Abstract—This study was conducted to compare the self-reported prevalence and treatment of hypertension in adult Canadians before and subsequent to the implementation of the Canadian Hypertension Education Program in 1999. Data were obtained from 5 cycles of the Canadian Health Surveys between 1994 and 2003 on respondents aged ≥20 years. Piecewise linear regression was used to calculate the average annual increase in rates, before and after 1999. Between 1994 and 2003, the percentage of adult Canadians aware of being diagnosed with hypertension increased by 51% (from 12.37% to 18.74%; P<0.001), and the percentage prescribed antihypertensive drugs increased by 66% (from 9.57% to 15.86%; P<0.001). After 1999, there was approximately a doubling of the annual rate of increase in the diagnosis of hypertension (from 0.52% of the population per year before 1999 to 1.03% per year after 1999; P<0.001) and the percentage prescribed antihypertensive drugs (from 0.54% of the population per year before 1999 versus 0.98% per year after 1999; P<0.001). The proportion of those aware of the diagnosis of hypertension but not being treated with drugs was reduced by half between 1994 and 2003 (from 31.47% untreated to 15.34% untreated; P<0.001). There was a greater increase in awareness of hypertension and use of antihypertensive drugs among men compared with women after 1999. The large increase in the diagnosis and treatment of hypertension in Canada between 1994 and 2003 is consistent with an overall beneficial effect of the Canadian Hypertension Education Program, including a reduced gender gap in hypertension care. (Hypertension. 2006;48:853-860.)

Key Words: hypertension ■ high blood pressure ■ quality of care ■ recommendations ■ guidelines

Hypertension is a common and prominent risk factor for premature disability and death.1,2 It is a leading cause of stroke, congestive heart failure, and other cardiovascular diseases. Stroke deaths parallel the prevalence of hypertension.3 Approximately 50% of cardiovascular disease can be attributed to suboptimal blood pressure because of its strong casual relationship.4 Many individuals with hypertension are unaware of their condition, and those that are aware are often untreated or undertreated.3,5–7 Hypertension is a global issue and has led the World Health Organization to declare that suboptimal blood pressure is the leading risk for death in women and the second leading risk for death in men in developed countries.4,8

There is large variability in the prevalence of hypertension and treatment and control rates of hypertension in Westernized countries.3 The prevalence of hypertension is lower and the treatment and control rate for hypertension is higher in North America than in Europe.3 The reasons for different rates of treatment and control of hypertension are poorly understood. Although the World Health Organization has recommended that treatment and control of hypertension is a global health priority, there is no consensus on how this should be accomplished.

There is substantial evidence that physicians frequently do not follow hypertension management guidelines and that current physician practice patterns represent a major barrier to the treatment and control of hypertension.9,10–20 Based on a low rate of treatment of those who were aware of having hypertension (Figure 1), an effort to improve the treatment and control of hypertension in Canada by healthcare professionals, the Canadian Hypertension Education Program (CHEP), was formed in 1999.21,22 The program annually updates evidence-based hypertension management recommendations and has an extensive knowledge translation program to assist healthcare professionals to adopt and implement these recommendations. Canada has regular national health questionnaire surveys that assess the diagnosis and pharmacotherapy of hypertension and, thus, presents a
Questions on Hypertension Awareness and Treatment in the Canadian Community Health Survey 2.1,25

Now I’d like to ask about certain chronic health conditions which [your/subject’s name] may have. We are interested in “long-term conditions” which are expected to last or have already lasted 6 months or more and that have been diagnosed by a health professional . . . . high blood pressure?

Now I’d like to ask a few questions about [your/subject’s name] use of medications, both prescription and over-the-counter. In the past month, that is, from [date one month ago] to yesterday, did [your/subject’s name] take: . . . medicine for blood pressure?

Figure 1. The percentage of the adult Canadian population aware of having hypertension and prescribed antihypertensive drug therapy in 1985–1992.46 The black aspect of the pie chart represents 66% of the adult Canadian population who was aware of having hypertension and were treated with antihypertensive drugs in the Canadian Heart Health Surveys (1985–1992). The clear aspect of the pie represents the 33% of those who were aware of having hypertension and were not treated with antihypertensive drugs.

unique opportunity to assess the impact of CHEP. In this article, we provide the self-reported prevalence of diagnosed hypertension and treatment of hypertension in adult Canadians before and subsequent to the implementation of the CHEP in 1999.

Methods

Data were obtained from the National Population Health Surveys over 2-year periods (cycle 1: 1994 to 1995; cycle 2: 1996 to 1997; cycle 3: 1998 to 1999) and the Canadian Community Health Surveys over 1-year periods (cycle 1.1: 2000; cycle 2.1: 2003). Both the National Population Health Surveys and Canadian Community Health Surveys are population-based surveys using multistage probability designs with stratification and clustering at various stages. Respondents are representative of Canadian household residents aged ≥12 years from all of the provinces excluding residents of Indian reserves or Crown lands, institutions, some remote areas, and full-time members of the Canadian Armed Forces. The response rate for all of the surveys was >80%. Further details of the sampling procedures, designs, and response rates appear elsewhere.23,24 All of the adult subjects of the National Population Health Surveys and Canadian Community Health Surveys who were >20 years of age, resided in a province, and were subjected to the chronic disease and drug use survey components were included in our analysis (National Population Health Survey cycle 1: n = 15 157; National Population Health Survey cycle 2: n = 62 666; National Population Health Survey cycle 3: n = 13 359; Canadian Community Health Survey cycle 1.1: n = 25 956; Canadian Community Health Survey cycle 2.1: n = 28 344). The Canadian Community Health Surveys included respondents living in the territories, and the National Population Health Surveys did not; therefore, only provincial residents were included in this study. In year 2000, data were collected from Ontario participants only, because the questions on treatment were not included in the other provincial surveys. In year 2003 (cycle 2.1), the question concerning prescribed antihypertensive medication was asked of a subsample of respondents (n = 28 344); consequently all of the analyses for that cycle are based only on the subsample, which was weighted to represent the Canadian population as a whole.

Participants were asked whether they had hypertension diagnosed by a healthcare professional and whether they were prescribed antihypertensive medications in the previous month (Table). There were very small changes in the questions over the surveys.25 Those who reported hypertension or treatment for hypertension were considered to be diagnosed hypertensive individuals. Prevalence rates and corresponding CIs were age standardized to the year 2003 and weighted to reflect the size of the adult Canadian population (~21.5 million adult Canadians). To account for the survey design effect, coefficients of variation and P values were estimated, and significance tests were performed using the bootstrap technique.26,27 The significance level was set at P < 0.05. Piecewise linear regression was used to calculate the average annual increase in rates before and after 1999. Tests of interaction, within linear regression, were performed to assess differences between men and women.

Results

Diagnosis of Hypertension by a Healthcare Professional

Since 1994 there has been a very large increase in the prevalence of Canadians aware of having hypertension diagnosed by a healthcare professional (Figure 2a). For men and women together, between 1994 and 1998, the prevalence of diagnosis of hypertension increased from 12.37% to 14.07% (average annual increase: 0.52%; age standardized/2003 Canadian Community Health Survey sample population as standard); and between 2000 and 2003, the increase was from 16.90% to 18.74% (average annual increase: 1.03%; age standardized/2003 Canadian Community Health Survey sample population as standard). The post-1999 doubling in the average annual increase was statistically significant (P < 0.001). The increase in Canadians reporting a diagnosis of hypertension was 51% between 1994 and 2003. The rate of increase in diagnosis was different between men and women, with a greater increase in men after 1999 (Figure 2a; average annual increase: 1.27% versus 0.80%; P < 0.001). However, the prevalence rates were still higher in women than in men over the entire time period. Older individuals, both men and women, were more likely to be diagnosed with hypertension than younger individuals (Figure 2b).

Prescription of Antihypertensive Medications

There was a very large increase in individuals reporting being prescribed medications for hypertension from 1994 onwards (Figure 3a). Prescriptions of antihypertensive medications
increased from 9.57% to 11.38% between 1994 and 1998 and from 14.20% to 15.86% between 2000 and 2003 for men and women together. The average annual increase almost doubled after 1999 (0.54% versus 0.98%; \(P<0.001\)) and the increase in numbers of Canadians reporting antihypertensive treatment between 1994 and 2003 was 66%. There was a greater increase in the proportion of men reporting drug treatment of hypertension than women after 1999 (Figure 3a; average annual increase: 1.09% versus 0.88%; \(P<0.001\)), but the proportion of women treated was still higher in than in men.
Older individuals, both men and women, were more likely to report being prescribed antihypertensive medications than younger individuals (Figure 3b; $P<0.001$). In 2003, $\approx 50\%$ of Canadian women $\geq 60$ years of age were prescribed antihypertensive medications (Figure 3b).

Diagnosed Hypertensives Who Were Not Treated With Antihypertensive Medications

The proportion of individuals who were diagnosed with hypertension but were not treated with antihypertensive medications is an indication of the intensity of therapy prescribed by physi-
In 1994, 31.47% of men and women who were diagnosed with hypertension were not treated, although in 2003 this was reduced by more than one half to 15.34% untreated (Figure 4a). There was a 5-fold change in the rate of decrease in the proportion of those diagnosed who were not treated before and after 1999 (average annual increase: $-0.63\%$ versus $-3.23\%$; $P<0.001$). Overall, there was a larger percentage of diagnosed hypertensive men not treated with drugs between 1994 and 2003 than women (Figure 4a). There was a consistently large age effect, with higher percentages of younger than older aware Canadians who were not treated with drugs (Figure 4b; $P<0.001$).
To determine whether the inclusion of data from only Ontario in year 2000 had influenced the results, we compared the age standardized rates of awareness of hypertension, treatment of hypertension, and aware hypertensive adults who received antihypertensive medications between Ontario and the rest of Canada for the years 1994, 1996, 1998, and 2003. The greatest difference in rates was <1% for any comparison in any year.

Discussion
The results from the present study demonstrated that there have been very large increases in the diagnosis of hypertension and prescription of antihypertensive drug therapy in Canada between 1994 and 2003. The rate of increase in the diagnosis of hypertension and prescription of drug therapy for hypertension approximately doubled after the introduction of a national program to educate healthcare professionals on the management of hypertension (CHEP) in 1999. An important marker of quality of care is the percentage of hypertensive patients who are aware of having hypertension but are not being treated. In the last physical measures survey of hypertension in Canada (1985–1992), 33% of adult Canadians who were aware of having hypertension were not treated pharmacologically (Figure 1). This remained essentially unchanged at 31.5% in 1994 but decreased to 15% in 2003 with a 5-fold higher rate of decrease in the proportion of aware hypertensive Canadians who were not prescribed antihypertensive drugs after 1999.

Our study demonstrated that a national education program aimed at healthcare professionals was associated with a reduced “gender gap” in hypertension management in Canada. In Canada, like the United States and England, men are less aware of having hypertension and are less likely to receive drug therapy than women. The rate of awareness of hypertension and drug treatment of hypertension have increased more markedly in men than in women in Canada since the introduction of CHEP. Consistent with our observations, there were greater increases in the rate of initiation of antihypertensive therapy in men than in women in Ontario Canada between 1994 and 2002. This suggests that a portion of the gender gap in hypertension diagnosis and treatment is related to healthcare practitioners and is amenable by educational programs. Between 1988 and 2000, in the United States, drug treatment of hypertension and treatment and control of hypertension has also increased in men, but unlike our study there was no increase in women. In England there has been an increase in awareness, treatment, and control of hypertension in both men and women between 1994 and 2003, and although the gender gap remains for treatment, there was a closing of the awareness gap. To our knowledge, large national changes in diagnosis and hypertension have not been formally associated with specific educational or guidelines interventions in the past.

Our study also found that large proportions of adult Canadians under age 40 years who are aware of having hypertension are not treated with antihypertensive drugs, and this has not changed with the introduction of CHEP. Some of these patients are likely to have a low short-term cardiovascular risk. Nevertheless, few hypertensive Canadians are at low risk, and many of the patients may have indications for antihypertensive therapy. Educational programs developed with CHEP have largely focused on treating older Canadians with hypertension and may be a possible explanation for this observation. Further determination of the cardiovascular risk of younger hypertensive Canadians is required, and specific educational programs on managing younger hypertensive may be required.

The CHEP is a volunteer program that was specifically designed to influence the clinical care provided by healthcare professionals, using approaches proven to influence prescribing patterns in small clinical trials. CHEP is particularly unique in having annually updated recommendations that involve most national clinical hypertension specialists in Canada. The evidence-based process is highly structured to reduce bias, increase transparency, focus on patient outcomes, and use rigorous research designs, thereby reducing debates based on personal opinion. The process that reviews contentious issues and new evidence annually results in a high level of support from those involved. Annual updated educational tools have an extensive and expanding dissemination program. Didactic and workshop-based educational sessions are held in most major centers by local and national opinion leaders. Many of the sessions are based on programs that directly use standardized CHEP educational material or programs endorsed by CHEP, and “train-the-trainer” sessions have been used extensively. Periodic clinical updates have been shown recently to influence prescribing. CHEP published periodic updates in ≤22 clinical journals per year since 1999. Furthermore, the summaries have emphasized a limited (5 or 6) number of key learning points. Many different learning tools (posters, summaries, 1-page handouts, pocket cards text books, and power point slide sets) have been produced to meet the individualized needs of different clinicians. They are available at http://www.hypertension.ca. The use of multiple strategies has been shown to be more effective than any one single strategy. The extensive, broad dissemination of CHEP recommendations is, therefore, a plausible explanation for the increases in drug prescribing patterns for hypertension observed in our study.

The results of this study are consistent with other sources of information on drug prescribing in Canada. Large increases in the rate of prescriptions of antihypertensive drugs in Canada were reported from commercial drug databases between 1995 and 2001 with a more marked increase in prescription rates coinciding with the introduction of CHEP. There were also increases in the initiation of antihypertensive drugs in the elderly living in Ontario between 1994 and 2002.

Several limitations of the present study are worth noting. The surveys used in this analysis did not measure blood pressure and relied instead on self-reports or proxy responses. In addition to being subject to the usual biases concerning recall, the situation is further complicated by the semantics surrounding the terms “hypertension” versus “high blood pressure” in respondents with controlled hypertension. Lack of awareness of a hypertension diagnosis on the part of the individual, given the lack of symptoms, also presents a measurement challenge. Consequently, for the purposes of
this study, any respondent reporting being treated for hypertension, whereas not reporting him or herself as having high blood pressure, was recoded as having hypertension. The question on treatment for hypertension also has limitations, because some respondents will have been treated for other indications (eg, ischemic heart disease), as well as hypertension, and may not attribute the treatment to hypertension. This could lead to underreporting of antihypertensive treatment. The design of this study is also limited by the methodology of the National Population Health Surveys and Canadian Community Health Surveys in terms of overall design and sampling, which, although largely consistent over time, have changed slightly from cycle to cycle. The timing of the largest changes in hypertension awareness and treatment coincide with the discontinuation of the National Population Health Surveys and the initiation of the Canadian Community Health Surveys in the year 2000. Methodologic differences between the 2 surveys are minor but include: interview location (proportion interviewed by telephone, 1998–1999 National Population Health Survey: 91.1%; 2000–2001 Canadian Community Health Survey: 53%) and response rate among respondents 12 years of age (1998–1999 National Population Health Survey: 98.4%; 2000–2001 Canadian Community Health Survey: 92.6%); the Canadian Community Health Surveys sampling scheme was designed to be representative of the 136 health regions, whereas coverage for the National Population Health Surveys was at the provincial level, resulting in a more "rural" Canadian Community Health Surveys sample (unweighted rural proportion of the sample: 1998–1999 National Population Health Survey: 23.2%; 2000–2001 Canadian Community Health Survey: 26.4%) and total sample size (number of respondents: 1998–1999 National Population Health Survey: 15 249; 2000–2001 Canadian Community Health Survey: 129 018; http://www.statcan.ca/english/sdss/document/3226_D17_T9.V1_E.pdf). In this study, only the province of Ontario was used to represent all of Canada for the year 2000. Although our analyses suggest that the Ontario sample was highly representative of the rest of Canada in terms of hypertension-related measures in previous surveys, the extent to which this holds for the year 2000 Canadian Community Health Survey sample is not known. Nevertheless, if the 2000 Canadian Community Health Survey sample was excluded, similar or greater increases in diagnosis and treatment would be observed by comparing the 2003 Canadian Community Health Survey to the 1998–1999 National Population Health Survey. Although none of the survey differences have obvious implications for hypertension, their impact on the data presented in this study is not known.

In summary, this study found a large increase in the diagnosis and treatment of hypertension in Canada when a healthcare professional education program started. The observational nature of the study precludes a cause and effect relationship from being established, and any combination of uptake of management recommendations, clinical trials data, local and regional initiatives, and changes in the healthcare system to improve the management of chronic noncommunicable diseases could affect the diagnosis and treatment of hypertension. More extensive analysis, including a national survey that includes blood pressure measurement and examination of national hospitalization and mortality data for hypertensive complications, is planned. There are also concerns regarding the increases in treatment of hypertension, because almost one half of Canadian women over age 60 years are currently taking antihypertensive therapy. This points to large gaps in programs to prevent hypertension.

**Perspectives**

Globally there is an epidemic of cardiovascular death and morbidity. Hypertension is the leading risk for death globally, in part, because of the lack of awareness, treatment, and control.

Unfortunately, there are few models of how to improve hypertension treatment and control on a national scale. Improved treatment and control of hypertension has recently been achieved in England after the introduction of government payments to physicians for achieving specific hypertension management targets. Although there has been no formal analysis, government run programs to improve hypertension management have been associated with improved awareness and treatment of hypertension in the United States and Finland. In this article, we have reported very large increases in the diagnosis and treatment of hypertension in Canada, associated with an education program targeted toward healthcare professionals. The CHEP, therefore, provides a model for improving hypertension management. The program was initiated by a hypertension society, is run by volunteers who are largely hypertension specialists, and can be generalized to other countries with hypertension societies. Beyond science and training, hypertension societies need to take greater responsibility for the treatment and control of hypertension in their respective countries.

**Acknowledgments**

We thank the more than 80 volunteers who contribute to the Canadian Hypertension Education Program. In addition, we acknowledge the expert assistance of Mario Bedard at Statistics Canada with regard to sample weighting during boot strap analysis.

**Sources of Funding**

The Canadian Hypertension Education Program is academically sponsored by the Canadian Hypertension Society, Blood Pressure Canada, the Public Health Agency of Canada, the Heart and Stroke Foundation of Canada, the College of Family Physicians of Canada, the Canadian Pharmacists Association, and the Canadian Council of Cardiovascular Nurses. M.E. was supported by an Alberta Heritage Foundation Medical Research Senior Health Scholar Award. N.R.C.C. is supported by the Canadian Chair in Hypertension Prevention and Control. C.M. is supported by the Canadian Institutes of Health Research (Institute of Aging) and the Alberta Heritage Foundation for Medical Research (AHFMR) and is a member of the Gender and Sex Determinants of Circulatory and Respiratory Diseases: Interdisciplinary Enhancement Teams Grant Program, Canadian Institutes of Health Research (CIHR) Institute of Gender and Health and the Heart and Stroke Foundation of Canada.

**Disclosures**

N.R.C.C. has been paid fees for speaking and for consulting by most pharmaceutical companies in Canada that produce trade medications to lower blood pressure. In addition, N.R.C.C. has received research funds from Pfizer Canada, Sanofi-Aventis, Servier, and Bristol-Myers-Squibb for research on the epidemiology of hypertension. The remaining authors report no conflicts.
References


Large Increases in Hypertension Diagnosis and Treatment in Canada After a Healthcare Professional Education Program

Jay Onysko, Colleen Maxwell, Michael Eliaziw, Jenny X. Zhang, Helen Johansen and Norm R.C. Campbell
for the Canadian Hypertension Education Program

Hypertension. 2006;48:853-860; originally published online September 18, 2006;
doi: 10.1161/01.HYP.0000242335.32890.c6

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://hyper.ahajournals.org/content/48/5/853

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Hypertension can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Hypertension is online at:
http://hyper.ahajournals.org/subscriptions/