Training/Practice
Health Policy and Promotion

Quality of Care for Percutaneous Coronary Intervention: Development of Canadian Cardiovascular Society Quality Indicators

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ABSTRACT
Currently there are more than 40 centres in Canada that perform more than 65,000 percutaneous coronary interventions (PCIs) in a year. Considering the high volume of procedures and number of operators, the potential for variation in processes of care is high, and might lead to variation in the quality of care. As part of its quality initiative, the Canadian Cardiovascular Society convened a working group to develop a set of PCI Quality Indicators (QIs) that would be relevant, scientifically acceptable, and feasible to measure and report. The working group was comprised of clinical experts from across Canada and members of provincial and federal organizations involved in promoting the quality of care in PCI.

Percutaneous coronary intervention (PCI) is the most frequently performed procedure to treat clinically significant coronary artery stenosis. Annually more than 65,000 PCIs are performed in Canada. Provision of high-quality care in PCI includes appropriate patient selection, a standardized process of care with appropriate documentation, quality procedural execution, and appropriate resource utilization, use of evidence-based therapy, and achievement of outcomes that meet common national standards. 1

Initial work on Canadian PCI Quality Indicators (QIs) was published in 2008 by Dennis Ko et al. 2 It proposed a list of 26 QIs. Since then, 8 years have passed and the Canadian Cardiovascular Society (CCS), as a part of its quality initiative convened a PCI QI working group in 2014 with a mandate to propose a short list of national PCI QIs that would be clinically

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of health care. Using the Canadian Cardiovascular Society “Best Practices for Developing Cardiovascular Quality Indicators” methodology, a total of 23 QIs were proposed. Subsequent ranking and discussion led to the selection of 8 QIs. The selection and ranking of QIs were on the basis of clinical importance and relevance, scientific acceptability, and feasibility of their operationalization at a national level. The data definitions and technical notes of the QIs were refined after feasibility testing and Web consultation. Feasibility testing indicated that standardization and enhancements of knowledge infrastructure are essential to provide the comprehensive patient data necessary to evaluate the quality of PCI across Canada.

**Methods**

After the review of existing literature for QIs the working group selected 23 initial QIs that were categorized as either structural, process, or outcome indicators. Each member of the working group ranked the selected QIs on the basis of their clinical importance and relevance, scientific acceptability, and feasibility of measurement and reporting using a 7-point Likert scale. Equal weight was assigned to the 3 parameters with a mean score assigned to each indicator. After review by the working group, a total of 8 PCI QIs were selected (Table 1).

A technical note for each QI was developed that included the description and definition, method of calculation, rationale, clinical recommendations, sources of data, and challenges to implementation (see Supplementary Material).

Further refinement of the QI definitions and technical notes was conducted in conjunction with key stakeholders and the Canadian cardiovascular community through Web consultation. The CCS Executive Committee approved the proposed QIs in November 2015.

**Annual PCI Volume According to Provider**

Observational studies have suggested that low operator volume (< 75 cases per year) is associated with a higher rate of adverse events including mortality among patients who undergo PCI, especially in a complex and emergency setting. Preliminary analysis by the CIHI indicated that most Canadian centres perform > 400 PCI cases per year, national measurement and reporting of volume was deemed important because of the continued establishment of new PCI centres.

**First Medical Contact to First Device Time for Primary PCI**

Historically, door to balloon time has been used as a QI for centres that perform primary PCI (PPCI). However, first medical contact (FMC) to first device time (FDT) is a more appropriate QI because it is a measure of the efficiency of the entire system including the emergency medical services (EMS), the referring centres without PPCI facilities, and the centre that performed the PPCI. The definition of FMC is explained in the Supplementary Material.

- After review of the available literature, guidelines, and extensive discussion it was agreed that the proportion of patients treated within each of the following times should be reported by all centres with the goal of the treatment delay being within the maximal in at least 75% of cases:
  - FMC to FDT < 90 minutes for patients who present directly to the PCI centres and < 120 minutes for those who require transfer from the non-PCI centres.
  - FMC to FDT should be < 90 minutes for direct EMS transfers to PCI centres but up to 120 minutes is acceptable especially when a cardiac catheterization laboratory serves a larger geographic area.

Several provincial organizations do report the door to balloon time and some are moving toward reporting FMC to FDT. All PCI centres involved in PPCI should be encouraged to develop a reporting system of this important QI because it cannot be measured using clinical administrative data sources and might not always be documented in the patient’s medical records for patients who use EMS or are transferred from another hospital.

**Renal Function Assessment Before Nonemergent PCI**

Knowledge of baseline renal function (serum creatinine and/or estimated glomerular filtration rate measurement) is helpful in defining the risk of contrast-induced nephropathy.
validated risk adjustment model that includes sex, age, and diagnosis of diabetes with complications, heart failure/pulmonary edema, renal failure, shock, cardiac dysrhythmias, ST-elevation myocardial infarction, unstable angina, and stable coronary artery disease before the index PCI. The limitations of the CIHI analyses are missing data for patients who die out of hospital and historically lack of statistical power because of the generally low incidence of mortality.

**30-Day Readmission Rate After PCI**

Unplanned 30-day readmission after PCI for the reasons of acute myocardial infarction, target vessel revascularization, unplanned coronary artery bypass grafting (CABG), or other adverse events, is an important outcome measure for PCI. In most circumstances, 30-day readmission is suggestive of a procedure-related adverse outcome and this has to be differentiated from a planned admission for PCI or CABG. However, for feasibility purposes, it was agreed that the QI would be the rate of all readmissions within the 30 days from hospital discharge because this QI can be measured by CIHI. Appropriate risk adjustment will be necessary to take into account differences in patient populations across PCI centres and other potential confounders.

**Peri-PCI Blood Transfusion**

Blood transfusion is a surrogate marker of major bleeding during or after a PCI procedure. Major bleeding is associated with higher mortality and increased risk of adverse events after PCI. The Committee was of the opinion that it would be prohibitively challenging to report on the incidence of major access site or non-access site bleeding after PCI. Therefore, index hospitalization non-CABG-related blood transfusion was chosen as the QI to measure post-PCI major bleeding complications. The incidence of blood transfusion after PCI is dependent on multiple factors and risk adjustment is necessary for appropriate reporting of this QI. This indicator is reportable by CIHI using data from the Discharge Abstract Database but it would include all blood transfusions given before or after the PCI.

**Peri-PCI Stroke**

Stroke is used as an all-inclusive term that includes any intracerebral/brain stem hemorrhage or infarction and subarachnoid hemorrhage. The initial diagnosis is clinical because there is often a delay for radiological evidence especially in the case of a nonhemorrhagic stroke. Although the incidence of stroke is low among patients who undergo cardiac catheterization and PCI, it is a clinically important and potentially debilitating outcome. The recommendation is to report the risk-adjusted rate of stroke within the same episode of care for adult patients who undergo PCI. The clinical administrative data sources (CIHI-Discharge Abstract Database, Hospital Morbidity Database) do have the capability to identify stroke during the hospital stay for PCI.

**Future Adaptation of the CCS PCI QIs**

The PCI QI Committee focused on developing indicators that are relevant, scientifically acceptable, and feasible to measure and report. The committee acknowledges that the

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**Table 1. Summary of selected CCS percutaneous coronary intervention Quality Indicators**

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural</td>
<td>Annual PCI volume according to provider</td>
<td>Hospital records (patient charts)</td>
</tr>
<tr>
<td></td>
<td>Annual PCI volume according to centre</td>
<td>Institutional clinical data, CIHI-DAD, Provincial medical services billing data</td>
</tr>
<tr>
<td>Process</td>
<td>First medical contact to first device time for primary PCI</td>
<td>Hospital records (patient charts), EMS data, Institutional clinical data</td>
</tr>
<tr>
<td></td>
<td>Renal function assessment before nonemergent PCI</td>
<td>Hospital records (patient charts), Institutional clinical data, Provincial death registries</td>
</tr>
<tr>
<td>Outcome</td>
<td>30-Day mortality after PCI</td>
<td>CIHI-DAD, HMDB, Hospital records (patient charts), Institutional clinical data, Provincial death registries</td>
</tr>
<tr>
<td></td>
<td>30-Day readmission rate after PCI</td>
<td>CIHI-DAD, HMDB, Institutional clinical data</td>
</tr>
<tr>
<td></td>
<td>Peri-PCI blood transfusion</td>
<td>Hospital records (patient charts), CIHI-DAD, NACRS, HMDB, Institutional clinical data</td>
</tr>
<tr>
<td></td>
<td>Peri-PCI stroke</td>
<td>CIHI-DAD, NACRS, HMDB, Institutional clinical data, Hospital records (patient charts)</td>
</tr>
</tbody>
</table>

CCS, Canadian Cardiovascular Society; CIHI, Canadian Institute for Health Information; DAD, Discharge Abstract Database; EMS, Emergency Medical Services; HMDB, Hospital Morbidity Database; NACRS, National Ambulatory Care Reporting System; PCI, percutaneous coronary intervention.
current list of indicators will require further adaptation in the future. The continued monitoring and refinement of the proposed QIs and the development of strong partnerships with national stakeholders including CIHI and the Canadian Association of Interventional Cardiology (CAIC) will be critical to success. The PCI QI Committee advocated expanding CIHI’s cardiac care QIs report to include 2 new indicators in 2016 (readmission and volume according to centre) in addition to the existing indicator of 30-day in-hospital mortality. Preliminary results for 4 indicators (operator and centre volumes, mortality, and readmission) were presented at a workshop at the Canadian Cardiovascular Congress in 2015. The next goal will be to produce a national report on the recommended QIs at regular intervals and to disseminate it widely to health care providers and respective health authorities. This major undertaking requires commitment and collaboration of all stakeholders. The PCI QI working group is grateful to CCS for providing the timely support that was necessary to develop these Canadian QIs for PCI.

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Disclosures
The authors have no conflicts of interest to disclose.

References
1. Harold JG, Bass TA, Bashore TM, et al. ACCF/AHA/SCAI 2013 update of the clinical competence statement on coronary artery inter-

Supplementary Material
To access the supplementary material accompanying this article, visit the online version of the Canadian Journal of Cardiology at www.onlinecjc.ca and at http://dx.doi.org/10.1016/j.cjca.2016.07.511.

Erratum
In the article, “Novel Approaches in Primary Cardiovascular Disease Prevention: The HOPE-3 Trial Rationale, Design, and Participants’ Baseline Characteristics” by Lonn et al., published in the March issue (Can J Cardiol 2016;32:311-8), there is an error on page 315.
In the first column, the authors state:
“To preserve alpha for testing of both coprimary outcomes and for testing at the margins of the factorial as well as the diagonal comparisons, the first coprimary outcome was tested at a P value of 0.04 and the second coprimary at P = 0.02 at the margins, and both coprimaries will be tested at a P value of 0.0044 for the diagonal comparisons (calculated through simulation based on 80% overlap between the coprimary outcomes).”

The corrected text should read as follows:
“To preserve alpha for testing of both coprimary outcomes and for testing at the margins of the factorial as well as the diagonal comparisons, the first coprimary outcome was tested at a P value of 0.04 and the second coprimary at P = 0.02 at the margins (calculated through simulation based on 80% overlap between the coprimary outcomes). If neither coprimary for the BP-lowering or lipid-lowering arms reached the above thresholds for statistical significance, then both coprimaries would be tested at a P value of 0.0044 for the diagonal comparisons. If any arm reached their prespecified levels of significance for either coprimary outcomes, then a nominal P value of < 0.05 would be used to test both coprimary outcomes to compare the double active vs the double placebo group.”