Systematic Review/Meta-analysis

Cardiovascular Risk Factor Management Performance in Canada and the United States: A Systematic Review

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Division of Endocrinology, Department of Medicine, St Michael’s Hospital, Toronto, Ontario, Canada
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ABSTRACT

Hypertension, dyslipidemia, diabetes, and smoking are established coronary heart disease risk factors whose effective management has been shown to reduce cardiovascular (CV) events. National guidelines recommend screening for these risk factors universally among patients with established coronary heart disease and among targeted at-risk populations for primary prevention of CV disease. There are also guidelines specific to the detection and management of hypertension, dyslipidemia, diabetes, and smoking, as well as recommendations to enhance the implementation of CV practice guidelines.


Methods: Nous avons procédé à un examen systématique de Medline et d’EMBASE jusqu’au 1er juin 2014. Les études admissibles faisaient état des taux de dépistage, de sensibilisation, de traitement ou de maîtrise de l’hypertension, de la dyslipidémie, du diabète et du tabagisme. Nous avons utilisé les «cotes» de performance catégoriques s’appuyant sur les régimes de santé les plus prospères des É.-U. pour classifier les taux comme étant sous-optimaux (< 50 %), sous les cibles (50 %-70 %), au-dessus des cibles (70 %-90 %), ou optimaux (> 90 %).

Hypertension, dyslipidemia, diabetes, and smoking are established coronary heart disease risk factors whose effective management has been shown to reduce cardiovascular (CV) events. National guidelines recommend screening for these risk factors universally among patients with established coronary heart disease and among targeted at-risk populations for primary prevention of CV disease. There are also guidelines specific to the detection and management of hypertension, dyslipidemia, diabetes, and smoking, as well as recommendations to enhance the implementation of CV practice guidelines.

It is unclear to what extent CV guidelines have been implemented in routine clinical practice. Physician awareness

See editorial by Teo and Dokainish, pages 300–302 of this issue.
Methods

For the complete study methods, please refer to the Methods section of the Supplementary Material.

Literature search

We performed a systematic review according to the Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines.24 We limited the systematic literature search to Medline and EMBASE between January 1, 2000 to June 1, 2014, to focus our review on contemporary studies.

Outcomes

Outcomes of interest were rates of screening, awareness, treatment, and target control achievement for hypertension, dyslipidemia, diabetes, and smoking.

Results

Baseline characteristics

We identified 397 potential articles, which, after full-text review and additional input, resulted in 127 final studies for inclusion (Fig. 1).27-159 Among these articles, 21 studies reported on Canadian metrics,27-31,33,34,36-42,50-55,153 97 studies reported on American indicators,36-152 and 9 studies reported on both countries.32,35,43-49 There were 58 hypertension study articles,27,44,48,54,56,94,145 36 on dyslipidemia,45,49,87,88,95-117,146-150,152 23 on diabetes,45,47,48,50-55,87,88,116,118-126,150,151 and 19 on smoking.127,144,153 Table 1 shows the data sources and descriptive characteristics for each risk factor metric evaluated. Most included surveys had a good representation of women (close to 50%). Most surveys reported on adult populations aged 18 or 20 years and older, however, some studies focused on higher-risk ages 35-45 years and older. Because some studies published a number of independent reports focused on various risk factor care, the final number of publications exceeded the final number of included studies/surveys according to data source. A study flow diagram depicting this is shown in Figure 1.

The most frequently used surveys in Canada on the basis of our included studies were the Canadian Health Measures Survey (CHMS), Canadian Community Health Survey...
(CCHS), Ontario Survey on the Prevalence and Control of Hypertension (ON-BP), Ontario Health Insurance Plan (OHIP) records, Canadian Tobacco Use Monitoring Survey (CTUMS), and Canadian Tobacco, Alcohol and Drugs Survey (CTADS). Meanwhile, common US surveys were the National Health and Nutrition Examination Survey (NHANES), Behavioral Risk Factor Surveillance System (BRFSS), and National Ambulatory Medical Care Survey (NAMCS), all of which were conducted through the Centers for Disease Control and Prevention (CDC). Because of this large volume of information, we opted to further exclude single-state studies, outdated studies (data before 2000), and studies restricted to older individuals, unless no alternative studies were available.

**Hypertension**

**Canada.** A total of 72,576 individuals in Canada were considered within the hypertension subset (Table 2). There was an improvement in awareness and control rates from 2007 to 2013, whereas treatment remained the same. Overall, awareness and treatment of hypertension in Canada were above target rates, and control was below target. In comparison, provincial data for Ontario and Quebec showed similar performance in hypertension awareness, treatment, and control.

**US.** A total of 1,270,898 individuals in the US were considered within the hypertension subset (Table 2). From 2000 to 2004, hypertension screening in office-based physician practices improved from suboptimal to below target. There was a general trend of improvement in awareness, treatment, and control from 2007 to 2012. Similar to Canada, awareness and treatment in the US were above target rates; however, hypertension control was initially suboptimal and improved to below target rates.

State-specific data for hypertension metrics in the US were reported in the BRFSS. There was substantial interstate variability in self-reported awareness (66%-90%), treatment (55%-86%), and control (43%-66%) in 2009, although there were increasing trends of improvement since 2001. The geographic distribution of awareness, treatment, and control levels indicated the top performers were generally localized to the southeastern states, a pattern consistent with hypertension prevalence rates in the US. More specifically, hypertension awareness was above target rates for most states, but these trended toward optimal rates in the southeastern region. Meanwhile, hypertension treatment trended from below target to above target rates toward the southeastern states. Finally, achieved blood pressure control ranged from suboptimal in the western states to below target rates in the southeastern region.

**Dyslipidemia**

**Canada.** A total of 7,654,293 individuals in Canada were considered within the dyslipidemia subset (Table 3). From 2004 to 2009, testing in screening-recommended individuals (5 years) in Ontario improved from below to above target rates. However, rates of dyslipidemia awareness, treatment, and control were all considered suboptimal between 2007 and 2009.

**US.** A total of 1,194,387 individuals in the US were considered within the dyslipidemia subset (Table 3). There was a steady improvement in all dyslipidemia performance measures from 1999 to 2010. Screening (5 years) improved from below to above target rates, whereas awareness and control improved from suboptimal to below target rates. However, treatment rates were consistently suboptimal, even with modest improvement.

State-specific data were also published for cholesterol screening (5 years) from 2005 to 2009 in the BRFSS. Wide variation was again seen interstate for cholesterol screening, which ranged from 66% to 80% in 2005, 66%-84% in 2007, and 68%-85% in 2009, with a temporally improving trend. Cholesterol screening was below target in the western states and improved steadily achieving...
Diabetes

Canada. A total of 8,460,873 individuals in Canada were considered within the diabetes subset (Table 4). The 5-year above target rates across the central US and toward the eastern states. Consistently top performing states from 2005 to 2009 were situated in the northeastern region of the US, and this was mirrored by the highest dyslipidemia prevalence rates.112

Table 1. Summary of sources reporting on CV risk factor quality metrics

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Region</th>
<th>Source</th>
<th>Year(s)</th>
<th>Sample size, n</th>
<th>Age, years</th>
<th>Female sex, %</th>
<th>Metrics reported</th>
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<td>CHMS</td>
<td>2007-2013</td>
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<td>2551</td>
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<td>BRFSS</td>
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<td>53.9</td>
<td>C</td>
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<td>A</td>
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<td></td>
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<td>A</td>
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<td></td>
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<td></td>
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<td>NHIS</td>
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<td>BRFSS</td>
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<td>≥18</td>
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<td>Wisconsin CPS</td>
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<td>≥15</td>
<td>N/A</td>
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<td>Tobacco Use Survey in Arizona</td>
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<td>≥18</td>
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<td>S, T</td>
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<td>1992-1999</td>
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<td>WTS</td>
<td>2003</td>
<td>1263</td>
<td>≥18</td>
<td>61.8</td>
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A, awareness; BRFSS, Behavioral Risk Factor Surveillance System; C, control; CCHS, Canadian Community Health Survey; CHMS, Canadian Health Measures Survey; CPS, Current Population Survey; CTSHS, Community Tracking Study Household Survey; GPAEDS, Group Practice Diabetes Management Study; HATT, Hypertension Assessment of Treatment to Target; HIT, Health Maintenance Organizations Investigating Tobacco; L-TAP, Lipid Treatment Assessment Project; M-CARE, Managed CARE Health Plan; MCO, managed care organizations; MEPS, Medical Expenditure Panel Survey (Agency for Health Care Research Quality); MESA, Multi-Ethnic Study of Atherosclerosis; MHS, Minnesota Heart Survey; MONICA, Multinational MONItoring of trends and determinants in Cardiovascular disease; N/A, not applicable; NAMCS, National Ambulatory Medical Care Survey; NCAGHH, North Carolina Guideline Adherence for Heart Health; NCQA, National Committee for Quality Assurance; NHANES, National Health and Nutrition Examination Survey; NHIS, National Health Interview Survey; NHWS, National Health and Wellness Survey; NPS, National Prediabetes Survey; ODD, Ontario Diabetes Database; OHIP, Ontario Health Insurance Plan; ON-BP, Ontario Survey on the Prevalence and Control of Hypertension; PSCS, Patient Safety Cohort Study; PURE, Prospective Urban Rural Epidemiology; S, screening; T, treatment; TUSCP, Tobacco Use Supplement of the Current Population Survey; US, United States; WHO, World Health Organization; WTS, Wisconsin Tobacco Survey.
Table 2. Hypertension screening, awareness, treatment, and control rates in Canada and the United States

<table>
<thead>
<tr>
<th></th>
<th>Rate, %</th>
<th>Year</th>
<th>Source</th>
<th>Rate, %</th>
<th>Year</th>
<th>Source</th>
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<td>CHMS</td>
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<td>2007-2008</td>
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<td>82.9</td>
<td>2009-2011</td>
<td></td>
<td>81.9</td>
<td>2009-2010</td>
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<tr>
<td></td>
<td>84.5</td>
<td>2012-2013</td>
<td></td>
<td>82.7</td>
<td>2011-2012</td>
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<tr>
<td>Treatment</td>
<td>79.9</td>
<td>2007-2009</td>
<td>CHMS</td>
<td>71.6</td>
<td>2007-2008</td>
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<td>82.0</td>
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<td>CCHS</td>
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<td>2012-2013</td>
<td></td>
<td>51.3</td>
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BP, blood pressure; CCHS, Canadian Community Health Survey; CHMS, Canadian Health Measures Survey; NAMCS, National Ambulatory Care Survey; NHANES, National Health And Nutrition Examination Survey.

Table 3. Dyslipidemia screening, awareness, treatment, and control rates in Canada and the United States

<table>
<thead>
<tr>
<th></th>
<th>Rate, %</th>
<th>Year</th>
<th>Source</th>
<th>Rate, %</th>
<th>Year</th>
<th>Source</th>
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<td>OHIP records</td>
<td>72.7</td>
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<td>28.3</td>
<td>2001-2002</td>
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<td>38.3</td>
<td>2003-2004</td>
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<td></td>
<td>40.8</td>
<td>2005-2006</td>
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<td></td>
<td>43.8</td>
<td>2007-2008</td>
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<td></td>
<td></td>
<td></td>
<td>43.0</td>
<td>2009-2010</td>
<td></td>
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<tr>
<td>Control</td>
<td>41.5</td>
<td>2007-2009</td>
<td>CHMS</td>
<td>55.5</td>
<td>2003-2004</td>
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<td></td>
<td></td>
<td>65.3</td>
<td>2005-2006</td>
<td></td>
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<td></td>
<td></td>
<td>62.5</td>
<td>2007-2008</td>
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<td></td>
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<td></td>
<td></td>
<td>63.6</td>
<td>2009-2010</td>
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* Screening defined as a blood test for cholesterol completed in the past 5 years.

Smoking

Canada. Although comparative screening and cessation counselling data for smoking across Canada were not identified, smoking prevalence showed a modest decline in absolute rates (25.2% to 14.6%) from 1999 to 2013, according to the CTUMS and CTADS. There was considerable interprovincial variation in changes in smoking rates, with Quebec decreasing more than 13% and Manitoba < 6%. British Columbia and Ontario maintained the lowest smoking rates throughout the years, whereas the Maritime provinces maintained the highest rates.153

US. A total of 83,559 individuals in the US were considered within the smoking subset. Screening for tobacco use by primary care providers in the US was above target rates (72.2%) by 2005. However, the NAMCS reported suboptimal counselling rates (27.4%) for screen-positive patients.127-130 Meanwhile, the National Health Interview Survey (NHIS) reported below target counselling rates (50.7%-58.9%) between 2000 and 2010, whereas the National Committee for Quality Assurance indicated improving counselling that reached above target rates (61.0% to 73.8%) by 2007.139 Finally, the BRFSS indicated that the proportion of smokers who have ever received advice to quit smoking by a health care professional was just below target rates (69.0%) in 2000.134,136

Discussion

Our systematic review of > 10.5 million individuals investigated variation in the quality of CV risk factor management in routine clinical practice in North America by compiling reports of screening, awareness, treatment, and control rates of hypertension, dyslipidemia, diabetes, and smoking since the turn of the century. To the best of our knowledge, this is the largest compendium of CV risk factor care performance and the first to provide comparative descriptive data on regional variation across Canada and the US. This review might serve as a clinical practice reference for contemporary CV preventive care achievement in North
Table 4. Diabetes screening, awareness, treatment, and control rates in Canada and the United States

<table>
<thead>
<tr>
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<th>Canada</th>
<th>United States</th>
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<tbody>
<tr>
<td></td>
<td>Rate</td>
<td>Year</td>
</tr>
<tr>
<td>Screening</td>
<td>73.4(^*)</td>
<td>2001-2006</td>
</tr>
<tr>
<td></td>
<td>37.0(^1)</td>
<td>2005</td>
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<tr>
<td></td>
<td>74.4(^1,3)</td>
<td>2004-2007</td>
</tr>
<tr>
<td></td>
<td>67.2(^1,3)</td>
<td>2009</td>
</tr>
<tr>
<td>Awareness</td>
<td>88.2(^1)</td>
<td>1996</td>
</tr>
<tr>
<td>Treatment</td>
<td>82.3(^*)</td>
<td>1998-1999</td>
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<td></td>
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<tr>
<td>Control</td>
<td>35.3(^5,6)</td>
<td>1998-1999</td>
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</table>

CCHS, Canadian Community Health Survey; GPDMS, Group Practice Diabetes Management Study; NHANES, National Health and Nutrition Examination Survey; NHWS, National Health and Wellness Survey; ODD, Ontario Diabetes Database; OHIP, Ontario Health Insurance Plan.

\(^*\) Blood glucose screening test in past 5 years.
\(^1\) Blood glucose screening test in past year.
\(^2\) Blood glucose screening test in past 3 years.
\(^3\) Study population age older than 40 years.
\(^4\) Screening-recommended patients according to American Diabetes Association Guidelines.\(^{155}\)
\(^5\) Type 2 diabetes population only.
\(^6\) Control defined as hemoglobin A1C level < 7% among all diabetes patients.

America; it also provides data on the degree of variation across regions and identifies outliers of high and low performers for each quality indicator. In elucidating these regional discrepancies, our review also highlights the need for further investigation of underlying contributory factors shaping the current CV prevention landscape.

Regional achievement of CV prevention care

Most Canadian data were produced through national surveys by Statistics Canada. In parallel, reporting on CV preventive care in the US was done primarily through national and state-level surveys conducted by the CDC. Our review identified more temporally consistent and regionally systematic reporting on CV risk factor management in the US overall. Canada, in contrast, showed more comprehensive reporting within Ontario, but to a lesser extent among the other provinces. In comparing CV risk factor care performance in the two nations, NHANES in the US and CHMS in Canada were the most analogous surveys, because they had similar sampling, data collection, and reporting methods.

In a comparison of the two countries, it is evident that Canada and the US achieved well above target rates for hypertension awareness and treatment. Although, overall, both countries’ participants could benefit from improvements in blood pressure control, Canada’s control rates were generally higher. In contrast, suboptimal Canadian performance rates in dyslipidemia awareness, treatment, and control were only marginally better in the US where levels were consistently below target rates. However, cholesterol screening in both nations hovered above target performance levels. Furthermore, diabetes awareness and treatment in Canada and the US were consistently above target rates, although achievement of blood sugar control remained suboptimal in Canada and below target rates in the US.

Implications for CV prevention care

There are a number of potential contributing factors that might explain the differences in each nation’s performance of which further exploration is warranted. For example, inherent differences in the health insurance infrastructure between Canada and the US might play a role in the variation.\(^{22,23}\) Furthermore, the introduction of CV practice guidelines independently within each country, such as the Canadian Hypertension Education Program guidelines, the Joint National Committee Hypertension guidelines, and the National Cholesterol Education Program guidelines, has resulted in general improvements in the prescribing rates and management of these CV risk factors.\(^{24-26}\) However, it is unclear whether the degree of their effect varies significantly on the basis of the extent of dissemination, the frequency of revisions, and the sources of evidence of these guidelines.\(^{159}\) For example, Figure 2 shows the timeline of major guideline updates for hypertension and cholesterol in North America.\(^{1-13}\) Evidently, Canadian guidelines have been updated more frequently than their US counterparts. In particular, whereas a decade had passed since the Joint National Committee Hypertension guidelines update, the Canadian Hypertension Education Program guidelines were updated annually since 1999.\(^{159}\) In addition, awareness of performance in the realm of CV prevention might be a driving motivator for improvement, and thus might highlight the importance of standardized reporting.

Moreover, summarizing this clinical practice reference might set the stage for future efforts to evaluate gains in a manner that translate into goal-directed targets of care.\(^{25,26}\) For example, Farley et al. modelled improvement in clinical preventive services according to the number of preventable deaths in the US for each incremental improvement.\(^{26}\) Estimates suggest we might see an additional 14,000 deaths prevented for every 10% increase in the hypertension treatment rate, whereas every 10% increase in treatment of high cholesterol might prevent a further 8000 deaths. Maciosek et al. similarly estimated the potential for additional quality-adjusted life years (QALYs) saved in the US with increased use of clinical preventive services.\(^{25}\) For services such as cholesterol screening, we might see 4000 additional QALYs saved for each 1% increase in the rate of screening, whereas...
each 1% increase in tobacco use screening and brief intervention might result in an additional 20,000 QALYs saved. In further quantifying the current rates and potential benefit of improvements in CV prevention, researchers can estimate the effect of performance improvement in Canada and the US overall and inter-regionally.

Limitations and quality of evidence

The goal of this review was to determine current performance and identify regional variation of quality of care indicators across Canada and the US. On the basis of the availability of data, the largest limitation of this study was the potential for incomplete reporting of regional or temporal trends, particularly in Canada because of an insufficient number of eligible studies. Contemporary standardized interprovincial data on traditional CV risk factors would have been more informative to identify potential disparities in the delivery of preventive CV health care services, particularly among vulnerable groups such as Aboriginal, immigrant, and those with low socioeconomic status. In addition, although the CHMS and NHANES had similar sampling, data collection, and reporting methods, the CCHS and BRFSS relied predominantly on self-report, and most Ontario surveys relied on administrative health data analyses. Results predominantly relying on self-report participant survey data might be at risk for recall or survival bias compared with data accrued using administrative health data analyses. In contrast, data on the basis of health care insurance claims might be limited by misdiagnosis or upcoding, although this is low in Canadian data. Nevertheless, these limitations advise caution when comparing metrics across countries. We also cannot exclude the possibility that the same patient was surveyed by different studies, but the reported methods for each respective study nevertheless provided a representative sample each time. Furthermore, few studies reported data with a focus solely on a primary prevention patient population, thereby limiting our ability to describe distinct trends in this group. However, the general population samples we reviewed overwhelmingly included patients without a history of a previous CV event with a detection rate of a previous CV event of approximately 3%. Last, the heterogeneity of study designs and data sources precluded a formal statistical comparison or meta-analytical approach.

Conclusions

This compendium of performance measures provides a contemporary reference for CV risk factor screening and treatment in the general North American population, which subsequent CV epidemiological studies and quality improvement initiatives can compare. Although both nations performed well in terms of hypertension, improvements are warranted with respect to dyslipidemia metrics and diabetes control. Moreover, there is a lack of Canadian smoking data with which the US statistics can be compared. Overall, risk factor management has increased in both nations, although there is room for further improvement, which might be facilitated (and monitored for continuous feedback) through standardized reporting of CV risk factor care at the national and provincial/state level. The frequency and dissemination of practice guidelines might also play a role in improving CV prevention, in addition to shifting the focus to goal-directed targets of care by reporting on the number of potential preventable deaths and QALYs saved.

Acknowledgements

Individual author contributions are shown in the Author Contributions section of the Supplementary Material, and acknowledgement of other contributions are shown in the Additional Contributions section of the Supplementary Material.

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Disclosures
The authors have no conflicts of interest to disclose.

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**Supplementary Material**

To access the supplementary material accompanying this article, visit the online version of the *Canadian Journal of Cardiology* at [www.onlinecjc.ca](http://www.onlinecjc.ca) and at [http://dx.doi.org/10.1016/j.cjca.2016.07.005](http://dx.doi.org/10.1016/j.cjca.2016.07.005).