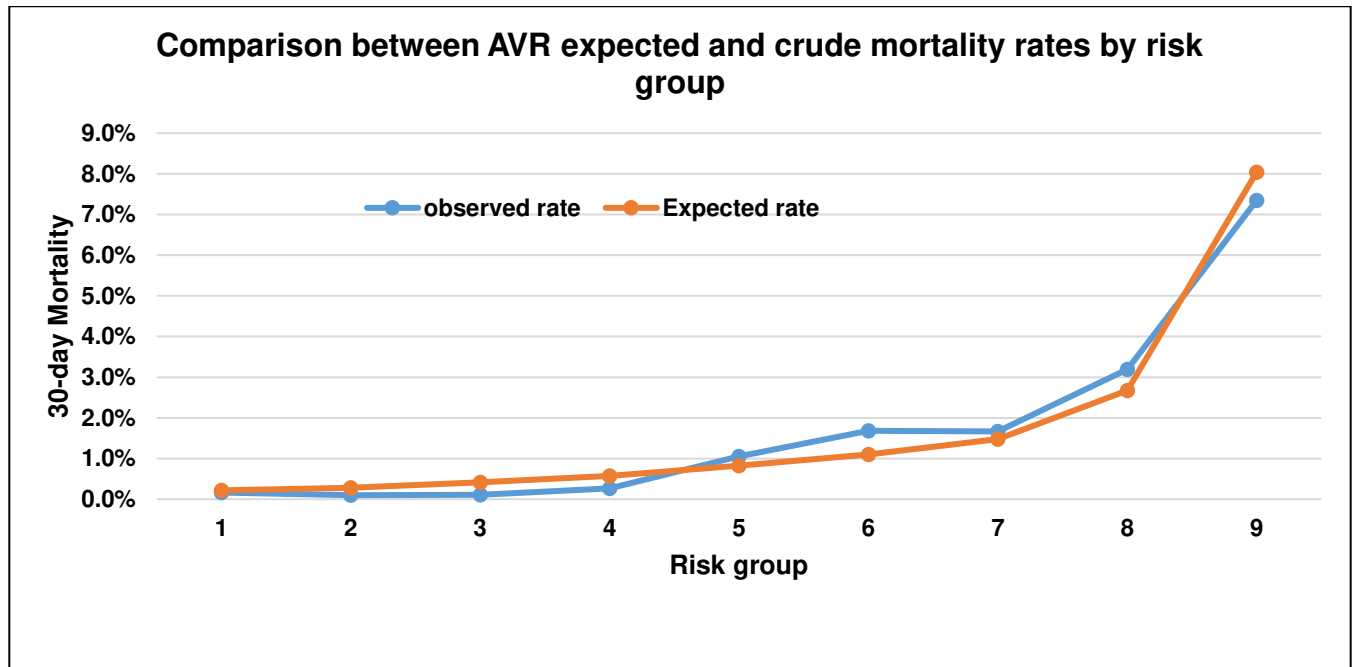
Table 5. Risk factors for 30-Day In-Hospital Mortality After Isolated AVR, 2015–2016 to 2017–2018 (3 years of pooled data)

| Risk factor | Number | Percentage | Coefficient | Odds ratio | Significance |
|--|--------|------------|-------------|------------|--------------|
| Intercept | n/a | n/a | -5.8 | n/a | <0.0001 |
| Age 18–49 (vs. 50–69) | 452 | 5.8 | 0.1 | 1.1 | 0.8493 |
| Age 70–79 (vs. 50–69) | 2,855 | 36.9 | 0.7 | 2.0 | 0.0223 |
| Age 80+ (vs. 50–69) | 1,064 | 13.7 | 1.5 | 4.7 | <0.0001 |
| Male (vs. female) | 4,830 | 62.4 | -0.3 | 0.7 | 0.1726 |
| Urgent/emergent admission | 1,168 | 15.1 | 0.2 | 1.3 | 0.3399 |
| Shock | 63 | 0.8 | 1.7 | 5.3 | 0.0021 |
| Previous cardiac surgery | 51 | 0.7 | 1.8 | 6.1 | 0.0122 |
| Cerebrovascular disease (non-Quebec records) | 133 | 2.3 | 0.8 | 2.1 | 0.1086 |
| Cerebrovascular disease (Quebec records) | 78 | 3.9 | -0.6 | 0.6 | 0.5777 |
| Cardiac dysrhythmias (non-Quebec records) | 560 | 9.7 | -0.2 | 0.8 | 0.6435 |
| Cardiac dysrhythmias (Quebec records) | 391 | 19.6 | 0.8 | 2.2 | 0.0164 |
| Acute renal failure (non-Quebec records) | 136 | 2.4 | 1.6 | 4.8 | <0.0001 |
| Acute renal failure (Quebec records) | 64 | 3.2 | 0.1 | 1.1 | 0.9126 |

| | | | | | |
|---------------------------------|-------|------|-----|-----|---------|
| Endocarditis | 281 | 3.6 | 0.0 | 1.0 | 0.9262 |
| Charlson group 1 (vs. 0) | 1,886 | 24.4 | 1.2 | 3.5 | <0.0001 |
| Charlson group 2 (vs. 0) | 547 | 7.1 | 1.5 | 4.6 | <0.0001 |

Age greater than 70, shock, previous cardiac surgery, acute renal failure (all jurisdictions except Quebec), cardiac dysrhythmias (Quebec only), and increased comorbidities as indicated by Charlson group were all predictive of increased mortality, with the odds ratios indicated in Table 5. Note that there are some risk factors with two coefficients — one for the data submitted by Quebec and one for all other jurisdictions. Quebec-specific coefficients were included in the model to address differences in data collection.

The C-statistic was excellent at 0.82. The STS does not have an individual isolated AVR model, rather isolated AVR is drawn from an isolated valve model using interaction terms³. The STS C-statistic for the isolated valve model was 0.78². Goodness of fit by deciles of predicted risk is shown in the following figure:

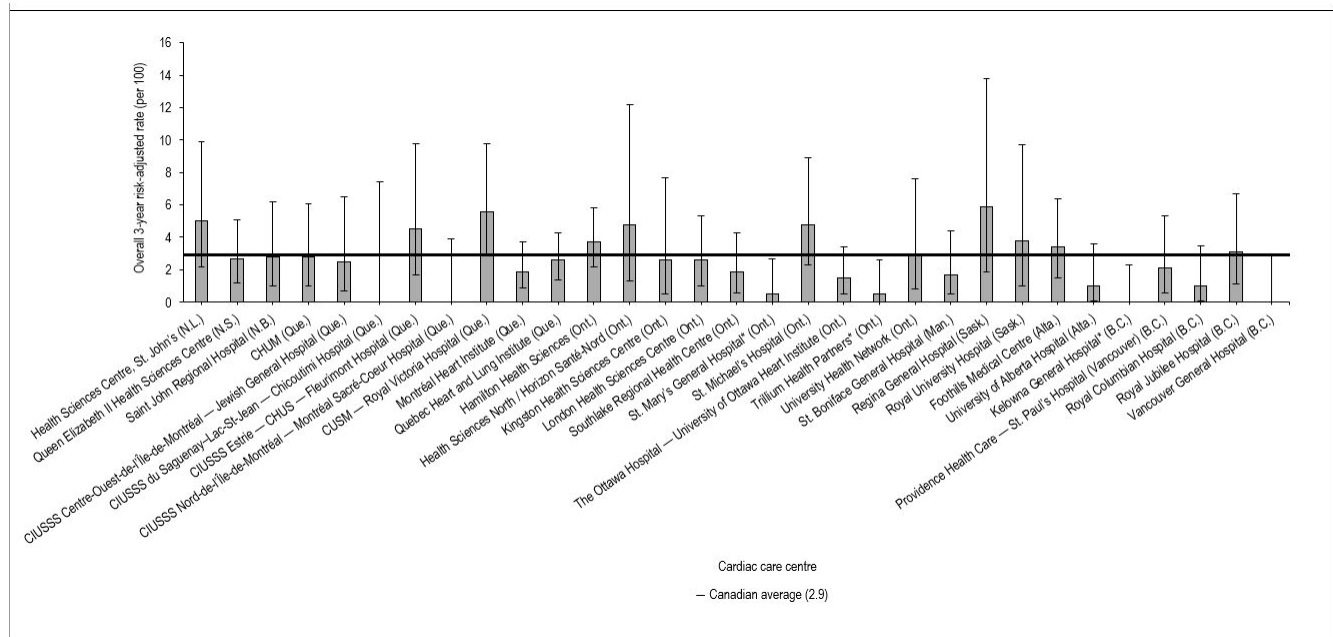


³ O'Brien SM et al. The Society of Thoracic Surgeons 2008 Cardiac Surgery Risk Models: Part 2—Isolated Valve Surgery. *Ann Thorac Surg* 88: S23–42

INDICATOR: 30-Day In-Hospital Mortality After CABG and AVR

The 33-month cohort included 5,874 patients. Average national in-hospital mortality after combined AVR and CABG is higher than each procedure in isolation at 2.9%, but has decreased from 3.1%.

Figure 6. Cardiac care centre risk-adjusted results for 30-Day In-Hospital Mortality After CABG and AVR, 2015–2016 to 2017–2018 (3 years of pooled data)



| Organization | Risk-adjusted rate | 95% confidence interval: LCL | 95% confidence interval: UCL | Canadian average |
|--|--------------------|------------------------------|------------------------------|------------------|
| Health Sciences Centre, St. John's (N.L.) | 5.0 | 2.2 | 9.9 | 2.9 |
| Queen Elizabeth II Health Sciences Centre (N.S.) | 2.7 | 1.2 | 5.1 | 2.9 |
| Saint John Regional Hospital (N.B.) | 2.8 | 1.0 | 6.2 | 2.9 |
| CHUM (Que.) | 2.8 | 1.0 | 6.1 | 2.9 |

| | | | | |
|---|-----|-----|------|-----|
| CIUSSS Centre-Ouest-de-l'Île-de-Montréal — Jewish General Hospital (Que.) | 2.5 | 0.7 | 6.5 | 2.9 |
| CIUSSS du Saguenay–Lac-St-Jean — Chicoutimi Hospital (Que.) | 0.0 | 0.0 | 7.4 | 2.9 |
| CIUSSS Estrie — CHUS — Fleurimont Hospital (Que.) | 4.5 | 1.7 | 9.8 | 2.9 |
| CIUSSS Nord-de-l'Île-de-Montréal — Montréal Sacré-Coeur Hospital (Que.) | 0.0 | 0.0 | 3.9 | 2.9 |
| CUSM — Royal Victoria Hospital (Que.) | 5.6 | 2.9 | 9.8 | 2.9 |
| Montréal Heart Institute (Que.) | 1.9 | 0.9 | 3.7 | 2.9 |
| Quebec Heart and Lung Institute (Que.) | 2.6 | 1.4 | 4.3 | 2.9 |
| Hamilton Health Sciences (Ont.) | 3.7 | 2.2 | 5.8 | 2.9 |
| Health Sciences North / Horizon Santé-Nord (Ont.) | 4.8 | 1.3 | 12.2 | 2.9 |
| Kingston Health Sciences Centre (Ont.) | 2.6 | 0.5 | 7.7 | 2.9 |
| London Health Sciences Centre (Ont.) | 2.6 | 1.0 | 5.3 | 2.9 |
| Southlake Regional Health Centre (Ont.) | 1.9 | 0.6 | 4.3 | 2.9 |
| St. Mary's General Hospital* (Ont.) | 0.5 | 0.0 | 2.7 | 2.9 |
| St. Michael's Hospital (Ont.) | 4.8 | 2.3 | 8.9 | 2.9 |
| The Ottawa Hospital — University of Ottawa Heart Institute (Ont.) | 1.5 | 0.5 | 3.4 | 2.9 |
| Trillium Health Partners* (Ont.) | 0.5 | 0.0 | 2.6 | 2.9 |
| University Health Network (Ont.) | 3.0 | 0.8 | 7.6 | 2.9 |
| St. Boniface General Hospital (Man.) | 1.7 | 0.5 | 4.4 | 2.9 |
| Regina General Hospital (Sask.) | 5.9 | 1.9 | 13.8 | 2.9 |
| Royal University Hospital (Sask.) | 3.8 | 1.0 | 9.7 | 2.9 |
| Foothills Medical Centre (Alta.) | 3.4 | 1.5 | 6.4 | 2.9 |
| University of Alberta Hospital (Alta.) | 1.0 | 0.1 | 3.6 | 2.9 |
| Kelowna General Hospital* (B.C.) | 0.0 | 0.0 | 2.3 | 2.9 |
| Providence Health Care — St. Paul's Hospital (Vancouver) (B.C.) | 2.1 | 0.6 | 5.3 | 2.9 |
| Royal Columbian Hospital (B.C.) | 1.0 | 0.1 | 3.5 | 2.9 |

| | | | | |
|-----------------------------------|-----|-----|-----|-----|
| Royal Jubilee Hospital (B.C.) | 3.1 | 1.1 | 6.7 | 2.9 |
| Vancouver General Hospital (B.C.) | 0.0 | 0.0 | 2.9 | 2.9 |

Figure 6 shows average in-hospital risk-adjusted mortality for a patient cohort of 5,874 over the 33-month time frame with 95% confidence limits. Risk-adjusted mortality ranged from 0 to 5.9%. Hospital mortality rates with 95% confidence limits not overlapping the national mean of 2.9% are significantly different from the national average.

Risk factors for 30-Day In-Hospital Mortality After CABG and AVR

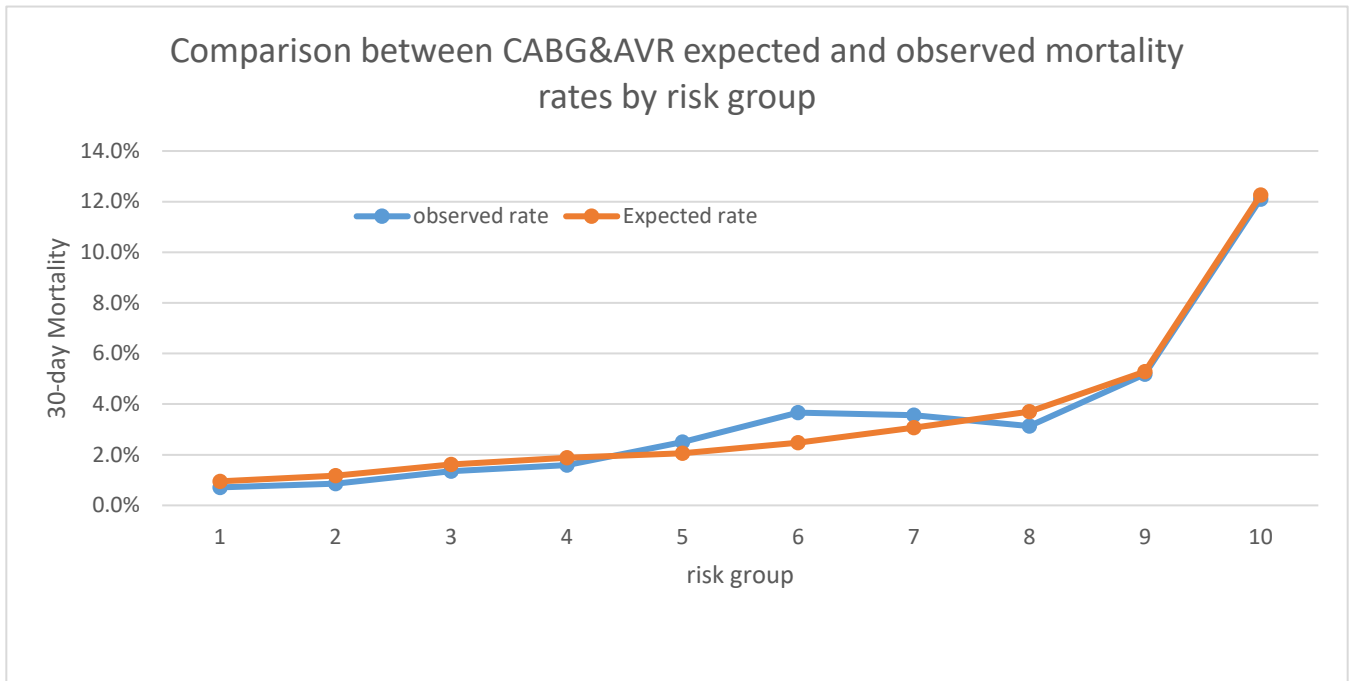
Table 6. Risk factors for 30-Day In-Hospital Mortality After CABG and AVR, 2015–2016 to 2017–2018 (3 years of pooled data)

| Risk factor | Number | Percentage | Coefficient | Odds ratio | Significance |
|--|--------|------------|-------------|------------|--------------|
| Intercept | n/a | n/a | -3.9 | n/a | <0.0001 |
| Age 18–49 (vs. 50–69) | 42 | 0.7 | 0.4 | 1.5 | 0.5791 |
| Age 70–79 (vs. 50–69) | 2,702 | 46.0 | 0.5 | 1.7 | 0.0093 |
| Age 80+ (vs. 50–69) | 1,239 | 21.1 | 0.7 | 2.1 | 0.0007 |
| Male (vs. female) | 4,595 | 78.2 | -0.6 | 0.6 | 0.0005 |
| Urgent/emergent admission | 1,601 | 27.3 | 0.5 | 1.7 | 0.0029 |
| Shock | 43 | 0.7 | 2.0 | 7.2 | <0.0001 |
| Previous cardiac surgery | 849 | 14.5 | 0.5 | 1.7 | 0.0052 |
| Cerebrovascular disease (non-Quebec records) | 269 | 4.6 | 0.8 | 2.2 | 0.0030 |
| Cerebrovascular disease (Quebec records) | 4 | 0.1 | -10.5 | 0.0 | 0.9832 |
| Cardiac dysrhythmias (non-Quebec records) | 457 | 10.9 | -0.1 | 0.9 | 0.7236 |
| Cardiac dysrhythmias (Quebec records) | 381 | 22.7 | 0.1 | 1.1 | 0.6916 |

| | | | | | |
|---|-------|------|------|-----|--------|
| Acute renal failure (non-Quebec records) | 46 | 0.8 | 1.1 | 3.0 | 0.0295 |
| Acute renal failure (Quebec records) | 115 | 2.7 | 0.9 | 2.5 | 0.0033 |
| Endocarditis | 117 | 7.0 | -1.1 | 0.3 | 0.0724 |
| Charlson group 1 (vs. 0) | 2,246 | 38.2 | -0.2 | 0.8 | 0.3577 |
| Charlson group 2 (vs. 0) | 658 | 11.2 | 0.6 | 1.8 | 0.0039 |

Age above 70, female sex, urgent/emergent hospital admission, shock, acute myocardial infarction without ST-segment elevation, and previous acute myocardial infarction and PCI in the same episode of care, acute renal failure (all jurisdictions except Quebec), and higher composite comorbidity as indicated by Charlson group 2, increased the probability of in-hospital mortality with odds ratios as indicated in Table 6.

The C-statistic is 0.72. The recent STS valve and CABG model had a C-statistic of 0.76². CIHI model goodness of fit is shown below:

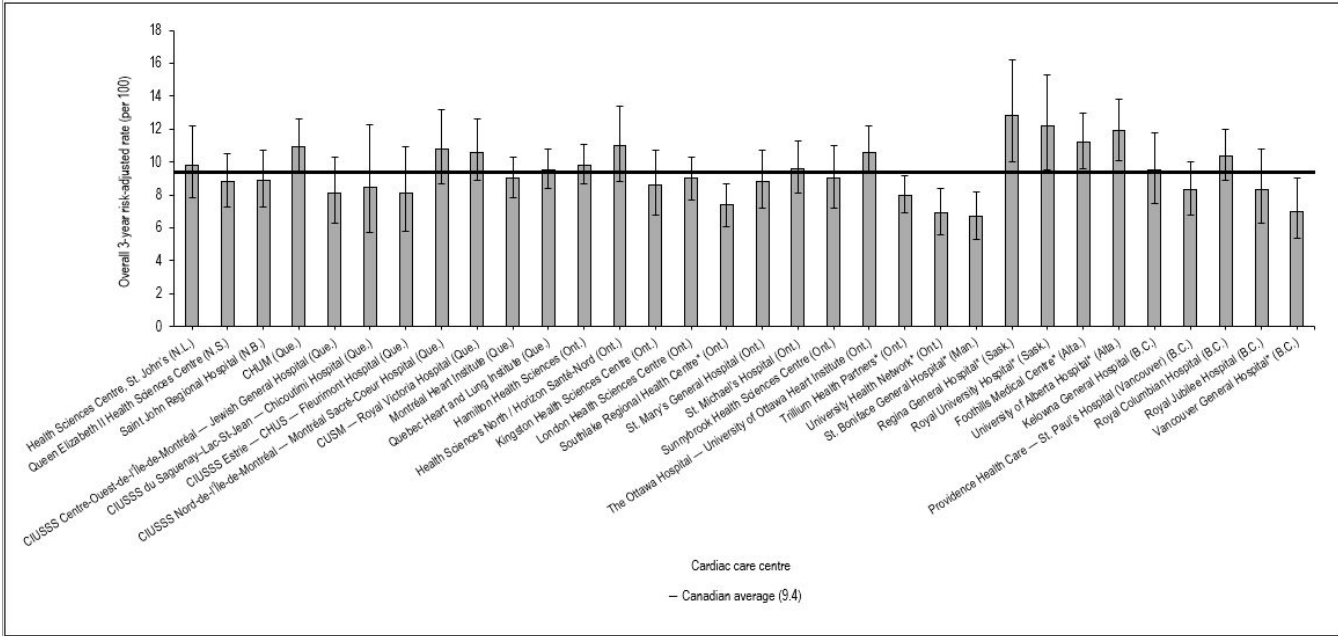


INDICATOR: 30-Day Readmission Rate After Isolated Coronary Artery Bypass

There were 3,967 readmissions within 30 days of discharge in 42,176 patients surviving to discharge. Average national 30-day readmission after isolated CABG over the three years was 9.4% and almost identical each year. Hospital readmission rates ranged from 6.7 to 12.8%.

The incremental out-of-hospital mortality from discharge prior to 30 days post discharge is not known, hence the true number of patients alive at 30 days and eligible to be readmitted is likely smaller, and calculated readmission rates are therefore underestimated.

Figure 8. Cardiac care centre risk-adjusted results for 30-Day All-Cause Readmission Rate After Isolated CABG, 2015–2016 to 2017–2018 (3 years of pooled data)



| Organization | Risk-adjusted rate | 95% confidence interval: LCL | 95% confidence interval: UCL | Canadian average |
|---|--------------------|------------------------------|------------------------------|------------------|
| Health Sciences Centre, St. John's (N.L.) | 9.8 | 7.8 | 12.2 | 9.4 |
| Queen Elizabeth II Health Sciences Centre (N.S.) | 8.8 | 7.3 | 10.5 | 9.4 |
| Saint John Regional Hospital (N.B.) | 8.9 | 7.3 | 10.7 | 9.4 |
| CHUM (Que.) | 10.9 | 9.4 | 12.6 | 9.4 |
| CIUSSS Centre-Ouest-de-l'Île-de-Montréal — Jewish General Hospital (Que.) | 8.1 | 6.3 | 10.3 | 9.4 |
| CIUSSS du Saguenay–Lac-St-Jean — Chicoutimi Hospital (Que.) | 8.5 | 5.7 | 12.3 | 9.4 |
| CIUSSS Estrie — CHUS — Fleurimont Hospital (Que.) | 8.1 | 5.8 | 10.9 | 9.4 |
| CIUSSS Nord-de-l'Île-de-Montréal — Montréal Sacré-Coeur Hospital (Que.) | 10.8 | 8.7 | 13.2 | 9.4 |
| CUSM — Royal Victoria Hospital (Que.) | 10.6 | 8.9 | 12.6 | 9.4 |
| Montréal Heart Institute (Que.) | 9.0 | 7.8 | 10.3 | 9.4 |
| Quebec Heart and Lung Institute (Que.) | 9.5 | 8.4 | 10.8 | 9.4 |
| Hamilton Health Sciences (Ont.) | 9.8 | 8.7 | 11.1 | 9.4 |
| Health Sciences North / Horizon Santé-Nord (Ont.) | 11.0 | 8.8 | 13.4 | 9.4 |
| Kingston Health Sciences Centre (Ont.) | 8.6 | 6.8 | 10.7 | 9.4 |
| London Health Sciences Centre (Ont.) | 9.0 | 7.7 | 10.3 | 9.4 |
| Southlake Regional Health Centre* (Ont.) | 7.4 | 6.1 | 8.7 | 9.4 |
| St. Mary's General Hospital (Ont.) | 8.8 | 7.2 | 10.7 | 9.4 |
| St. Michael's Hospital (Ont.) | 9.6 | 8.1 | 11.3 | 9.4 |
| Sunnybrook Health Sciences Centre (Ont.) | 9.0 | 7.2 | 11.0 | 9.4 |
| The Ottawa Hospital — University of Ottawa Heart Institute (Ont.) | 10.6 | 9.3 | 12.2 | 9.4 |
| Trillium Health Partners* (Ont.) | 8.0 | 6.9 | 9.2 | 9.4 |
| University Health Network* (Ont.) | 6.9 | 5.6 | 8.4 | 9.4 |

| | | | | |
|--|------|------|------|-----|
| St. Boniface General Hospital* (Man.) | 6.7 | 5.3 | 8.2 | 9.4 |
| Regina General Hospital* (Sask.) | 12.8 | 10.0 | 16.2 | 9.4 |
| Royal University Hospital* (Sask.) | 12.2 | 9.5 | 15.3 | 9.4 |
| Foothills Medical Centre* (Alta.) | 11.2 | 9.6 | 13.0 | 9.4 |
| University of Alberta Hospital* (Alta.) | 11.9 | 10.1 | 13.8 | 9.4 |
| Kelowna General Hospital (B.C.) | 9.5 | 7.5 | 11.8 | 9.4 |
| Providence Health Care — St. Paul's Hospital (Vancouver) (B.C.) | 8.3 | 6.8 | 10.0 | 9.4 |
| Royal Columbian Hospital (B.C.) | 10.4 | 8.9 | 12.0 | 9.4 |
| Royal Jubilee Hospital (B.C.) | 8.3 | 6.3 | 10.8 | 9.4 |
| Vancouver General Hospital* (B.C.) | 7.0 | 5.4 | 9.0 | 9.4 |

Figure 8 shows average hospital 30-day readmission rates over the 33-month time frame with 95% confidence limits. Hospital risk-adjusted readmission rates ranged from 6.7 to 12.8%. Hospital readmission 95% confidence limits not overlapping the national mean of 9.4% are significantly different from the mean.

Risk factors for 30-Day Readmission Rate after Isolated Coronary Artery Bypass

Risk factors predicting 30-day readmission were age greater than 70, female sex, urgent/emergent admission, acute myocardial infarction, cardiac dysrhythmias, PCI within the same episode of care, acute renal failure, peripheral vascular disease, and increased Charlson Comorbidity Index. The C-statistic is 0.62. Discrimination of readmission based on preoperative factors alone is challenging and this model is consistent with others⁴.

Table 8. Risk factors for 30-Day All-Cause Readmission Rate After Isolated CABG, 2015–2016 to 2017–2018 (3 years of pooled data)

| Risk factor | Number | Percentage | Coefficient | Odds ratio | Significance |
|---|---------------|-------------------|--------------------|-------------------|---------------------|
| Intercept | n/a | n/a | -2.5 | n/a | <0.0001 |
| Age 18–49 (vs. 50–69) | 1,898 | 4.5 | 0.1 | 1.1 | 0.5227 |
| Age 70–79 (vs. 50–69) | 13,006 | 30.8 | 0.2 | 1.2 | <0.0001 |
| Age 80+ (vs. 50–69) | 2,778 | 6.6 | 0.3 | 1.4 | <0.0001 |
| Male (vs. female) | 34,215 | 81.1 | -0.3 | 0.7 | <0.0001 |
| Urgent/emergent admission | 21,293 | 50.5 | 0.1 | 1.1 | 0.0001 |
| Previous AMI | 3,023 | 7.2 | 0.3 | 1.4 | <0.0001 |
| Cardiac dysrhythmias (non-Quebec records) | 2,045 | 6.4 | 0.3 | 1.3 | <0.0001 |
| Cardiac dysrhythmias (Quebec records) | 1,486 | 14.8 | 0.2 | 1.2 | 0.0256 |
| Hypertension (non-Quebec records) | 5,481 | 17.1 | 0.1 | 1.1 | 0.0514 |
| Hypertension (Quebec records) | 8,211 | 81.7 | 0.0 | 1.0 | 0.7821 |
| Multiple cardiac interventions in same episode of care (PCI, CABG) | 1,597 | 3.8 | 0.3 | 1.4 | 0.0001 |
| Peripheral vascular disease (non-Quebec records) | 600 | 1.9 | 0.4 | 1.6 | <0.0001 |
| Peripheral vascular disease (Quebec records) | 1,791 | 17.8 | 0.3 | 1.3 | 0.0019 |
| Acute renal failure (non-Quebec records) | 683 | 2.1 | 0.3 | 1.4 | 0.0057 |
| Acute renal failure (Quebec records) | 527 | 5.2 | 0.2 | 1.3 | 0.0677 |
| Charlson group 1 (vs. 0) | 16,950 | 40.2 | 0.4 | 1.5 | <0.0001 |
| Charlson group 2 (vs. 0) | 2,992 | 7.1 | 0.8 | 2.2 | <0.0001 |

⁴ Hannan E et al. Predictors of Readmission for Complications of Coronary Artery Bypass Graft Surgery. JAMA. 920(6):773-780.