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Uncontrolled Blood Pressure Among Hypertensive Older Adult Patients in Family Practice Settings: The Contribution of Physician and Patient Characteristics

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Uncontrolled blood pressure among hypertensive older adult patients in family practice settings: the contribution of physician and patient characteristics

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Abstract

Objective: To determine the patient and physician characteristics associated with blood pressure control among older hypertensive patients in family practice, the prevalence of hypertension and the percent of hypertensive patients with controlled blood pressure.

Methods: A systematic review has been performed of published studies which reported an analysis of the association between patient and physician characteristics and hypertension control;

Data collected in a retrospective review of patients' health records in 28 family practices and a questionnaire for the participating family physicians has been analyzed. Hierarchical logistic modeling has been conducted to determine the predictors for blood pressure control.

Results: More than half of the patients were hypertensive. Among hypertensive patients, almost half had their blood pressure under control. The predictors for good blood pressure control were male gender, presence of cardiovascular disease or nephropathy, less than five blood pressure readings/year and young age of the physician. Diabetes predicted poor blood pressure control.

Conclusion: Although blood pressure control has improved considerably, more than half of hypertensive patients remain poorly controlled. Selected patient characteristics and physician practice behavior and characteristics were predictors of the blood pressure control.

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INTRODUCTION

1.1. The importance of hypertension as a risk factor in cardiovascular disease

Hypertension is a major risk factor for the development of stroke, congestive heart failure, coronary heart disease, peripheral vascular disease and renal failure. The risk to develop these conditions is increased proportional to the increase in the level of blood pressure (Wolf 1991).Cardiovascular diseases are the leading cause of death and a major cause of hospitalization in Canada (Manuel 2003; Heart and Stroke Foundation of Canada 2003).

Adequate treatment and control of hypertension in individuals over 60 is associated with a significant reduction in strokes and cardiovascular events. It is estimated that treating blood pressure to the target will result in a 36% reduction in the risk of stroke and 25% reduction in the risk of coronary events (Moser 1998, Staessen 1997, Ezzati 2003). The most recent and convincing evidence regarding the benefits of blood pressure reduction, particularly in very old individuals, was made public in August, 2007 by United Kingdom researchers who led an international trial of drugs to lower blood pressure in individuals over 80 years of age. The HYVET trial involving 3,845 patients showed significant reduction in strokes and heart-related deaths in treated patients compared to controls (Beckett 2008).

The identification of the factors associated with blood pressure control and implementing measures to improve the control, has the potential to reduce the incidence of stroke and cardiovascular diseases.

1.2.Hypertension prevalence and control

Although hypertension is one of the most modifiable cardiovascular risk factors only a quarter of hypertensive patients in North America over 65 years of age are controlled to the goal levels of systolic and diastolic blood pressure (Lloyd-Jones 2002). Over half of the hypertensive stroke cases in family medicine practice have either untreated or poorly controlled blood pressure (Lloyd-Jones 2002).

According to the Canadian Hypertension Society most Canadians are estimated to develop hypertension in their adulthood (http://hypertension.ca/chep/). The results of the Canadian Heart Health Survey (1986 – 1992) showed that the prevalence of hypertension (defined as a systolic and diastolic blood pressure $\geq$ 140/90 mmHg) in the Canadian adult population 18 to 70 years old was 22%; for population between 65 and 74 the prevalence of hypertension was 56% for men and 58 % for women (Joffres 1997). Of all hypertensive adults 40% were not aware of their condition. For those who were aware of their high blood pressure, only two thirds were being treated. Most of the time, the treatment was not adequate and blood pressure values were above the recommended level. Only 13% of hypertensive patients were satisfactory treated and their blood pressure values were under control (Joffres 1997). A recent study of individuals older than 18 in Southwestern Ontario (Petrella 2007), conducted in 35 randomly selected family practices, found an overall prevalence of hypertension of 17.3%. Of all subjects, 68.6% were untreated, 12.8% were treated but uncontrolled and only 15.8% were treated and controlled. In 2008, Karen Tu et al reported the results of a population-based cohort study which used administrative data for adults aged 20 years and older in Ontario between 1995 and 2005 (Tu 2008). The authors

found that the prevalence of hypertension in the general population increased from 15.3% in 1995 to 24.4% in 2005. In the same period, the study found that prevalence of hypertension in people over 50 years of age increased from 31.8% to 50.6% in the same period of time. Data from the Ontario Survey on the Prevalence and Control of Hypertension (Leenen 2008) showed similar results. The authors reported a prevalence of hypertension in the general population of 21.3% and 51.6% among those 60 to 79 years of age. They also found an important improvement in the management of hypertension. Leenen and colleagues reported that among people with hypertension in Ontario, 65.7% were undergoing treatment with control of blood pressure. Although this recent study reported an improvement in blood pressure control, a large number of people diagnosed with hypertension had their blood pressure poorly controlled and remained at increased risk for premature cardiovascular disease. These results suggest that treatment and control of hypertension remain a challenge in Canada.

1.3. Hypertension in older patients

According to the 2006 Census 13.7% of the total population of Canada is over 65 years of age or an absolute number of 4.3 million people (www.statcan.ca). The growth in the number of elderly presents a major challenge to the health care providers. In the 2003 Canadian Community Health Survey, seven in ten seniors reported themselves in good health. However, the proportion of elderly people in good health declines sharply with age. In 2003, 80% of seniors aged 65 to 74 had no disability or had a fully corrected disability, but among seniors older than 85 only 37% were in good health (www.statcan.ca). Arthritis and high blood pressure were the chronic conditions reported most often by elderly in 2005 (www.statcan.ca). Isolated systolic hypertension is the dominant (87%) form of hypertension in elderly in their sixth decade of life

and the least well managed of the three types. The other two types are isolated diastolic hypertension and systolic-diastolic hypertension. More than four times as many uncontrolled hypertensive patients over 50 years of age had isolated systolic hypertension compared to isolated diastolic hypertension or systolic-diastolic hypertension (Franklin 2001).

The age-related changes in mean systolic and diastolic blood pressure are explained by major hemodynamic alterations as a result of increased arterial stiffness from atherosclerosis in the large arteries and prolonged ventricular ejection time (Asmar 2003). The diminished elasticity of the arteries' wall determines an increase in systolic blood pressure and decrease of diastolic blood pressure and consequently, a wide pulse pressure. An elevated systolic blood pressure and pulse pressure can lead to left ventricle hypertrophy and increased oxygen consumption, while a decrease of diastolic blood pressure reduces the coronary flow. As a result, the heart has to work harder in conditions of reduced perfusion increasing the risk for myocardial alteration and coronary heart diseases (Asmar 2003). Alterations in the arterial wall also increase the risk of stroke and vascular dementia. Epidemiological studies have shown that the relative risk of stroke is strongly related to systolic blood pressure (Stamler 1993, Asmar 2003).

Isolated systolic hypertension and pulse pressure are important predictors of cardiovascular diseases risk, especially among people over 50 years of age (Amery 1985, Staessen 2000, Asmar 2003). Accurate diagnosis of systolic hypertension is difficult in patients who often have variable blood pressure as a result of increased anxiety from being in a doctor's office , the condition known as "white-coat effect" (Staessen 2000).

Antihypertensive treatment is beneficial to a great extent to older hypertensive patients by reducing the morbidity and mortality associated with high blood pressure and improving the quality of life. A meta-analysis of pooled data from five randomized trials (Gueyffier 1999) has shown that there is no age threshold beyond which antihypertensive treatment should not be considered beneficial. Antihypertensive treatment of patients over 80 years of age reduces the risk of stroke by 34% and heart failure by 39%, but does not reduces cardiovascular and all-causes mortality.

Most people with hypertension require a combination of both lifestyle and drug therapy to reach the blood pressure target level. Simple lifestyle changes, such as healthy diet, regular physical activity, moderate alcohol consumption, reduction in dietary salt and a smoke free environment, are at the core of prevention and control of hypertension (http://hypertension.ca/chep/). The Canadian Hypertension Education Program (CHEP), a knowledge translation program for health professionals, recommends an increased consumption of fruits and vegetables, low-fat dairy products, and whole grains and proteins from plant sources that are low in saturated fat and cholesterol. In addition to this diet, also called Dietary Approach to Stop Hypertension (DASH), a Cochrane review showed that a reduced dietary sodium intake lowered the systolic blood pressure in hypertensive or normotensive adults (Hooper 2004). Physically active people may also have better hypertension management and control. Aerobic activities such as walking, jogging, swimming, cycling may help reduce blood pressure in hypertensive and normotensive adults (Whelton 2002). According to CHEP, the accumulation of 30 to 60 minutes of physical activity per day, four to seven times per week has the maximum effectiveness in reducing the level of blood pressure.

Lifestyle changes can have similar blood pressure lowering effects as an anti-hypertensive drug as well as reducing other cardiovascular risk factors. Published practice guidelines recommend that hypertensive patients should be treated using a combination of drugs and lifestyle modifications to achieve their individualized target. Each visit to the family physician is, therefore, an opportunity to assess and improve adherence to pharmacological and non-pharmacological methods of treatment (http://www.hypertension.ca/chep/educational-resources/slides).

1.4.Prevention and management of hypertension in primary care

Primary care plays a central role in the community and is the patient's first point of contact with a health service. Primary care responds to a spectrum of acute and chronic health care needs, health promotion and disease prevention, health maintenance and patient education on a long term basis. It is the base from which consultations with other specialist physicians and health professionals are arranged. Because of the high prevalence of hypertension in the general population and its importance as a major modifiable risk factor for other disease, family physicians need to put significant effort into the identification of hypertensive cases and in implementing prevention and management approaches. Nevertheless, a relatively large number of patients remain under-detected and under-treated (Petrella 2007). This situation is partly a result of the challenges that the primary care is facing but also a result of patient-related barriers. To prevent and manage hypertension, the primary care practitioner is required to give special attention to patient's characteristics, such as gender, age, race, lifestyle, comorbid conditions, choice of antihypertensive drug treatment, and compliance with treatment. Also, older patients in primary care often have two or more chronic conditions adding to the complexity of the care provided by family physicians.

Poor adherence to antihypertensive medication could be one of the most important factors contributing to the low rates of blood pressure control in hypertensive patients (Krousel-Wood 2004). Research studies note that among the potential barriers to medication adherence are the lack of understanding by the patients of their disease and treatment, adverse effects of the treatment, dissatisfaction with the treatment, complex dosing regimens or the cost of the medication (Harmon 2006). Regular visits to a family physician, patient education and lifestyle counselling can improve communication between patients and health care providers and can lead to a greater adherence to medication (Rosenow 2005). During these visits, the physician can implement changes that address the identified barriers to adherence. These changes include replacing medication for patients reporting adverse effects, simplifying the dosing for patients with complex regimens, or switching to less expensive drugs if the cost is an issue. For a successful clinical management of hypertension, both the provider's commitment and the patient's willingness are required (Krousel-Wood 2005).

Optimal control and secondary prevention of hypertension complications require regular follow-up visits to the family physician. Ideally, through these visits chronically ill patients are not only monitored but also receive lifestyle counselling intended to increase knowledge of the disease and its treatment, leading to self-confidence and skills in self-management of the condition (Rothman 2004). Effective collaboration among chronically ill patients and healthcare providers can improve outcome and increase control of the disease.

Management of hypertension is complex. As hypertension is more common in the elderly, who have a greater (more than 50%) prevalence of two or more chronic diseases (Leenen 2008),

family physicians often must manage multiple chronic illnesses in the same patient. Consequently, family physicians and their allied health professional colleagues in primary care settings should allocate additional scheduled time for health promotion and chronic care visits. Delegation of primary care interventions across the primary care team can improve the quality of care provided. Research in health services (Bogden 2001, Sommers 2000) has identified the need to improve the organization of the primary care team in order to properly care for both chronically ill patients as well as those who present with acute conditions (Grumbach 2004)). Family physicians working outside a team of allied health professionals in primary care might be less able to do this. These family physicians might possibly have less time to provide minimal patient education. Without a primary care team approach and reorganization of primary care practice, the care of chronic illnesses in general, and hypertension in particular, can be characterized as a poorly connected string of episodes determined by patient's problems (Rothman 2004).

Another issue identified as a barrier against the good management of hypertension is the evidence suggesting that family physicians are not always aggressive enough with the management of hypertension and do not recommend tests and medication in accord with guidelines (Oliviera 2002). Studies have found that poorly controlled patients often receive inappropriate medication or an inadequate dosage of appropriate drugs (O'Connor 2005). Researchers have suggested that shared care between primary care physicians and specialists (Greenfield 1999), by improving the referral process for patients with complicated conditions and promoting co-management, may produce the best outcomes (Harrold 1999).

In 2004, 28 randomly selected family physician practices in Hamilton and Ottawa were part of a study funded by the Canadian Institutes of Health Research (CIHR) that included review of health records of 1430 randomly selected patients 65 years of age and older to determine their hypertension status and other related clinical information. Baseline data from this study were used in this thesis to examine the different aspects of the management of hypertension. These data offered an insight of real life activity of the physician and how the patient was managed. Additional data collected from the participating family physicians opened the opportunity to analyze the role of physician and practice characteristics in reaching the outcome.

This thesis aimed to bring more clarity regarding the nature of the relationship between the different elements that have a role in the management of hypertension in primary care.

1.5. Objectives of the current study

The objectives of the thesis are:

(1) to perform a systematic review of published studies which reported an analysis of the association between patient and physician characteristics and hypertension control;

(2) to identify the patient and physician characteristics associated with blood pressure control among hypertensive patients from 28 randomly selected family physicians practices in Ottawa and Hamilton; and

(3) to determine the prevalence and control rate of hypertension from 28 randomly selected family physicians practices in Ottawa and Hamilton;

1.6. Hypotheses

The hypothesis to be tested in this thesis is:

Selected patient characteristics and physician practice characteristics are associated with the control of hypertension in patients over 65 years of age in community

1.7.Conceptual framework

The important progress with new and effective treatments for hypertension, such as new drugs, diet, weight loss, physical activity has not changed the status of blood pressure as an important public health issue. Nevertheless, blood pressure is controlled in only a fraction of people with hypertension. Patient, physician and health system factors may all contribute to suboptimal management of blood pressure control in hypertensive patients.

Drawing from the Wagner's Chronic Care Model (Wagner 2001, 2005) and the Kim et al. model for patient, clinician and system factors interaction (Kim 2003), a conceptual framework for how these factors interrelate was developed (Figure 1).

Wagner's model of Chronic Care states that productive interactions between patient and physician can be significant contributors to chronic disease control. For these interactions to be beneficial, both the patient and clinician have to be proactive and well informed (Wagner 2005). The health system components, such as self-management support, the health service delivery system, the decision support system, and the clinical information system, which are observed through the characteristics of the practice, may influence the interaction between patient and physician. Wagner's model focuses on features of the health care system that can influence health care delivery. The outcome of the interaction between the chronically ill patient and the family physician may be influenced by the quality of care offered by the practice teams which are required the necessary expertise, relevant patient information, time, and resources to act, rather than just react, to ensure effective clinical and behavioral management (Wagner 2001). The strength of this model is that it provides a detailed description of health system

characteristics that probably influence chronic disease management. This model is useful in understanding the changes required to primary care practices to improve care but does not include the patient and physician characteristics that may influence the management of chronic disease.

Kim and colleagues developed a conceptual model to explain how patient, clinician and health system factors are affecting the management of cholesterol in high-risk patients. This model may be easily applied to other chronic disease, such as hypertension to understand the barriers in the management. The model developed by Kim et al hypothesizes that perception of the risks and barriers to screening and treatment of cardiovascular disease risk factors will affect the clinician's behavior during the health visit (Kim 2003). These perceptions can be partially predicted from patient characteristics such as gender or age. In addition, the health system structure affects screening and treatment of cardiovascular disease by affecting clinician and patient behavior (Kim 2003). This model is useful on understanding how patient and physician characteristics influence clinician's behavior during visits. It has been validated in a study aimed to investigate the gender disparities on the clinical management of dyslipidemia.

The conceptual framework (see Figure 1) in this thesis presupposes that the effectiveness of the interactions between patient and physician influence the control of blood pressure levels to the target in hypertensive patients. These interactions may be influenced by the characteristics of the patient, physician and family practice. Clinician behavior during these visits may be affected by characteristics of the physician and practice such as the number of years in practice, location and certification with the Canadian College of Family Physicians. Patient behavior is influenced by

patient characteristics such as demographics, comorbidities, socio-economic status and level of education.

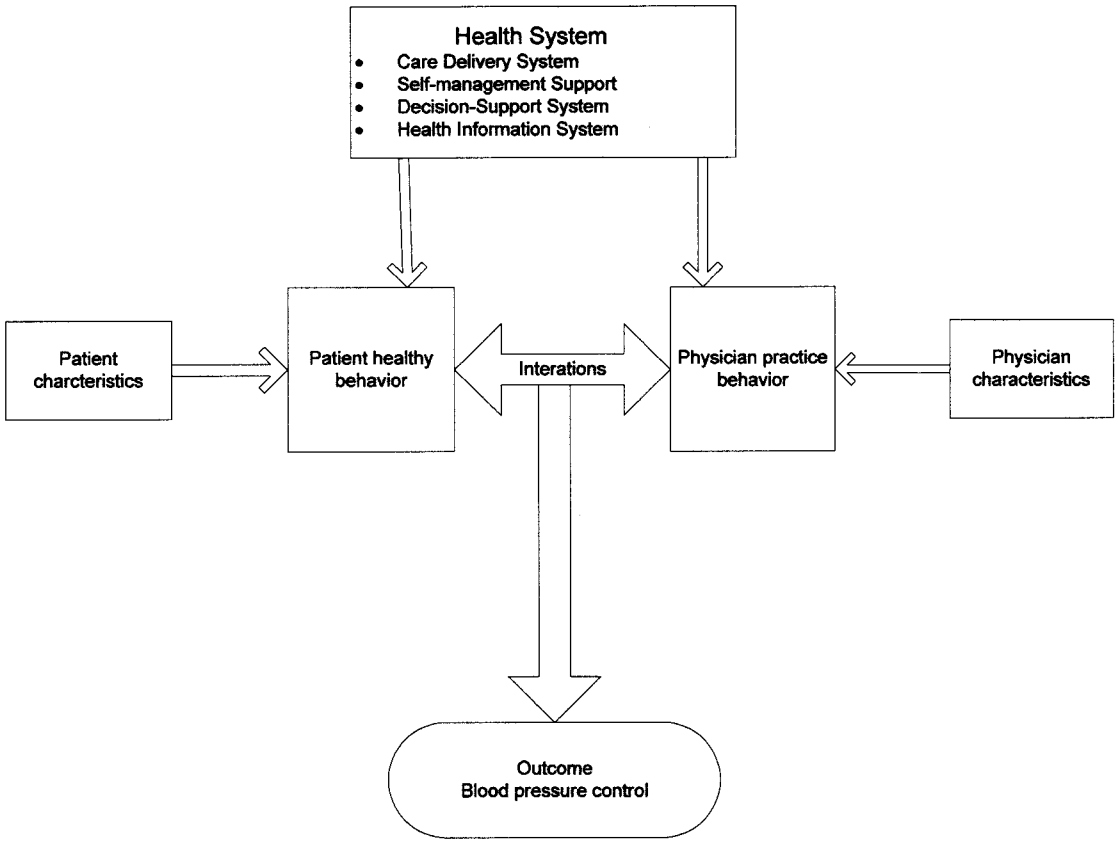
Many of the factors that affect the interaction between patient and physician could be modified. Through interventions directed to patient and physician knowledge and skills, as well as efforts to improve practice through changes in the healthcare system, we may attain better blood pressure control and improve the quality of life for hypertensive patients (Fahey 2006). Conversely, biological characteristics of the patient or physician are difficult or impossible to modify. Their influence on the behavior of the patient or clinician may diminish the impact of any intervention intended to improve the hypertension control.

Table 1 presents a summary of the differences between the Wagner Model, Kim et al. Model and the framework for this thesis.

Table 1: Comparison between elements of the Wagner, Kim and Thesis models

Components	Wagner Model	Kim Model	Thesis Framework
Interaction between patient and physician affect the management of hypertension	Present	Present	Present
Patient characteristics influence patient behaviour		Present	Present
Patient characteristics influence physician practice behaviour		Present	Present
Physician characteristics influence physician behaviour		Present	Present
Healthcare system and its components influence the behaviour and interaction between patient and physician	Present	Present	Present

Figure 1: Conceptual framework: Patient's characteristics and Physician's practice behavior and characteristics are associated with the control of blood pressure in hypertensive patients in family practice.



2. LITERATURE REVIEW

The goal of this systematic review is to identify and synthesize evidence from multiple studies that analysed the relationship between poor blood pressure control and patient and physician characteristics. The findings from this review will be used in the analysis and the discussion section of this thesis.

2.1. Objective

This systematic review sought to answer the following questions:

1. What characteristics of elderly patients and their physicians are associated with poor blood pressure control reported by studies conducted in general practice?
2. What is the rate of blood pressure control reported by the included studies?

2.2. Search strategy

Studies that assessed the association between poor blood pressure control and patient and/or physician characteristics were identified using the following inclusion criteria:

1. The studies were based in primary care settings. Primary care was defined as the first point of consultations for all patients by a general practitioner of family physician, outside a hospital setting.
2. Control rate of hypertension on patients over 65 years of age was reported. Hypertension control was defined as reaching and maintaining a target blood pressure level of 140/85 mmHg or 130/80mmHg for high-risk patients such as those with diabetes.
3. Statistical analysis of the association between patient and physician characteristics and hypertension control was reported.
4. Published studies in English language journals
5. No restriction to publication period

These inclusion criteria were selected to identify high quality studies reporting on findings that are relevant for this thesis. The first criterion of only including studies conducted in primary care was selected because hypertension in the general population is managed mainly in primary care. There are differences between the samples from primary care patients and samples from the general population which can affect the value of prevalence and control of hypertension. By including studies that reported the control rate of hypertension on older patients, the findings from this thesis can be compared with those of similar studies. The criterion of only including studies that reported analysis of the associations between patient and physician characteristics and blood pressure control was required to identify variables likely to be related to control of hypertension. Although it may introduce selection bias, only English language articles were taken into consideration in preparation of this thesis. Publication bias was not investigated and unpublished studies were not searched.

Published articles from Medline, EMBASE, CINAHL and Journals@OVID were searched using the following key searching terms: hypertension, control, primary care, older patients, patient characteristics, physician characteristics, cross-sectional study. A second search was performed on Medline database in February 2009, using a new search strategy, developed in collaboration with an information specialist from the University of Ottawa Library (Lee-Anne Lufholz). Appendix E contains both search strategies for the Medline database, using an OVID interface.
A list of potentially relevant citations was generated. The titles and abstracts of the studies identified in both first and second search were screened and not relevant citations were excluded. For the remaining potentially relevant studies, full texts were retrieved. A detailed assessment of the full text studies resulted in the exclusion of additional irrelevant studies. Potential additional relevant studies were identified from the reference lists of the studies reviewed.

2.3. Search results

A total of 188 reports of studies were obtained from the initial search of the above databases until the end of January, 2008. After an initial screening using the inclusion criteria, 147 citations were excluded (see Figure 2). Hard copies of the remaining 41 studies were retrieved and assessed. Of these studies, 16 were not undertaken in primary care, 15 did not report an analysis of the association between hypertension control and patient or physician characteristics, two were performed in patients younger than 65, and eight articles reported studies undertaken in special populations such as patients with diabetes or stroke survivors. One study was identified from the citations of the reviewed studies. Four studies met all the inclusion criteria and were included in the review.

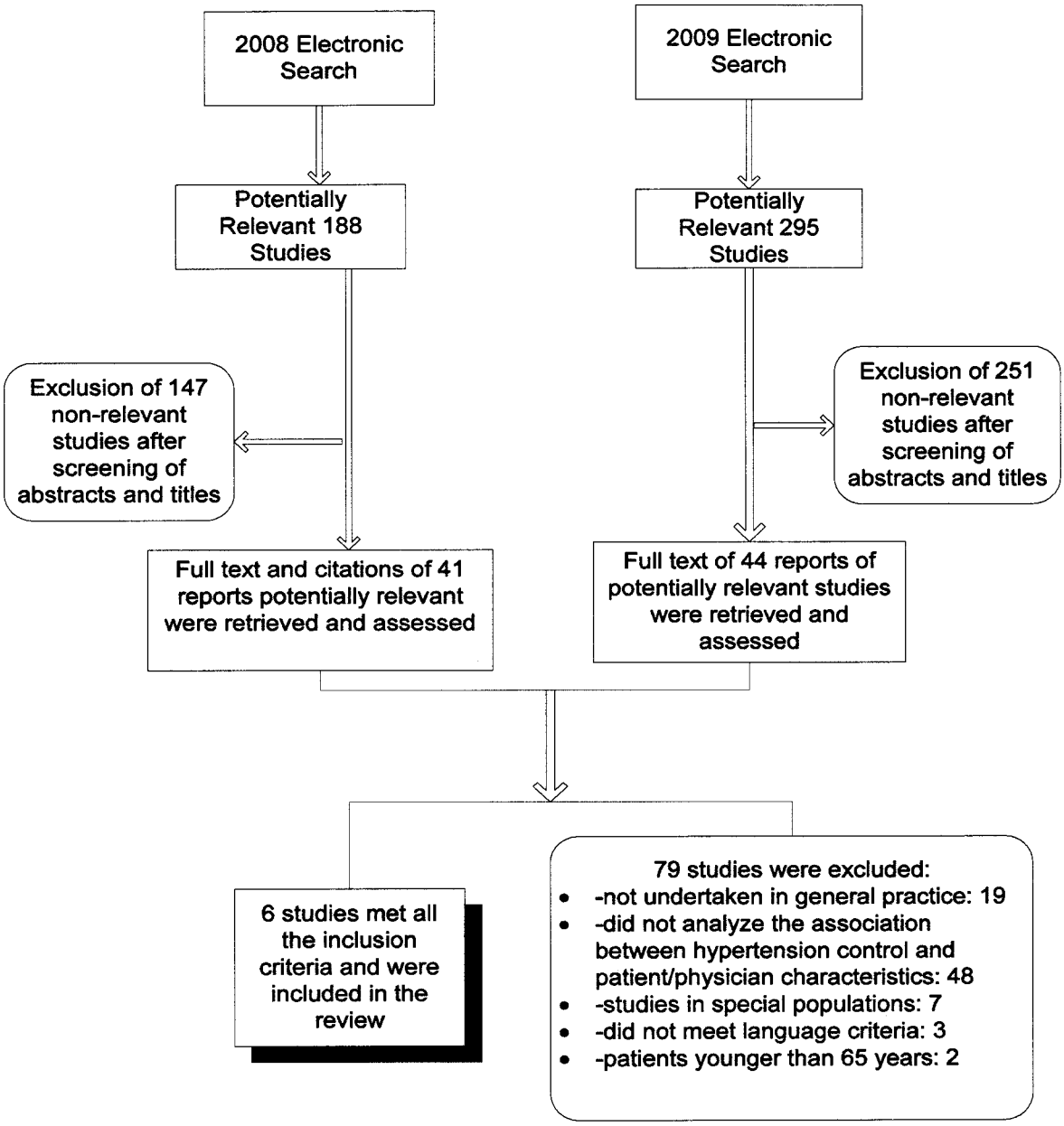
The second electronic search identified 295 reports of studies published until January 2009 (see Figure 2). Of these, 251 studies were excluded after the first screening step. Of the remaining 44, three studies did not meet the language requirement, three studies were conducted in hospital-based clinics, and 34 studies did not assess the association between blood pressure control and patient and/or physician characteristics. Two additional studies, not found in the first search, met all the inclusion criteria and were included in this review. The citations in the reference list of the studies reviewed in the second search were not explored for additional relevant studies because of limited time.

From the six studies that met the inclusion criteria, the following information was extracted: sample size, sample frame, sample method, age of study population, setting, method of data collection, reported prevalence of hypertension, reported proportion of controlled hypertensive patients, target value of blood pressure for control, patient/physician characteristics and behaviour associated with control of hypertension.

It is recommended that systematic reviews be undertaken by more than one person (Cochrane Handbook for Systematic Reviews of Interventions). The selection of studies for inclusion, data extraction or quality analysis of the included studies should be performed by at least two people independently, reducing the chance of error. The author of this review had limited resources to

engage other researchers or graduate students as collaborators in the process. Thus, the selection of studies, extraction of data and quality assessment of the included studies were performed by the author of this review.

Figure 2 The flowchart of the process of identifying relevant studies



2.4. Quality assessment of the studies reviewed

An important component of a systematic review is the evaluation of the methodological quality of the primary studies. The assessment of individual studies is required to limit bias in conducting the systematic review and to guide the interpretation of findings (See Table 2). Rigorous studies are more likely to generate accurate results (Cochrane Handbook for Systematic Reviews of Interventions). A comprehensive systematic review of tools to assess observational studies identified 86 tools, comprised of checklists and scales (Sanderson 2007). The authors concluded that there are no 'gold standard' appraisal methods; many are developed for specific systematic reviews. When a scale is used to assess the quality of the studies, there is concern regarding the weighting of component items. It is uncertain how weights for different items should be established and as a result, different scales may arrive at different conclusions on the quality of an individual study. Scales may generate a greater risk of confusing the quality of reporting with the validity of the study. Sanderson et al concluded that a transparent checklist that concentrates on the principal sources of bias in a study's findings would be a better choice for the evaluation of the study methodology (Sanderson 2007).

A concise quality assessment checklist was developed to help standardize decisions regarding the quality of studies included in this review. The quality assessment checklist (Appendix D) was developed using "Critical Appraisal of the Health Research Literature: Prevalence or Incidence of a Health Problem", developed by Loney and Chambers (Loney 2000 – available at: http://www.phac-aspc.gc.ca/publicat/cdic-mcc/19-4/e_e.html) and Ottawa - Newcastle Scale for the Quality Assessment of Cohort Studies. Based on a literature review and a critical review of the items by experts, Loney and colleagues developed the following six questions to critically appraise the validity of a study's methods.

1. Are the study design and sampling method appropriate for the research question?
2. Is the sampling frame appropriate?
3. Is the sample size adequate?
4. Are objective, suitable and standard criteria used for measurement of the health outcome?
5. Is the health outcome measured in an unbiased fashion?
6. Is the response rate adequate? Are the refusers described?

Based on these questions a checklist was developed for the review of articles for this thesis (Appendix D). Equal weight was given to the items on the list. Articles were awarded one point for each numbered item from the check list to a maximum of nine points. The first issue was the sampling method. The best technique to avoid selection bias is random sampling of patients from the family practice population. The second issue was the type of sampling frame. Random selection from the rostered patients was considered an adequate sampling for the purpose of this review. The third issue was the sample size. Using a large sample size produces narrow confidence intervals, making the findings more precise. Based on the average percentage of controlled hypertension in the general population reported by previous studies (25%), a margin of error of 5% or less and 95% confidence level, the minimum sample size should be 289 (D'Agostino 2004). Thus, a sample size of minimum 300 subjects was considered adequate for the purpose of this review. The fourth issue was the hypertension diagnosis. In many epidemiological studies the diagnosis of hypertension was based on the blood pressure taken and recorded as part of the study as well as the use of antihypertensive medication. As a result, patients treated with non-pharmacological therapy and blood pressure at target could be misclassified as non-hypertensive. In studies in which a diagnoses of hypertension was determined through a review of health records, the diagnosis were made by the physician, who followed specific criteria as recommended by practice guidelines. Review of health record was considered an adequate source for the ascertainment of hypertension diagnosis. The next issue in the quality assessment checklist was the definition of the status of control in hypertensive patients. Currently, the recommended threshold for hypertension diagnosis and control is 140 mmHg for systolic blood pressure and 90 mmHg for diastolic blood pressure, with lower levels (130/85 mmHg) recommended for high risk patients, such as those with diabetes.

This target level, proposed in 1997, was considered adequate for this review. Studies undertaken in the late 1980s and 1990s reported the data using an earlier threshold (160/95 mmHg) or both, the new and the old threshold. Items number four and five on the checklist were adapted from the Ottawa-Newcastle Scale and answer the following question: Is the case definition adequate? A significant issue was the appropriate measurement of the blood pressure using standardized procedures and blood pressure monitors, such as BPTru monitors and mercury sphygmomanometers that had been evaluated according to the international norms. An adequate response rate was another important issue for the quality assessment of the studies. A large number of patients available for blood pressure measurement increased the of the estimate. A response rate in population surveys of two thirds to three quarters has been suggested to be generalizable to the population samples (Loney 2000). A response rate of 70% or more was considered acceptable. The next issue in the quality assessment checklist was the reporting of the confidence intervals. For a better interpretation of the estimates reported by the reviewed studies it was important that the 95% confidence intervals were also provided. Confidence intervals indicated the extent to which one knows whether the estimates are due to chance.

Table 2: Validity issues addressed in the studies in this review

Author	Is the sampling method adequate?	Is the sampling frame appropriate?	Is the sample size adequate?	Is the ascertainment of diagnosis of hypertension based on medical records?	Is the definition of blood pressure control according to the guidelines?	Is there unbiased measurement of outcome (blood pressure control)?	Is the response rate adequate?	Are the refusers described?	Are the estimates given with confidence intervals and in detail by subgroup.
Roux		√	√		√	√			√
Patel		√	√	√					√
Abaci		√	√		√	√			√
Senior		√	√	√	√				√
Grandi		√	√	√	√	√			
Amar		√	√	√	√	√			√

√ = The validity issue was reported and correctly addressed

Table 3: The methods of participants' selection and data collection reported in the reviewed studies.

Author	Selection of participants	Data collection method	BP measurement
Roux	A "representative panel of 2500 general practitioners accepted to participate in the study" Each physician included the first two patients who met the inclusion criteria.	Questionnaire completed at recruitment	Blood pressure was measured at the physician's office using a mercury sphygmomanometer, after 5 min. of rest, in supine position
Senior	The 73 general practitioners invited to participate in the study were identified on the basis that their practice type was known to serve a high proportion of older people by virtue of location or demographic region. Health records of all patients aged 80 and older from the practices of the participating physicians were reviewed.	Both paper and computerized medical records from participating practices were reviewed by trained research officers using pre-coded questionnaires	Average of the blood pressure measurements in the previous 5 years recorded in the medical record
Patel	In British Regional Heart study men were selected from the age-sex register of one group general practice in each of 24 British towns. In British Women's Heart and Health Study the sampling was stratified by town and five year age group to ensure the distribution proportionately matched that of the men.	Similar protocols, measurements and questionnaires were used in both studies. Health records review, questionnaire were used to collect patient data.	A Dinamap 1846SX vital sign monitor was used to perform two blood pressure measurements at one minute interval with the participant seated. The mean of the two measurements was used in analysis.

Author	Selection of participants	Data collection method	BP measurement
Grandi	All general practitioners in the Varese district (Italy) were invited to participate and 87% agreed. Each physician "enrolled 5-10 consecutive patients with known essential hypertension".	Data was collected at recruitment by physician. Method was not stated.	Blood pressure was evaluated by the physician, averaging the values obtained from three measurements, taken with a mercury sphygmomanometer, in sitting position, at 5 minutes interval.
Abaci	One physician from 1000 primary care units enrolled patients previously diagnosed with hypertension. Over a period of 10 consecutive days, patients "coming first in morning and afternoon in each health centre' were included in the study.	Data was collected at recruitment using a questionnaire.	Blood pressure was evaluated by the physician, averaging the values obtained from two measurements, taken with a mercury sphygmomanometer, in sitting position, at 5 minutes interval.
Amar	In the PRATIK study a sample of 3153 general practitioners enrolled "the first five hypertensive patients received at the office". In ESPOIR study the participating general practitioners, selected by stratified random selection, enrolled "the first six patients with coronary disease received at the practitioner's office".	The method of data collection was not described.	Blood pressure was measured using a mercury sphygmomanometer. The average of three blood pressure measurements was used in analysis.

Table 4: Predictors of blood pressure control reported in the studies reviewed

Author	Sample size	Predictors of blood pressure control	Odds Ratio		Confidence intervals		Quality evaluation
Roux 2006	4702	**Age (per 11.6 years)**	**0.79**		**0,72-0.86 (p<0.0001)**		**5**
		Gender (female vs. male)	**1.38**		**1.14-1.66(p=0.002)**		
		Previous cardiovascular event (no vs. yes)	**0.75**		**0.58-0.97(p=0.019)**		
		Heart rate (per 9 beats/min)	**0.90**		**0.82-0.98(p=0.021)**		
		Weight (per 14 Kg)	**0.90**		**0.81-0.99(p=0.023)**		
Patel 2006	4286 women (A) and 4252 men (B)		Women	Men	Women	Men	**4**
		Age 60-69 vs.70-79	**0.52**	0.82	**0.41-0.67**	0.60-1.22	
		Smoking : never vs. past never vs. current	0.96 0.90	1.27 1.42	0.74-1.23 0.58-1.40	0.90-1.79 0.86-2.35	
		Obesity : <30 vs. ≥30	**1.35**	1.08	**1.05-1.73**	0.75-1.54	
		Physical activity : ≥2h/week vs. <2h/week	1.12	0.91	0.84-1.49	0.65-1.27	
		Alcohol consumption: less than daily vs. daily	0.88	**0.71**	0.64-1.22	**0.51-0.98**	
		Education : ≥16 vs. <16	1.02	0.96	0.79-1.30	0.69-1.33	
		Adult social class: Non-manual vs. Manual	1.19	1.04	0.94-1.50	0.76-1.42	
		Treatment with NSAIDs : No vs. Yes	**1.60**	**0.54**	**1.11-2.30**	**0.31-0.95**	

1

Author	Sample size	Predictors of blood pressure control
Abaci 2006	6270	**Age ≥65 vs. <65** **Diabetes (present vs. absent)** **Body mass index (Kg/m²)≥ 25 vs. <25** **Cardiovascular disease (present vs. absent)**
Senior 2006	3068	Age Female **Stroke** **Heart disease** Diabetes Mellitus **High cholesterol** Peripheral vascular disease
Grandi 2006	5524	**Cardiovascular risk** **Diabetes** **Body Mass Index** **Renal dysfunction**

Odds Ratio	Confidence intervals	Quality evaluation
1.33	**1.22-1.44 p<0.001**	**5**
4.96	**4.27-5.76 p<0.001**	
1.41	**1.28-1.55 p<0.001**	
0.84	**0.76-0.92 p<0.001**	
0.99	0.96-1.03	**5**
0.97	0.75-1.25	
1.39	**1.01-1.91**	
1.65	**1.30-2.11**	
1.23	0.86-1.75	
1.60	**1.16-2.20**	
1.46	0.93-2.29	
Not provided	**P<0.001**	**5**
	P<0.005	
	P<0.01	
	P<0.02	

Author	Sample size	Predictors of blood pressure control	Odds Ratio	Confidence intervals	Quality evaluation
	3155	**Sex (men vs. women)**	**0.83**	**0.71-0.97 p=0.02**	**6**
Amar	hypertensi	**Age (per 1 year)**	**1.03**	**1.02-1.04 p<0.0001**	
2003	ve patients	**Body mass index (Kg/m²)(≥ 30 vs.**	**1.25**	**1.06-1.47 p=0.008**	
		<30)	**1.33**	**1.06-1.67 p=0.01**	
		Current smoking (yes vs. no)	**1.45**	**1.24-1.71 p<0.0001**	
		Diabetes (yes vs. no)	**1.59**	**1.32-1.92 p<0.0001**	
		Total cholesterol (g/l) (> 2.5 vs. ≤ 2.5)			

Characteristics found to have a statistically significant association with hypertension control are identifies in bold. NS means non-significant.

2.5. Predictors of blood pressure control reported in the included studies

All of the six studies reviewed analyzed the association between blood pressure control and patient or physician characteristics in primary care settings (See Table 4). The majority of the studies received low quality marks (five points or less). Four of the six studies reported only the statistically significant associations between patient characteristics and hypertension control. None of the included studies assessed the association between physicians' characteristics and blood pressure control in their hypertensive patients in primary care.

Table 3 shows the method of selection for the participating physicians and patients, as well as the data collection approach reported in the reviewed studies.

The EPISTRAT study (Roux 2006) was a non-random, cross-sectional study conducted in 2001 in France on hypertensive patients treated in general practice with antihypertensive drugs for less than a year (five out of nine quality points). The study showed that the characteristics independently associated with good blood pressure control were young age and female gender and, to a lesser extent, absence of previous cardiovascular events, low heart rate and low weight. The relatively short duration of hypertension in participating patients may have had an impact on the effectiveness of the disease management; some of the patients may not have had enough time to be investigated and to receive optimal treatment.

Patel and colleagues (Patel 2006) (four out of nine quality points) analyzed the data from two randomized prospective studies: British Women's Heart and Health Study and British Regional Heart Study, which provided information on women aged 60 to 79 years and men aged 58 to 81 years. Participants in both studies were selected from the age-sex registries of one group general practice in each of the 24 participating British towns. Similar data collection procedures were used for both studies. Detailed reviews of participants' general practice health records and questionnaires were undertaken. The authors reported that frequent use of alcohol or anti-inflammatory medication in men decreased the likelihood of blood pressure control. Among

women, the use of non-steroid anti-inflammatory drugs (NSAIDs) and a body mass index under 30 was associated with increased blood pressure control. Older women were less likely to have their blood pressure controlled. No significant association was found between lifestyle factors such as smoking, physical activity or alcohol consumption and blood pressure control. Social factors such as education and social class were also not found to be predictors of blood pressure control.

The TURKSAHA Study (Abaci 2006) (five out of nine quality points) was a non-randomized survey intended to determine patient characteristics and blood pressure control rates among hypertensive patients in Turkey. The authors reported that age over 65 years, the presence of diabetes and a body mass index higher than 25 kg/m^2 were associated with poor blood pressure control. Patients with a history of cardiovascular disease were more likely to have their blood pressure controlled.

The study reported by Grandi and colleagues (five out of nine quality points) was a prospective study intended to evaluate the rate of blood pressure control among known essential hypertensive patients and the impact of physicians' training on the implementation of hypertension guidelines (Grandi 2006). All general practitioners from the district of Varese, Italy were invited to participate in this study with a response rate of 87.8%. Practitioners attended a one day training session on the World Health Organization guidelines for the management of hypertension. Following this training, physicians enrolled known hypertensive patients from their practice. An analysis of the baseline data suggested that older and obese patients, as well as those with comorbidities such as cardiovascular disease, diabetes and renal dysfunction were more likely to have poor blood pressure control.

Senior et al conducted a cross-sectional study to assess the management of hypertension for the elderly over 80 years of age (Senior 2006) (five out of nine quality points). More than 3000 medical records of people aged 80 and older, from 67 non-randomly selected urban general practices were reviewed. Data showed that factors such as history of stroke, heart disease and hypercholesterolemia, but not age and gender, were predictors of good blood pressure control.

Although diabetic patients were more likely to be on anti-hypertensive medication than were patients without diabetes, they were less likely to have good blood pressure control.

Amar et al analyzed pooled data from PRATIK and ESPOIR studies (six out of nine), two non-random cross-sectional surveys conducted in primary care in France.
Multivariate analysis for the assessment of the association between hypertension control and patient characteristics showed that age, women, total cholesterol, obesity, current smoking and diabetes were associated with poor hypertension control.

All six studies used standard logistic regression to analyze the association between patient or physician characteristics and blood pressure control and did not include adjustment for clustering effect(s). Odds ratios were ranged from 0.4 to 1.65, with one exception: relationship between diabetes and poor blood pressure control in the TURKSAHA Study (Abaci 2006) OR = 4.96.

Table 5: Patient and physician characteristics associated with blood pressure control, reported in the studies reviewed

Statistically significant predictors	Senior 2006	Grandi 2006	Roux 2006	Patel 2006	Abaci 2006	Amar 2003
Patient's characteristics						
Age	NS	-	-	-	-	-
Gender (male)	NS		-			+
Education				NS		
Adult social class				NS		
Body mass index (or weight or obesity)		-	-	+	-	-
Smoking				NS		-
Alcohol consumption				-		
Lack of physical activity				NS		
Cardiovascular disease	+	-	-		+	
Cerebrovascular disease	+					
Peripheral vascular disease	NS					
Diabetes	NS	-			-	-
Total cholesterol > 2.5 g/L	+					-
Heart rate (increased)			-			
Renal dysfunction		-				
Treatment with NSAIDs**				+		

- indicates predictor of poor blood pressure control; + indicates predictor of good blood pressure control; NS indicates not statistically significant association; ** Non-Steroid Anti Inflammatory Drugs

For those variables measured in the reviewed studies, the following were found as predictors of blood pressure control (see Table 5). Almost all studies included in the review found a statistically significant association between age and gender and blood pressure control. Five of the six studies reported a statistically significant association between older age and lack of blood pressure control among hypertensive patients. Some authors (Amar 2003) reported that being male was associated with good blood pressure control, while others (Roux 2006) found that women were more likely to have good control of blood pressure. One study reported a non-significant relationship between gender and hypertension control (Senior 2006). Four studies reported that persons with obesity or high body mass index were less likely to have good blood pressure control compared to those of normal weight. Only one study showed a significant association between obesity and good hypertension control (Patel 2006). Two studies investigated the effect of patient's lifestyle on blood pressure control. These studies found that hypertensive patients who smoked or consumed alcohol were less likely to have good hypertension control; however lack of physical activity was not a predictor of hypertension control. One study investigated the impact of social factors on hypertension control. Findings showed that neither education nor social class were associated with control of blood pressure. Presence of comorbidities in hypertensive patients was found in many of the studies to be significantly associated with blood pressure control. Two studies reported that the presence of previous cardiovascular events was a predictor of good blood pressure control (Abaci 2006, Senior 2006). Two other studies (Roux 2006, Grandi 2006) found that hypertensive patients diagnosed with other cardiovascular disease were less controlled, in spite of increased use of antihypertensive medication. Several studies indicated that diabetes and elevated fasting glucose in hypertensive patients were predictors of poor blood pressure control. Three studies showed a clear and consistent effect: presence of diabetes reduces the likelihood of blood pressure control (Abaci 2006, Grandi 2006 and Amar 2003).

Some of the patient characteristics were consistently found to be associated with poor blood pressure control across the studies. Older age, obesity, diabetes and renal dysfunction were found to be significant, although weak independent predictors of poor blood pressure control. History of cardiovascular or cerebro-vascular disease was the sole patient characteristic that may predict better hypertension control.

While the research in the included studies focused on patient characteristics, none of them investigated an association between physician characteristics and control of blood pressure in hypertensive patients.

An important lesson to be learned from this review is that the variability in findings from the studies suggests a weak relationship between certain patient characteristics and poor blood pressure control in hypertensive older adults. The findings should be regarded with skepticism given the low methodological quality of the studies that analyzed the association.

Table 6: Percentage of hypertensive patients with blood pressure at target in the studies reviewed

Study	Sample size	Date and location of study	Response rate	Definition of hypertension control	Measurement of blood pressure	Proportion of control (%)	Quality score and limitations
Roux 2006	4702	2001 France	Not stated	Blood pressure <140/90 mmHg	Blood pressure measured at physician's office using a mercury sphygmomanometer	Overall: 18% **60-70 years:16% >70 years: 14%**	**5** -No random selection of patients and physicians
Patel 2006	4286 women (A) and 4252 men (B)	1998-2001 UK	60% for women (A) and 76% for men (B)	Blood-pressure ≤ 150/90 mmHg	Nurse measured blood pressure using Dinamap monitor	**29%for women(A) 16% for men(B)**	**4**-Inadequate threshold for blood pressure control
Abaci 2006	16270	2004 Turkey	Not stated	Below 140/90 mmHg or <130/80 mmHg if diabetic	Physician measured blood pressure twice, using mercury sphygmomanometer ; mean used in analysis	Overall: 24.2% <65:27.7% **≥65:22.7%**	**5**- No random selection, ascertainment of hypertension diagnosis not stated
Senior	3068	2003-2004	Not stated	Well controlled:	Average of the three most	**Well**	**5** -No random

Study	Sample size	Date and location of study	Response rate	Definition of hypertension control	Measurement of blood pressure	Proportion of control (%)	Quality score and limitations
2006		New Zealand		<140/85 Controlled: <150/90 Mild: 149-159/90-99 Moderate: 160-179/100/109 Severe: >180/110	recently recorded blood pressure measurements	**controlled: 31%** **Uncontrolled: 69%**	selection of general practitioners who participated in the study
Grandi 2006	5524	2000 Italy	Not stated	Below 140/90 mmHg or <130/80 mmHg if diabetic	Blood pressure measured at physician's office using a mercury sphygmomanometer	Overall:33.4% **≥60 years: 32.2%** <60:38%	**6-**Number and characteristics of those who refused participation was not stated
Amar 2003	3155	1999-2000 France	Not stated	< 140/90 mmHg	Investigators measured blood pressure using a mercury sphygmomanometer; average of three recordings was used in analysis	33.2%	**4-** No random selection; Prevalence and control not reported by age group

In bold is the percentage of older hypertensive people with blood pressure control.

2.6. Blood pressure control among hypertensive patients reported in the included studies

The status of hypertension control reported in the studies reviewed is summarized in Table 6. The studies indicated that, globally, the percent of hypertensive patients of all ages with blood pressure controlled to below 140/90 mmHg ranged from 16% among older British men (Patel 2006) to more than 33% in general practice in Italy (Grandi 2006).

In this review, surveys conducted in Europe reported a wide range of hypertension control in general practice rates and had low quality scores. One study, with a quality score of five out of nine (Roux 2006), reported that a minority of all hypertensive patients in France were well controlled. Data were collected in 2001 through a questionnaire completed by the participating general practitioners that enrolled known hypertensive patients from their practice. The selection of physicians and patients was not random. The findings revealed that 18% of the hypertensive patients over 18 years of age in general practice had their blood pressure controlled. The hypertension control rate was lower among older participants, 16% for patients aged 60-70 and only 14% for those older than 70 years of age (Roux 2006).

Another study, conducted in France, investigated the control of blood pressure among hypertensive patients from general practice (Amar 2003). Individual data from patients recruited to participate in two surveys on cardiovascular prevention, the PRATIK study and the ESPOIR study, were analyzed. Both studies were cross-sectional surveys conducted in September 1999 - May 2000(PRATIK) and October 2000-July 2001 (ESPOIR), respectively. The hypertensive patients who participated in these studies were not-randomly selected by their general practitioner. The analysis of data from the health records of participants excluded patients with a history of stroke, coronary disease, significant valvular disease and idiopathic dilated cardiomyopathy. The participants in the ESPOIR study were significantly older (average age of 64) than those in PRATIK study (average age of 69). The proportion of patients with blood pressure control was 33.2% in PRATIK and 40.8% in ESPOIR.

Grandi et al found a low control rate among Italian hypertensive patients (Grandi 2006). The prospective study that aimed to evaluate the rate of blood pressure control among known hypertensive patients was conducted in all 670 practices in the District of Varese. Data, collected by physicians showed an overall control rate of 33.4% among the patients with known hypertension. People aged 60 and older had their blood pressure under control in 32.2% of cases.

The level of blood pressure control among British hypertensive people was found to be similar to other European countries; 29% of women and 16% of men reached the target blood pressure level. The authors analyzed data from two prospective studies of cardio-vascular disease. Baseline examination data from the British Women's Heart and Health Study undertaken between 1999 and 2001, as well as data from a clinical re-examination (1998-2000) of men participating in the British Regional Heart Study were analyzed to determine the proportion of older patients living in the northern region of Britain with optimal control of hypertension. It is important to note that the authors used an inadequate threshold for blood pressure control in their analysis. Well controlled hypertension was defined as a systolic of $\leq$ 150 mmHg and a diastolic of $\leq$ 90mmHg. In addition, patients with a history of cardio-vascular disease, defined as myocardial infarction, angina or stroke, were excluded from the analysis (Patel 2006).

A study conducted in New Zealand between 2003 and 2004 (Senior 2006) evaluated the management of hypertension for the elderly patients over the age of 80. Structured reviews of health records were conducted for all ambulatory people aged 80 and older registered with a participating general practitioner. Physicians were not randomly selected; they were identified on the basis that their practice type was known to serve a higher proportion of older people. The authors reported that 31% of the hypertensive patients aged 80 and older had their blood pressure controlled to the target. Patients were considered well controlled if the average of the last three blood pressure measurements recorded at the physician's office were < 140/85 mmHg (Senior 2006).

Findings from a survey conducted in 2004 in Turkey showed that 24.2% of all treated hypertensive patients over 18 years of age had their blood pressure under control (Abaci 2006).

Older patients were better controlled (27.7%) compared with those younger than 65 years of age (22.7%).

The majority of studies that reported the hypertension control rate according to age group showed that poor control was more common in older patients. Only one study found that older patients were slightly better controlled than the younger patients (Abaci 2006). Among older hypertensive patients, blood pressure of women was better controlled than that of men (Patel 2006).

2.7. Conclusion

The control of hypertension among patients in primary care has improved in the last decade. Nevertheless, more than half of the patients had their blood pressure poorly controlled despite improving trends in the management of hypertension. Achieving hypertension control has been a significant challenge and the reason for this continues to be a topic of research. The inconsistent findings from the reviewed studies suggest a weak association between hypertension control and selected patient characteristics. Studies undertaken in primary care found that older age, gender, obesity, diabetes and renal dysfunction may be predictors of poor blood pressure control, while a history of cardiovascular or cerebro-vascular disease is a patient characteristic that may predict a better control of hypertension. This review did not find any study that reported an analysis of the relationship between physician characteristics and blood pressure control in primary care patients.

The studies brought together in this review had low method quality scores (See Table 2 and Table 6). The risk of selection bias was high given that none of them had an adequate random sampling of participants, response rate for the participants was not stated or was inadequate, and non-respondents were not described. Four of the reviewed studies reported only the significant association between patient characteristics and hypertension control reducing confidence in the results and raising the question what other non-significant characteristics were evaluated and not

reported. The presence of selection and reporting bias, as well as inconsistencies in the patient characteristics reported by these studies made any quantitative summary inappropriate.

This systematic review has some limitations. The search strategy did not include unpublished studies and no hand search was performed. Only reports of studies published in English language journals were considered for inclusion. As a result, it is possible that relevant studies were missed. Furthermore, one person screened the results of the electronic search increasing the possibility that relevant reports were discarded. Quality assessment of the included studies, as well as data collection, was performed by one person increasing the risk of error.

The studies reviewed in this thesis focused only on the evaluation of patient characteristics associated with blood pressure control. Researchers in hypertension management suggest that physician and practice characteristics may also be barriers to the effective control of hypertension (Oliviera 2002). This review found that to date no study undertaken in primary care has investigated the combined relationship between physician and practice characteristics and the optimal management of hypertension in his/her patients.

Future research should be directed at determining physician and practice related barriers to effective blood pressure control in primary care. Furthermore, good quality studies performed in general practice should attempt to clarify the role of patient characteristics in attaining an optimal outcome of hypertension management.

In this context, the study conducted in 2004 on 28 family practices in Ontario made available information on the management of hypertension in Canadian primary care. Good quality data, collected from a health records review and questionnaires sent to participating family physicians made possible the investigation of the effectiveness of the interaction between hypertensive patients and their family physicians. These data permitted the analysis of the relationship between patients and physicians characteristics and blood pressure control among hypertensive patients under the care of family physicians.

3. METHODS

3.1. Context of the Hamilton/Ottawa study

This study is based on analysis of retrospective data collected from 28 randomly selected, non-academic family practices in Hamilton and Ottawa. The data used here is kept by the Cardiovascular Health Awareness Program (CHAP) Working Group (www.chapprogram.ca). The data analyzed in this study is derived from a cluster randomized controlled trial that was designed to assess the effectiveness of pharmacy-based blood pressure clinics led by peer health educators, with feed-back to family physicians on the monitoring and management of blood pressure among older adults.

The participants of the trial included the patients, practices of family physicians, pharmacies and peer health educators. Eligible patients were 65 years or older at the beginning of the trial, regular patients of their family physician, community-dwelling and able to leave their home and attend the community-based pharmacy sessions. Eligible physicians were those who had non-academic, full-time, regular family practice in terms of patient population and case mix and who were able to generate a roster of regular patients aged 65 and older. Family physicians involved in teaching and other academic activities associated with universities were excluded from the study to increase the study's generalizability to most of the 7,000 family physicians in Ontario.

All family physicians practicing in Hamilton (n=335) and Ottawa (n=592) were identified using databases held in each city (obtained from the Family Medicine Association in Hamilton, and purchased from a clinician-researcher in Ottawa). Following a computerized random selection process, an initial group of 242 physicians were screened for eligibility. Of the screened physicians, 214 were excluded; 134 physicians did not meet the inclusion criteria, 48 physicians could not be contacted and 32 refused collaboration. The 28 family physicians that collaborated with the study represent 47% of eligible contacted family physicians (See Figure 3). Of the 28 family practices, fourteen were randomly allocated to the intervention (pharmacy blood pressure clinics) and fourteen to the control group (no blood pressure clinics were offered).

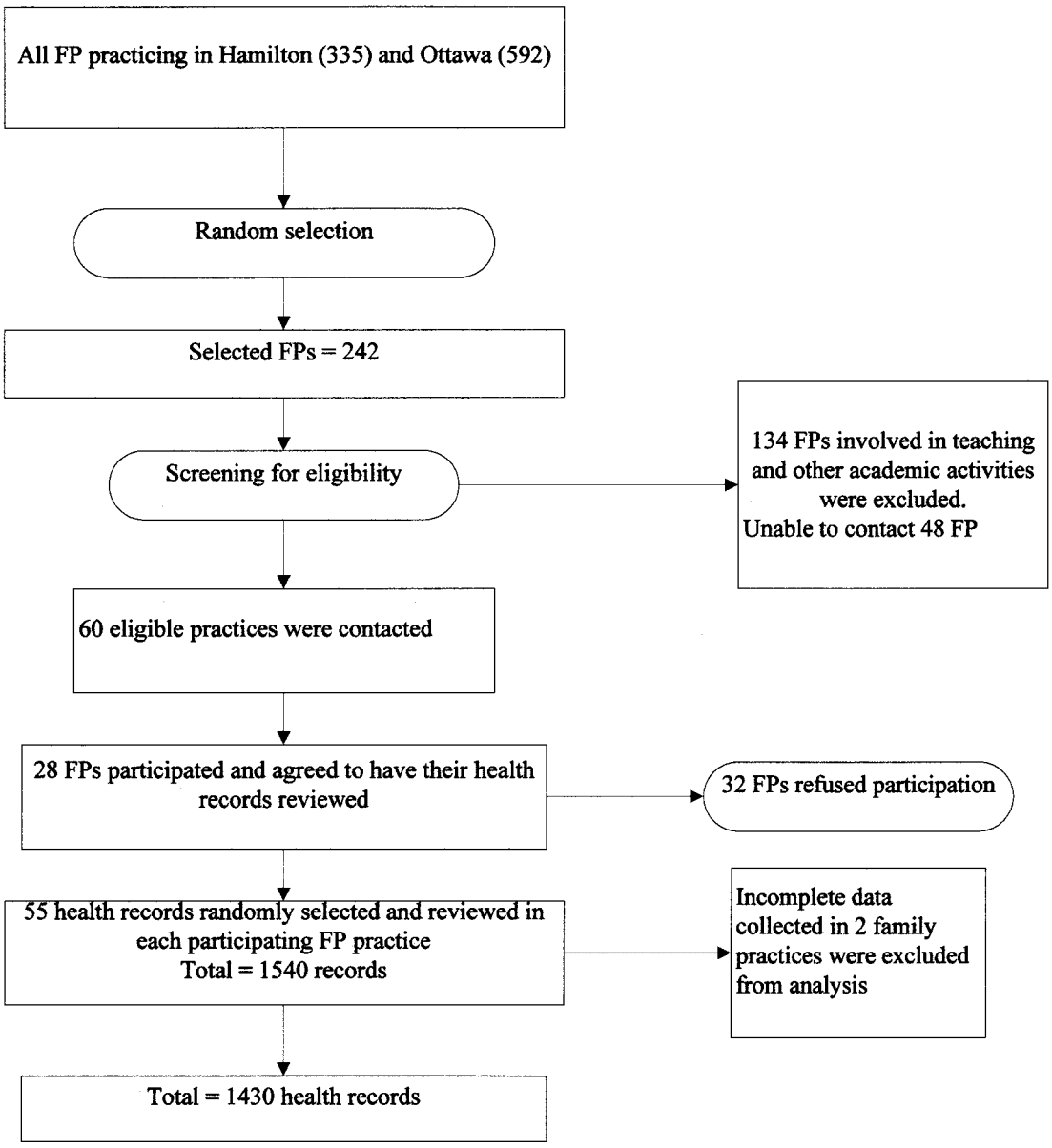
To assess the impact of the intervention, a retroactive health records review was conducted in the family practices rosters using 55 randomly selected patients. The health records of 1540 patients were reviewed. Trained research nurses conducted the review and collected data covering a period of 24 months, twelve months before and twelve months after the intervention. This thesis analyzes data from the period that preceded the trial.

All 28 family physicians completed a Family Physician Questionnaire (Appendix B) which provided information about the physicians' practice characteristics.
The study was reviewed and approved by the research ethics boards of the Bruyère Continuing Care and Hamilton Health Services and the Faculty of Heath Science at McMaster University in Hamilton.

3.2. Data sources

Fifty-five randomly selected health records, from all people 65 years old and over were reviewed in each participating family practice. Data analyzed in this thesis included detailed information on chronic conditions, health service use and hypertension management for the 12 months period that preceded the trial. Information from the healthcare records was abstracted by trained abstractors. A data abstraction form and guide were produced collaboratively and tested in pilot audits at each site. For data abstraction, research nurses were recruited and trained; three in Hamilton and five in Ottawa. To train the abstractors, 59 health records from practices not participating in the main study were reviewed. During this training exercise, inter-observer reliability was very good (k scores ranged from 0.66 to 1 with an average of 0.88). Teleconferences between the Ottawa and Hamilton teams and a videoconference were used to allow discussions of issues identified in the pilot phase. Issues relating to the interpretation of the data abstraction instructions and/or health record content emerging at each site were documented for discussion by the team at weekly meetings, and decisions documented and shared with all abstractors.

Figure 3: Selection of Family Physicians (FPs) and Patients Health Records


All FP practicing in Hamilton (335) and Ottawa (592)
Random selection
Selected FPs = 242
Screening for eligibility
134 FPs involved in teaching and other academic activities were excluded.
Unable to contact 48 FP
60 eligible practices were contacted
28 FPs participated and agreed to have their health records reviewed
32 FPs refused participation
55 health records randomly selected and reviewed in each participating FP practice
Total = 1540 records
Incomplete data collected in 2 family practices were excluded from analysis
Total = 1430 health records

3.3. Variables

The majority of the variables had been defined in the analysis of the trial data, in which the author of this thesis was not involved. Eleven new variables were computed from the available data. From the list of all available variables, those describing the elements of the conceptual model (Figure 1) and those identified in other studies were selected for the analysis. Thus, the patient variables, described in the systematic review, as well as additional variables describing physician characteristics, physician practice behaviour or practice characteristics, were analyzed.

Patients were considered hypertensive if any of the following notations was found in their health records: diagnoses of "hypertension"(HTN), "high blood pressure" or "high (↑) bp", the term "isolated systolic hypertension", a high blood pressure reading accompanied by indication of a targeted treatment such as reduction of alcohol and salt intake, weight reduction or prescription anti-hypertensive agents.

The outcome variable was the control of blood pressure in hypertensive patients. The number and date of blood pressure readings during the review period were obtained from health records. The mean value of five consecutive blood pressure readings, recorded in the patient's record, was compared to the recommended value from the Canadian Hypertension Education Program guidelines (http://www.hypertension.ca/chep). Patients with systolic blood pressure lower than 140 mmHg, or 130 mmHg for those with diabetes, were considered controlled. Observations with no blood pressure readings during the review period were deleted.

Patients' demographic characteristics, co-morbidities such as heart disease, diabetes, nephropathy, stroke, high cholesterol, number and type of antihypertensive medication, number of visits to family physicians and other indicators of the health services use were categorized as patient variables.

Information on physician characteristics and practice behaviour was collected from the health records and a questionnaire completed by the physicians on their socio-demographic and practice characteristics. The variables describing the physician's approach to diagnosis of hypertension or

adherence to guidelines of practice reveal the influence of the health system on physician's practice behaviour during the interaction with the patient. Physicians' approach to hypertension management was captured in variables such as the number of referrals to a specialist, number and type of antihypertensive medication prescribed or number of lifestyle counselling sessions offered to hypertensive patients. The Canadian Hypertension Education Program (http://hypertension.ca/chep/recommendations) recommends follow-up of patients on antihypertensive medication every three to six months for patients with blood pressure on target and monthly for those with blood pressure above the recommended value. Routine laboratory blood tests and electrocardiograms are also recommended to hypertensive patients (http://hypertension.ca/chep/recommendations). To describe the physicians' adherence to the recommended follow-up intensity and laboratory monitoring, information on the number of blood pressure readings and average length of time between readings, as well as the number of electrocardiograms and lipids blood tests ordered in the review period was also noted from the health records. The characteristics of the practice were captured in variables such as: total number of patients, number of patients seen in a day, location and type of practice. Information about physician characteristics was obtained from a questionnaire completed by family physicians and was expressed in variables such as: physician's age and gender, number of years in practice, and certification status with the Canadian College of Family Physicians. For a list of all variables, see Appendix A.

3.4. Missing data

For the variables with missing values (Appendix C), median and mean substitution was used. For some variables that described co-morbidities, a missing data was classified as absence of disease. For example, for the variable 'Has the patient been diagnosed with stroke?' missing data were interpreted as absence of the cerebrovascular event in that patient.

3.5.Data analysis

There were three components to the statistical analysis:

1. Assessing the percent of hypertensive patients whose blood pressure was controlled;
2. Examining the relationship of patient and physician characteristics in the control of hypertension; and,
3. Estimating the prevalence of hypertension in the population older than 65 years of age, based on health records review.

The original datasets used in this analysis were stored in SPSS format. The initial descriptive analysis was performed in this format. In the preliminary analysis the categorical variables were summarized using contingency tables that classified the observations according to their hypertensive status. The frequency and proportion of hypertensive and non-hypertensive patients according to each variable was observed. The linear variables were described with their mean, standard deviation and range. Graphical analysis was used for data visualization and to verify the normal distribution of the linear variables.

3.5.1. Percent of patients whose blood pressure is controlled

To identify the percent of hypertensive patients with controlled blood pressure and to identify patient and physician characteristics associated with control, only patients previously diagnosed with hypertension were considered. The percent of patients with controlled systolic blood pressure, according to patient and physician characteristics, was calculated using cross tabulation for the categorical variables. For the continuous variables the means in the two categories, controlled and uncontrolled, was obtained.

The application of standard tests for statistical significance on cluster data (family practice) could be inappropriate because the fundamental assumption that the sample observations are statistically independent is violated. This would imply that the computed chi-square test and t-test for difference in means is likely biased. Failure to adjust standard statistical methods for within-cluster dependence will result in spuriously low P values (Donner &Klar). When the

outcome variable is dichotomous – controlled vs. uncontrolled blood pressure, the analysis is challenging since there are many possible approaches. The methods that can be used are approximate and there is no single approach that has uniformly superior properties (Donner & Klar). One possible approach is to adjust the statistical test for the clustering of responses within a family practice. The adjustment depends on the computing of a clustering correction factor for each variable and for each group: controlled and uncontrolled. This factor can be calculated based on the number of observations in each cluster and the value of the intra-cluster correlation factor. Intra-cluster correlation factor (ρ = rho) is a measure of the interrelation between clustered data. It compares the variance within clusters with the variance between clusters. Mathematically, it is the between cluster variability divided by the sum of the within and between cluster variabilities. It can produce values between zero and one. A very small value indicates that the within cluster variance is much greater than the between cluster variance (Killip 2004).

One appropriate approach would be to fit a mixed-effect model or a hierarchical regression analysis for each variable, as described in the next section. This approach might not be appropriate for variables with a small number of observations.

3.5.2. Hierarchical model for the analysis of the association between patient and physician characteristics and blood pressure control

Single predictor analysis

PROC GLIMMIX procedure in SAS was used to perform a single predictor analysis for each variable separately. The hierarchical logistic regression, which takes into account the dependencies among individuals within the same cluster, was used to compute odds ratio and their 95% confidence intervals as well as P values for the hypothesis of significance for each variable. All variables with a P value lower than 0.2 were used in the multivariable multilevel model. All the covariates were entered simultaneously into the regression model.

Hierarchical logistic analysis

To examine the association between patient and physician characteristics and behaviour, a hierarchical modeling or multivariable multilevel analysis was performed. As described above, the study design involved random selection of family physicians and random selection of patients in each practice. Therefore, in the statistical analysis of the data, the hierarchical structure of the collected data was taken into account. The control of hypertension in patients clustered within family physicians practices was analyzed. The main consequence for a cluster design is that the outcome for each patient can no longer be assumed to be independent. The analysis assumed that the management of patients within a practice is likely to be more consistent than the management of patients across several practices and those patients within a practice are more likely to have similar outcomes. Given that the independence of observations can no longer be assumed, standard statistical techniques are no longer appropriate. If the clustering effect is ignored P-values will be artificially extreme and confidence intervals will be over-narrow, increasing the likelihood of spuriously significant findings and misleading conclusions (West 2007). In multilevel terminology, the dataset analysed have had a two-level structure: patients are the lower level and physicians represent the higher level. In a hierarchical model, variables from both levels are represented in the equation. A variable identifying each physician was used in the analysis to correct for the dependency of the observations within the physician. This enabled the multilevel analysis to generate a random intercept and the variance of the intercepts to be estimated. The PROC GLIMMIX procedure in SAS 9.1 was used to perform a logistic multilevel analysis, where the binomial dependant variable was whether blood pressure was controlled or not. Variables with P values lower than 0.2 in the single-predictor analysis and those identified by other studies to be statistically significant were introduced to the model. Only variables that were found significant at $P < 0.05$ level in the multilevel analysis were retained in the model.

Model diagnostic

To answer the question whether or not it was required to allow intercepts to be different for the physicians or in other words, if it was required to correct for the physician in the analysis, the

magnitude of the intercepts' variance in combination with the standard error was used. The likelihood ratio test cannot be performed because, in logistic multilevel analysis, the parameters are estimated with pseudo-likelihood and -2 log likelihood cannot be estimated. Theoretically it is not correct to perform a Wald test on variance parameters but it gives an indication of whether or not the variance of the intercepts is 'important'. When the variance is more than two times higher than its own standard error, the variance 'must' be considered important and therefore the corresponding regression coefficient 'must' be allowed to be random (Twisk 2006).

Because logistic multilevel analysis is an extension of standard logistic regression, all assumptions for logistic regression also hold for the multilevel model. An additional assumption that is characteristic for hierarchical analysis is the normal distribution of the intercepts (Twisk 2006, West 2007). This was verified by obtaining a Q-Q plot of the intercepts, whose values were obtained from the analysis.

3.5.3. Prevalence of hypertension

To determine the overall prevalence of hypertension, the entire sample was analyzed using descriptive statistics. Prevalence of hypertension and relative risk, according to the patient and physician variables, were calculated. For example, the prevalence of hypertension among diabetic patients was calculated and was compared to the prevalence in non-diabetics. The risk of hypertension in the two groups was compared and relative risk was calculated.

4. RESULTS

4.1. Demographic characteristic of patients whose health records were reviewed

A total of 1430 individual health records were reviewed. Of those, 609 (42.6%) were men and 820 (57.3%) were women. Of the 753 patients diagnosed with hypertension 40.8% were men and 59.2% were women. All participants in the study were older than 65 years and lived in an urban area.

4.2. Hypertension control among patients in Ottawa/Hamilton study

Good control of blood pressure was observed in 43% of all hypertensive patients and there was no difference in age between those with good and poor control (SeeTable 7).

On average, both controlled and uncontrolled hypertensive patients visited their family physician six times a year. Patients with good blood pressure control tended to visit the emergency room more often but they were hospitalized less frequently than those with poor control. Patients with diabetes were less well controlled than those without this condition. Among those with diabetes, 70% had blood pressure levels above the recommended target. Conversely, patients with a history of nephropathy were better controlled than those without a kidney disease; in almost 60% of cases blood pressure was well managed.

Table 7: Differences between controlled and uncontrolled family practice hypertensive patients older than 65 in the Hamilton/Ottawa study

Variable	Uncontrolled	Controlled	Variable	Uncontrolled	Controlled
Patient Characteristics			**Physician practice behaviour**		
Total	**57%**	**43%**			
Demographics			**Diagnosis**		
Age(mean)	75	75	Number of referrals (mean)	0.52	0.58
Male(%)	52	48	Number of cardio referrals (mean)	0.5	0.6
Health service use			**Treatment**		
Number of visits to FP during review period (mean)	6.03	5.85	Number of meds (mean)	1.48	1.48
Number of visits to ER (mean)	0.19	0.22	One or more medicines prescribed for the last day of the review period (%)	55	45
Patient was hospitalized during review period (%)	59	41	Number of BP readings (mean)	4.22	3.32
Number of hospital admissions (mean)	0.13	0.10	Number of lifestyle counselling visits (mean)	0.55	0.51
Diagnosis			**Lab monitoring**		
Systolic BP at physician's office(mean)	150	129	Number of ECG referrals (mean)	0.5	0.6
Average length of time between readings (days)	123	120	Ambulatory blood pressure monitoring ordered (%)	1.5	1.7
			Lipids ordered (mean number)	0.33	0.44

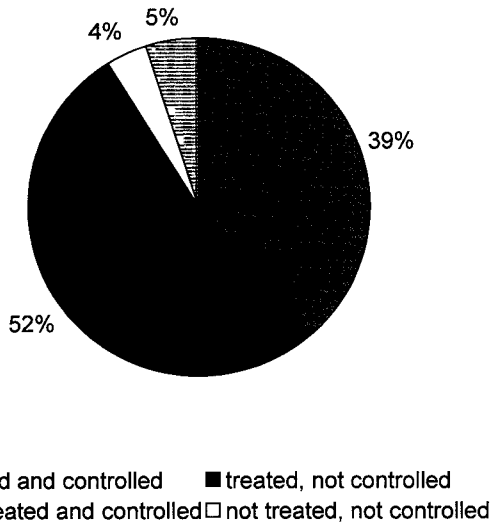
Variable	Uncontrolled	Controlled	Variable	Uncontrolled	Controlled
Co-morbidities					
Diabetes (%)	70	30	**Physicians and practices characteristics**		
Nephropathy (%)	41	59	Physician's age (mean)	53	51
Heart disease (%)	52	48	Male physician (%)	73.7	75.5
Stroke (%)	49	51	Number of years in practice (mean)	26	25
Peripheral vascular disease (%)	51	49	Number of patients/day(mean)	30	29
			Number of patients/practice(mean)	2300	2411
			Practice type: Solo (vs. shared patients) (%)	45 (50)	55 (50)
			Certification with Canadian College of Family Physicians (%)	79	78

In the analysis of physician practice behaviour, the results showed family physicians were less likely to refer patients with poor blood pressure control for tests or to specialist physicians but monitored their blood pressure more often and offered them more lifestyle counselling compared to those with good control. On average, blood pressure in patients with poor control was measured four times a year or every three months; three blood pressure measurements per year were taken on patients with good control. Most hypertensive patients (88%) received antihypertensive drug therapy and patients with poor control tended to be treated more often (55%) compared to the controlled patients (45%). There was no difference in the number of prescribed drugs for controlled and uncontrolled patients.

Patients with poor hypertension control had slightly older physicians but there were no differences regarding the physician's gender. Practice characteristics were very similar for both controlled and uncontrolled patients. No major differences were found between controlled and uncontrolled hypertensive patients concerning the number of patients per practice, status of certification with the Canadian College of Family Physicians, or type of practice. Although more hypertensive patients were seen in solo practices, compared to shared practices, a similar proportion of controlled and uncontrolled patients were seen in both types of practice.

Figure 4 shows the percent of treated and controlled hypertensive patients over 65 years of age in family practice in Ontario, as determined in 2004 by the Hamilton/Ottawa study. Although the percentage of patients with controlled hypertension has improved (43%) compared to a previous study in family practice (Petrella 2007), more than half of the hypertensive patients remain poorly controlled (52%).

Figure 4: Status of blood pressure control among patients with hypertension in 26 family practices in 2004 in Ontario, according to health records review (N = 709) in the Hamilton/Ottawa study



4.3. Hierarchical logistic model for the association between blood pressure control and patient and physician variables

4.3.1. Single predictor analysis

The single predictor analysis included 24 independent variables (See Table 1). Patient or physician characteristics that were found relevant in the reviewed studies were selected for this analysis. The association between each of the predictive factors and systolic blood pressure control was analyzed using a multilevel logistic regression that simultaneously corrects for the cluster design and the patient variation within each family practice. Male gender and the presence of comorbidities were the patient characteristics that were found to be significantly associated with good blood pressure control. Diagnosis of diabetes was strongly associated with less control of blood pressure. In patients with diabetes, hypertension was less than half as likely to be controlled compared to in non-diabetics (OR = 0.49 [0.33-0.71]). Diagnosis of heart disease and nephropathy was also associated with good blood pressure control.

Among the variables describing the physicians' practice behaviour, only the number of blood pressure readings was found to be associated with hypertension control. Patients with less than five readings per year were twice as likely to be controlled (95 % CI: 1.11 – 3.69) compared to those with 10 readings or more. The association was statistically significant with a P value of 0.02. The rationale for the dividing the number of blood pressure this way resided in the recommendations for blood pressure monitoring from the Canadian Hypertension Education Program. The Program recommend that blood pressure be monitored monthly at a physician's office (or more than ten times a year) if the readings are above the target, and every three to six months (or less than five times a year) if the target blood pressure has been reached. Thus, the analysis confirms that physicians clearly assessed blood pressure more often on patients with uncontrolled compared to controlled hypertension.

Table 8: Hierarchical Logistic Model single variable analysis of patient and physician characteristics assessing their relationship with the control of systolic blood pressure in the Hamilton/Ottawa study

	Variable	OR °	95% CI§	P value¶
	Patient's characteristics			
1	Gender (male vs. female)	1.48	1.08-2.03	0.01
2	Patients' age	1*	0.97-1.02	0.78
3	Diabetes (yes vs. no)	0.49	0.33-0.71	0.0003
4	Heart disease (yes vs. no)	1.5	1.08-2.08	0.01
5	Nephropathy (yes vs. no)	2.22	1.17-4.21	0.01
6	Stroke (yes vs. no)	1.46	0.88-2.44	0.14
7	Peripheral vascular disease (yes vs. no)	1.37	0.68-2.74	0.38
8	Number of visits to emergency room	1.16*	0.9-1.5	0.26
9	Number of visits to family physician	0.99*	0.95-1.03	0.6
10	Number of hospitalizations	0.7*	0.46-1.07	0.09
	Physicians' practice behavior			
11	Number of meds	1.05*	0.91-1.19	0.5
12	Referral to any specialist (yes vs. no)	1.11	0.80-1.54	0.52
13	Referral to cardiologist (yes vs. no)	1.00	0.58-1.74	0.98
14	Number of referrals to any specialist	1.12*	0.94-1.33	0.2
14	Number of electrocardiogram referrals	1*	0.58-1.74	0.98
15	Number of lipids referrals	1.23*	0.96-1.56	0.09
16	Number of BP readings			
	<5	2.02	1.11-3-69	0.02
	5 – 10	1.06	0.57-1.97	0.84
	>10	1		
17	Number of counseling visits	0.9*	0.75-1.06	0.2

	Variable	OR °	95% CI§	P value¶
	Physicians, characteristics			
18	Physician's gender	1.13	0.65-1.96	0.66
19	Physician's age:			
	≤ 40	3.86	1.41 – 10.55	0.008
	41- 50	1.09	0.54-2.2	0.80
	51 – 60	0.92	0.45-1.88	0.83
	> 60	1		
20	Physician's certification with Canadian College of Family Physicians (yes vs. no)	0.94	0.52-1.68	0.83
21	Type of practice	0.80	0.57-1.12	0.2
22	Physician's academic appointment (yes vs. no)	1.18	0.72-1.92	0.5
23	Number of patients/ day (less than 30 vs. >30	1.40	0.84-2.34	0.19
24	Number of patients/ practice (less than 2000 vs. >2000)	1.20	0.72-1.99	0.47

° Odds Ratio

§ 95% Confidence Intervals for the OR

*OR of continuous variables are assessed as one unit offset from the mean

¶ P value for the significance of the regression coefficient

Analysing the relationship between hypertension control and physician characteristics, only physicians' age was statistically significant associated with the hypertension control. Young physicians were almost four times more likely to control their patients' blood pressure compared to physicians older than 60.

4.3.2. Hierarchical model

Fourteen variables with a P value for the β coefficient lower than 0.2 in the single predictor analysis, as outlined in Table 8, were initially used in the hierarchical model. They were simultaneously introduced in the multivariable multilevel logistic analysis. Using a backwards elimination, non-significant covariates were removed and only six predictors for systolic blood pressure control with a P <0.05 were retained in the final model (See Table 9). Patient characteristics with a statistically significant association with blood pressure control were presence of comorbidities such as diabetes, heart disease and nephropathy and male gender. In accordance with the findings from the single predictor analysis, diabetes reduced by half the likelihood of control among hypertensive patients. In contrast, the presence of heart or kidney diseases increased the likelihood of blood pressure control. The likelihood of control in patients with nephropathy was more than two times higher when compared with those without the disease. Presence of heart disease increased by 1.67 times the likelihood of control in hypertensive patients. Men were more likely to be controlled compared to women (P = 0.01).

Among variables describing physician practice behaviour analysed in the model, only the number of blood pressure readings over a one year period was found to have a statistically significant association with control. The only physician characteristic that was statistically significant was the age of family physicians. Patients with young doctors were more than five times more likely to have their systolic blood pressure under control compared to patients of physicians older than 60 (P = 0.005).

Finally, in the final regression model, interactions between patients' age and other variables were analysed and were found not significant. This confirms that the association between control of blood pressure and other predictors did not vary with patient age.

Table 9 : Multi-variable hierarchical and logistic regression model results in the Hamilton/Ottawa study

	Multivariable hierarchical model					Logistic regression model				
Covariate	**OR***	**CI****	**β†**	**SE†††**	**P†††**	**OR**	**CI**	**β**	**SE**	**P**
Patients' characteristics										
Diabetes	0.43	0.28-0.65	-0.83	0.21	<0.0001	0.45	0.30-0.67	-0.80	0.10	0.0001
Heart diseases	1.67	1.17-2.38	0.51	0.18	0.004	1.60	1.14-2.26	0.47	0.08	0.007
Nephropathy	2.37	1.21-4.64	0.86	0.34	0.01	2.28	1.18-4.42	0.83	0.17	0.01
Patient's gender	1.5	1.07-2.09	0.40	0.17	0.01	1.48	1.07-2.05	0.39	0.08	0.01
Physicians' practice behavior										
BP readings: <5	2.58	1.35-4.92	0.95	0.33	0.004	2.44	1.30-4.58	0.89	0.13	0.0002
5 to 10	1.2	0.62-2.31	0.18	0.33	0.58	1.20	0.63-2.27	0.18	0.14	0.22
>10	1		0			1				1
Physicians' characteristics										
Physician's age:30-40	5.40	1.65-7.66	1.69	0.60	0.005	4.90	2.22-10.86	1.59	0.26	<0.000
40-50	1.07	0.47-2.42	0.07	0.41	0.86	1.00	0.60-1.68	0.001	0.14	0.44
50-60	0.86	0.37-1.98	-0.14	0.42	0.73	0.81	0.48-1.38	-0.21	0.14	1
>60	1					1				
Number of referrals	-	-	-		-	1.20	1.00-1.44	0.18		0.047

* Odds Ratio

** 95 % Confidence Intervals for the OR

† Regression coefficient estimate

†† Standard error for the regression coefficient

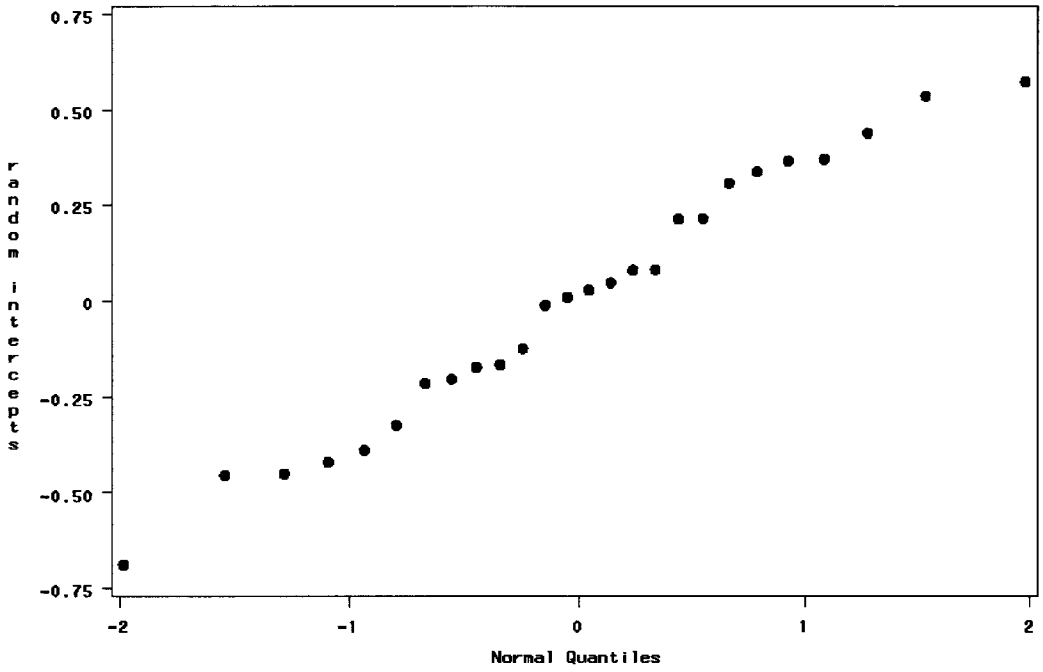
††† P value for the statistical significance of the coefficient

4.3.3. Evaluation of the hierarchical model

The first question raised was whether or not the intercepts corresponding to each physician should be allowed to be random. Since it was not possible to perform the likelihood ratio test, the magnitude of the variance of the intercept in comparison with the standard error of the variance was used. In this analysis, the estimate value of the variance of the intercept was 0.23 and the corresponding standard error was 0.12. The value of the ratio was 1.88. As the variance was less than two times higher than the corresponding standard error, the random coefficient for the intercept can not be considered important and the random effect associated with the physician-specific intercepts can be omitted. In other words, according to this test, the correction for physician was not necessary.

The most important assumption in multilevel logistic regression is the normal distribution of intercepts. The assumption was verified using a Q-Q plot of the intercepts (Figure 5). The linear trend in the plot indicated normal distribution of the intercepts and confirmed that the assumption was correct.

Figure 5: Q-Q plot of the random intercepts in the multilevel logistic regression



4.3.4. Comparison between the results of hierarchical logistic model and standard logistic model

As presented in section 4.3.3, the statistical test that assessed the need for hierarchical analysis of the data showed that the random variation at the physician's level does not add new information. This test was theoretically "incorrect" as it gives only an indication of whether or not the variance of the intercepts is important. The question "Is the hierarchical model necessary?" could be answered by comparing the results of the hierarchical analysis with the results of a standard logistic regression analysis. The results of a 'standard' logistic regression on the same dataset are shown in Table 9. In this analysis, all observations were assumed to be independent and no correction was made for dependence of patients within practices. From Table 9 it can be seen that the same covariates were found to be associated with systolic blood pressure control as in hierarchical logistic analysis. In the relationship between blood pressure control and patient characteristics the odds ratio, regression coefficients and standard errors were slightly decreased in the standard logistic model. The odds of blood pressure control for those with heart disease decreased from 1.67 to 1.60 and the standard error decreased from 0.18 in the mixed model to 0.08 in the standard model. Only for diabetes, did the values for odds ratio and β coefficient increase minimally in the standard analysis; the standard error decreased from 0.21 to 0.10. The P value based on Wald statistics revealed the same significant values in both analyses.

The results obtained in the analysis of the relationship of practice behaviour with control of blood pressure were similar in both, hierarchical and standard logistic regression (See Table 9). A minimal decrease was observed in the standard logistic regression for odds ratio, regression coefficients and standard errors. As to the statistical significance, P values were also lower in the logistic regression. Thus, the P value for the significance of less than five readings decreased from 0.004 in the hierarchical model to 0.0002 in the logistic model. Standard error for the same variable decreased from 0.33 in the multilevel analysis to 0.13 in the logistic model.

The analysis of the relationship between control of hypertension and physician's age followed the same pattern. The odds of hypertension control for patients with young physicians (under 40 years old) compared to patients with older physicians decreased from 5.4, in the analysis that corrected for the family doctor, to 4.9 in the standard logistic regression. Standard error also decreased from 0.60 to 0.26. For P values corresponding to the same variable, an important reduction was noticed. The P value decreased from 0.005 in the mixed model to less than 0.0001 in the logistic regression.

The variable describing the physician practice behaviour was found to be not statistically significant in the multilevel model but of borderline significance in the standard logistic regression. The association between hypertension control and the number of referrals ordered by the family physician in a year was not significant in the hierarchical model but statistically significant when the correction for physician was absent (P = 0.047).

4.4. Prevalence of hypertension in patients older than 65 participating in the Hamilton/Ottawa study

4.4.1. Prevalence and control of hypertension in patients with comorbidities participating in the Hamilton/Ottawa study

Of all health records reviewed, 751 (52%) documented hypertension (See Table 12). Patients with comorbidities were hypertensive in a higher proportion than the sample average. More than 70% of those with other chronic illnesses were also diagnosed with hypertension. Among patients diagnosed with heart disease, 64% also had high blood pressure. Conversely, among hypertensive patients, the prevalence of other chronic conditions ranged between five and 30 % of patients whose health records documented hypertension (See Table 10), 22 % also were diagnosed with diabetes. Of all comorbidities, heart disease was most prevalent (31 %) among those diagnosed with hypertension and 25% in the total sample. Cerebrovascular disease had a prevalence of 7 % among all patients and almost 10 % among those with high blood pressure.

With the exception of patients with diabetes, the proportion of patients with comorbidities whose blood pressure was controlled was greater than the sample average. Participants with nephropathy had the highest control rate (59 %) and patients with diabetes had the lowest (30%) rate. Patients with heart disease were controlled for blood pressure in almost 48% of cases and those with history of stroke had a control rate of approximately 51 %.

Table 10 : Prevalence of co-morbidities among family practice hypertensive participants over 65 years old and proportion of controlled in the Hamilton/Ottawa study

Comorbidity	Prevalence in individuals over 65 years (%)	Prevalence among hypertensive over 65 years (%)	Proportion of controlled hypertension in individuals with comorbidities (%)
Diabetes	16.4	22.0	30
Nephropathy	3.6	6.0	59
Heart disease	25.2	30.9	48
Stroke or transient ischemic attack	7.0	9.5	51
Peripheral vascular disease	3.2	4.7	49
Study population			**43**

4.4.2. Healthcare services used by the participants in the Hamilton/Ottawa study during the review period

Health care services were used moderately by patients with high blood pressure. Hypertensive patients tended to use health services more often than non-hypertensive patients. The volume of health care services used by the participants in the study is shown in Table 11.

Hypertensive patients in this study visited their family physician, on average, six times during the review period. According to the guidelines for high blood pressure management, it is recommended that patients visit their doctor every three to six months. In this population of patients, they visited their physician, in average, every two months. Hypertensive patients visited the emergency room on average 0.22 times per year, or once every five years and were hospitalized in average, once every eight years

Table 11: Physician practice behavior toward elderly hypertensive and non-hypertensive patients in the Hamilton/Ottawa study

Variable	Average for non-hypertensive participants	Average for hypertensive participants	Proportion of hypertensive patients that used the service (%)
Number of visits to family physician	4.55	6.12	98
Number of referrals to any specialist	0.49	0.53	37
Number of visits to emergency room	0.15	0.22	17
Number of hospital admissions	0.10	0.12	10
Number of referrals to cardiovascular specialist	0.04	0.06	6
Number of electrocardiograms referrals	0.04	0.06	6
Number of echocardiograms orders	0.03	0.05	5
Number of lipids	0.24	0.35	30
Number of blood pressure readings	1.8	4.3	94
Number of lifestyle counseling visits	0.38	0.50	30

4.8 Physicians' practice behaviour in hypertensive participants

The analysis of physician practice behaviour indicated that 67 % of the referrals to a cardiovascular specialist were for hypertensive patients (See Table 12). Conversely, of all hypertensive patients 5% received referrals for echocardiography and 6 % were referred to a physician specialized in cardiovascular diseases. Almost a third of hypertensive participants were referred for lipids blood tests, a mean number of 0.35 referrals per year or approximately once every three years. The frequency of referrals for routine laboratory tests is not stated in the guidelines and should reflect the clinical situation of the patient. Among those who received lifestyle counselling, 58% were hypertensive. Conversely, only 30% of hypertensive individuals received one or more counselling sessions from their family physician, although guidelines strongly recommend lifestyle counselling for those diagnosed with high blood pressure.

Table 12: **Prevalence of hypertension among family practice participants in the Hamilton/Ottawa study**

Variables	Total number of patients	Prevalence of Hypertension (%)	Variables	Total number of patients	Prevalence of Hypertension (%)
Total	**1430**	**52.6**			
Patient characteristics			**Physician practice behaviour**		
Male	609	50.4	Referral to any specialist physician	870	53.5
Diabetes	235	70.5	Referral to cardiovascular specialist	165	66.7
Nephropathy	51	88.2	ECG ordered	642	58.6
Heart disease	359	64.3	Ambulatory ECG recorder ordered	8	62.5
Patient previously had stroke or TIA	100	71	Exercise stress test ordered	93	53.8
Peripheral vascular disease	46	76.1	Echocardiography ordered	184	60.3
Aortic aneurysm	29	53.6	Perfusion study for heart ordered	64	60.9
No visits to physician during the review period	6	16.7	Lower extremity arterial perfusion study	20	60
Visits to the emergency room for any reason	352	58.7	Carotid artery evaluation ordered	107	62.6
Patient hospitalized for any reason	249	56.2	Heart catheterization ordered	22	59.1
No antihypertensive medication prescribed	782	23.8	Ambulatory BP monitoring ordered	14	64.3
No blood pressure readings recorded	77	13.2	Lipids ordered	935	56.2
Patient stopped smoking	26	30.8	Lifestyle counselling provided	566	58.1

Variables	Total number of patients	Prevalence of Hypertension (%)	Variables	Total number of patients	Prevalence of Hypertension (%)
Physician and practice characteristics					
Physician's age* ≤ 40	110	51.8			
41-50	603	52.9			
51-60	550	51.5			
≥ 60	164	56.1			
Type of practice: Solo practice	1154	54.5			
Shared patients	273	44.7			
Number of patients per day: ≤ 30 patients/day	934	51.8			
>30 patients/day	440	55.5			
Number of patients per practice: ≤ 2000	880	51.7			
> 2000	494	55.3			
Accreditation with CCFP	1098	53.6			

* Proportion of hypertensive patients in the practices of physicians with certain age; † Proportion of hypertensive patients in practices with < 30 patients /day compared to practices with > 30 patients/day; ‡ Proportion of hypertensive patients in practices with more than 2000 patients compared to practices with 2000 or less

5. Discussion

This thesis analyzed the baseline data for a clustered randomized trial performed in 2004 on 28 family practices in Ottawa and Hamilton. Detailed data were collected from the patients' health records for the twelve months preceding the start of the trial. The findings from the health records review allowed the observation of hypertension management in urban general practice settings in Ontario over a period of one year.

Strengths and limitations

The lists of all family physicians in Ottawa and Hamilton were used as the sampling frame. The rosters of 28 family practices that agreed to participate were used for the random selection of health records. The sample of family practices participating in this study might not be representative of primary care practices in Ontario for the following reasons: only the practices located in these two cities were invited to participate in the trial and no information was collected from rural areas; only non-academic physicians were considered eligible; physicians' participation rate was low (47%). In the Ottawa/Hamilton study no data was collected on family physicians that refused to participate and it is not known if important information was missed. Difficulty in obtaining physician participation in health research has been noted by other authors. Commonly cited reasons are lack of time, lack of interest, and insufficient office staff (Asch 2000). In a review of the literature undertaken to identify the factors associated with higher physician participation rates in community-based health research, the authors found that family physicians had a notably lower participation rate (between 55% and 65%) compared to other specialties. Participating physicians may differ in some ways from non-participants, increasing the risk of bias. Collecting information on non-participants is important for estimating the direction and the magnitude of the bias (Asch 2000) but this data collection exercise was outside the scope of this thesis.

Data on patient characteristics, in conjunction with data on physician practice behavior were collected from the patients' health records. This was a strong point of the study because it

offered an insight of real life activity of the physician and how the patient was managed. It was assumed in this study that the health records reflected the interaction between the patients and their family physician. Data from the health records offered extensive clinical information about patients, which was readily available for this study. These data also revealed details about physician practice behavior: the regularity of blood pressure readings, the pattern of medication prescription, the frequency of lifestyle counseling sessions offered, and the collaboration with other specialist physicians for the management of hypertension. Despite the availability and the depth of information abstracted from the health records the following sources of error are possible. First, there is a great variability in the completeness and accuracy of the health records. Research revealed that general practitioners record only part of the health information on patients and their brief notes offer few details (Rethans JJ 1994). Second, errors may also be introduced by the misinterpretation of the examination findings or of the test results, or by the inaccurate health histories provided by the patient (Pan 2005). Third, manual collection of data from many pages of typed reports and handwritten notes may also introduce inaccuracies. To help maximize the accuracy in data abstraction, researchers in the Hamilton/Ottawa study developed a detailed data collection guide, offered training to the data abstractors, and maintained regular contacts with the abstractors to clarify questions. Another important limitation of this thesis was the fact that data was collected for another purpose and did not include all the information that might have contributed to a better understanding of the relationship between patient and physician characteristics and hypertension control Although the use of electronic medical records may improve the quality of data, only a quarter of family practices in this study had a computerized system for recording patient information.

Data about the physician and practice characteristics were collected using a self-completed physician questionnaire with closed-ended questions. The researchers provided a set of pre-determined response alternatives for respondents to use when answering the questions. The use of a self-completed questionnaire has advantages, as well as limitations. This type of data collection allows physicians to answer at a convenient time and location; data can be collected relatively quickly and at low cost; data collected through closed-ended questions was easily analyzed and interpreted in the context of the hierarchical multilevel analysis used in this thesis. The main disadvantage of the closed-ended question format was the limitation to physician

responses; added comments provided limited details. Also, discussing questions with others may lead to unknown influences on responses. In a self-completed questionnaire, the respondent may skip the sensitive questions. All 28 family physicians participating in this study returned the questionnaires fully completed. Another possible source of error is the possibility that a person other than the physician, such as the nurse, completed the questionnaire. Data from the Hamilton/Ottawa study did not contain any information about the identity of the person from the family practice who completed the questionnaire.

In the Hamilton/Ottawa study, the ascertainment of diagnosis of hypertension was based on medical records. The patient was considered hypertensive only if a diagnosis of hypertension was recorded in the health record by the treating physician. This approach was an important strength of this study because it minimized the risk of bias due to misclassification; the physicians used an array of information to establish the diagnosis, as opposed to other studies that used self-reported diagnosis.

Accurate blood pressure readings are very important to the diagnosis and treatment of hypertension, as well as to research. In this study, information regarding the technique of measurement, type of instrument used or the person who performed the measurement, the nurse or the physician, was not collected. Furthermore, patients who did not visit their physician during the review period or did not have blood pressure readings could not be assessed.

Blood pressure readings are greatly influenced by many factors. First, patients, especially the elderly, are subject to higher circadian blood pressure variability (Beevers 2001). Second, the healthcare environment can increase the anxiety and raise the blood pressure in normo-tensive, as well as hypertensive patients, condition known as "white coat syndrome". The values of blood pressure analyzed in this study were measured at the physician's office, in real life settings and they might be associated with "white coat" response. Third, blood pressure readings can be influenced by the manner in which the reading is taken. Blood pressure levels tend to increase in the sitting or standing posture compared to the lying position. The arm position bellow the heart level and the absence of arm support can also lead to an over-estimation of the blood pressure (Beevers 2001). Using a cuff of inappropriate dimension for the arm can be a serious source of

error which can lead to incorrect diagnosis and erroneous conclusions in hypertension research. There is evidence that a cuff that is either too narrow or too short can cause over estimation of blood pressure (O'Brian 1996). The accuracy of the measuring device is another possible source of error. A sphygmomanometer, a recently calibrated aneroid device or a validated and calibrated electronic device are the recommended blood pressure monitors for a physician's office (http://hypertension.ca/chep/recommendations-2009). All these possible sources of error in blood pressure reading can have serious implications for the epidemiology of hypertension and clinical practice.

The use of a hierarchical multilevel model for the data analysis was another strong point of the thesis. The hierarchical analysis and the comparison with the standard logistic regression showed the importance of taking into account the similarities between patients with the same family physician or the lack of independence of the patients in the sample. The hierarchical model proved to be more conservative compared to the standard logistic regression. The standard regression showed that the number of referrals was significantly associated with blood pressure control, but this was not confirmed when the hierarchical structure of the data was taken into account. Failure to use the hierarchical analysis would have led to inaccurate results.

Despite the limitations, the current study identified some potentially important findings regarding hypertension control in general practice. The thesis generated three important findings. First, hypertension control in Ontario has improved considerably since the last Canadian Heart Health Survey (Joffres 1997). Second, selected patient characteristics and physician practice behavior and characteristics were significantly associated with the control of high blood pressure in patients diagnosed with hypertension in family practice. Third, the prevalence of hypertension in people over 65 in family practice is similar to the prevalence observed in other studies.

Control of hypertension

Overall, the Hamilton/Ottawa results showed that blood pressure was controlled in almost half of patients diagnosed with hypertension by their family physician (See Figure 4). The findings related to blood pressure control were comparable with those from the most recent survey of the

general population in Ontario (Leenen et al. 2008) which demonstrated that the overall proportion of hypertension control has improved considerably, compared to the level of control observed in the last Canadian Heart Health Survey (1992), when only 13 % of hypertensive patients were treated and controlled (Joffres1997). This overall increase in blood pressure control in the last decade is related to a significant improvement in the management of the condition and increased efforts directed to patient education. The Ontario Survey on the Prevalence and Control of Hypertension found an overall hypertension control of 66 % and 67% for those between 60 and 80 years of age (Leenen et al. 2008). The higher proportion of blood pressure control in Leenen's study compared with present study could be explained by the differences in blood pressure measurement and sampling frame. In the Hamilton/Ottawa study, blood pressure was measured at the physician's office during regular visits and documented in the patient's health record. The average blood pressure reading in five consecutive visits was used to determine the proportion of hypertension control. 'White coat effect 'could explain the higher blood pressure measurements and the lower proportion of hypertension control in family practice. In Leenen's study, participants were selected from the general population and were examined by a trained nurse in a home visit. The status of control of hypertension was based on a single visit measurement, using a BpTRU automated blood pressure measuring device.

A possible explanation for the improvement in hypertension management could be the initiation of a number of collaborative efforts in the late 90s in Canada. In 1997, Health Canada established the National Hypertension Control Strategy, a country-wide strategy to evaluate the prevalence, incidence and approaches to the control of hypertension (http://www.phac-aspc.gc.ca/ccdpc-cpcmc/websites_e.html). Other organizations and programs at national level, such as Canadian Hypertension Society, the Canadian Hypertension Education Program and the Blood Pressure Canada, have set as their priorities to promote effective approaches to the management of hypertension, to annually update the diagnosis, management and treatment of hypertension and to increase awareness about hypertension in Canada (http://www.hypertension.ca/). At the provincial level, the Ministry of Health Promotion in Ontario collaborated with various groups, including health and education agencies, the Ontario College of Family Physicians, voluntary associations and community groups to run comprehensive programs to prevent chronic disease such as heart disease, type 2 diabetes and

stroke. According to the Hamilton/Ottawa study, and other studies reported in the last year (Leenen 2008, Tu 2008), these initiatives appear to have had a positive impact, increasing the overall control of hypertension, including in patients with coexisting chronic disease such as renal and cardiovascular disease. With diabetes, the analysis of the data in the present study and other Ontario studies suggests that reaching blood pressure goals in diabetes continues to be a challenge.

Patient and physician characteristics associated with blood pressure control

The multivariable hierarchical analysis indicated that selected patient characteristics, as well as physician characteristics and practice behavior, were important predictors of blood pressure control.

In this review of family practice health records from 2004, it was found that men and patients with comorbidities were more likely to have blood pressure under control. A possible explanation for this finding is that patients with complex chronic disease may benefit from a better clinical management generally, including the management of hypertension. Physicians might be identifying these patients at high risk and focusing their efforts on hypertension control in this group. Patients with coexisting chronic complex conditions such as cardiovascular, cerebrovascular disease, peripheral arterial disease or nephropathy might have received more time during regular visits and benefited from a more effective interaction with their healthcare provider. Physicians are aware that blood pressure control is an important factor to prevent the progression of these chronic diseases, and therefore, may treat hypertension more aggressively. Nevertheless, successful management of hypertension requires effective partnership between the healthcare provider and the patient. Patients with comorbidities may perceive the importance of greater involvement in the management of their complex condition. Other studies also found that hypertensive patients with coexisting cardiovascular, cerebrovascular disease or nephropathies are more likely to have their blood pressure well controlled (Abaci 2006, Senior 2006) but the reason for this result was not investigated. Further research is needed to clarify the reasons for these findings.

In the Hamilton/Ottawa study, the analysis showed that the control of hypertension in patients with diabetes was low. Similar results were found consistently across studies located in the systematic review (Abaci 2006, Grandi 2006, Amar 2003). This may be related to the lower blood pressure goals in patients with diabetes, which are more difficult to achieve. There is a need for more aggressive treatment and control of high blood pressure in diabetic patients.

The Hamilton/Ottawa study also showed that while older men were less likely to be hypertensive those diagnosed with high blood pressure were more likely to be controlled compared to women. The increased likelihood of blood pressure control in men was also reported in one of the reviewed studies (Amar 2003) conducted in primary care settings. Nevertheless, the role of gender as a predictor of blood pressure control is uncertain since other reviewed studies found that being male decreased the likelihood of blood pressure control (Roux 2006) or reported non-significant relationship (Senior 2006). Such variability in findings indicates a weak relationship between gender and blood pressure control.

Frequency of blood pressure readings was an important physician's practice behavior that was found to be significantly associated with hypertension control. Patients who had their blood pressure monitored by their family doctor according to the guidelines, on average every three months, were more likely to be controlled. An increased number of readings was not associated with a positive effect on blood pressure control. It is possible that patients with difficult to treat hypertension and uncontrolled blood pressure had their blood pressure measured more often compared to controlled hypertensive patients. The association between the frequency of blood pressure monitoring and hypertension control has not been reported in previous prevalence studies.

Physician's age was the best predictor of blood pressure control. Physicians under 40 managed their patients' hypertension five times better than physicians over 60. Although older physicians cared for more hypertensive patients than younger physicians, the difference in proportion was too small to account entirely for the effect of physician's age on hypertension management. Other potential reasons for this finding could be that young doctors completed their training more recently and were more knowledgeable about blood pressure control. In addition, starting a

new practice gives them more time, more energy and interest to build a good relationship with their patients. Good communication and collaboration between patient and physician could have an important effect in promoting good management of hypertension and better control of blood pressure. Other studies provide support for this supposition. An example is a study conducted in primary care clinics in Japan (Asai 2002) whose main objective was to analyze physician prescribing behavior in poorly controlled hypertensive patients. This retrospective survey of medical records showed that younger physicians were more likely to increase medication in hypertensive patients with poor blood pressure control. However, the role of physicians' age in the successful management of their patients has rarely been investigated and further research is needed to clarify the significance of this finding. Greater understanding of the influence of physician characteristics on practice behavior could lead to an improvement in the management of hypertension and could reduce the burden of uncontrolled hypertension.

Prevalence of hypertension among patients in Hamilton/Ottawa study

Overall, the results of the present study indicate that in family practices in Ontario the prevalence of hypertension among older patients is high. More than half of patients over 65 years old were diagnosed with hypertension by their family doctor and the prevalence was similar for both men and women. The review of health records for the very old patients in primary care in New Zealand showed a similar result (Senior 2006). In this study, the hypertensive status was determined in more than half (56%) of all ambulatory people aged 80 and over, in primary care. The Ontario Survey on the Prevalence and Control of Hypertension, (Leenen 2008) obtained comparable figures for the prevalence of hypertension in the Canadian general population. The study showed that the general population in Ontario aged 20 and older had an overall prevalence of hypertension of 21% which increased to 52% among those between 60 and 80 years of age.

The thesis results reveal that hypertension is more prevalent among patients with comorbidities. More than three quarters of those diagnosed with diabetes were also hypertensive. The increasing in prevalence of diabetes in Ontario, in response to the rising rates of obesity and other factors such as aging population, could contribute further to the burden of cardiovascular disease. There

is a need for greater efforts to prevent diabetes, as well as efforts to aggressively treat and control high blood pressure in patients with diabetes.

Hypertension is a major modifiable risk factor for heart and kidney disease. Although the Hamilton/Ottawa study found a higher than average prevalence of hypertension among patients with nephropathy and heart disease, the proportion of blood pressure control in these categories of hypertensive patients was above the sample average. The better control rate could be due to the improvement in hypertension management through new guideline recommendations and health education efforts that have increased the public's knowledge about the benefits of treating hypertension.

All hypertensive patients visited their family physician at least once in a one year period. On average, they saw their doctor every two months. Blood pressure was measured more often in patients with poor blood pressure control confirming physicians' compliance with the guidelines for hypertension management. A third of hypertensive patients were tested for blood lipids abnormalities but a low percentage of them received lifestyle counseling from their family physician.

This study found no difference in the number of antihypertensive drugs prescribed to controlled and uncontrolled hypertensive patients. The cross-sectional design of the study did not allow the investigation of therapeutic changes over time that should be recommended by physicians to patients with suboptimal control of blood pressure. Treatment adjustment includes switching to another drug, or the use of additional antihypertensive drugs (http://hypertension.ca/chep). In this context, it is difficult to interpret this finding about the physicians' prescription patterns. Patients' adherence to treatment regimens was an important piece of information that was missing from the data analyzed here. It would be extremely valuable to compare treatment adherence data in hypertensive patients with good and poor control. Patients' compliance with treatment may also be an indicator for physician practice behavior. Recent research suggested that the physician played an important role in influencing patient adherence to medication (Harmon 2006). Follow-up visits, as well as effective communication (e.g. explanations,

reassurance, support and encouragement) with their physicians may facilitate patients' adherence to treatment recommendations.

Diet and lifestyle changes are strongly recommended by the CHEP guidelines for the management of hypertension (http://www.hypertension.ca/chep/). The low number of lifestyle counseling visits recorded in the health records could be due to the time restraints faced by family physicians practices. It is possible that brief lifestyle recommendations were offered to patients during regular visits but were not recorded. Physicians should increase their attention to this important issue. Additional time is required to be scheduled for high-risk patients who need more attention outside of the routine physician encounter. In Family Health Teams and Community Health Centers in Ontario nurses and other clinical staff are available to provide lifestyle counseling.

The prevalence of hypertension among patients was found to be different only for physicians in solo practices or older than 60. These physicians cared for a slightly larger proportion of hypertensive patients compared to young physicians or group practices. This finding is consistent with the results of the National Family Physicians Survey (http://www.nationalphysiciansurvey.ca/nps/news/reportsnews).

As proposed in the conceptual framework, this study aimed to understand the nature of the relationship between different elements that have a role in the management of hypertension. This analysis showed that selected patient and physician characteristics may influence the management of hypertension in primary care. On the other hand, this investigation could not confirm with certainty the role of the health care system in achieving blood pressure control. Data on practice characteristics and physician practice behavior, which may reflect the influences of the entire system, failed to provide sufficient evidence to demonstrate that the health care system has a role on hypertension management. The only physician practice behavior characteristic found to be associated with the control of blood pressure was the number of blood pressure readings during the review period. This result demonstrates that physicians assessed blood pressure more frequently in patients with difficult to treat conditions but future studies would be required to determine if this leads to a better outcome in family practice. Consistent

with previous studies identified through the systematic review (Senior 2006, Grandi 2006, Roux 2006, Amar 2003), this thesis shows that the patient characteristics that may influence the management of hypertension are patient gender and the presence of complex chronic conditions. Gender was a weak non-modifiable risk factor for poor blood pressure control but awareness can help to identify at-risk patients and to improve prevention and clinical management of hypertensive patients. Presence of comorbidities in hypertensive patients was a good predictor of good blood pressure control. This finding may indicate an effective patient-physician interaction and an indirect intervention of the health system. Thus, better control in patients with comorbidities demonstrated that physicians changed their practice behavior and adopted more aggressive strategies for the management of hypertension associated with other chronic illnesses. In addition, these patients may have benefited from a valuable collaboration among clinicians from different specialties. Health programs provided by the healthcare system may have a significant impact on patient outcome. Patients with complex chronic condition often benefit from these programs which work to implement activities that promote healthy living and reduce the burden of chronic disease. Often these activities aim to increase patients' knowledge and skills, and the confidence to manage their condition assuring more effective interaction with the physician and improving disease control (Wagner 2001).

The only physician characteristic that had a positive effect on blood pressure control was the age. The role of physicians' personal characteristics on patient outcomes has seldom been investigated. Physician's age may influence both, physician's practice behavior and patient behavior; younger physicians may adopt a more vigorous approach to hypertension treatment (Asai 2002) and also influence patient adherence to antihypertensive medication (Ren 2002). Although this characteristic cannot be influenced by external interventions, further research is required to confirm this finding and to identify potential implications for the management of hypertension.

The relationship between blood pressure control and patient and physician characteristics is very complex. Although the role of patient characteristics in the control of hypertension has been examined in numerous studies, the assessment of the role of physician practice behaviour and personal characteristics has rarely been explored. This study brought an important contribution to

this effort. The association between hypertension control and the number of blood pressure readings and physician age were new findings, not reported by previous research. Further studies are required to confirm these findings.

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Appendix A

Factors that could contribute to uncontrolled hypertension

Information extracted from CHAT Exit Chart Review (see www.chapprogram.ca)

PATIENT CHARACTERISTICS:

A. Patient demographics:

1. Age
2. Gender
3. Patient status: patient left, non-ambulatory, nursing home, deceased

B. Health service utilization:

4. Number of visits to FP during review period
5. Average length of time between visits
6. Patient did not visit FP during review period
7. Patient visited the ER for any reason during review period
8. Number of visits to the ER for any reason during review period
9. Was the patient hospitalized during review period?
10. Number of hospitalization during review period

C. Blood pressure readings

11. Average systolic BP during review period at FP's office
12. Average systolic BP during review period in the specialist's office
13. Average ambulatory readings during review period
14. Average length of time between readings

D. Treatment:

15. Number of anti-hypertensive medication taken

16. No anti-hypertensive medication prescribed for the last day of the review period

E. Co-morbidities:

17. Patient diagnosed with diabetes
18. Patient diagnosed with retinopathy
19. Patient diagnosed with nephropathy
20. Patient diagnosed with heart disease
22. Patient diagnosed with stroke
23. Patient diagnosed with peripheral vascular disease
24. Smoking status

PHYSIC IAN'S CHARACTERISTICS AND BEHAVIOUR:

A. DIAGNOSTIC:

1. Number of referrals to a specialist physician for any reason during review period
2. Number of referrals to a specialist physician for cardiovascular condition during the review period

B. TREATMENT:

3. Type of anti-hypertensive medication prescribed
4. Number of drugs prescribed
5. Lifestyle counseling during review period

C. FOLLOW-UP INTENSITY:

6. Number of BP readings in FP's office
7. Average length of time between blood pressure readings
8. Number of counseling visits during review period

D. LABORATORY MONITORING:

9. Electrocardiogram ordered during review period
10. Holter monitor ordered during review period
11. Exercise stress test ordered during review period
12. Echocardiography ordered during review period
13. Chest X-Ray ordered during review period
14. Ambulatory blood pressure monitoring ordered during review period
15. Lipids ordered during review period

E. PHYSICIAN AND PRACTICE CHARACTERISTICS

16. Physician's age
17. Number of years in practice
18. Practice location
19. Practice type
20. Physician's certification with the Canadian College of Family Physician
21. Total number of patients per practice

Appendix B

Baseline Questionnaire: Family Physician & Practice Characteristics

1. Physician gender:
   - o Male
   - o Female

2. Physician date of birth

   Mm/dd/yyyy

3. Physician age at graduation from medical school

   __ Years

4. Certification with the Canadian College of family Physicians:
   - o Yes
   - o No

5. Practice location
   - o Urban
   - o Rural
   - o

6. Practice type
   - o Solo
   - o Group → shared office space only

     Shared patients

7. Practicing under:
   - o Fee for service
   - o Health Service Organization
   - o Community Health Centre

- Primary Care Reform
-

8. Academic Appointment with a Health Science Centre:
   - Yes
   - No

Variable in the dataset	Question on the health record abstraction form
Patient characteristics (medical records)	
Age*	Date of birth: Mm/dd/yyyy
Gender*	Sex : Male/Female
Hypertensive status	Was the patient hypertensive during the first twelve months of the review period? A patient is considered to be diagnosed with hypertension if any of the following are found: a. The diagnosis of "hypertension" (HTN) appears, or 'high blood pressure " or high (↑) bp appears in the context of a diagnosis, rather than to describe one elevated reading. b. The diagnosis is unambiguously noted (without question mark, terms "query", "probable" or "probably", "monitor"). c. The term "isolated systolic hypertension" (ISH) appears; a reading > 160/90 without "isolated systolic hypertension" is not sufficient. d. A high blood pressure reading or a comment regarding BP is accompanied by indication of a targeted treatment. Treatment includes reduction of alcohol and salt intake, weight reduction measures, or prescription of anti-hypertensive agents.
Diabetes*	Does the health record state that the patient has diabetes? (Diabetes may include: Diabetes mellitus, Type 1 diabetes, Type2 diabetes, insulin dependent diabetes, non-insulin dependent diabetes, adult-onset diabetes)

Variable in the dataset	Question on the health record abstraction form
Nephropathy*	Does the health record state that the patient has nephropathy? (Nephropathy may include: chronic renal insufficiency, chronic renal/kidney failure, chronic kidney disease, end-stage renal disease. Nephrosclerosis)
Heart disease*	Does the health record state that the patient has heart disease? * (Heart disease may include: left ventricular hypertrophy, angina, atrial fibrillation, prior myocardial infarction, prior coronary revascularization, coronary artery disease, ischemic/arteriosclerotic heart disease, congestive heart failure, acute coronary syndrome, coronary artery bypass surgery, arteriosclerosis)
Stroke*	Does the health record state that the patient has had stroke or transient ischemic attack?
Aortic aneurism	Does the health record state that the patient has an aortic aneurysm?
Hospitalization	Was the patient admitted to the hospital for any reason during the review period? If yes, record the dates of the hospital admission in chronological order.
Smoke	Does the patient currently smoke?
Patient behavior (medical records)	
Visit	Record the dates the patient made a visit to the family physician's practice for any reason during the review period. (Include all instances where the patient saw the physician or nurse. Do not include telephone consults between physician/nurse and patient; do not include instances where the patient visited the practice solely to drop off a test sample.)

Variable in the dataset	Question on the health record abstraction form
Emergency visit	Did the patient visit the Emergency Room for any reason during the review period? If yes, record the dates of the ER visit in chronological order. (If the patient was admitted to the hospital during an ER visit, this would count as an Admission and not an ER visit. If the patient is sent to the ER with a consult note, this would count as a Specialist Referral. If the patient is sent to the ER with a consult note and admitted to the hospital, this would count as an Admission.)
Physician practice behavior (medical records)	
Referrals	Was the patient referred to a specialist physician for any reason during the review period? If yes, record the dates the referral was made.
Cardiovascular referral	Was the patient referred to a specialist physician for a cardiovascular condition during the review period? If yes, record the dates the referral was made.
Lipids ECG Echocardiography Ambulatory BP Holter monitor	Indicate whether the patient had any of the following tests ordered during the review period: electrocardiogram, Holter monitor, echocardiography, carotid artery evaluation, ambulatory BP monitoring, lipids. (Record the date the test was ordered. It is not necessary that the test have been completed/performed).
BP Readings	Record blood pressure readings taken during the review period. Record the date the reading was taken in chronological order. If more than one reading is recorded for a single visit, record the lowest reading based on the systolic value.

Variable in the dataset	Question on the health record abstraction form
Lifestyle counseling	Is the lifestyle counseling noted during the review period? If yes, record the dates the counseling took place and provide details. (Record if any of the following lifestyle risk factors were discussed, regardless of who initiated the discussion: body weight, salt intake, physical activity, alcohol intake, smoking, management of life stress.)
Anti-hypertensive medication	Record all current antihypertensive medication as of the last day of the review period. Record any date associated with a currently prescribed antihypertensive medication, including refills.
Physician characteristics (physician questionnaire)	
Physician gender	Physician gender
Physician age	Physician date of birth
Number of years of practice	Physician age at graduation from medical school
Certification with CCFP	Certification with the Canadian College of Family Physicians
Practice characteristics (physician questionnaire)	
Practice location	Practice location
Practice type	Practice type (Solo, Group)

Variable in the dataset	Question on the health record abstraction form
Academic appointment	Academic appointment with a Health Science Centre

* Represent patient characteristics identified in the systematic review

Appendix C

Missing data among hypertensive patients for variables used in hierarchical multilevel analysis:

Variable	Missing (%)	Strategy for Handling Missing Data
Patient's gender	0	
Diabetes	0	
Heart disease	0.5	Considered absence of heart disease
Nephropathy	0.7	Considered absence of nephropathy
Stroke	0.4	Considered absence of cerebrovascular event
Number of hospitalization	0	
Number of referral to any specialist	0	
Number of lipids test referrals	0	
Number of blood pressure readings	5.7	Deleted the observations
Number of counseling visits	0.1	Considered absence of counseling visits
Number of patients/day	3.1	Replaced with the mean
Number of patients /practice	3.1	Replaced with the mean

Appendix D:

Quality assessment checklist for the studies included in the systematic review

Author:

Year of Publication:

Journal:

1. Is the sampling method adequate (random selection of participants)?

a) Yes (1 point)

b) No

2. Is the sampling frame appropriate?

a) Yes (1 point)

b) No

3. Is the sample size adequate?

a) Yes (1 point)

b) No

4. Is the ascertainment of diagnosis of hypertension based on medical records?

a) Yes (1 point)

b) No

5. Is the definition of blood pressure control adequate and according to the guidelines?

a) Yes (1 point)

b) No

6. Is there unbiased measurement of outcome (blood pressure control)?

a) Yes (1 point)

b) No

7. Is the response rate adequate?

a) Yes (1 point)

b) No

8. Are the refusers described?

a) Yes (1 point)

b) No

9. Are the estimates of prevalence or incidence given with confidence intervals and in detail by subgroup, if appropriate?

a) Yes (1 point)

b) No

Appendix E

Search strategy for the Medline database using an OVID interface:

1 primary care.mp.
2 community.mp. [mp=ti, ab, tx, ct, sh, hw, it, tn, ot, dm, mf, nm]
3 family practice.mp.
4 family physician.mp. [mp=ti, ab, tx, ct, sh, hw, it, tn, ot, dm, mf, nm]
5 patient.mp. [mp=ti, ab, tx, ct, sh, hw, it, tn, ot, dm, mf, nm]
6 physician characteristics.mp. [mp=ti, ab, tx, ct, sh, hw, it, tn, ot, dm, mf, nm]
7 patient characteristics.mp. [mp=ti, ab, tx, ct, sh, hw, it, tn, ot, dm, mf, nm]
8 hypertension.mp. [mp=ti, ab, tx, ct, sh, hw, it, tn, ot, dm, mf, nm]
9 high blood pressure.mp. [mp=ti, ab, tx, ct, sh, hw, it, tn, ot, dm, mf, nm]
10 controlled hypertension.mp. [mp=ti, ab, tx, ct, sh, hw, it, tn, ot, dm, mf, nm]
11 cross-sectional study.mp. [mp=ti, ab, tx, ct, sh, hw, it, tn, ot, dm, mf, nm]
12 1 or 2 or 3 or 4 or 5
13 8 or 9 or 10 or 11
14 12 and 13 and 6 and 7
15 remove duplicates from 14

February 2009 search strategy, using MeSH terms for Medline database using OVID interface

1 primary health care/ or "continuity of patient care"/ or patient-centered care/
2 community health services/
3 Family Practice/
4 Patient Care/
5 Patient Care Management/
6 Physicians, Family/
7 Physician's Practice Patterns/
8 Physician-Patient Relations/

9	Patients/
10	Aged/or middle aged/
11	Aged, 80 and over/
12	treatment outcome/
13	Risk Factors/
14	*Hypertension/
15	*Blood Pressure/
16	1 or 2 or 3 or 4 or 5
17	6 or 7 or 8 or 9 or 10 or 11 or 12 or 13
18	14 or 15
19	16 and 17 and 18
20	exp cohort studies/or exp cross-sectional studies/
21	19 and 20