The impact of the Canadian Hypertension Education Programme in its first decade

Finlay A. McAlister1*, Ross D. Feldman2, Katherine Wyard3, Rollin Brant4, and Norman R.C. Campbell5 for the CHEP Outcomes Research Task Force

High blood pressure remains a major risk factor for premature death and disability.1 Worldwide, 62% of strokes and 49% of myocardial infarctions have been attributed to suboptimal blood pressure control and two-thirds of this attributable burden occur in middle-aged individuals (45–69 years).2 Hypertension is already the number one reason for primary care physician visits in Canada3 and the prevalence of hypertension is increasing faster than previously predicted.4 Although part of this increase in prevalence reflects lowering of the blood pressure thresholds for diagnosis of hypertension and increasing recognition of hypertension by physicians, there is also evidence that this increase has been at least partially driven by increasing incidence and decreasing mortality over the past decade.4,5 The increasing incidence is not surprising given the underlying demographic shifts over the past decade in the form of an ageing population with worsening levels of obesity and reduced physical activity.

Lowering of systolic blood pressure prevents cardiovascular events both in younger and older patients.6 To that end, it is worth noting that approximately one half of the global burden of hypertensive disease occurs in those with systolic blood pressure levels between 130 and 150 mmHg.2 Furthermore, even those hypertensive individuals who are treated and have their blood pressures well controlled still exhibit an increased risk of stroke and myocardial infarction compared with age- and sex-matched controls, possibly due to the undertreatment of their other atherosclerotic risk factors (particularly hyperlipidaemia).8

Since the mid-1970s, there have been national efforts in Canada to educate healthcare professionals and the general public about hypertension prevention, diagnosis, and treatment. However, as of the early 1990s, these efforts appeared to have had little impact.6 As a result, various organizations including Blood Pressure Canada, the Heart and Stroke Foundation of Canada, the Public Health Agency of Canada, the Canadian Hypertension Society, the Canadian Pharmacy Association, the Canadian Council of Cardiovascular Nurses, the College of Family Physicians of Canada, the Canadian Society of Internal Medicine, the Canadian Diabetes Association, the Canadian Stroke Network, and the Canadian Cardiovascular Society contributed to the development of the Canadian Hypertension Education Programme (CHEP) in the late 1990s as a vehicle to more effectively develop, disseminate, and implement optimal management approaches for the treatment of patients with hypertension.

Brief overview of the CHEP

As outlined in detail elsewhere,10 CHEP was developed to address several shortfalls that were identified in Canadian hypertension guidelines published prior to 1999. Moreover, CHEP moved to an annual recommendation process in order to keep abreast of the evolving literature base and, arguably more importantly, to keep hypertension ‘on the radar screen’ for healthcare providers, policy makers, and the general public.

Each year, draft CHEP recommendations developed by content experts on the basis of yearly systematic reviews of the literature in each of the 14 topic areas (Table 1) are independently vetted by a group of clinical epidemiologists applying a priori standardized rules of evidence to assign evidence grades to the draft recommendations. A consensus conference of ~40 members of the CHEP Evidence-Based Recommendations Task Force is then held to review the evidence and to debate the draft recommendations; subsequently, the draft recommendations are presented to the general membership of the Canadian Hypertension and Canadian Cardiovascular Societies at an open session at the annual Canadian Cardiovascular Congress each October, with feedback

1Division of General Internal Medicine, 2F1.21 WMC, University of Alberta, 8440 112 Street, Edmonton, AB, Canada T6G 2R7; 2Department of Medicine, University of Western Ontario, Canada; 3Consultant to Public Health Agency of Canada, Toronto, Canada; 4Department of Statistics, University of British Columbia, Canada; and 5Departments of Medicine, Community Health Sciences and of Pharmacology and Therapeutics, Libin Cardiovascular Institute, University of Calgary, Canada

Received 16 December 2008; revised 8 April 2009; accepted 27 April 2009; online publish-ahead-of-print 10 2009

doi:10.1093/eurheartj/ehp192

The opinions expressed in this article are not necessarily those of the Editors of the European Heart Journal or of the European Society of Cardiology.

Published on behalf of the European Society of Cardiology. All rights reserved. © The Author 2009. For permissions please email: journals.permissions@oxfordjournals.org.
Changes in the diagnosis of hypertension in Canada over the past decade

Comparison of data from five cross-sectional nationally representative surveys revealed a 51% increase in the percentage of adult Canadians who reported that they had been diagnosed by a healthcare professional as having hypertension between 1994 and 2003. Prior to the initiation of CHEP, the average annual increase in the prevalence of self-reported hypertension was 0.5% per year from 1994 to 1998; after the introduction of CHEP, the average annual increase in self-reported prevalence of hypertension doubled to 1% between 1999 and 2003 ($P < 0.001$). In addition, the introduction of CHEP was associated with a substantial reduction in the gender gap evident in the surveys from the early 1990s, in that the awareness of hypertension among men increased at a faster rate than among women (Table 2).

Additional analyses of the same surveys revealed a 66% increase in the self-reported rate of pharmacologic treatment among those individuals identifying themselves as being hypertensive (Figure 1). The rate of increase was nearly double post-CHEP as pre-CHEP ($P < 0.001$), such that by the 2003 survey only 15% of adult Canadians who were aware that they were hypertensive reported that they were not taking pharmacologic therapy.

An analysis of the 8198 respondents who were followed longitudinally through five cycles of the Canadian National Population Health Survey between 1994 and 2002 confirmed the findings from the cross-sectional surveys, in that the use of antihypertensive medication among individuals who were aware that they had hypertension increased substantially over time, with strong temporal trends towards increased self-reported use of multiple antihypertensive medications concurrently and increased self-reported persistence with antihypertensive medications.

Changes in the treatment of hypertension in Canada over the past decade

Analyses of the IMS Compuscript database (which includes prescribing information from two-thirds of all retail pharmacies in Canada) demonstrated substantial increases in all antihypertensive drug classes from the mid-1990s to the mid-2000s. Subsequent time-series analyses confirmed that the upswing in antihypertensive prescriptions was temporally related to initiation of CHEP (Table 2).

Although some may speculate that increases in antihypertensive prescribing would be driven as much by pharmaceutical company marketing of these agents as by any national guideline, three particular results argue for an effect of CHEP. One, the upswing in prescriptions was most marked for thiazides, the one drug class that was endorsed in the CHEP recommendations for first-line pharmacotherapy in hypertension but would not have benefited from pharmaceutical company marketing over that time frame (with a 2% annualized increase per year pre-CHEP increasing to 13% annualized increase after CHEP, $P = 0.03$). Second, the CHEP recommendation supporting the use of calcium channel blockers as one

---

**Table 1** Clinical topic areas covered by the CHEP Evidence-based Recommendations Task Force

<table>
<thead>
<tr>
<th>Topic subgroups (each of which contains 3–6 content experts):</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Office measurement of blood pressure</td>
</tr>
<tr>
<td>2. Self-measurement of blood pressure</td>
</tr>
<tr>
<td>3. Ambulatory blood pressure monitoring</td>
</tr>
<tr>
<td>4. Follow-up on patients with hypertension</td>
</tr>
<tr>
<td>5. Routine laboratory tests</td>
</tr>
<tr>
<td>6. Echocardiography</td>
</tr>
<tr>
<td>7. Lifestyle modification in hypertension</td>
</tr>
<tr>
<td>8. Adherence strategies for patients</td>
</tr>
<tr>
<td>9. Global cardiovascular risk assessment</td>
</tr>
<tr>
<td>10. Pharmacotherapy for hypertensive patients with cardiovascular disease (3 subgroups: coronary disease, heart failure, and stroke)</td>
</tr>
<tr>
<td>11. Pharmacotherapy for hypertensive patients without compelling indications</td>
</tr>
<tr>
<td>12. Endocrinological forms of hypertension</td>
</tr>
<tr>
<td>13. Renal and renovascular hypertension</td>
</tr>
<tr>
<td>14. Hypertension and diabetes</td>
</tr>
</tbody>
</table>

Incorporated before the recommendations are ‘finalized’ for voting. The recommendations are then circulated to all voting members of CHEP (~100 unpaid volunteers including primary care physicians, nurses, pharmacists, general internists, endocrinologists, nephrologists, and cardiologists—see www.hypertension.ca for current membership) in early November and individuals vote to accept/reject each recommendation (including new recommendations as well as older recommendations from previous years that have not changed that year)—those recommendations receiving the support of >70% of voters are included in each year’s finalized recommendations.

These recommendations are then turned over to a CHEP Task Force specifically charged with implementing the guidelines using a variety of knowledge translation techniques including local opinion leader led small group workshops and individual academic detailing, as well as more traditional guideline dissemination techniques such as mailed information packages, web sites, and journal publications. In addition to mailing out over 135 000 hard copies of the summary recommendations for distribution to the public via physician offices, several of the public education and health professional implementation tools are made freely available on the CHEP web site (www.hypertension.ca)—analysis of our web site tracking reveals a monthly average of 18 169 visits and 5319 unique IP addresses (Selina Omar Allu, Co-ordinator, Blood Pressure Canada, personal communication, 3 March 2009).

We are now entering the 10th year of the CHEP process in Canada and can draw on an accumulating body of evidence to examine the impact of CHEP on hypertension diagnosis, management, and outcomes in Canada over the past decade (Table 2).
of the five approved classes for initial pharmacotherapy was associated with a marked reversal in calcium channel blocker prescribing—from an annual 1.6% decline pre-1999 to a 5.7% increase per annum after CHEP \( (P = 0.01) \). Importantly, both of these findings are contrary to data from the USA demonstrating continued decline in the use of calcium channel blockers in the post-CHEP time frame and only marginal increases in the use of diuretics. Finally, although beta-blocker use was increasing in elderly hypertensives before CHEP (by 0.8% per annum between 1994 and 1998), after the CHEP recommendation against beta-blocker use for initial monotherapy in the elderly was released, we observed a 1.2% per year (95% CI: 0.3–2.1%) decrease in their use as initial agents in newly treated elderly hypertensives. Although the IMS Compuscript data permits analyses of total antihypertensive prescriptions on a national basis which is not age restricted, no clinical details are collected in the pharmacies. Thus, in order to explore whether the upswing in antihypertensive prescriptions was truly due to hypertension or due to an increasing prevalence of other cardiovascular diseases, detailed analyses of the Ontario Drug Benefit database were conducted. Although the Ontario Drug Benefit database is restricted to individuals over the age of 65, this database is linkable to other hospital and billing databases which include clinical information unavailable in the IMS data sets. Thus, in analysing the Ontario administrative databases, we were able to exclude patients with heart failure, coronary disease, diabetes mellitus, and other cardiovascular conditions and thereby examine prescribing strictly for hypertension. While the antihypertensive prescription rate for elderly Ontarians was decreasing by 0.6% per year before 1999, after the introduction of CHEP antihypertensive prescription rates increased by 6% per year. In addition, we found a near doubling in the concurrent use of two or more drugs (from 21–40% pre- vs. post-CHEP, \( P < 0.0001 \) on time-series analysis) and a marked reduction in non-persistence with antihypertensive drug therapy in the first 2 years after treatment (from 36% discontinuing all antihypertensive drugs within 2 years pre-CHEP down to 21% post-CHEP, \( P < 0.0001 \)).

### Changes in the control of hypertension in Canada over the past decade

The Canadian Heart Health survey conducted in 1986–92 revealed that only 16% of adult Canadians with hypertension

---

**Table 2** Summary of hypertension in Canada before and after initiation of CHEP in 1999

<table>
<thead>
<tr>
<th>Parameter studied</th>
<th>Status before CHEP</th>
<th>Observed change after CHEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension diagnosis</td>
<td>Self-reported hypertension diagnosis increasing by 0.5% per annum; significantly lower self-reported prevalence in men (11%) than women (14%)</td>
<td>Self-reported hypertension diagnosis increasing by 1% per annum (51% increase over pre-CHEP prevalence); gender gap narrowed with annual rate of increase in men 1.3 vs. 0.8% in women (self-reported prevalence in 2003, 18% in men vs. 19% in women)</td>
</tr>
<tr>
<td>Hypertension treatment—self-report</td>
<td>Self-reported ‘aware but untreated’ hypertension decreasing by 0.6% per annum; significantly higher self-reported untreated hypertension in men (37%) than women (27%)</td>
<td>Self-reported ‘aware but untreated’ hypertension decreasing by 3.2% per annum (51% decrease from pre-CHEP prevalence); gender gap narrowed (self-reported prevalence of untreated hypertension 18% in men vs. 13% in women)</td>
</tr>
</tbody>
</table>
| Intensity of hypertension treatment—self-report | (i) Self-reported use of two or more antihypertensive drugs 8% (13% in respondents older than 60 years)  
(ii) Self-reported persistence with any antihypertensive therapy over 2 years, 70% | (i) Self-reported use of two or more antihypertensive drugs 11% (17% in respondents older than 60 years)  
(ii) Self-reported persistence with any antihypertensive therapy over 2 years, 75% |
| Hypertension treatment—administrative data | Annual prescription rates for some antihypertensive classes increasing, but some stagnant (diuretics) and some decreasing (calcium channel blockers) such that overall annualized antihypertensive drug use increasing by 2% per annum for entire population (in elderly individuals, antihypertensive drug use decreasing 0.6% per annum) | Annual prescription rates of recommended drug classes for initial therapy accelerated significantly, especially diuretics (13% increase per annum); beta-blocker use in the elderly declined. Annualized antihypertensive drug prescriptions increasing by 10% per annum for entire population (in elderly individuals, antihypertensive drug use increasing 5.6% per annum) |
| Intensity of hypertension treatment—administrative data | 21% using two or more antihypertensive drugs concurrently within first 2 years of diagnosis; 65% still persistent with any antihypertensive therapy within first 2 years of diagnosis | 40% using two or more antihypertensive drugs concurrently within first 2 years of diagnosis; 79% still persistent with any antihypertensive therapy within first 2 years of diagnosis |
| Hypertension control                   | 13% of hypertensive individuals treated and controlled (Canada Heart Health Survey 1992) | 66% of hypertensive individuals treated and controlled (Ontario Survey 2006) |
| Age- and sex-standardized mortality rates | Deaths from cardiovascular disease decreasing between 1992 and 1998 [by 4% per annum (95% CI: 6–3%) for heart failure, 8% per annum (95% CI: 10–6%) for acute myocardial infarction, and by 3% per annum (95% CI: 4% decrease to 2% increase) for stroke] | Deaths from cardiovascular disease decreasing at a faster rate between 1999 and 2004 [by 11% per annum (95% CI: 12–9%) for heart failure, 12% per annum (95% CI: 14–11%) for acute myocardial infarction, and by 11% per annum (95% CI: 13–8%) for stroke] |

---

*F.A. McAllister et al.*
were treated and controlled and another 23% were on treatment but had suboptimal blood pressure control. In 2006, the Heart and Stroke Foundation of Ontario conducted a similar physical measures survey of a randomly selected sample of adults across Canada’s most populous province and found that the treatment and control rates had improved markedly such that 66% of hypertensive adults had blood pressures controlled to target. A further 15% were on treatment but had suboptimal blood pressure control, and only 14% were unaware of their diagnosis. The very high rates of awareness and treatment for hypertension seen in the Ontario BP Survey are entirely consistent with the trends observed in the five self-report surveys conducted in Canada over the past decade. Notably, the awareness, treatment, and control rates documented in Canada over the past few years are markedly higher than those recently reported from the USA or Western Europe.

Changes in hypertension-related clinical events in Canada over the past decade

The benefits of blood pressure reduction on major hypertension-related cardiovascular diseases such as stroke, myocardial infarction, and heart failure are known to appear within a few years of initiating treatment. Analyses of the national mortality database maintained by Statistics Canada demonstrated a strong inverse correlation ($P < 0.0001$) between the increase in antihypertensive prescriptions between 1992 and 2003 and the reductions in the age- and sex-adjusted mortality rates from stroke, heart failure, and acute myocardial infarction evident in Canada during that time frame. Although mortality rates from each of these conditions were decreasing prior to 1998, the decline after the initiation of CHEP in 1999 was more marked than would be expected from these secular trends. Figure 2 outlines the decline in the annual mortality rate for major causes of death in Canada post-1998, adjusted for secular trends pre-CHEP. Values that cross the line of unity imply no significant difference in age-/sex-standardized mortality rates pre- vs. post-CHEP. CHF, congestive heart failure; AMI, acute myocardial infarction; non-CVD, non-cardiovascular death; CVD, cardiovascular death (includes deaths due to heart failure, stroke, or myocardial infarction).

Figure 1 The proportion of Canadian individuals with hypertension who are aware of their diagnosis but are not taking treatment over the past 15 years. Data for 1992 derived from Canadian Heart Health Survey, data for 1994–99 derived from three cycles of the Canadian National Population Health Surveys, data for 2000–03 derived from two cycles of the Canadian Community Health Surveys, and 2006 data derived from the Ontario BP Survey. All seven surveys were cross-sectional population-based surveys. The assessment of blood pressure varied between four blood pressure measurements spread over two visits (one home and one clinic, 2 weeks apart) in the Canadian Heart Health Survey and five blood pressure measurements using the automated BpTRU device (BpTRU Medical Devices Ltd, Coquitlam, British Columbia, Canada) in a clinic setting for the Ontario BP Survey.

Figure 2 Annual per cent change in age- and sex-standardized Canadian mortality rates 1999–2003 (after CHEP), adjusted for temporal trends 1992–98. Note that values to the left of the line of unity indicate significantly greater declines in the annual per cent change in mortality rates after initiation of CHEP, adjusted for secular trends pre-CHEP. Values that cross the line of unity imply no significant difference in age-/sex-standardized mortality rates pre- vs. post-CHEP. CHF, congestive heart failure; AMI, acute myocardial infarction; non-CVD, non-cardiovascular death; CVD, cardiovascular death (includes deaths due to heart failure, stroke, or myocardial infarction).
fibrillation) are coded as ‘non-cardiovascular deaths’ by Statistics Canada.

It is notable that these marked reductions in mortality from hypertension-related clinical events have occurred on a background of various population health surveys in Canada demonstrating worsening rates of obesity, diabetes, and sedentary lifestyles. Although statin prescriptions have also increased markedly in Canada over the past decade and may also be expected to impact these clinical events, the magnitude of the increase in statin prescribing has only been approximately one-third the size of the increase in antihypertensive prescribing.24

Summary

Although all of the sources of data reviewed above are observational and cause and effect relationships cannot be definitively made, data from multiple independent sources consistently indicate improvements in the diagnosis, management, and control of hypertension in Canada temporally related with the initiation of CHEP in 1999. Although it is impossible to conduct a randomized trial to prove the efficacy of a national hypertension education programme such as CHEP, the study results discussed in this manuscript do provide an evidence base to support the conclusion that CHEP has driven improvements in hypertension management within Canada. The consistency of effect across studies and the magnitude of the relationships we observed are highly suggestive that our conclusions about the impact of CHEP are real. In addition, our findings are consistent with the a priori hypothesis that improving antihypertensive prescribing and blood pressure control on a national basis would translate into improved clinical outcomes. Our findings are also broadly consistent with similar improvements seen in the USA after initiation of the National High Blood Pressure Education Programme in the 1970s.25 Thus, we believe that CHEP does provide a model for a national programme to attain better outcomes for individuals with hypertension or other chronic diseases. The challenge now is to maintain the progress that has been made over the past decade and expand the CHEP model into guidelines for other disease conditions.

Acknowledgements

The CHEP Outcomes Research Task Force is supported by the Public Health Agency of Canada and project-specific funding has been provided by the Canadian Institutes of Health Research, the Heart and Stroke Foundation of Canada, the Alberta Heritage Foundation for Medical Research, Pfizer Canada, Merck Frosst Canada, Bristol–Myers Squibb, and Servier Canada. In addition to the authors of this manuscript, the Outcomes Research Task Force includes the following volunteers (many of whom provided comments on earlier drafts of this manuscript): Oliver Baclic, Hude Quan, Karen Tu, Michael Hill, Brenda Hemmelgarn, Michel Joffres, Mark Tremblay, Gillian Bartlett, Larry Svenson, Susan Quach, Helen Johansen, Guanmin Chen, Ernest Amankwah, Michael Eliasziw, William Ghali, Steven Grover, Nicole Kelly, Nadia Khan, Lisa Lix, Colleen Maxwell, Sailesh Mohan, Stephen Phillips, Mark Smith, Greg Taylor, Andy Wielgosz, Jennifer Zhang, Janusz Kaczorowski, Scott Klarenbach, Chris Robinson, Gary Teare, Kim Reimer, Robert Nolan, Patty Lindsay, Femida Gwadry-Sridhar, Christina Bacej, Sarah Connor-Gorber, Kathryn Wilkins, Marianne Nichol, and Robin Walker. The authors thank Lianne Vardy and Oliver Baclic with the Public Health Agency of Canada for encouraging production of this report.

Funding

F.A.M. is supported by an Alberta Heritage Foundation for Medical Research Health Scholar Award and holds the University of Alberta/Merck Frosst/Aventis Chair in Patient Health Management. R.D.F. holds the RW Gunton Professor of Medicine Chair at the University of Western Ontario. N.R.C.C. holds the CIHR Canada Chair in Hypertension Prevention and Control funded by the Canadian Institutes of Health Research, the Canadian Hypertension Society, and Sanofi Aventis.

Conflict of interest: none declared.

References

A 27-year-old asymptomatic pregnant woman underwent echocardiography because of a mild systolic murmur, detected during routine medical evaluation. She had no history of endocarditis, collagen vascular disease, or rheumatic fever and no embolic or neurologic symptoms were reported. Twelve-lead electrocardiogram was unremarkable. Transthoracic echocardiography revealed a normal-sized heart with normal systolic function and thin leaflet mitral valve.

An unexpected rounded, thin-walled cystic image (13 mm in diameter) was clearly visualized, firmly attached to the ventricular side of the anterior mitral leaflet (Panel 1A). No mitral regurgitation was detected and there was no evidence of left ventricular inflow or outflow obstruction. Real-time live three-dimensional echocardiography was performed using a commercially available ultrasound system (IE33, Philips Medical Systems, Bothell, WA, USA) equipped with a matrix transducer. It confirmed the presence of a rounded structure with very low internal echogenicity, which appeared surrounded by tendinea chordae (Panels 1B and C, white arrow points at partially visible chordae).

For further tissue characterization, cardiac magnetic resonance (1.5 Tesla) was performed, without the use of contrast, contraindicated by pregnancy. The cyst demonstrated low signal using steady-state free precession sequence (Panels 2A and B), while using a T2-w sequence it appeared isointense with a slightly hyperintense core, consistent with chronic blood appearance (Panel 3A). A proton-density sequence without (Panel 3B) and with (Panel 3C) fat-suppression demonstrated the absence of relevant fat component in the mass. Although a cardiac blood cyst is a very rare finding during pregnancy, it can be non-invasively diagnosed using radiation-free echocardiography plus cardiac MRI, without the need of any contrast media.