

Screening for Hypertension

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Abstract

Background: Hypertension has been defined as a blood pressure level at which an otherwise healthy person would have an increased risk of cardiovascular disease that could be mitigated through blood pressure-lowering treatment. Worldwide, hypertension is the number one cause of death. The prevalence of hypertension and cardiovascular disease increases with age, and has been found to be higher in those of South Asian and African ancestry, and in Aboriginal populations. Not only is hypertension one of the most important risk factors for cardiovascular disease, it is also the number one modifiable risk factor for stroke. In Canada, an estimated 7 million adults are living with diagnosed hypertension.

Purpose: The purpose of this review is to summarize the evidence on screening for hypertension (detecting undiagnosed hypertension) in primary care. This review aims to determine the effectiveness of hypertension screening in primary care in reducing the risk of cardiovascular events and all-cause mortality. Determining the effectiveness of screening in reducing blood pressure (BP) is a subsidiary aim. The harms of hypertension screening – excluding harms caused by treatment – will also be reviewed.

Data Sources: A search strategy was developed to identify the literature on screening for hypertension. The search was limited to English and French language literature published between 1996 and November 2010 (and subsequently updated to include literature published from 1985 to 1995 and November 2010 to September 14, 2011). Both searches were performed in three bibliographic databases: Medline, EMBASE and EBM Cochrane Controlled Trials. Separate search strategies were used to incorporate the distinct subject headings employed in Medline and Cochrane Controlled Trials (MESH) and in EMBASE (Emtree).

Study Selection: Systematic reviews, randomized controlled trials, and observational studies with evidence for the clinical benefit or potential harms of screening were used to address key questions. Contextual questions were addressed with systematic reviews, randomized controlled trials, and observational studies.

Data Abstraction: Title/abstract and full text screening, data abstraction and quality assessment were completed by two people. All disagreements were resolved through discussion with the synthesis team. The included studies were reviewed according to the criteria set out in the CTFPHC Procedure Manual. The strength of evidence was determined based on the GRADE system of rating quality of evidence using GRADEPro® software. The exceptions to this process were studies related to the contextual questions of costs, performance indicators, patient preferences, subpopulations, and grey literature, for which abstraction was done by one person and evidence was not rated using the GRADE system.

Results: This review found no controlled studies of the effectiveness of screening for hypertension in primary care. It did find one cluster randomized trial assessing whether a community-based cardiovascular screening program that included hypertension screening is superior to usual screening practice and one modeling study that met inclusion criteria for studies on the benefits of hypertension screening. There were no studies that met the inclusion criteria for identifying the optimal frequency and/or timing of screening for identifying patients who

might benefit from treatment, nor for identifying specific criteria that should trigger an increase in the frequency of screening. No studies that met inclusion criteria were found to address the harms ranked ‘critical’ by the Hypertension Working Group. However, two papers (and one companion paper) of interest were identified regarding the consequences of informing patients of a new diagnosis of hypertension.

Limitations: Only articles in English and French are included. For the contextual questions on special populations, access to screening, cost effectiveness, performance indicators, and patient values and preferences, the searches are limited to the past five years and results are not based on a full systematic review.

Discussion: The major question addressed in this review was whether there is direct evidence to support screening for hypertension in primary care practice. Such evidence could arise from studies comparing current clinical practice with either less intense or more intense screening, yet a literature search returned only a single paper that met inclusion criteria for studies on the benefits of hypertension screening, although the program was not limited to just the detection of undiagnosed hypertension. This program provided more intense screening than what is provided in usual clinical practice and led to an increase in antihypertensive therapy and a decrease in cardiovascular morbidity in a target population aged 65 and older (RR 1.10, 1.02 to 1.20, $p=0.02$; RR 0.86, 0.73 to 1.01, $p=0.06$). Despite demonstrating strong evidence of benefit, these results can only indirectly address the major question in our review, which is focused on general population screening in primary care practice. The base result of the single modeling study exercise included in the review was that annual screening for hypertension as a risk factor for chronic kidney disease would lead to a gain of 0.116 Quality Adjusted Life Years (QALYs) (95% CI: -1.396 to 1.745) per patient screened. The major limitations of this study were the focus on chronic kidney disease and assumptions regarding hypertension management, leading to concerns over the detail to which hypertensive disease progression was modeled. Thus, while the model suggested that there may be substantial incremental QALYs gained per individual screened, the statistical uncertainty around the estimates was large. Of the papers of interest identified regarding the consequences of informing patients of a new diagnosis of hypertension, none compared two groups who were screened differently. Rather, they compared groups who were informed differently of their screening results. Moreover, only patients who screened positive for hypertension underwent testing. Both of these studies were considered only very weakly informative regarding potential harms of hypertension screening on a population basis.

Conclusion: In this review, there were no studies identified that specifically and directly assessed whether screening for hypertension in primary care practice reduces the risk of cardiovascular morbidity, cardiovascular mortality, and all-cause mortality and/or whether it leads to sustained reductions in blood pressure. As well, there were no studies identified that assessed whether measuring blood pressure at most clinical encounters in primary care achieved the desired cardiovascular morbidity or mortality outcomes or sustained reductions in blood pressure. However, in light of some evidence for benefit from a more intense (cardiovascular) screening program that included hypertension screening, and the overwhelming evidence that treating patients diagnosed with hypertension improves patient outcomes, there is indirect evidence to support screening for hypertension by measuring blood pressure in most primary care encounters rather than screening less frequently.

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Chapter 1: Introduction

Purpose

The purpose of this review is to summarize the evidence on the effectiveness of screening for hypertension in primary care. Worldwide, hypertension is the number one cause of death and is ranked number four in disability adjusted life years (DALY), a measure of disease burden based on the estimated rate of premature death, disability and infirmity caused by a given disease.¹ A recent study found that in 2007/08 an estimated 6 million Canadian adults (23% of the population) were living with diagnosed hypertension.² Based on these findings, it is estimated that in 2011 these numbers would have reached 7 million Canadian adults living with hypertension. In addition to being one of the most important risk factors for heart disease, hypertension is also the number one modifiable risk factor for stroke.³ Over 90% of individuals aged 55 to 65 with normal blood pressure would be expected to develop high blood pressure over the remainder of their lifetime. Therefore, reviewing the evidence on the effectiveness of screening for hypertension in primary care was chosen as a high priority for the Canadian Task Force on Preventive Health Care (CTFPHC) in their topic prioritization process.³

The CTFPHC has not reviewed this topic since 1994.⁴ Current clinical practice guidelines by the Canadian Hypertension Education Program (CHEP) recommend that all adults have blood pressure assessed at all appropriate clinical visits, although the frequency of such visits is not specified. In addition, CHEP guidelines state that all people with high normal blood pressure require annual assessment.⁵ However, CHEP cites no direct evidence regarding the benefits of hypertension screening, and their screening recommendations are implicitly grounded in the evidence of benefit from the treatment of diagnosed hypertension.

This review aims to determine the effectiveness of hypertension screening in primary care in reducing the risk of cardiovascular events and all-cause mortality. Determining the effectiveness of screening in reducing blood pressure (BP) is a subsidiary aim. The harms of hypertension screening – excluding harms caused by treatment – will also be reviewed. The work done by CHEP to address the treatment aspects related to hypertension is recognized and acknowledged.

In 2004, the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC7) recommended yearly screening for hypertension in patients with baseline systolic blood pressure (SBP) 120 to 139mmHg or diastolic blood pressure (DBP) 80 to 89mmHg. In patients with BP less than 120/80mmHg, they recommended screening every two years.⁶ The absence of similar in depth Canadian recommendations for the primary prevention of hypertension was a further motivation for the CTFPHC to select this topic for a new review in 2010.

Background

Definition

Hypertension is conceptually defined as the presence of a blood pressure at which an otherwise healthy person would have an increase in cardiovascular risk that could be mitigated through blood pressure-lowering treatment.⁷ Although mortality increases linearly with blood pressure, hypertension is defined in Canada by standardized auscultatory office SBP equal to or exceeding 140mmHg or DBP equal to or exceeding 90mmHg over a number of visits in persons

without target organ damage or comorbid conditions such as diabetes or kidney disease.⁸ The diagnosis may be made in fewer clinic visits in people with more prominently elevated blood pressure, with target organ damage, or with specific comorbidities. Classification criteria for hypertension using home and daytime ambulatory blood pressure measurements require SBP equal to or exceeding 135mmHg or DBP equal to or exceeding 85mmHg.⁸ The thresholds for 24-hour ambulatory blood pressure measurements SBP equal to or exceeding 130mmHg or DBP equal to or exceeding 80mmHg.⁵

Prevalence and burden of disease

In 2007/08 an estimated 6 million Canadian adults (23% of the population) were living with diagnosed hypertension.² Based on these findings, it is estimated that in 2011 these numbers would have reached 7 million Canadian adults living with hypertension. The prevalence of hypertension is nearly identical between men (19.7%) and women (19.0%) and increases with age, from 2% of 20 to 39 year olds to 53% of 60 to 79 year olds.⁹

Etiology

The etiology of essential hypertension is thought to be multifactorial. Obesity, sedentary lifestyle, poor diet with excess intake of salt and alcohol are major contributors.¹⁰ Candidate genes have been identified in a number of genome-wide association studies.^{11,12} Hormonal factors contributing to the development of hypertension include increased activity of angiotensin II, mineralocorticoids and the sympathetic nervous system.¹³ Secondary causes of hypertension include drugs, renal and vascular disease, endocrine disorders and obstructive sleep apnea.¹⁴ Hypertension is more common in people of African and South Asian ancestry and in those with a family history of hypertension.^{15,16}

Consequences of untreated hypertension

Hypertension is the most important risk factor for cardiovascular disease, the consequences of which include death, stroke, and myocardial infarction. Hypertension is also an important risk factor for chronic kidney disease, left ventricular hypertrophy and congestive heart failure, and dementia.¹⁷⁻²¹ Severe and acute elevations in blood pressure may cause encephalopathy, retinopathy, acute decompensated congestive heart failure, aortic dissection, and acute kidney injury.²² Globally, hypertension accounts for 13% of all deaths, 51% of deaths from stroke, 45% of deaths from ischemic heart disease and 4% of disability-adjusted life years lost.¹

Rationale for screening

A large body of evidence supports the effectiveness of blood pressure lowering therapy in preventing, reducing, or delaying the consequences of hypertension.^{23,24} Hypertension is usually asymptomatic until complications develop, and the Canadian Health Measures Survey showed that 17% of Canadians with hypertension are unaware of their condition.⁹ Therefore, hypertension screening could be a valuable strategy in preventive healthcare. However, the optimal methods, frequency and target population for screening are not well described and practitioners would benefit from having these clearly defined within an evidence-based guideline.

Screening strategies

Hypertension screening is a tactic to detect hypertension in patients without a prior diagnosis of hypertension. The usual screening test for hypertension is simply the measurement of blood pressure. Traditionally, blood pressure has been measured by physicians and nurses in the office using a manual sphygmomanometer, although operators, settings, and devices are becoming more diverse. As blood pressure is considered to be a vital sign that should be routinely measured at most clinical encounters, hypertension screening is implicitly part of routine medical practice. This review will examine strategies that employ any practitioner (e.g., physician, nurse, pharmacist) or patient, using any device (e.g., mercury manometer, aneroid, automatic cuff, or 24-hour blood pressure monitor), in any setting supervised by a primary care professional (e.g., home, office, pharmacy), with any frequency, to screen for hypertension.

Because hypertension is traditionally defined by office blood pressure measurements, the performance characteristics of office blood pressure measurement as a screening test for hypertension cannot be determined unless a different test (e.g., 24-hour blood pressure) is adopted as the reference standard. Both ambulatory blood pressure monitoring (ABPM) and home blood pressure monitoring (HBPM) are superior risk prognosticators of mortality and cardiovascular morbidity when compared to office blood pressure.^{8,25-27}

Beyond screening - interventions and therapies

Patients diagnosed with hypertension are recommended to have a global assessment of cardiovascular risk and to undergo laboratory investigation and electrocardiography as a screen for target organ damage, secondary causes of hypertension and associated vascular risk factors.^{5,8} Lifestyle modification measures are broadly encouraged, including physical exercise, weight loss, and consumption of a healthy diet with restricted alcohol and salt intake.⁸ Antihypertensive drug therapy is recommended for patients with BP $\geq 160/100$, for those with BP $\geq 140/90$ with target organ damage or other vascular risk factors, and for those with BP $\geq 140/90$ without target organ damage whose BP is not lowered with non-pharmacological approaches after four to five visits.⁵ First-line agents include thiazide-type diuretics, beta-blockers, angiotensin-converting enzyme inhibitors (ACEIs), long-acting calcium channel blockers (CCBs), and angiotensin II receptor blockers (ARBs).⁵ The agent(s) of choice and the target blood pressure depend on a number of patient characteristics.⁵ The goals of therapy are to prevent target organ damage and to improve survival. Therapy, however, is beyond the scope of this review which is limited to the evidence on the effectiveness of screening for, not treatment of, hypertension.

Current clinical practice

The 2012 Canadian Hypertension Education Program (CHEP) recommendations for the management of hypertension propose that the blood pressure of all adult patients should be assessed at all appropriate visits for the determination of cardiovascular risk and recommend annual follow up for people with high normal blood pressure (SBP 130-139 mmHg and/or DBP 85-89 mmHg).⁵ This recommendation does not make a distinction between screening for undiagnosed hypertension and monitoring previously diagnosed hypertension patients, and does not identify a specific interval for standard hypertension screening. In practice, blood pressure is measured during most clinical encounters – whether explicitly for the purpose of hypertension screening or not. A recent cross section study that screened unselected Canadian adults found that 17% of patients with hypertension were unaware of their hypertension. The fact that 83% of the study population had already been informed of a diagnosis implies that screening is widely

performed.⁹ However, the most appropriate practitioner, device, setting and frequency for hypertension screening have not yet been determined.

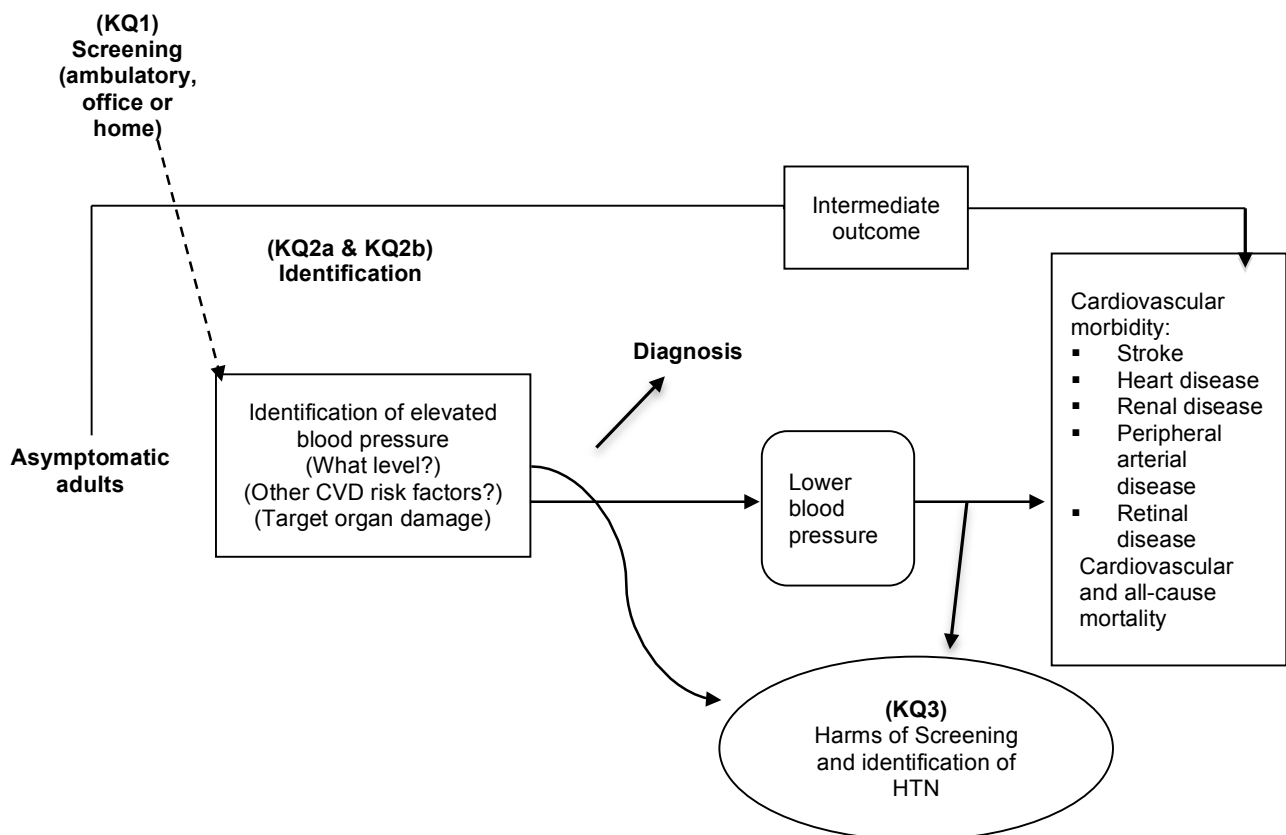
Chapter 2: Methods

Analytic Framework

Analytic frameworks are used to describe the clinical concepts and logic underlying beliefs about how interventions may improve health outcomes. Figure 1 depicts the analytic framework for evaluating studies of screening for hypertension. This analytic framework draws heavily from the framework designed by the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC7).⁶ In this analytic framework:

- Straight arrows depict actions (such as the performance of a screening test)
- Curved arrows depict adverse events (also considered to be actions)
- Rectangles with square corners depict clinically relevant outcomes (such as decreased cardiovascular morbidity); and
- Rectangles with rounded corners depict intermediate outcomes (such as lowered blood pressure)

Figure 1. Hypertension Analytical Framework



Note: This framework does not include management of diagnosed hypertension, as it is beyond the scope of the CTF mandate

Key Questions

KQ1: Does screening for hypertension in primary care practice reduce the risk of cardiovascular morbidityⁱ, cardiovascular mortality, and all-cause mortality? Does it lead to sustained reductions in blood pressure?

KQ2: How can we most effectively screen for people in whom blood pressure reduction may be beneficial?

KQ2a: Which method of blood pressure screening (ambulatory, office or home blood pressure measurements) is most effective for identifying patients who might benefit from treatment?ⁱⁱ

KQ2b: What is the optimal frequency and timing of screening (including age of onset of screening) for identifying patients who might benefit from treatment? Are there specific criteria that should trigger an increase in the frequency of screening?

KQ3: Excluding harms directly related to treatment of hypertension, what are the harms associated with screening to identify hypertension?

Contextual Questions

Contextual questions are not key questions associated with the analytic framework; however, they represent issues in a review for which the CTFPHC needs a valid, but not necessarily systematic, summary of current research. Results from the contextual question searches are only incorporated in a narrative summary and are not assessed with the GRADE²⁸ system. The search strategy for contextual questions is outlined in the Literature Search and Review section.

CQ1: Is there evidence that the burden of disease, the risk: benefit ratio of screening or the optimal screening method differ in the following subgroups: people of south-east Asian or African ancestry; Aboriginal populations; women with a history of hypertension during pregnancy?

CQ2: Is there evidence that access to screening differs for the following subgroups: Aboriginal populations; rural and remote populations?

ⁱ Cardiovascular morbidity includes stroke, heart disease, renal disease, peripheral arterial disease, and retinal disease

ⁱⁱ The recommendations will defer to CHEP for a description of the specific processes for taking blood pressure in office, home and ambulatory

CQ3: What are the resource implications and cost effectiveness of blood pressure screening in Canada?

CQ4: What are patients' values and preferences regarding blood pressure screening?

CQ5: What process and outcome performance measures (indicators) are identified in the literature to measure and monitor the impact of screening for hypertension?

CQ6: Is there any evidence that the utility of screening in the workplace, at a health fair or pharmacy differs from screening in the family physician's office?

Literature Search and Review

In 1996 the evidence regarding screening for hypertension was reviewed by the U.S. Preventive Services Task Force (USPSTF). At that time no studies were found that examined the direct effect of screening for elevated blood pressure on clinical outcomes (although many trials had shown a beneficial effect of treating patients who were enrolled on the basis of high blood pressures detected during screening examinations).²⁹ For this reason 1996 was selected as the starting year for the search. A search strategy was developed to identify the literature on screening for hypertension. The search was limited to English and French language literature published between 1996 and November 2010 (see Appendix A for detailed search terms). The search was performed in three bibliographic databases: Medline, EMBASE and EBM Cochrane Controlled Trials. Separate search strategies were used to incorporate the distinct subject headings employed in Medline and Cochrane Controlled Trials (MESH) and in EMBASE (Emtree).

To address the contextual questions, six additional expedited searches were conducted in Medline, EMBASE and EBM Cochrane Controlled Trials (Appendix B). These searches were limited to English and French language systematic reviews, meta-analyses, randomized control trials, observational studies and simulation modeling studies published between 2005 and 2011. Studies of patient preferences and values could be any study design, including qualitative studies. Opportunistic screening was also completed while reviewing the comprehensive literature searches for the key questions. A search of the grey literature was conducted to identify relevant Canadian data disseminated from high-quality governmental and nongovernmental organizations such as the Public Health Agency of Canada, the Canadian Institutes for Health Research, Statistics Canada and the Canadian Agency for Drugs and Technologies in Health. Grey literature was only incorporated into the review as contextual information and was not assessed with the GRADE system.

Study Selection

Table 1 presents the inclusion/exclusion criteria established for all Key Questions. Table 2 presents the detailed ranking by the Hypertension Working Group of the outcomes and harms associated with hypertension screening.

Table 1. Study Selection Inclusion/Exclusion Criteria

	Inclusion	Exclusion
Population	Adults - 18 years and older (KQ1, KQ2, KQ3) General population including subsets with higher than average risk of hypertension, vascular risk and average baseline blood pressure. Population groups at high risk include: Family history of hypertension Individuals of African ancestry Individuals with other vascular risk factors including dyslipidemia, diabetes mellitus, obesity (metabolic syndrome)	Adults <18 years (KQ1, KQ2, KQ3) Patient high risk groups excluded: Individuals with established or documented cardiovascular disease
Interventions	Any program or process, in any setting supervised by a primary care professional, by which people with undiagnosed hypertension will be identified (KQ1,KQ2,KQ3)	System level, or hypertension care management interventions that did not involve screening are excluded Procedures (and techniques) for measuring blood pressure are excluded (KQ2a). The CTFPHC recommendations will defer to CHEP for a description of the specific procedures (and techniques) for measuring blood pressure in office, home and ambulatory.
Study Design	Systematic reviews (KQ1, KQ2, KQ3) RCT/CCT (KQ1, KQ2, KQ3) Experimental designs and observational designs with comparison groups (KQ1, KQ2, KQ3) Modeling studies (KQ1)	Single cohort before/after comparisons (KQ1, KQ2b, KQ3) Case series (KQ1, KQ2b, KQ3) Screening trials MUST have used the results in the care of the intervention participants and MUST NOT have used screening results in the care of the control participants
Screening Instruments	Any blood pressure measurement by any equipment in any setting supervised by a primary care professional (KQ1, KQ2, KQ3)	No comparator
Outcomes	Health outcomes: 1. Cardiovascular morbidity (stroke, heart disease, renal disease, retinal disease, peripheral arterial disease); cardiovascular-related mortality and all-cause mortality (KQ1, KQ2b) 2. Systolic and diastolic blood pressure (KQ1) 3. New diagnosis of hypertension (KQ2b) Harms: 4. False positive or false negative diagnosis; psychosocial impact; economic costs (lost work time, insurance) (KQ3)	
Follow up time	1 year or more (KQ1) No limit (KQ2, KQ3)	Anything <1 year (KQ1 only)
Language	English and French language publications (KQ1,KQ2,KQ3)	Not English or French language.
Setting	Primary Care setting or setting supervised by a primary care professional (KQ1,KQ2b,KQ3)	Setting not supervised by a primary care professional

The Hypertension Screening Working Group rated each of the potential outcomes and harms of screening using the GRADE Process.²⁸ GRADE suggests a nine point scale (1 to 9) to judge the importance of the outcomes and harms. The upper end of the scale, rankings of 7 to 9, identifies outcomes of critical importance for clinical decision making. Rankings of 4 to 6 represent outcomes that are important but not critical, whereas rankings of 1 to 3 are deemed to be of limited importance to decision making or to patients. The outcomes and harms associated with hypertension screening resulted in the rankings presented in Table 2.

Table 2. CTFPHC Hypertension Screening - Ranking of Outcomes and Harms

Outcomes	Median Ranking	Importance
Vascular disease	9.0	Critical
Stroke	9.0	Critical
Heart disease	8.0	Critical
Renal disease	8.0	Critical
Retinal disease	8.0	Critical
Vascular mortality	8.0	Critical
All-cause mortality	8.0	Critical
Systolic and diastolic blood pressure	7.0	Critical
Harms	Median Ranking	Importance
False Positive diagnosis	7.0	Critical
False Negative diagnosis	7.0	Critical
Anxiety	4.0	Important
Psychosocial impact	6.0	Important
Economic costs (lost work, insurance)	6.0	Important

External Review

The research protocol and key questions were reviewed by two Evidence, Review, and Synthesis Centre (ERSC) project consultants and the Hypertension Working Group. The revised protocol was then sent to four external reviewers with expertise in review methodology and/or hypertension. Feedback on the protocol and key questions was received, revisions were made, and a draft of the revised protocol was approved by the Hypertension Working Group prior to beginning the review.

Quality Assessment, Data Abstraction and Analysis

The titles and abstracts were reviewed in duplicate by members of the synthesis team. Articles marked for inclusion by either team member went on to full text rating. Full text inclusion, data abstraction and quality assessment were done by two people at all times. All disagreements were resolved through discussions with the synthesis team and inclusion results were reviewed by a third person. Data were abstracted using a standard format by two people. Abstracted data included, when available, study design, participant selection process, exclusions, blinding, confounders, intervention and control group characteristics (e.g. size, gender, age, ethnicity, family history of hypertension, etc.), intervention details (e.g. description, duration, number of follow ups, loss to follow up, screening instrument, screener, setting of screening, etc.), reported outcomes and results. The exceptions to this process were studies related to the contextual questions of costs, performance indicators, patient preferences, subpopulations, and grey literature, for which abstraction was conducted by one person.

The included studies were reviewed according to the criteria set out in the CTFPHC Procedure Manual. The strength of evidence was determined based on the GRADE system of rating quality of evidence using GRADEPro® software.^{28,30} The GRADE system classifies quality of evidence according to one of four levels: high, moderate, low and very low. The final grade is based on the risk of bias due to limitations in design, inconsistency of findings, indirectness, imprecision and publication bias. Information to determine the quality of evidence was abstracted in duplicate from the primary methodology paper from each study. Those abstracting the data were blind to each other's ratings. In cases of disagreement, final decisions were determined by consensus after consultation with a third reviewer. All outcomes of interest for the Key Questions are presented separately in GRADE Evidence Profile KQ1 and GRADE Evidence Profile KQ3. The CTFPHC will defer to CHEP recommendations for specific procedures and techniques for measuring blood pressure. Therefore literature was not searched to address KQ2a nor is any data presented for this question. No literature was identified to address KQ2b and therefore no data for this question is presented. In addition to data required to complete the GRADE process, the McMaster Evidence Review and Synthesis Centre (MERSC) abstracted data about the patient population, the study design, analysis and results for each study (Table 3- Characteristics of Included Studies).

Chapter 3: Results

Summary of the Literature Search and Screening Results

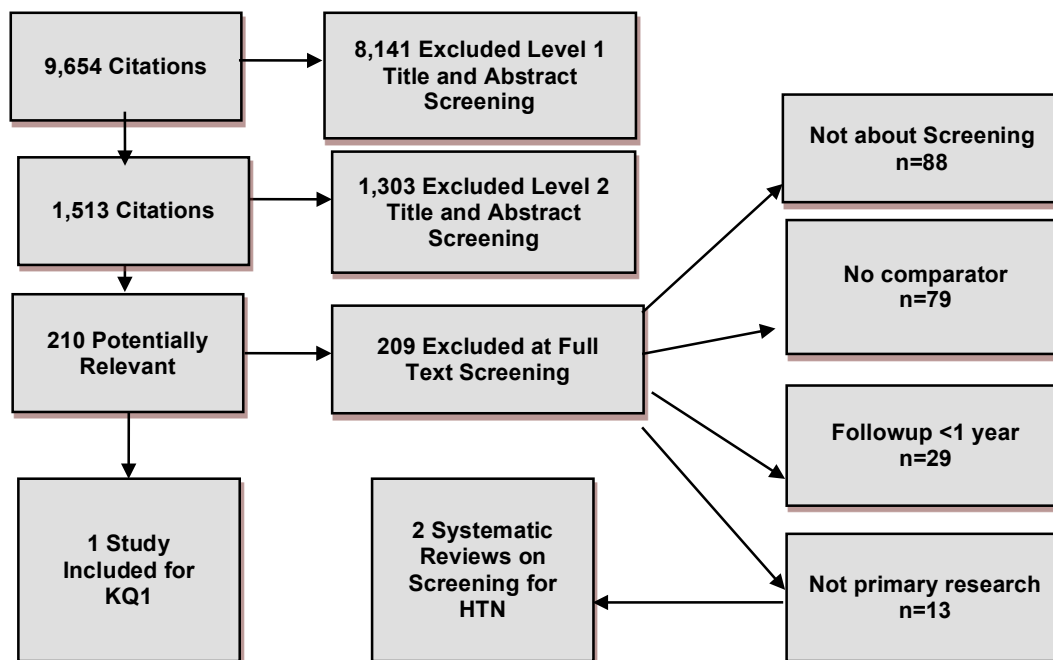
The initial literature search for KQ1 - *Does screening for hypertension in primary care practice reduce the risk of cardiovascular morbidity (including stroke, heart disease, peripheral arterial disease, renal disease, and retinal disease), cardiovascular mortality, and all-cause mortality? Does it lead to sustained reductions in blood pressure?* - identified 9,654 citations. As outlined in the quorum diagram (Figure 2), a three level review of these citations was completed. At the first two levels, all titles/abstracts were each screened by two reviewers for possible inclusion or exclusion before retrieving full text versions of the publications for the third level screen. Citations were excluded for any of the following reasons:

- The article was not in English or French
- The article was not about humans
- The research did not address screening for hypertension
- The population was less than 18 years of age
- The population was comprised of persons with established or documented cardiovascular disease
- The article was a commentary/note, conference proceeding, letter, editorial, methods description, case series, literature review
- The study did not compare screening versus not screening
- The follow up was less than one year

A total of 9,444 publications were excluded in the first two levels. At full text screening, another 209 publications were excluded. Reasons for exclusion following the full text review are identified in the quorum diagram (Figure 2). One member of the investigative team completed a quality control review of the abstracts for the 79 items excluded for having no comparator, requesting full text documents when there was any uncertainty. This did not result in any new items being added to the included list. The 29 studies that were excluded on the <1-year follow up criteria were also reviewed to determine whether any of these studies may be eligible for KQ2b or KQ3, both of which did not have a limit on the follow up period. None of these studies were eligible for inclusion for either of these questions. The full list of excluded publications for Key Question 1 can be viewed in Appendix C.

Screeners identified five studies and two systematic reviews during the full text screening phase.³¹⁻³⁷ Three of the included studies had conflicting ratings.³¹⁻³³ All five studies were reviewed at a meeting with the clinical and method experts. Consensus was reached that four of the five studies did not have eligible control groups and they were excluded.³¹⁻³⁴

Figure 2. Quorum Diagram Literature Search and Screen – Key Question 1



This left one study³⁵ included for KQ1. References of the included study were hand-searched to ensure that any studies that would potentially have met the eligibility requirements for KQ1 had not been missed. This did not result in the addition of any further studies. The references of the two systematic reviews on screening for hypertension^{36,37} were also hand-searched to ensure all studies in the reviews had been picked up in the initial literature search and had been through the screening process. All of the studies had been through the screening process, but as neither of the systematic reviews found direct evidence on the benefits of screening, this did not result in the addition of any further studies to the results of screening for KQ1.

Update of the Literature Search and Screen

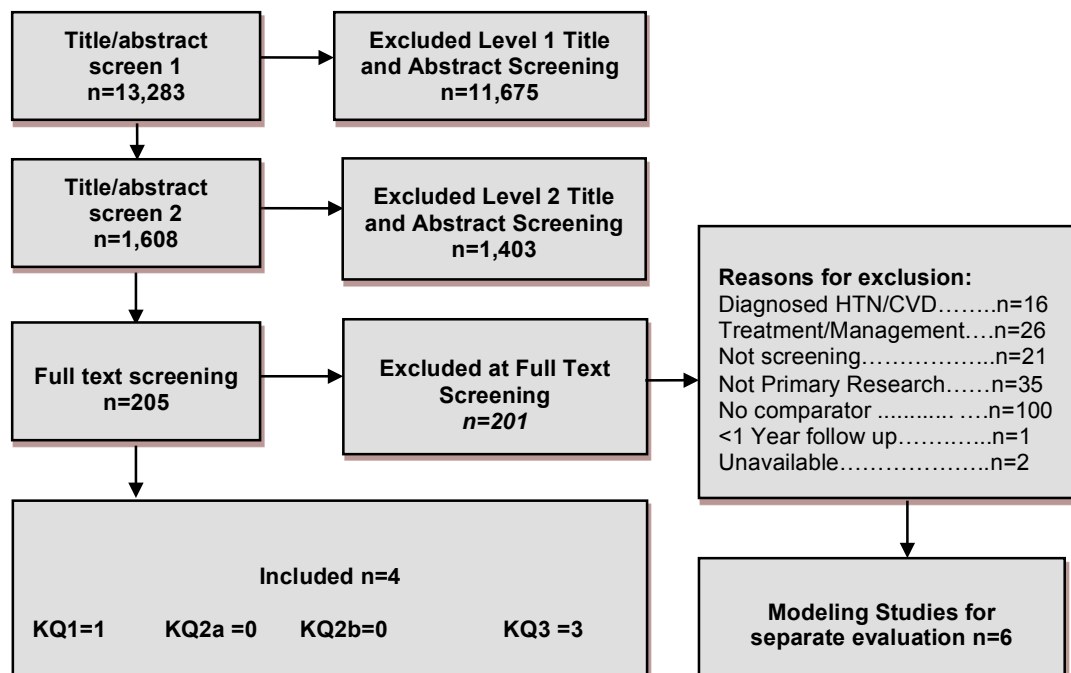
Given the paucity of research identified in the first screening for KQ1, a decision was made by the ERSC and the Hypertension Working Group to expand the search date parameters prior to starting the next screening for KQ2 and KQ3. The search was rerun on September 14, 2011 in the same databases, using the original search criteria, with the dates amended to pick up older research published between 1985 and 1996. Concurrently, the search was updated to include any research published from the date of the initial search in November 2010 up until September 14, 2011. The result, once duplicates were removed, was the addition of 3,629 new citations to the original 9,654 citations previously screened for KQ1. A full screen was completed for *all* KQs on the 13,283 citations in the updated database. The inclusion of a second screening for KQ1 was to ensure that any relevant research evidence from the updates would be captured by the screeners.

As outlined in the quorum diagram (Figure 3), a three level review was utilized to screen these citations for all of the KQs. At the first two levels, the titles/abstracts of identified studies were screened for inclusion/exclusion by two reviewers. Citations were excluded for any of the following reasons:

- The article was not in English or French
- The article was not about humans
- The research did not address screening for hypertension
- The population was less than 18 years of age
- The population was comprised of persons with established or documented cardiovascular disease
- The article was a commentary/note, conference proceeding, letter, editorial, methods description, case series, literature review
- There was not an eligible comparator /control group
- The follow up was less than one year (KQ1 only)

A total of 13,078 publications were excluded in the first two levels. A full text review was completed for each of the remaining 205 publications resulting in the exclusion of a further 201 articles. Reasons for exclusion following the full text review are identified in the quorum diagram (Figure 3). When there was any disagreement between the screeners, abstracts and full text articles were discussed by the investigative team until consensus on inclusion or exclusion was reached. The full list of publications excluded at full-text screening can be viewed in Appendix D.

Figure 3. Quorum Diagram Updated Literature Search and Screen – KQ1, KQ2a, KQ2b, KQ3



The result of full text screening is as follows:

KQ1: Does screening for hypertension in primary care practice reduce the risk of cardiovascular morbidity (including stroke, heart disease, renal disease, peripheral arterial disease, and retinal disease), cardiovascular mortality, and all-cause mortality and/or does it lead to sustained reductions in blood pressure? The second screening picked up the same article for KQ1 as the first screening (previously noted)³⁵ plus one additional article³⁸ that was subsequently excluded by the investigators for having a follow up period of less than one year. References were reviewed and no further papers were added.

Six modeling studies that potentially address screening for hypertension were identified in the second screening^{32,33,39-42} with a seventh identified in the grey literature search.⁴³ The seven identified studies were subject to a 5 step review process which concludes with any eligible studies being reviewed with respect to GRADE level of evidence. Steps 1-3 relate to determination of studies meeting the eligibility criteria for inclusion and a review for level of limitations (minor potentially serious and serious). At this stage, four studies were discarded due to perceived serious limitations (see Table 4).^{32,33,41,43} The fourth stage focused more on applicability to the specific context of this review which led to two further studies being discarded (see Table 5).^{40,42} One study³⁹ therefore was considered further, with respect to the evaluation of effectiveness and cost effectiveness of hypertension screening. References were reviewed and no further papers were added.

KQ 2a: Which method of blood pressure screening (ambulatory, office or home blood pressure measurements) is most effective for identifying patients who might benefit from treatment? The Canadian Hypertension Education Program (CHEP) is being deferred to for all guidelines pertaining to procedures (and techniques) for measuring blood pressure.

KQ 2b: What are the optimal frequency and/or timing of screening (including age of onset) for identifying patients who might benefit from treatment, and are there specific criteria that should trigger an increase in the frequency of screening? After an investigative team discussion of five articles with conflicting ratings at level 3 screening, all potential articles for KQ2b were excluded. One article did not provide data for the comparison group⁴⁴ and the other four articles did not compare two groups with different timing or frequency of screening.^{33,45-47} References of these studies were reviewed and no further papers were added.

KQ3: Excluding harms directly related to treatment of hypertension, what are the harms associated with screening to identify hypertension? Three articles met the inclusion criteria for KQ3.⁴⁸⁻⁵⁰ All articles were published by the same primary author. One of the articles was a companion piece reporting on the same data.⁵⁰ References for all included studies were reviewed and no further papers were added.

Systematic Reviews

Two previous systematic reviews attempted to address the benefits and harms of screening for hypertension.^{36,37} However, neither review identified any studies evaluating the benefits and harms of screening *protocols* (either a comparison between screening protocols or of screening compared to no screening).

Discussion of Included Studies – Key Question 1

There were no studies identified that specifically and directly assessed whether screening for hypertension in primary care practice reduces the risk of cardiovascular morbidity, cardiovascular mortality, and all-cause mortality and/or whether it leads to sustained reductions in blood pressure. As well, there were no studies identified that assessed whether measuring blood pressure at most clinical encounters in primary care achieved the desired cardiovascular morbidity or mortality outcomes or sustained reductions in blood pressure.

The Cardiovascular Health Awareness Program (CHAP) was described as a community cluster randomized trial of a community-based health promotion and prevention program in 39 Ontario municipalities with populations between 10,000 and 60,000.³⁵ Twenty intervention communities received weekday 3-hour blood pressure and cardiovascular disease (CVD) risk-factor assessment sessions in local pharmacies over 10 weeks. The intervention was targeted at persons aged 65 years and older, although younger persons were allowed to participate. Participants' blood pressure was measured by volunteer peer health educators using the BpTRU™ automated device. An on-call nurse was available to assess participants whose blood pressure exceeded 180/110mmHg. Other CVD risk factors were identified on questionnaires. Besides blood pressure measurement, no other physical examination or diagnostic testing was administered as part of the risk factor assessment. Participants were provided with risk-factor specific educational material, and summary CVD risk forms were sent to their physicians and pharmacists. At the end of the ten weeks, family physicians were sent reports rank-ordering their patients by systolic blood pressure and diagnostic/treatment status. Comparative feedback was sent to family physicians after six months. Nineteen control communities received no intervention.

The primary outcome measure in CHAP was the change in the mean annual rate of hospital admissions for myocardial infarction, congestive heart failure, or stroke among community-dwelling residents aged 65 years and over, comparing the 1-year period prior to CHAP with the 1-year period following implementation. End points were identified using administrative databases. Secondary outcomes included the number of residents admitted to hospital for the above causes, mortality during these admissions, all-cause mortality, and the new initiation of antihypertensive drug therapy. While the study design did not permit blinding of the residents or health care workers in the intervention communities, the names of the control communities were not publicized.

In the intervention communities, 13,379 of 69,942 (19%) of persons aged 65 years or greater completed at least one cardiovascular assessment. The relative risk for the primary outcome measure was 0.91 in the intervention communities as compared with the controls (95% confidence interval (CI) 0.86 to 0.97, $p=0.002$). Risk reductions were seen for the mean annual rate of hospital admissions for myocardial infarction (RR 0.87, 0.79 to 0.97, $p=0.008$) and congestive heart failure (RR 0.90, 0.81 to 0.99, $p=0.029$) but not for stroke (RR 0.99, 0.88 to 1.12, $p=0.89$). In analyses of the number of persons admitted for these diagnoses (rather than the total number of admissions), a significant reduction was seen in myocardial infarction (RR 0.89, 0.79 to 0.99, $p=0.03$) but not significant for the primary outcome measure (RR 0.95, 0.89 to 1.02, $p=0.13$), congestive heart failure (RR 0.97, 0.87 to 1.08, $p=0.59$), or stroke (RR 1.01, 0.89 to 1.15, $p=0.87$). Residents of the intervention communities were more likely to start antihypertensive therapy (RR 1.10, 1.02 to 1.20, $p=0.02$) and had a trend towards fewer in-hospital cardiovascular deaths (RR 0.86, 0.73 to 1.01, $p=0.06$), although overall mortality was unchanged (RR 0.98, 0.92 to 1.03, $p=0.38$).

CHAP demonstrated that a community-based hypertension screening program (as part of a cardiovascular risk reduction program) led to an increase in antihypertensive therapy and a decrease in cardiovascular morbidity. Although participants completed a comprehensive cardiovascular risk profile form, the only screening or diagnostic intervention was blood pressure measurement with the BpTRU device. The frequency of screening in the control group was not defined, as the purpose of the study was to determine whether the community-based screening program would be superior to usual screening practice. (See Table 2: Characteristics of Included Studies - KQ1 for more study details).

In a cost utility study, Howard and colleagues examined the cost effectiveness of alternative screening programs which may impact chronic kidney disease.³⁹ Hypertension screening was identified as a potential key intervention. The study assessed, from the Australian context, the cost effectiveness of screening through blood pressure measurement in general practice followed by intensive blood pressure control. The target population was aged 50-69. Screening participation was assumed to be 75% with sensitivity analysis using estimates of 25% and 100%.

The modeling framework focused mostly on the development of chronic kidney disease and related problems but incorporated increased risk of cardiovascular morbidity and mortality. In this study, effectiveness was expressed as QALYs gained through screening, incorporating disutility associated with the diagnosis of hypertension and CVD events as well as related renal complications. Effectiveness was based on the assumption that blood pressure measurement in primary care was 100% sensitivity and specificity. Following the diagnosis of hypertension, it was assumed that patients would receive appropriate antihypertensive therapy which would reduce the probability of CVD morbidity, mortality and progression to end stage kidney disease. Thus, the model was a simplistic representation of hypertensive disease with health states relating to the hypertensive disease and incidence of cardiovascular disease, chronic kidney disease and death. The relative risk of CVD mortality, CVD events and progression to end stage kidney disease and estimates of the baseline transition probabilities were derived from published literature.

The base result of the modeling exercise is that annual screening for hypertension as a risk factor for chronic kidney disease would lead to a gain of 0.116 QALYs (95% CI: -1.396 to 1.745) per patient screened.

Quality and Strength of Evidence – Key Question 1

Meta-Analysis

As the outcomes of interest differed between the two studies, a meta-analysis was not appropriate.

Quality of Evidence

As defined by the GRADE Working Group, the quality of evidence is the extent to which the confidence in an estimate of the effect is adequate to support a particular recommendation.²⁸ According to the GRADE system for assessing quality, RCT evidence begins with a high rating and may be downgraded for limitations or concerns across five categories, risk of bias, inconsistency, indirectness, imprecision, and other considerations.²⁸

There was no serious risk of bias or imprecision identified in the Kaczorowski RCT (see Evidence Set One: KQ1). With only the single study being GRADED, inconsistency could not be assessed. Publication bias was not evident. It was noted that although the study compared changes in CHAP vs. non-CHAP communities over time, this was an appropriate way to analyze

a cluster-randomized trial of this type as it is not probable that groups would be at equal risk of events prior to enrolment. However, the study only included persons 65 years of age and older, and the intervention was not simply blood pressure screening but also the provision of cardiovascular risk assessment and education sessions. As the study did not directly address the question of whether isolated hypertension screening improves cardiovascular outcomes in the general adult population the Kaczorowski paper was downgraded one level for indirectness in each of the five outcomes for which data based on individual hospital admission rates were provided - Acute Myocardial Infarction (AMI); Congestive Heart Failure (CHF) Stroke; Composite (AMI, CHF and Stroke); and All-cause Mortality (see Tables 6 and 7); and in each of the four outcomes for which data based on cumulative hospital admission rates were provided - Acute Myocardial Infarction (AMI); Congestive Heart Failure (CHF) Stroke; and Composite (AMI, CHF and Stroke) (see Tables 8 and 9).

The modeling study by Howard et al (2010) incorporates a limited disease model. The model appears technically correct but does not involve a detailed modeling of the progression of cardiovascular disease. The major limitation of this study was the focus on chronic kidney disease leading to concerns over the detail to which hypertensive disease progression was modeled (see Evidence Set Two: Modified GRADE Evidence Profile and Summary of Modeling Study Findings). Similar to the Kaczorowski paper the target population of the study was limited (in this case to persons between 50 and 69 years of age). Thus, while the model suggests that there may be substantial incremental QALYs gained per individual screened (though the statistical uncertainty around these estimates was large), given the limitations in this study, this evidence was graded “very low” quality.

Discussion of Included Studies – Key Question 2

There were no studies identified that met the inclusion criteria for Key Question 2: What are the optimal frequency and/or timing of screening (including age of onset) for identifying patients who might benefit from treatment, and are there specific criteria that should trigger an increase in the frequency of screening?

Discussion of Included Studies – Key Question 3

Although no data to address harms ranked ‘critical’ by the Hypertension Working Group (presented in Table 2) were identified, Rostrup and colleagues published two papers (and one companion paper) of interest regarding the consequences of informing patients of a new diagnosis of hypertension.⁴⁸⁻⁵⁰ (See Table 3: Characteristics of Included Studies for more study details). Study participants were 19-year old Norwegian men whose medical examination for the military draft revealed mean blood pressure above the 95th and 98th percentile for age (116mmHg). These men were randomized to receive either a letter informing them of the diagnosis of hypertension or a neutral letter. Both groups then underwent various physical, laboratory, and psychological tests (n=29 to 36 for different sub-studies). Men who had been informed of their high screening blood pressure had higher blood pressure on repeat measurements.⁴⁹ Furthermore, they had greater increments in heart rate and plasma epinephrine after a cold pressor test⁴⁹, greater adrenergic responses to a mental arithmetic challenge test.⁴⁸ None of these studies, however, compared two groups who were screened differently; rather, they compared groups who were informed differently of their screening results. Moreover, only patients who screened positive for hypertension underwent testing. Therefore, these studies are

only very weakly informative regarding potential harms of hypertension screening on a population basis.

Quality and Strength of Evidence – Key Question 3

Meta-Analysis

As the outcomes of interest differed between the two trials, a meta-analysis was not appropriate.

Quality Assessment

The GRADE process was used to assess risk of bias for the two Rostrup RCTs addressing Key Question 3. This was then used with the summary of findings to assess the overall quality of the evidence (see Evidence Set Three: KQ3).^{28,30} Serious risk of bias or inconsistency were not identified. Very serious indirectness and serious imprecision were identified. The homogenous population of 19 year old Norwegian male military recruits in both of these studies are not representative of the general hypertension screening population and the study design did not actually compare screening with not screening (rather it simulated the effect of not screening by not disclosing screening results to half of the participants). For these two reasons both articles were downgraded to ‘very serious’ in the indirectness category. As the total population size was less than 400 for both studies (a threshold rule-of-thumb value) and there was no effect, both articles were downgraded to ‘serious’ in the imprecision category. The resultant GRADE was Very Low for both of the Rostrup articles. As noted, these studies are only weakly informative regarding potential harms of hypertension screening on a population basis.

Discussion of Results

Three questions were addressed in this review. The first, and most important, was whether there is direct evidence to support screening for hypertension in primary care practice. Such evidence could arise from studies comparing current clinical practice (i.e., measuring blood pressure in most encounters in primary care) with either less intense or more intense screening. A literature search returned only a single primary research paper that met the inclusion criteria for studies on the benefits of hypertension screening, although the intervention was not a program of hypertension screening in primary care. The paper showed clinically and statistically significant evidence of benefit from a community-based cardiovascular risk assessment and education program (incorporating hypertension screening) targeted at persons aged 65 years and older. This program provided more intense screening than what was currently recommended in clinical practice⁵¹ and led to an increase in antihypertensive therapy and a decrease in cardiovascular morbidity. Despite demonstrating strong evidence of benefit, these results can only indirectly address the major question in our review, which is focused on general population screening in primary care practice. The single modeling study included in the review incorporated a limited disease model that was technically correct but did not involve a detailed modeling of the progression of cardiovascular disease. The major limitations of this study were the assumptions regarding the treatment of hypertension and the focus on chronic kidney disease, leading to concerns over the detail to which hypertensive disease progression was modeled. Similar to the Kaczorowski paper the target population was limited (in this case to persons between 50 and 69 years of age). Thus, while the model did suggest that there may be substantial incremental QALYs gained per individual screened, the statistical uncertainty around the estimates was large.

The second question addressed in this review was whether there is direct evidence identifying the optimal frequency and/or timing of screening for identifying patients who might benefit from treatment and whether there are specific criteria that should trigger an increase in

the frequency of screening. The literature search did not identify any studies that met the inclusion criteria. This is consistent with findings of the 2003 USPSTF systematic review of the evidence on screening for high blood pressure that found no comparative studies examining the optimal frequency of screening based on a patient's prior blood pressure levels or other cardiovascular risk factors.³⁷ In the absence of comparative data the best evidence for the optimal frequency and timing of screening comes from cohort studies examining the age-specific incidence of hypertension in the general population and in persons with high-normal blood pressure.^{46,47}

The final question addressed in this review was, excluding harms directly related to treatment of hypertension, what are the harms associated with screening to identify hypertension? Although no data to address harms ranked 'critical' were identified, two papers (and one companion paper) of interest regarding the consequences of informing patients of a new diagnosis of hypertension were identified. As none of these studies compared two groups who were screened differently they were only very weakly informative regarding potential harms of hypertension screening on a population basis. Most of the studies on the adverse effects of screening for hypertension were conducted from the late 1970s and to the mid-1980s and focused on the effects of screening and the subsequent labeling of a person as 'hypertensive'.⁵²⁻⁶² Although these studies would not have met our inclusion criteria, in many instances due to the focus on worksite screening programs, we note that the 2003 USPSTF systematic review of the evidence on screening for high blood pressure concluded that these studies provide fair quality evidence that screening and labeling adults with hypertension does not produce any adverse effect on psychological well-being, but show mixed effects on absenteeism rates for work.³⁷ A follow up USPSTF review in 2007 did not find any new evidence on the harms of screening for high blood pressure.³⁶

The benefits of treating diagnosed hypertension were demonstrated many decades ago in randomized trials on patients with severe hypertension. More recently, large trials have demonstrated the benefits of treating early and mild hypertension. A recent meta-analysis of 147 RCTs demonstrated that lowering blood pressure by 10/5 mmHg (similar to the effect of one drug at standard dose) prevents 22% of coronary artery disease events and 41% of strokes.²⁴ Treating all levels of hypertension has become a common part of clinical practice in developed countries. As a result, checking a patient's blood pressure during almost any health care encounter has become a part of common clinical practice. It is assumed that this practice would help identify undiagnosed hypertension (hypertension screening) and would identify patients with uncontrolled hypertension (hypertension monitoring). In Canada over the past two decades this appears to be so; there has been a major increase in awareness, treatment and control of hypertension. Incidence rates of undiagnosed hypertension decreased from 43.2% to 17.4% ($p < 0.001$) between 1992 and 2009 and uncontrolled hypertension decreased from 86.8% in 1992 to 35.4% in 2009 ($p < 0.001$).⁶³

Conclusion

In this review, there were no studies identified that specifically and directly assessed whether screening for hypertension in primary care practice reduces the risk of cardiovascular morbidity, cardiovascular mortality, and all-cause mortality and/or whether it leads to sustained reductions in blood pressure. As well, there were no studies identified that assessed whether measuring blood pressure at most clinical encounters in primary care achieved the desired cardiovascular morbidity or mortality outcomes or sustained reductions in blood pressure. However, in light of

some evidence for benefit from a more intense (cardiovascular) screening program that included hypertension screening, and the overwhelming evidence that treating patients diagnosed with hypertension improves patient outcomes, there is indirect evidence to support screening for hypertension by measuring blood pressure in most primary care encounters rather than screening less frequently.

Contextual Questions

CQ1: Is there evidence that the burden of disease, the risk: benefit ratio of screening or the optimal screening method differ for people of South Asian ancestry; people of African ancestry; Aboriginal populations; or women with a history of hypertension during pregnancy?

Burden of Disease

People of South Asian Ancestry

Globally, a disproportionately high incidence of hypertension and cardiovascular disease (CVD) has been identified in people of both South Asian and African ancestry.^{15,18,64-69} Canadian research prior to the cut-off date of this contextual search, but still important to understanding current trends, demonstrated that Canadian migrant South Asians had rates of cardiovascular morbidity and mortality 2-5 times higher than those of European ancestry.⁷⁰⁻⁷² For individuals of South Asian ancestry, hypertension is noted as being influential in the high prevalence of coronary artery disease and ischemic heart disease^{65,73} The proportional mortality from ischemic heart disease (reported as a proportion of all-cause mortality from 1979-1993) was higher in Canadian men and women of South Asian descent as compared to those of European descent (42% and 29%, and 29% and 19% respectively).^{72,73} More recently, an analysis of three cross-sectional cycles of the Canadian Community Health Survey (2000, 2003 and 2005) serves to demonstrate that cardiovascular risk factors continue to vary by ethnic group in Canada.¹⁶ In this study, after adjustment for socio-demographic characteristics and chronic conditions, hypertension is identified as more prevalent in participants of Filipino or South Asian ethnicity (odds ratio [OR] 1.54, 95% confidence interval [CI] 1.23-1.93) relative to white people. At the provincial level, the Ontario Survey on Prevalence and Control of Hypertension (ON-BP) examined the prevalence, treatment and control of hypertension among 2551 adults in Ontario.¹⁵ Adjusting for the specific impact of age, sex and body mass index, hypertension was more prevalent in those of South Asian ancestry ([OR] 2.7, 95% [CI] 1.6-4.6, p=0.01) than in those identified as White.¹⁵

People of African Ancestry

Studies have been consistent in reporting that there is higher prevalence of hypertension in blacks than in whites and that this contributes to higher incidence of cardiovascular disease, and poorer cardiovascular and renal outcomes in blacks.^{69,74-77} Although much of the research is based on African American populations, the analysis of three cross-sectional cycles of the Canadian Community Health Survey (2000, 2003 and 2005) shows that cardiovascular risk factors vary dramatically for those Canadians of black ancestry as well.¹⁶ In this study, relative to white people, hypertension is identified as more prevalent in participants of black ethnicity ([OR] 1.69, 95% [CI] 1.43-2.00)¹⁶ At the provincial level, the Ontario Survey on Prevalence and Control of Hypertension (ON-BP) examined the prevalence, treatment and control of hypertension among 2551 adults in Ontario.¹⁵ Adjusting for the specific impact of age, sex and body mass index, hypertension was more prevalent in those black ancestry ([OR] 3.3., 95% [CI] 1.7-6.4, p<0.001) than in those identified as white.¹⁵ Black females in the ON-BP study were also shown to be three times more likely than white females to have hypertension.¹⁵

Aboriginal Populations

The First Nations Regional Health Summary Preliminary Report⁷⁸ found that the prevalence of high blood pressure among First Nations adults in Canada is increasing with age, with current percentages of prevalence ranging from 3.8% for the 18 to 24 age group, 9.2% for the 25 to 39 age group, 28.6% for the 40-54 age group, up to 48.7% for those 55 years and older. For those First Nations seniors (55+) with Type 2 diabetes, the percentage also reporting hypertension is just over 66%. Higher incidence of comorbidity of chronic diseases and conditions put First Nations populations at higher risk of hypertension, coronary heart disease and certain cancers, but may also increase the already high prevalence of diabetes among First Nations populations, and the health complications associated with this chronic disease.^{78,79} In a 2011 cohort study of obesity and the prevalence of obesity-related comorbidities among a study population of Manitoba First Nations (n=483), 75% of the participants were found to have at least one of the following conditions: obesity, dyslipidemia, hypertension or diabetes, with 22% of participants with undiagnosed hypertension.⁸⁰ Those with undiagnosed hypertension were also more likely, (22% of men and 43% of women aged 18 to 29), to have two or more chronic conditions. A recent report profiling only Métis health status and healthcare utilization in Manitoba (2010) identified hypertension as a substantial problem affecting at least one in four Manitobans but showing the Métis prevalence of hypertension (in adults 19 years of age and over) is higher than that of all other Manitobans (27.9% vs. 24.8%).⁸¹

Researchers collecting prevalence data on metabolic syndrome (MetS) for First Nations populations (residing in Ontario, Manitoba and Alberta) have concluded that high rates of obesity, pre-diabetes and metabolic syndrome, particularly for participants less than 18 years of age, should also be raising concerns about the future prevalence of cardiovascular disease and diabetes.⁸²⁻⁸⁵ This is consistent with a study profiling hypertension among the Nunavik Inuit, which found significant associations between hypertension and prehypertension and rising obesity even after adjusting for confounding variables.⁸⁶ The overall prevalence of hypertension ($\geq 140/90$ mmHg or the use of medication) was 19% with no gender difference. An increase in odds of prehypertension (130–139/80–89 mmHg) was also observed as Body Mass Index increased (p for trend, $p < 0.0001$). The proportion of hypertension under control (number of treated hypertensive individuals with BP $< 140/90$ mmHg divided by the total number of hypertensives) was 17.0%; with the proportion of treated hypertensives under control in the study found to be 26.0%. This study concludes that, with the growing health challenge of obesity-associated hypertension, screening, diagnosis and management of hypertension may be inadequate among the Nunavik Inuit.⁸⁶

Women with a History of Hypertension during Pregnancy

Hypertension is the most common medical disorder in pregnancy and has been estimated to occur in 6% to 8% of all pregnancies.⁸⁷ In Canada, hypertensive pregnancy disorders (HPDs) are the second leading cause of maternal mortality accounting for 16% of all obstetrical deaths.⁸⁸ Hypertensive pregnancy disorders were traditionally believed to have no long-term impact on mothers' health, however recent evidence has suggested otherwise.⁸⁹⁻⁹² HPDs increase the mother's risk of cardiovascular disease later in life⁹³ and women with HPDs continue to be at greater risk for years after the affected pregnancies compared to normotensive mothers.⁸⁹ A case-control study conducted in the U.S. by Hedderson and Ferrara (2008) found women with hypertension during pregnancy were also twice as likely to develop gestational diabetes mellitus

(GDM) (OR 2.04 [95% CI 1.14-3.65]) compared with normotensive subjects.⁹⁴ High normal blood pressure (odds ratio [OR] 1.56 [95% CI 1.16-2.10]) and hypertension prior to pregnancy (1.44 [0.95-2.19] for high normal blood pressure and 2.01 [1.01-3.99] for hypertension) both slightly increased the mothers risk of developing GDM.

Risk: Benefit Ratio of Screening and Optimal Screening Methods

People of South Asian Ancestry

We did not identify any systematic reviews or primary research directly addressing the risk: benefit ratio of, or the optimal method of screening for high blood pressure in people of South Asian ancestry. However, the research linking public health initiatives tailored to specific ethnic/racial groups to improved understanding of hypertension, paired with the effects of patient engagement, suggests screening methods could be optimized by integrating lower health literacy considerations when promoting hypertension screening.^{66,67,73} For example, adapted English and translated pamphlets developed to accommodate lower health literacy skills in Calgary's Indo-Asian population were rated as improving users' understanding of hypertension over the original English version.^{67,73}

People of African Ancestry

We did not identify any systematic reviews or primary research directly addressing the risk: benefit ratio of, or the optimal method of screening for high blood pressure in people of African Ancestry.

Aboriginal Populations

We did not identify any systematic reviews or primary research directly addressing the risk: benefit ratio of, or the optimal method of screening for high blood pressure in Aboriginal populations in Canada. The authors of one Canadian study in the area of diabetes screening did conclude that among Aboriginal groups, who may otherwise not seek conventional health care, opportunistic screening may be particularly advantageous.⁹⁵

Women with a History of Hypertension during Pregnancy

We did not identify any systematic reviews or primary research directly addressing the risk: benefit ratio of screening for high blood pressure in women with a history of hypertension during pregnancy. For women with a history of hypertension during pregnancy, Poon et al. (2011) do report effective screening for early and late preeclampsia (PE) and gestational hypertension (GH) by combining blood pressure and the maternal factor-derived *a priori* risk within the first-trimester. The authors performed a case-control screening study for hypertensive disorders in 8366 singleton pregnancies at gestation of 11–13 weeks (including 205 that developed PE or GH). To derive the patient specific risk for early PE, late PE and GH multiple regression analysis was used by combining the disease-specific maternal factor-derived risk with measurements of the mean arterial pressure (MAP) and the uterine artery pulsatility index (PI) recorded from the artery with the lowest PI (L-PI)⁸. The estimated detection rates of early PE, late PE and GH were 89, 57 and 50%, respectively, at a 10% false-positive rate and 78, 42 and 36%, respectively, at a 5% false-positive rate. In this study, increased blood pressure recorded at mothers' first hospital visit (11-13 weeks) screenings predicted PE and GH in later pregnancy.⁹⁶ In terms of optimal screening and preferences, Ross-McGill et al, in a pilot RCT found home-blood pressure

measurements to be an acceptable form of screening during pregnancy using a reduced visit schedule. Women preferred a reduced visit schedule (34, 38, 41 weeks) compared to the standard 9 visits (30, 32, 34, 36, 37, 38, 39, 40, 41 weeks) and yielded more blood pressure measurements (9 vs. 7, $p < 0.001$). There was no significant difference in the detection of abnormalities and anxiety levels between the two groups.

CQ2: Is there evidence that access to screening differs for rural and remote populations and for Aboriginal populations?

Rural and Remote Populations

The 2008 Canadian Community Health Survey indicates that rural Canadian residents have been more likely than urban Canadians to have high blood pressure, with 19.1% of rural dwellers having been diagnosed with high blood pressure, compared with 15.8% of those in urban areas.⁹⁷ However, we did not find systematic review or other evidence that access to screening differs for rural and remote populations in Canada in our literature search. The literature that addressed the concept of ‘access’ was mainly focused on ‘access’ related to regional variations in treatment and pharmacologic management of diagnosed hypertension.^{97,98} When ‘access’ is identified as a potential reason for variations in treatment and management, it is as an issue of access to a family doctor in general. For example, Mohan et al (2010), utilizing data from the 2005 Canadian Community Health Survey, report that 37% of aware adult hypertensives not receiving antihypertensive treatment have also reported not having access to a family doctor (OR 2.14; CI 95% [1.84-2.50]).⁹⁸ Although these authors provide a further breakdown of the data by region (mostly provinces), rural and remote areas and/or populations within these regions are not specifically defined. In underserved populations, it has also been suggested that inadequate surveillance and treatment allows hypertension to persist until actual cardiovascular events occur.⁹⁹ In those rural and/or remote areas where access to family physicians and health care services in general can be problematic, at present given the lack of dedicated research, it can only be inferred that access to screening would also be inadequate.

Aboriginal Populations

For First Nations adults, perceived level of health care access in general (when compared to the general Canadian population), is correlated to their level of geographic remoteness. Over 64% of those who reside in special access areas perceive less access to health care. This percentage decreases as geographic location moves from remote (39.6%) to rural (36.7%) to urban (32.7%). Barriers to health care access related to geography and availability of health services can range from no health facilities or services available in one’s area, to doctors or nurses being unavailable.⁷⁸ *A Statistical Profile on the Health of First Nations in Canada: Determinants of Health 1990 to 2003* identified transportation barriers, economic barriers and cultural appropriateness of services as barriers to accessibility of screening programs for First Nations populations.⁷⁹ The screening services reported on in this document are mammograms and pap smears, but likely similar issues need consideration for hypertension screening.

When reporting on the proportion of First Nations adults having received selected health screening tests within the past 12 months, 66.6% of women and 57% of men responded that they had received a blood pressure test. Whether this test was a component of a complete physical exam (also reported on in the same data table), an example of opportunistic screening, or a

singular dedicated screening test for hypertension without other primary care intervention is not differentiated in this report.⁷⁸

CQ3: What are the resource implications and cost-effectiveness of blood pressure screening in Canada?

Summary

We did not identify any systematic reviews of studies on the cost-effectiveness of blood pressure screening *per se*. One systematic review on the cost of cardiovascular disease was identified which included nine studies focused directly on the costs of hypertension, but none of those nine studies addressed the cost of blood pressure screening.¹⁰⁰ Costs to individuals were not identified in the literature review. Most cost effectiveness studies for hypertension are focused on the cost effectiveness of treatment, specifically on differences in the cost of selected drugs (rather than differences in effectiveness of drugs).¹⁰¹ Six studies were identified in the literature screen and one in the grey literature search that were based on various modeling approaches but none of these studies addressed the resource implications and cost-effectiveness of blood pressure screening in Canada.^{32,33,39-43} Based on the current evaluative framework only one study³⁹ was considered of high enough quality and relevance to contribute to the discussion on cost effectiveness. This study (Howard et al) is previously discussed.

CQ4: What are patients' values and preferences regarding blood pressure screening?

Summary

No systematic review or direct research evidence was found that addressed patients' values and/or preferences regarding blood pressure screening. The research found in our literature search for this question focused mainly on populations already diagnosed with hypertension. For example, patient values and/or preferences when identified were related to the location of blood pressure monitoring or type of monitoring device;^{102,103} to hypertension treatment and/or adherence;¹⁰⁴⁻¹⁰⁷ and individual health beliefs, perceptions and behaviours regarding treatment.¹⁰⁸⁻¹¹¹

CQ5: What process and outcome performance measures (indicators) have been identified in the literature to measure and monitor the impact of screening for hypertension?

Summary

There is little dedicated research data on performance measures for hypertension screening. The majority of indicators identified in the literature are related to quality of hypertension treatment and management rather than to screening. The identification of domains and measures useful for hypertension screening may be built upon those utilized for other screening programs, such as diabetes and cervical cancer. A separate document has been circulated for Working Group consideration utilizing these domains and measures as guidelines.

CQ6: Is there any evidence that the utility of screening in the workplace, at a health fair or pharmacy differs from screening in the family physicians office?

Summary

A total of 19 articles were identified. Three of the studies compared pharmacy screening with screening in other settings.¹¹²⁻¹¹⁴ The remaining 16 articles did not make comparisons between screening locations. Of these 16 articles, there were 7 single studies that evaluated screening programs in pharmacies.¹¹⁵⁻¹²¹ Five single studies assessed screening programs in various community-based settings.¹²²⁻¹²⁶ One study was found that evaluated screening in the workplace¹²⁷ and 3 examined screening in other healthcare settings (i.e., dental practices and blood donor centres).¹²⁸⁻¹³⁰

Sabater-Hernandez et al. conducted a systematic review of studies that 1) measured the agreement between blood pressure measurements taken in community pharmacies over the course of multiple visits, or 2) measured the concordance between community pharmacy blood pressure reading methods and alternative measurement methods applied in clinical practices.¹¹³ They found 3 studies that compared community pharmacy blood pressure measurement methods with alternative methods. One of these studies compared blood pressure measured by pharmacists with blood pressure measured by a nurse. Clinical agreement between the two measurements was not acceptable. Furthermore, it was impossible to conclude which blood pressure measurement was the most accurate as there was no reference method used to determine the participants' actual blood pressure. Another study compared community pharmacy blood pressure (CPBP) with four other methods: home blood pressure monitoring (HBPM), ambulatory blood pressure monitoring (ABPM) and blood pressure taken by a nurse in a physician's office. Agreement was measured between the various methods using the Pearson correlation coefficient. Based on a high correlation between CPBP and HBPM, the authors determined that CPBP captures participants' real blood pressure. Overall, there was a paucity of studies found that measured the agreement between blood pressure measurement methods used in community pharmacies and other methods. The few studies that were found were deemed to be incomparable due to the fact that they all used different objectives and results. Significant biases and limitations were present in all of the studies and as a result, the authors suggested that further research of a higher calibre is required.

A study by Snella, et al., evaluated a screening program to identify cases of diabetes, hypertension, and dyslipidemia in at-risk populations.¹¹⁴ Screening was conducted in 26 pharmacies and 4 non-healthcare facilities (large shopping facilities). Participants (n=888) were screened for plasma glucose, total cholesterol, high-density lipoprotein cholesterol and blood pressure. A risk assessment was also conducted using the ADA (American Diabetes Association) risk factor assessment tool. Pharmacists were responsible for the screening in both settings. Of the 888 screened, there were 794 individuals that received additional screening due to a risk factor tool score of at least 10. A total of 437 participants were referred for follow-up due elevated blood pressure, of which 9 were diagnosed with hypertension. Physician follow-up rates were higher in community pharmacy screenings than in non-healthcare settings. There were no statistical differences found between groups in reasons for not following through with physician appointments. There were no statistical differences calculated between the two screening groups in relation to incidence of new diagnoses.

Sookaneknun, et al., conducted an economic analysis of a hypertension screening program jointly administered by community pharmacies and a government primary care unit.¹¹² Model 1

consisted of screening in pharmacies, while Model 2 involved screening in the community. There were 25.5% of participants in Model 1 and 13.8% of participants in Model 2 who had blood pressure readings of at least 140/90mmHg. Of the participants (n=51) screened in the pharmacy, there was one confirmed diagnosis of hypertension. Of the participants (n=405) screened in the community, one was diagnosed with hypertension. Pharmacy screenings produced higher success rates for referrals to family physicians than the community-based screenings.

We also refer the reader to review the results for KQ1. The purpose of the CHAP study was to determine whether the community-based screening program would be superior to usual screening practice. The study demonstrated that a community-based hypertension screening program led to an increase in antihypertensive therapy and a decrease in cardiovascular morbidity.³⁵

Table 3. Characteristics of Included Studies

Study KQ1	Kaczorowski et al, 2011, Canada
Objective	"To evaluate the effectiveness of the community based Cardiovascular Health Awareness Program (CHAP) on morbidity from cardiovascular disease." (Kaczorowski, 2011)
Methods	<p>Design: 2 Arm Cluster RCT</p> <p>Selection: Community dwelling residents ≥ 65 years old</p> <p>Exclusions: 2 communities were excluded for having "pilot-tested" the interventions</p> <p>Blinding: Participants were informed that CHAP was being evaluated but the evaluation focus (community randomized trial) was not publicized</p> <p>Confounders: NR</p>
Participants	<p>Sample: All 39 Ontario communities with a population between 10,000-60,000 were included</p> <p>39 Communities: $N_I = 20$ $N_C = 19$</p> <p>Intervention: Subjects: $N_I = 13,379$ $N_C = 3,830$</p> <p>Characteristics:</p> <p>Mean Age: I: 74.82 C: 74.49</p> <p>Female: I: 57.08% C: 57.35%</p> <p>Ethnicity: NR</p> <p>Family Hx of HTN: NR</p> <p>Loss to follow-up: NR</p>
Intervention	<p>CHAP intervention: Over a 10 week period, 3 hour weekday blood pressure and cardiovascular risk assessment and educational sessions were available. Results were shared with patient and those at high risk were given immediate follow up, reports sent to patients' physicians.</p> <p>Study Duration: 12 months</p> <p>Received results 1 year after initial screening</p> <p>Follow-up: 1 year through database assessment</p>
Measurement (screening) tool	<p>Screening Instrument: BpTRU, VS.M Medtech, 2004</p> <p>Screener: Trained volunteer peer health educators</p> <p>Screening Setting: Community based pharmacies</p> <p>Other rating: NR</p>

Table 3. Characteristics of Included Studies (cont'd)

Study KQ1	Kaczorowski et al, 2011, Canada
Outcomes	<p>Main Outcome: The relative change in the mean annual rate of hospital admissions with a “most responsible” (primary) discharge diagnosis of acute myocardial infarction, congestive heart failure, or stroke (composite end point) among community-dwelling residents aged 65 years and over in the year before compared with the year following implementation of CHAP.</p> <p>Secondary Outcome: Mortality during the above hospital admissions</p> <p>Secondary Outcome: All-cause mortality</p> <p>Secondary Outcome: Newly prescribed antihypertensive drug treatment</p> <p>Results: None of the differences between the intervention and control communities at baseline reached statistical significance at the conventional level.</p> <p>After adjustment for hospital admission rates the year before intervention, CHAP was associated with a 9% relative reduction in the composite end point (rate ratio 0.91, 95% CI, 0.86 to 0.97; p=0.002) or 3.02 fewer annual hospital admissions for cardiovascular disease per 1,000 people aged 65 and over.</p> <p>Statistically significant reductions favouring the intervention communities were seen in hospital admissions for acute myocardial infarction (rate ratio 0.87, 0.79 to 0.97; p=0.008) and congestive heart failure (0.90, 0.81 to 0.99; p=0.029) but not for stroke (0.99, 0.88 to 1.12; p=0.89).</p> <p>Analysis of secondary outcomes showed a statistically significant difference favouring the CHAP intervention in newly prescribed antihypertensive drug treatment (rate ratio 1.10, 1.02 to 1.20; p=0.020), a trend towards lower in hospital cardiovascular mortality (0.86, 0.73 to 1.01; p=0.06), and no difference in terms of all-cause mortality (0.98, 0.92 to 1.03; p=0.38)</p>
Comments	<p>The specific components of CHAP active in the observed outcomes cannot be detected with the evaluation.</p> <p>CHAP was demonstrated to be ‘feasible and effective’ in mid-sized Ontario communities, these results may not apply to communities that organize healthcare delivery differently.</p> <p>Standard municipal boundaries were used to define the study population; the effect of the intervention could have been underestimated if CHAP participants resided out of the boundaries.</p>
Study KQ3	Rostrup et al, 1990, Norway
Objective	To examine the effects of awareness of hypertension on blood pressure and sympathetic responses to the cold pressure test. (Rostrup, 1990)
Methods	<p>Design: RCT</p> <p>Selection: Within the city of Oslo, 19-year old male draftees with a mean blood pressure above the 98th percentile(>116mmHg) during a standardized blood pressure measurement were selected for inclusion.</p> <p>Subjects included had no history of hypertension, normal physical examination and normal results of ECG, routine blood test and urinalysis. Subjects randomized into two groups matched by height and weight.</p> <p>Exclusions: NR</p> <p>Blinding: Physicians and subjects were blind to the initial blood pressure reading and subsequent readings. Technician was unaware of participants’ group status.</p> <p>Confounders: NR</p>

Table 3. Characteristics of Included Studies (cont'd)

Study KQ3	Rostrup et al, 1990, Norway
Participants	<p>Sample: N = 3,861</p> <p>Intervention: N_I = 16 N_C = 13</p> <p>Characteristics: 19 years old Military draft participants Female: 0% Ethnicity: White Family Hx of HTN: Subjects had no history of Hypertension Loss to follow up: 16 of 16 intervention completed protocol. 13 of 16 control subjects completed protocol; no reasons for attrition were given. Other relevant information such as years of recruitment: Recruitment, 1987</p>
Intervention	<p>N_I: Screening + informed of high blood pressure via letter + follow up measurements N_C: Screening + neutral letter + follow up measurements Study Duration: 12 months Follow-up: Examined 2 weeks after receiving letter Received results 1 year after initial screening</p>
Measurement (screening) tool	<p>Screening Instrument: Automated sphygmomanometer (Boso Digital II S) Screener: Physician Screening Setting: Military Draft Examination Other Rating: NR</p>

Table 3. Characteristics of Included Studies (cont'd)

Study KQ3	Rostrup et al, 1990, Norway
Outcomes	<p>Main Outcome: Change in blood pressure and heart rate before, during and following CPT</p> <p>Secondary Outcome: Change in response in heart rate, or plasma catecholamines before, during and following CPT</p> <p>Results: Significant reduction in SBP in uninformed ($p<0.001$) and informed ($p<0.02$) after 15min sitting compared to after 5min sitting one year earlier. A significant decrease in the DBP was observed in the uninformed group only ($p<0.001$) The decrease in BP was greater in the uninformed then the informed ($22.1/12.1\pm4.2/3.3$ v $9.9/6.0\pm3.8/3.0$mmHg, $p<0.05/P=0.05$).</p> <p>The informed group had a significantly higher systolic ($p<0.01$) and diastolic ($p<0.05$) after 15min sitting when measured using a random zero sphygmomanometer, systolic was still higher ($p<0.01$) when using an auscultatory automatic device.</p> <p>Mean blood pressure after 30min in supine position was significantly higher in the informed group (90.3 ± 1.8mmHg v 86.0 ± 0.9mmHg, $p<0.05$) with an overall consideration (ANOVA) showing significantly higher mean blood pressure of the informed group throughout the 30min period ($p<0.05$).</p> <p>The proportion of subjects with high BP (SBP>140, DBP>90) after 15min sitting was significantly higher in the informed group using the sphygmomanometer ($p<0.005$) and automatic auscultatory device($p<0.01$) Overall mean BP was higher in the informed group during recovery ($p<0.05$)</p> <p>Result on heart rate and plasma catecholamines were also available</p>
Comments	<p>Study limitations identified by the study or review authors: Participants were not diagnosed as hypertensive, to establish a diagnosis additional blood pressure examinations would have been necessary. Participants were expected to qualify as borderline hypertensive. The blood pressure & sympathetic responses could be non-generalizable to hypertensive individuals.</p>
Study KQ3	Rostrup et al, 1991, Norway
Objective	To examine the effects of awareness of high blood pressure on participants whose pressures were next to normal. (Rostrup, 1991)
Methods	<p>Design: RCT</p> <p>Selection: Within the city of Oslo, 19-year old male draftees with a mean blood pressure at the 95th percentile (110mmHg) during a standardized blood pressure measurement provided 46 subjects, 36 of whom were selected for inclusion who could be matched in 2 equal groups.</p> <p>Included subjects had history of hypertension, a normal physical examination and normal results of ECG, routine blood test and urinalysis. Subjects were randomized into two groups matched by height and weight.</p> <p>Exclusions: Subjects were excluded due to syncope during the arterial cannulation. They were also excluded if the arterial cannulation was initially unsuccessful.</p> <p>Blinding: Physicians and subjects were blind to the initial blood pressure reading and subsequent readings. Physicians were blind to the subjects' assignment.</p> <p>Confounders: NR</p>

Table 3. Characteristics of Included Studies (cont'd)

Study KQ3	Rostrup et al, 1991, Norway
Participants	<p>Sample: N = 4,123</p> <p>Intervention: N_I = 13 N_C = 13</p> <p>Characteristics: 19 years old Military draft participants Female: 0% Ethnicity: White Family Hx of HTN: Subjects had no history of Hypertension</p> <p>Loss to follow-up: All subjects participated in the follow-up blood pressure measurement. For the invasive portion of the follow up 2 subjects refused to participate. The syncope during arterial cannulation excluded 2 subjects and technical reasons were cited to exclude an additional 6 subjects.</p> <p>Other relevant information such as years of recruitment: Recruitment, 1987</p>
Intervention	<p>N_I: Screening + informed of high blood pressure via letter + follow up measurements and mental challenge</p> <p>N_C: Screening + neutral letter + follow up measurements and mental challenge</p> <p>Study Duration: 12 months</p> <p>Follow-up: Examined 2 weeks after receiving letter</p> <p>Received results 1 year after initial screening.</p>
Measurement (screening) tool	<p>Screening Instrument: Mercury sphygmomanometer</p> <p>Screener: Physician</p> <p>Screening Setting: Military Draft Examination</p> <p>Other Rating: NR</p>

Table 3. Characteristics of Included Studies (cont'd)

Study KQ3	Rostrup et al, 1991, Norway
Outcomes	<p>Main Outcome: Change in physiological response to stress due to labeling</p> <p>Secondary Outcome: Change in intra-arterial blood pressure throughout 30min monitoring (includes CPT and MST)</p> <p>Secondary Outcome: Difference in platelet/ plasmacatecholamines throughout 30min monitoring</p> <p>Secondary Outcome: Changes in heart rate throughout 30min monitoring</p> <p>Results: There were exaggerated adrenaline ($p<0.05$) and diastolic blood pressure ($p<0.05$) responses to mental stress in the informed group.</p> <p>Both systolic ($p<0.05$) and diastolic ($p<0.05$) blood pressure increased in the informed group when the CPT was explained. Diastolic blood pressure increased significantly more ($p<0.05$) in the informed group during the MST.</p> <p>At start of the 30min resting period, plasma noradrenaline was significantly higher in the informed group ($p<0.05$). Plasma adrenaline increased in the informed group during the resting period ($p<0.05$). There was no change in the uninformed group.</p> <p>Heart rate was significantly higher in the informed group after 15min sitting ($p<0.05$), but there was no significant difference after 30min supine rest.</p>
Comments	<p>Study limitations identified by the study or review authors: Some responses to the mental challenge is likely attributable to test excitement rather than the test itself. The influence of test excitement was avoided on resting period evaluations by delaying the announcement of the tests to the participants.</p>

Abbreviations: C = control; CPT = cold pressor test; DBP = diastolic blood pressure; Hx = history; I = intervention; MST = mental stress test; NR = not reported; RCT = randomized controlled trial, SBP = systolic blood pressure

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APPENDIX A

Search Strategies Key Questions & Contextual Questions

MERSC Hypertension Detailed Search Strategies

OVID-Medline

April 27 2011

1. exp Hypertension/
2. hypertens*.ti.
3. hypertension.tw.
4. high blood pressure.mp.
5. or/1-4
6. mass screening/
7. screen*.mp.
8. diagnos*.ti.
9. or/6-8
10. 5 and 9
11. ((blood pressure or hypertension) adj3 (screen* or diagnos*)).tw.
12. 10 or 11
13. animals/ not (animals/ and humans/)
14. 12 not 13
15. limit 14 to (english or french)
16. limit 15 to yr="1985 -Current"

OVID-Embase

April 27 2011

1. mass screening/
2. screen*.mp.
3. diagnos*.ti.
4. or/1-3
5. ((blood pressure or hypertension) adj3 (screen* or diagnos*)).tw.
6. exp *hypertension/
7. hypertens*.ti.
8. high blood pressure.mp.
9. 6 or 7 or 8
10. 4 and 9
11. 5 or 10
12. limit 11 to yr="1985 -Current"
13. limit 12 to (english or french)
14. limit 13 to human
15. limit 14 to (book or editorial or letter or note)
16. 14 not 15

OVID-Cochrane Central

April 27 2011

1. exp Hypertension/
2. hypertens*.ti.
3. hypertension.tw.

4. high blood pressure.mp.
5. or/1-4
6. mass screening/
7. screen*.mp.
8. diagnos*.ti.
9. or/6-8
10. 5 and 9
11. ((blood pressure or hypertension) adj3 (screen* or diagnos*)).tw.
12. 10 or 11
13. limit 12 to yr="1985 -Current"

APPENDIX B

Contextual Question Search Strategies

Context Question 1

OVID-Medline and Cochrane Database of Systematic Reviews

May 13 2011

1. exp Hypertension/
2. hypertens*.ti.
3. hypertension.tw.
4. high blood pressure.mp.
5. or/1-4
6. mass screening/
7. screen*.mp.
8. diagnos*.ti.
9. or/6-8
10. 5 and 9
11. ((blood pressure or hypertension) adj3 (screen* or diagnos*)).tw.
12. *blood pressure determination/ or *blood pressure monitoring, ambulatory/
13. or/10-12
14. 10 or 13
15. animals/ not humans/
16. 14 not 15
17. limit 16 to (english or french)
18. limit 17 to yr="2005 -Current"
19. Ethnic Groups/
20. ethnic*.ti.
21. Indians, North American/
22. first nations.tw.
23. native canadian?.tw.
24. (aboriginal? and canada).tw.
25. exp Hypertension, Pregnancy-Induced/
26. ethnic groups/ or african americans/ or asian americans/
27. ((African or Asian or Indo) adj2 Canadian).mp.
28. or/19-27
29. 18 and 28
30. *Hypertension/ep, mo [Epidemiology, Mortality]
31. 28 and 30
32. 29 or 31
33. animals/ not humans/
34. 32 not 33
35. limit 34 to (english or french)
36. limit 35 to yr="2005 -Current"

OVID-Embase

May 13 2011

1. mass screening/
2. screen*.mp.
3. diagnos*.ti.
4. or/1-3

5. ((blood pressure or hypertension) adj3 (screen* or diagnos*)).tw.
6. exp *hypertension/
7. hypertens*.ti.
8. high blood pressure.mp.
9. 6 or 7 or 8
10. 4 and 9
11. 5 or 10
12. *blood pressure measurement/
13. 11 or 12
14. *maternal hypertension/
15. exp *negro/
16. ((African or Asian or Indo) adj2 Canadian).mp.
17. exp *asian/
18. first nations.tw.
19. *american indian/
20. (aboriginal? and canada).tw.
21. native canadians.tw.
22. (immigran* or new canadians).tw.
23. (immigran* or new canadians).tw.
24. (minority group or minority population).tw.
25. or/14-24
26. exp *hypertension/dm, ep [Disease Management, Epidemiology]
27. 25 and 26
28. 13 and 25
29. 27 or 28
30. animal/ or animal experiment/
31. human/
32. 30 not 31
33. 29 not 32
34. limit 33 to (english or french)
35. limit 34 to yr="2005 -Current"

Context Question 2

OVID-Medline

1. exp Hypertension/
2. hypertens*.ti.
3. hypertension.tw.
4. high blood pressure.mp.
5. or/1-4
6. mass screening/
7. screen*.mp.
8. diagnos*.ti.
9. or/6-8
10. 5 and 9
11. ((blood pressure or hypertension) adj3 (screen* or diagnos*)).tw.
12. *blood pressure determination/ or *blood pressure monitoring, ambulatory/

13. or/10-12
14. 10 or 13
15. animals/ not humans/
16. 14 not 15
17. limit 16 to (english or french)
18. limit 17 to yr="2005 -Current"
19. exp Canada/
20. 18 and 19
21. Ethnic Groups/
22. ethnic*.ti.
23. Rural Health/
24. Rural Population/
25. rural health services/
26. (rural or remote).ti.
27. (geographic and disparity).ti.
28. Indians, North American/
29. first nations.tw.
30. native canadian?.tw.
31. (aboriginal? and canada).tw.
32. or/21-31
33. 18 and 32
34. 20 or 33
35. exp africa/ or exp central america/ or exp latin america/ or exp south america/ or exp asia/
36. 34 not 35

OVID-Embase

1. first nations.tw.
2. (aboriginal? and canada).tw.
3. native canadians.tw.
4. (immigran* or new canadians).tw.
5. ((African or Asian or Indo or Columbian or Spanish or Chinese) adj2 Canadian).mp.
6. rural health care/
7. rural population/
8. (rural adj (population? or area? or region?)).tw.
9. exp Canada/
10. or/1-9
11. mass screening/
12. screen*.mp.
13. diagnos*.ti.
14. or/11-13
15. ((blood pressure or hypertension) adj3 (screen* or diagnos*)).tw.
16. exp *hypertension/
17. hypertens*.ti.
18. high blood pressure.mp.
19. 16 or 17 or 18
20. 14 and 19

21. 15 or 20
22. *blood pressure measurement/
23. 21 or 22
24. 10 and 23
25. animal/ or animal experiment/
26. human/
27. 25 not 26
28. 24 not 27
29. limit 28 to (english or french)
30. limit 29 to yr="2005 -Current"
31. exp africa/ or exp asia/
32. exp "South and Central America"/
33. 31 or 32
34. 30 not 33

Context Question 3

OVID-Medline and Cochrane Database of Systematic Reviews

May 12 2011

1. exp Hypertension/
2. hypertens*.ti.
3. hypertension.tw.
4. high blood pressure.mp.
5. or/1-4
6. mass screening/
7. screen*.mp.
8. diagnos*.ti.
9. or/6-8
10. 5 and 9
11. ((blood pressure or hypertension) adj2 (screen* or diagnos* or determin*)).tw.
12. exp Blood Pressure Determination/
13. or/10-12
14. animals/ not humans/
15. 13 not 14
16. exp *"Costs and Cost Analysis"/
17. (cost or econom*).ti.
18. 16 or 17
19. 15 and 18
20. limit 19 to (english or french)
21. limit 20 to yr="2005 -Current"

OVID-Embase

May 12 2011

1. exp Hypertension/
2. hypertens*.ti.
3. hypertension.tw.
4. high blood pressure.mp.

5. or/1-4
6. mass screening/
7. screen*.mp.
8. diagnos*.ti.
9. or/6-8
10. 5 and 9
11. ((blood pressure or hypertension) adj2 (screen* or diagnos* or determin*)).tw.
12. exp Blood Pressure Determination/
13. or/10-12
14. limit 13 to yr="2005 -Current"
15. mass screening/
16. screen*.mp.
17. diagnos*.ti.
18. or/15-17
19. ((blood pressure or hypertension) adj3 (screen* or diagnos*)).tw.
20. exp *hypertension/
21. hypertens*.ti.
22. high blood pressure.mp.
23. 20 or 21 or 22
24. 18 and 23
25. 19 or 24
26. *blood pressure measurement/
27. 25 or 26
28. exp *health economics/
29. (cost or econom*).ti.
30. or/28-29
31. 27 and 30
32. animal/ or animal experiment/
33. human/
34. 32 not 33
35. 31 not 34
36. limit 35 to (english or french)
37. limit 36 to yr="2005 -Current"

Context Question 4

OVID-Medline and Cochrane Database of Systematic Reviews

May 10 2011

1. exp Hypertension/
2. hypertens*.ti.
3. hypertension.tw.
4. high blood pressure.mp.
5. or/1-4
6. mass screening/
7. screen*.mp.
8. diagnos*.ti.
9. or/6-8

10. 5 and 9
11. ((blood pressure or hypertension) adj2 (screen* or diagnos* or determin*)).tw.
12. 10 or 11
13. animals/ not (animals/ and humans/)
14. 12 not 13
15. limit 14 to (english or french)
16. limit 15 to yr="2005 -Current"
17. *"patient acceptance of health care"/ or *patient compliance/ or *patient participation/ or patient satisfaction/ or patient preference/ or *treatment refusal/
18. (women? adj3 (acceptance or preference? or satisfaction or experience?)).tw.
19. (consumer? adj3 (acceptance or preference? or satisfaction or experience?)).tw.
20. (patient? adj3 (acceptance or preference? or satisfaction or experience?)).tw.
21. willingness to pay.tw.
22. ((conjoint or contingent) adj3 (valuation or analysis)).tw.
23. or/17-22
24. 16 and 23
25. exp Blood Pressure Determination/
26. 23 and 25
27. animals/ not (animals/ and humans/)
28. 26 not 27
29. limit 28 to (english or french)
30. limit 29 to yr="2005 -Current"
31. 24 or 30

OVID-Embase

May 10 2011

1. mass screening/
2. screen*.mp.
3. diagnos*.ti.
4. or/1-3
5. ((blood pressure or hypertension) adj3 (screen* or diagnos*)).tw.
6. exp *hypertension/
7. hypertens*.ti.
8. high blood pressure.mp.
9. 6 or 7 or 8
10. 4 and 9
11. 5 or 10
12. *blood pressure measurement/
13. 11 or 12
14. exp patient attitude/
15. (women? adj3 (acceptance or preference? or satisfaction or experience?)).tw.
16. (consumer? adj3 (acceptance or preference? or satisfaction or experience?)).tw.
17. (patient? adj3 (acceptance or preference? or satisfaction or experience?)).tw.
18. willingness to pay.tw.
19. ((conjoint or contingent) adj3 (valuation or analysis)).tw.
20. or/14-19

21. 13 and 20
22. animal/ or animal experiment/
23. human/
24. 22 not 23
25. 21 not 24
26. limit 25 to (english or french)
27. limit 26 to yr="2006 -Current"
28. preference.tw.
29. 13 and 28
30. 29 not 24
31. limit 30 to (english or french)
32. limit 31 to yr="2005 -Current"
33. 27 or 32

Context Question 6

OVID-Medline

May 31 2011

1. Pharmacists/
2. Pharmacies/
3. Health Fairs/
4. Workplace/
5. community health services/ or community health nursing/ or community pharmacy services/
6. or/1-4
7. or/1-5
8. (pharmacy or pharmacist? or workplace or health fair?).tw.
9. 7 or 8
10. 6 or 8
11. exp Hypertension/
12. hypertens*.ti.
13. hypertension.tw.
14. high blood pressure.mp.
15. or/11-14
16. mass screening/
17. screen*.mp.
18. diagnos*.ti.
19. or/16-18
20. 15 and 19
21. ((blood pressure or hypertension) adj3 (screen* or diagnos*)).tw.
22. 20 or 21
23. animals/ not (animals/ and humans/)
24. 22 not 23
25. limit 24 to (english or french)
26. limit 25 to yr="1996 -Current"
27. *blood pressure determination/

28. limit 27 to (english or french)
29. limit 28 to yr="1996 -Current"
30. 29 not 26
31. limit 30 to (case reports or comment or congresses or editorial or letter or news or newspaper article or video-audio media or webcasts)
32. 30 not 31
33. 26 or 29
34. 9 and 33

OVID-Embase

May 31 2011

1. Pharmacists/
2. Pharmacies/
3. Health Fairs/
4. Workplace/
5. community health services/ or community health nursing/ or community pharmacy services/
6. or/1-4
7. or/1-5
8. (pharmacy or pharmacist? or workplace or health fair?).tw.
9. 7 or 8
10. 6 or 8
11. pharmacist/
12. pharmacy/
13. workplace/
14. community care/ or community program/
15. or/11-14
16. exp Hypertension/
17. hypertens*.ti.
18. hypertension.tw.
19. high blood pressure.mp.
20. or/16-19
21. mass screening/
22. screen*.mp.
23. diagnos*.ti.
24. or/21-23
25. 20 and 24
26. ((blood pressure or hypertension) adj3 (screen* or diagnos*)).tw.
27. 25 or 26
28. animals/ not (animals/ and humans/)
29. 27 not 28
30. limit 29 to (english or french)
31. limit 30 to yr="1996 -Current"
32. *blood pressure determination/
33. limit 32 to (english or french)
34. limit 33 to yr="1996 -Current"
35. 34 not 31

36. exp *blood pressure measurement/
37. limit 36 to (english or french)
38. limit 37 to yr="1996 -Current"
39. (pediatric* or paediatric* or child* or adolescent?).jn.
40. 38 not 39
41. limit 40 to (book or book series or conference abstract or conference paper or editorial or letter or note or proceeding)
42. 40 not 41
43. animal/
44. animal experiment/
45. 43 or 44
46. human/
47. 45 not 46
48. 42 not 47
49. limit 48 to "review"
50. meta analysis/
51. systematic review/
52. (meta analy* or metaanaly* or met analy* or metanaly*).tw.
53. (collaborative research or collaborative review* or collaborative overview*).tw.
54. (integrative research or integrative review* or intergrative overview*).tw.
55. (quantitative adj3 (research or review* or overview*)).tw.
56. (research integration or research overview*).tw.
57. (systematic* adj3 (review* or overview*)).tw.
58. (methodologic* adj3 (review* or overview*)).tw.
59. biomedical technology assessment/
60. (hta or thas or technology assessment*).tw.
61. ((hand adj2 search*) or (manual* adj search*)).tw.
62. ((electronic adj database*) or (bibliographic* adj database*)).tw.
63. ((data adj2 abstract*) or (data adj2 extract*)).tw.
64. (data adj3 (pooled or pool or pooling)).tw.
65. (analys* adj3 (pool or pooled or pooling)).tw.
66. mantel haenszel.tw.
67. (cochrane or Pubmed or pub med or medline or embase or psycinfo or psyclit or psychinfo or psychlit or cinahl or science citation index).ab.
68. or/50-67
69. 48 and 68
70. 49 not 69
71. 48 not 70
72. 31 or 34 or 48
73. 15 or 72
74. 15 and 72
75. limit 74 to yr="2005 -Current"

APPENDIX C

Excluded Studies KQ1 Screen

KQ1: Excluded List

Ambulatory blood pressure monitoring for diagnosing hypertension in patients with elevated office blood pressure. *Tecnologica MAP Supplement* 1999;1-3. PMID:10848161 OVID-Medline.
Exclude: No Comparator

Cardiovascular disease prevention for women attending breast and cervical cancer screening programs: the WISEWOMAN projects. The WISEWOMAN Workgroup. *Prev Med* 1999;28(5):496-502.
PMID:10329340 OVID-Medline.
Exclude: No Comparator

Agarwal R, Andersen MJ, Bishu K, et al. Home blood pressure monitoring improves the diagnosis of hypertension in hemodialysis patients. *Kidney Int* 2006;69(5):900-6. PMID:16518349 OVID-Medline.
Exclude: Not Screening

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Lin JW, Chu PL, Liou JM, et al. Applying a multiple screening program aided by a guideline-driven computerized decision support system - a pilot experience in Yun-Lin, Taiwan. *J Formosan Med Assoc* 2007;106(1):58-68. PMID:17282972 OVID-Medline.
Exclude: No Comparator

Lin S, Cheng TO, Liu X, et al. Impact of dysglycemia, body mass index, and waist-to-hip ratio on the prevalence of systemic hypertension in a lean Chinese population. *Am J Cardiol* 2006;97(6):839-42. PMID:16516586 OVID-Medline.
Exclude: Not Screening

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Exclude: Not Screening

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Exclude: No Comparator

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Exclude: No Comparator

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Exclude: No Comparator

Lusk SL. Worksite hypertension screening and intervention programs. *AAOHN Journal* 1996;44(9):470-3. PMID:8924071 OVID-Medline.
Exclude: Not Primary Research

Maldonado J. Blood pressure screening, management and control in England: results from the Health Survey for England 1994. *Rev Port Cardiol* 1999;18(10):959-60. PMID:10590661 OVID-Medline.
Exclude: No Comparator

Marques-Vidal P, Ferrieres J, Ruidavets JB, et al. Trends in the screening and management of hypertension and hypercholesterolemia in men in Haute-Garonne. [French]. *Revue d'Epidemiologie et de Sante Publique* 1996;44(3):193-9. PMID:8766978 OVID-Medline.
Exclude: No Comparator

McGowan N, Atkins N, O'Brien E, et al. Computerized reporting improves the clinical use of ambulatory blood pressure measurement. *Blood Pres Monit* 2010;15(3):115-23. PMID:20436348 OVID-Medline.
Exclude: 1 Year Follow up

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Exclude: Not Screening

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Exclude: Not Screening

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Exclude: Not Screening

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Exclude: Not Screening

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Exclude: Not Screening

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Exclude: No Comparator

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Exclude: 1 Year Follow up

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Exclude: Not Screening

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Exclude: No Comparator

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Exclude: Not Screening

Niiranen TJ, Jula AM, Kantola IM, et al. Comparison of agreement between clinic and home-measured blood pressure in the Finnish population: the Finn-HOME Study. *J Hypertens* 2006;24(8):1549-55. PMID:16877957 OVID-Medline.
Exclude: No Comparator

Niyonsenga T, Vanasse A, Courteau J, et al. Impact of terminal digit preference by family physicians and sphygmomanometer calibration errors on blood pressure value: implication for hypertension screening. *J Clin Hypertens* 2008;10(5):341-7. PMID:18453792 OVID-Medline.
Exclude: Not Screening

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Exclude: No Comparator

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Exclude: Not Screening

Nyklicek I, Vingerhoets AJJM, Van Heck GL. Elevated blood pressure and self-reported symptom complaints, daily hassles, and defensiveness. *Int J Behav Med* 1999;6(2):177-89. OVID-EMBASE.
Exclude: Not Screening

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Exclude: Not Screening

Ohkubo T, Imai Y, Tsuji I, et al. Prediction of mortality by ambulatory blood pressure monitoring versus screening blood pressure measurements: a pilot study in Ohasama. *J Hypertens* 1997;15(4):357-64. PMID:9211170 OVID-Medline.
Exclude: No Comparator

Ohkubo T, Imai Y, Tsuji I, et al. Home blood pressure measurement has a stronger predictive power for mortality than does screening blood pressure measurement: a population-based observation in Ohasama, Japan. *J Hypertens* 1998;16(7):971-5. PMID:9794737 OVID-Medline.
Exclude: No Comparator

Ohkubo T, Hozawa A, Nagai K, et al. Prediction of stroke by ambulatory blood pressure monitoring versus screening blood pressure measurements in a general population: the Ohasama study. *J Hypertens* 2000;18(7):847-54. PMID:10930181 OVID-Medline.
Exclude: No Comparator

Ohrig E, Geiss HC, Haas GM, et al. The Prevention Education Program (PEP) Nuremberg: design and baseline data of a family oriented intervention study. *Int J Obesity Relat Metab Disord* 2001;25:S589-92. PMID:11466597 OVID-Medline.
Exclude: Not Screening

Palatini P, Winnicki M, Santonastaso M, et al. Prevalence and clinical significance of isolated ambulatory hypertension in young subjects screened for stage 1 hypertension. *Hypertens* 2004;44(2):170-4. PMID:15210653 OVID-Medline.
Exclude: Not Screening

Patel JV, Gunaratne A, Lane D, et al. Widening access to cardiovascular healthcare: community screening among ethnic minorities in inner-city Britain - the Healthy Hearts Project. *BMC Health Serv Res* 2007;7:192 PMID:18036225 OVID-Medline.
Exclude: No Comparator

Peek M, Shennan A, Halligan A, et al. Hypertension in pregnancy: which method of blood pressure measurement is most predictive of outcome? *Obstet Gynecol* 1996;88(6):1030-3. PMID:8942848 OVID-Medline.
Exclude: Not Screening

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Exclude: No Comparator

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Exclude: Not Screening

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Exclude: Not Screening

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Exclude: Not Screening

Pozzan R, Brandao AA, da Silva SL, et al. Hyperglycemia, hyperinsulinemia, overweight, and high blood pressure in young adults: the Rio de Janeiro Study. *Hypertens* 1997;30(3:Pt 2):t-3 PMID:9322998 OVID-Medline.
Exclude: No Comparator

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Exclude: Not Screening

Rafey M. Beyond office sphygmomanometry: ways to better assess blood pressure. *Cleve Clin J Med* 2009;76(11):657-62. PMID:19884295 OVID-Medline.
Exclude: Not Primary Research

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Exclude: Not Screening

Reid CM, Ryan P, Miles H, et al. Who's really hypertensive?--Quality control issues in the assessment of blood pressure for randomized trials. *Blood Pres* 2005;14(3):133-8. PMID:16036492 OVID-Medline.
Exclude: Not Primary Research

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Exclude: Not Screening

Releford BJ, Frencher SK, Jr., Yancey AK, et al. Cardiovascular disease control through barbershops: design of a nationwide outreach program. *J Natl Med Assoc* 2010;102(4):336-45. PMID:20437741 OVID-Medline.
Exclude: Not Screening

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Exclude: 1 Year Follow up

Ross-McGill H, Hewison J, Hirst J, et al. Antenatal home blood pressure monitoring: a pilot randomised controlled trial. *BJOG Int J Obstet Gynaecol* 2000;107(2):217-21. PMID:10688505 OVID-Medline.
Exclude: 1 Year Follow up

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Exclude: 1 Year Follow up

Russo D, Napolitano P, Sirico ML, et al. A project to prevent renal diseases in the general population. *J Nephrol* 2007;20(1):36-42. PMID:17347971 OVID-Medline.
Exclude: No Comparator

Sakuma M, Imai Y, Nagai K, et al. Reproducibility of home blood pressure measurements over a 1-year period. *Am J Hypertens* 1997;10(7:Pt 1):798-803. PMID:9234836 OVID-Medline.
Exclude: No Comparator

Sakurai M, Miura K, Takamura T, et al. Gender differences in the association between anthropometric indices of obesity and blood pressure in Japanese. *Hypertens Res Clin Exp* 2006;29(2):75-80. PMID:16755140 OVID-Medline.
Exclude: No Comparator

Schlundt DG, Greene C, Reid R, et al. An evaluation of the Nashville REACH 2010 community health screening strategy. *Journal of Ambulatory Care Management* 2006;29(2):151-61. CQ6 setting
Health fair; community. PMID:16552324 OVID-Medline.
Exclude: 1 Year Follow up

Simay A, Lakatos Z, Ilyes I, et al. Assessment of cardiovascular risk factors and their correlation in 28,000 Hungarians. *Publ Health* 2005;119(5):437-41. PMID:15780334 OVID-Medline.
Exclude: Not Screening

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Exclude: 1 Year Follow up

Staal EM, rd OK, Omvik P, et al. Blood pressure measurements by the Keito machine. Evaluation versus office blood pressure by physicians. *Blood Pres Monit* 2004;9(3):167-72. CQ6 setting. PMID:15199310 OVID-Medline.
Exclude: 1 Year Follow up

Stella A, Grella PV. Automated blood pressure monitoring in normal pregnancy. *Int J Gynaecol Obstet* 1996;55(1):11-7. OVID-EMBASE.
Exclude: Not Screening

Stergiou GS, Skeva II, Baibas NM, et al. Diagnosis of hypertension using home or ambulatory blood pressure monitoring: comparison with the conventional strategy based on repeated clinic blood pressure measurements. *J Hypertens* 2000;18(12):1745-51. PMID:11132597 OVID-Medline.
Exclude: Not Screening

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Exclude: 1 Year Follow up

Stergiou GS, Salgami EV, Tzamouranis DG, et al. Masked hypertension assessed by ambulatory blood pressure versus home blood pressure monitoring: is it the same phenomenon? *Am J Hypertens* 2005;18(6):772-8. PMID:15925734 OVID-Medline.
Exclude: Not Screening

Taleb A, Mohammed BB, Benrezkallah L, et al. Noise exposure, psychosocial environment and arterial hypertension in industrial companies. [French]. *Archives des Maladies Professionnelles et de Medecine du Travail* 2003;64(4):246-52. OVID-EMBASE.
Exclude: 1 Year Follow up

Terawaki H, Metoki H, Nakayama M, et al. Masked hypertension determined by self-measured blood pressure at home and chronic kidney disease in the Japanese general population: the Ohasama study. *Hypertens Res Clin Exp* 2008;31(12):2129-35. PMID:19139602 OVID-Medline.
Exclude: No Comparator

Thomson R, Greenaway J, Chinn DJ, et al. The impact of implementing national hypertension guidelines on prevalence and workload in primary care: a population-based survey of older people. *J Hum Hypertens* 2005;19(9):683-9. PMID:15920451 OVID-Medline.
Exclude: Not Screening

Thorogood M, Connor MD, Hundt GL, et al. Understanding and managing hypertension in an African sub-district: a multidisciplinary approach. *Scandinavian Journal of Public Health* 2007;Supplement.(69):52-9. PMID:17676503 OVID-Medline.
Exclude: No Comparator

Toth-Pal E, Nilsson GH, Furhoff AK. Clinical effect of computer generated physician reminders in health screening in primary health care--a controlled clinical trial of preventive services among the elderly. *Int J*

Med Informat 2004;73(9-10):695-703. PMID:15325326 OVID-Medline.
Exclude: Not Screening

Tourdjman M, Jacobi D, Petit P, et al. Ten-year incidence of high blood pressure in the general population: influence of clinical parameters, and implication for screening strategies. [French]. Arch Mal Coeur Vaiss 2007;100(8):615-9. PMID:17928762 OVID-Medline.
Exclude: No Comparator

Toyama H, Hasegawa Y, Ejima Y, et al. Characteristics of young-onset white coat hypertension identified by targeted screening for hypertension at a university health check-up. Hypertens Res Clin Exp 2008;31(6):1063-8. PMID:18716352 OVID-Medline.
Exclude: 1 Year Follow up

Tozawa M, Oshiro S, Iseki C, et al. Family history of hypertension and blood pressure in a screened cohort. Hypertens Res Clin Exp 2001;24(2):93-8. PMID:11325080 OVID-Medline.
Exclude: No Comparator

Trudel X, Brisson C, Larocque B, et al. Masked hypertension: different blood pressure measurement methodology and risk factors in a working population. J Hypertens 2009;27(8):1560-7. CQ6 setting. PMID:19444141 OVID-Medline.
Exclude: 1 Year Follow up

Tsuji I, Imai Y, Nagai K, et al. Proposal of reference values for home blood pressure measurement: prognostic criteria based on a prospective observation of the general population in Ohasama, Japan. Am J Hypertens 1997;10(4:Pt 1):409-18. PMID:9128207 OVID-Medline.
Exclude: No Comparator

Tu K, Cauch-Dudek K, Chen Z. Comparison of primary care physician payment models in the management of hypertension. Can Fam Physician 2009;55(7):719-27. PMID:19602662 OVID-Medline.
Exclude: Not Screening

Tuomisto MT, Majahalme S, Kahonen M, et al. Psychological stress tasks in the prediction of blood pressure level and need for antihypertensive medication: 9-12 years of follow-up. Health Psychol 2005;24(1):77-87. PMID:15631565 OVID-Medline.
Exclude: Not Screening

U.S.Preventive Services Task Force. Screening for high blood pressure: recommendations and rationale. Am Fam Physician 2003;68(10):2019-22. PMID:14655813 OVID-Medline.
Exclude: Not Primary Research

Uallachain GN, Murphy G, Avalos G. The RAMBLER study: the role of ambulatory blood pressure measurement in routine clinical practice: a cross-sectional study. Ir Med J 2006;99(9):276-9. PMID:17144238 OVID-Medline.
Exclude: Not Screening

Ungar A, Pepe G, Monami M, et al. Isolated ambulatory hypertension is common in outpatients referred to a hypertension centre. J Hum Hypertens 2004;18(12):897-903. PMID:15241442 OVID-Medline.
Exclude: No Comparator

van den Berg PJ, van Dalsen CL, de Rooij RA, et al. Cardiovascular health check in the elderly in one general practice: does it offer new information and lead to interventions? Fam Pract 1999;16(4):389-94. KQ2b

CQ6 setting. PMID:10493710 OVID-Medline.
Exclude: 1 Year Follow up

Vasan RS, Levy D. Rates of progression to hypertension among non-hypertensive subjects: implications for blood pressure screening. *Eur Heart J* 2002;23(14):1067-70. Editorial. PMID:12090739 OVID-Medline.

Exclude: Not Primary Research

Vasan R, Larson M, Leip E, et al. Assessment of frequency of progression to hypertension in nonhypertensive participants in the Framingham Heart Study: A cohort study. *Lancet* 2001;358:1682-6.

Exclude: No Comparator

Vaughan R, Cushman LF, Nye A. The New York City Community Outreach Study: biomedical and mental health status among a community sample of urban Hispanics. *Ethn Dis* 2007;17(1):99-105.

PMID:17274217 OVID-Medline.

Exclude: No Comparator

Wang PE, Wang TT, Chiu YH, et al. Evolution of multiple disease screening in Keelung: a model for community involvement in health interventions? *J Med Screen* 2006;13:S54-8. PMID:17227644 OVID-Medline.

Exclude: No Comparator

Watanabe Y, Metoki H, Ohkubo T, et al. Parental longevity and offspring's home blood pressure: the Ohasama study. *J Hypertens* 2010;28(2):272-7. PMID:19829146 OVID-Medline.

Exclude: No Comparator

Watman GP, Jepson M. Patient screening by a community pharmacist located in a GP practice. *J Soc Admin Pharm* 2002;19(3):105-14. setting, practitioner. OVID-EMBASE.

Exclude: No Comparator

Weber F, Anlauf M, Hirche H, et al. Differences in blood pressure values by simultaneous auscultation of Korotkoff sounds inside the cuff and in the antecubital fossa. *J Hum Hypertens* 1999;13(10):695-700.

PMID:10516740 OVID-Medline.

Exclude: Not Screening

Wendelin-Saarenhovi M, Isoaho R, Hartiala J, et al. Ambulatory blood pressure: associations with coronary heart disease in the aged Finnish population. *Aging Clin Exp Res* 2007;19(6):432-7.

PMID:18172363 OVID-Medline.

Exclude: Not Screening

Westhoff TH, Straub-Hohenbleicher H, Schmidt S, et al. Convenience of ambulatory blood pressure monitoring: comparison of different devices. *Blood Pres Monit* 2005;10(5):239-42. OVID-CCTR.

Exclude: Not Screening

Wingfield D, Freeman GK, Bulpitt CJ, et al. Selective recording in blood pressure readings may increase subsequent mortality. *QJM Int J Med* 2002;95(9):571-7. PMID:12205334 OVID-Medline.

Exclude: Not Screening

Wingfield D, Grodzicki T, Palmer AJ, et al. Transiently elevated diastolic blood pressure is associated with a gender-dependent effect on cardiovascular risk. *J Hum Hypertens* 2005;19(5):347-54.

PMID:15744334 OVID-Medline.

Exclude: No Comparator

Wittchen HU, Glaesmer H, Marz W, et al. Cardiovascular risk factors in primary care: methods and baseline prevalence rates--the DETECT program. *Curr Med Res Opin* 2005;21(4):619-30.

PMID:15899112 OVID-Medline.

Exclude: No Comparator

Wong RC, Yeo TC. 'Office-hour' ambulatory blood pressure monitoring is sufficient for blood pressure diagnosis. *J Hum Hypertens* 2006;20(6):440-3. PMID:16598289 OVID-Medline.
Exclude: Not Screening

Yasui D, Asayama K, Ohkubo T, et al. Stroke risk in treated hypertension based on home blood pressure: the Ohasama study. *Am J Hypertens* 2010;23(5):508-14. PMID:20186131 OVID-Medline.
Exclude: Not Screening

Yosefy C, Dicker D, Viskoper JR, et al. The Ashkelon Hypertension Detection and Control Program (AHDC Program): a community approach to reducing cardiovascular mortality. *Prev Med* 2003;37(6:Pt 1):751-6. PMID:14636790 OVID-Medline.
Exclude: No Comparator

Zdrojewski T, Gluszek J, Posadzy-Malaczynska A, et al. Effects of social intervention on detection and efficacy of treatment for arterial hypertension. Main results of the Polish Four Cities Programme. *Kardiologia Polska* 559;61(12):546-58. PMID:15815755 OVID-Medline.
Exclude: 1 Year Follow up

Zdrojewski T, Kozicka-Kakol K, Chwojnicky K, et al. Arm circumference in adults in Poland as an important factor influencing the accuracy of blood pressure readings. *Blood Pres Monit* 2005;10(2):73-7. PMID:15812254 OVID-Medline.
Exclude: Not Screening

APPENDIX D

Excluded Studies Screen 2

KQ1, KQ2a&b, KQ3: Excluded List

Hypertension: questions of prevalence, diagnosis, and management. Medical Technology and Practice Patterns Institute. *J Clin Hypertens* 1987;3(4):757-67. PMID:3453401 Exclude: Not Primary Research

Chronic disease surveys. Evaluation of hypertension screening in a Swiss community using the cluster survey methodology of the EPI. *Wkly Epidemiol Rec* 1990;65(43):331-3. PMID:2252865 OVID-Medline. Exclude: No Comparator

Agarwal R. Hypertension diagnosis and prognosis in chronic kidney disease with out-of-office blood pressure monitoring. *Curr Opin Nephrol Hypertens* 2006;15(3):309-13. PMID:16609300 OVID-Medline. Exclude: Not Primary Research

Allan K, Murphy P, Singleton S, et al. Audit of diagnosis and management of hypertension in primary care. Interpractice variation in prevalence of hypertension is due to inadequate detection. *BMJ* 1997;315(7103):314 PMID:9274572 OVID-Medline. Exclude: Not Primary Research

Allander E, Bring J, Gudmundsson L, et al. What is the long term value of multiphasic health screening and the initial judgement of benefit? *Scand J Soc Med* 1997;Supplementum.(51):1-20. PMID:9241695 OVID-Medline. Exclude: No Comparator

Andersen MJ, Khawandi W, Agarwal R. Home blood pressure monitoring in CKD. *Am J Kidney Dis* 2005;45(6):994-1001. PMID:15957127 OVID-Medline. Exclude: Not Screening

Arroll B. Screening: the double edged sword! *New Zeal Med J* 1990;103(894):346-8. PMID:2115635 OVID-Medline. Exclude: Not Primary Research

Asayama K, Ohkubo T, Sato A, et al. Proposal of a risk-stratification system for the Japanese population based on blood pressure levels: the Ohasama study. *Hypertens Res Clin Exp* 2008;31(7):1315-22. PMID:18957801 OVID-Medline. Exclude: No Comparator

Augustovs.ki FA, Calvo CB, Deprati M, et al. The deep-breath test as a diagnostic maneuver for white-coat effect in hypertensive patients. *J Am Board Fam Pract* 2004;17(3):184-9. PMID:15226282 OVID-Medline. Exclude: No Comparator

Barger SD, Muldoon MF. Hypertension labelling was associated with poorer self-rated health in the Third US National Health and Nutrition Examination Survey. *J Hum Hypertens* 2006;20(2):117-23. PMID:16267563 OVID-Medline. Exclude: No Comparator

Barry D, Hogan MJ. A comparison of responses to a health and lifestyle questionnaire completed before and then after blood pressure screening. *J Expo Anal Environ Epidemiol* 2002;12(4):244-51. PMID:12087430 OVID-Medline. Exclude: No Comparator

Bartys S, Baker D, Lewis P, et al. Inequity in recording of risk in a local population-based screening programme for cardiovascular disease. *Eur J Cardiovasc Prev Rehabil* 2005;12(1):63-7. PMID:15703508 OVID-Medline. Exclude: Not Screening

Bass MJ, McWhinney IR, Donner A. Do family physicians need medical assistants to detect and manage hypertension? *CMAJ* 1986;134(11):1247-55. PMID:2871915 Exclude: Not Screening

Berglund G, Nilsson P, Eriksson KF, et al. Long-term outcome of the Malmo; preventive project: mortality and cardiovascular morbidity. *J Intern Med* 2000;247(1):19-29. PMID:10672127 OVID-Medline.
Exclude: Not Screening

Berwick DM. Screening in health fairs. A critical review of benefits, risks, and costs. *JAMA* 1985;254(11):1492-8. CQ6, health fair. PMID:3928913 Exclude: Not Primary Research

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Exclude: Not Screening

Tozawa M, Iseki K, Iseki C, et al. Impact of multiple risk factor clustering on the elevation of blood pressure. *Hypertens Res Clin Exp* 2002;25(6):811-6. PMID:12484502 OVID-Medline.

Exclude: No Comparator

Tu K, Cauch-Dudek K, Chen Z. Comparison of primary care physician payment models in the management of hypertension. *Can Fam Physician* 2009;55(7):719-27. PMID:19602662 OVID-Medline.

Exclude: Not Screening

Turner MJ, Baker AB, Kam PC. Effects of systematic errors in blood pressure measurements on the diagnosis of hypertension. *Blood Pres Monit* 2004;9(5):249-53. PMID:15472497 OVID-Medline.

Exclude: No Comparator

Umscheid CA, Maguire MG, Pines JM, et al. Untreated hypertension and the emergency department: a chance to intervene? *Acad Emerg Med* 2008;15(6):529-36. PMID:18616438 OVID-Medline.

Exclude: Not Screening

Ungar A, Pepe G, Monami M, et al. Isolated ambulatory hypertension is common in outpatients referred to a hypertension centre. *J Hum Hypertens* 2004;18(12):897-903. PMID:15241442 OVID-Medline.

Exclude: No Comparator

van den Berg PJ, van Dalsen CL, de Rooij RA, et al. Cardiovascular health check in the elderly in one general practice: does it offer new information and lead to interventions? *Fam Pract* 2011;16(4):389-94. KQ2b. Exclude: Not Screening

Van der Niepen P, van de Borne P, Persu A, et al. Prevalence of hypertension and cardiovascular risk factors in Belgian civil employees: results of the screening during World Hypertension Day 2007. *J Hypertens* 2008;26(5):1045-6. PMID:18398350 OVID-Medline.
Exclude: No Comparator

Van Viet H, Chevalier P, De Jaeger C, et al. False positive diagnosis of arterial hypertension: The diagnostic errors and their avoidance. In *J Risk Saf Med* 1992;3(1):29-36. OVID-Embase.
Exclude: Not Primary Research

Vasan RS, Levy D. Rates of progression to hypertension among non-hypertensive subjects: implications for blood pressure screening. *Eur Heart J* 2002;23(14):1067-70. Editorial. PMID:12090739 OVID-Medline.
Exclude: Not Primary Research

Vasan RS, Levy D. Rates of progression screening to hypertension among non-hypertensive subject: implications for blood pressure. *Eur Heart J* 2011;23(14):1067-70.
Exclude: Not Primary Research

Vasan R, Larson M, Leip E, et al. Assessment of frequency of progression to hypertension in nonhypertensive participants in the Framingham Heart Study: A cohort study. *Lancet* 2001;358:1682-6.
Exclude: No Comparator

Viera AJ, Thorpe JM, Garrett JM. Effects of sex, age, and visits on receipt of preventive healthcare services: a secondary analysis of national data. *BMC Health Serv Res* 2006;6:15 CQ1 African American. PMID:16504097 OVID-Medline.
Exclude: Not Screening

Wang PE, Wang TT, Chiu YH, et al. Evolution of multiple disease screening in Keelung: a model for community involvement in health interventions? *J Med Screen* 2006;13:S54-8. PMID:17227644 OVID-Medline.
Exclude: No Comparator

Watanabe Y, Metoki H, Ohkubo T, et al. Parental longevity and offspring's home blood pressure: the Ohasama study. *J Hypertens* 2010;28(2):272-7. PMID:19829146 OVID-Medline.
Exclude: No Comparator

Watson S, Wenzel RR, di MC, et al. Accuracy of a new wrist cuff oscillometric blood pressure device: comparisons with intraarterial and mercury manometer measurements. *Am J Hypertens* 1998;11(12):1469-74. OVID-CCTR.
Exclude: No Comparator

Weiler PG, Lubben JE, Chi I. Hypertension in elderly people in a preventive health program. *Am J Prev Med* 1989;5(4):216-24. PMID:2765292 OVID-Medline.
Exclude: No Comparator

Whitcomb BL, Prochazka A, LoVerde M, et al. Failure of the community-based Vita-Stat automated blood pressure device to accurately measure blood pressure. *Arch Fam Med* 1995;4(5):419-24. PMID:7742964 OVID-Medline.
Exclude: No Comparator

Wildman RP. Utility of the metabolic syndrome diagnosis: can home blood pressures help settle the debate? *Am J Hypertens* 2008;21(5):486 PMID:18437134 OVID-Medline.
Exclude: Not Primary Research

Wingfield D, Freeman GK, Bulpitt CJ, et al. Selective recording in blood pressure readings may increase subsequent mortality. *QJM Int J Med* 2002;95(9):571-7. PMID:12205334 OVID-Medline.
Exclude: No Comparator

Wingfield D, Grodzicki T, Palmer AJ, et al. Transiently elevated diastolic blood pressure is associated with a gender-dependent effect on cardiovascular risk. *J Hum Hypertens* 2005;19(5):347-54. PMID:15744334 OVID-Medline.
Exclude: No Comparator

Zhang H, Thijs L, Kuznetsova T, et al. Progression to hypertension in the non-hypertensive participants in the Flemish Study on Environment, Genes and Health Outcomes. *J Hypertens* 2006;24(9):1719-27. KQ2b. Ref Search.
Exclude: No Comparator

Zhou L, Chen Y, Sun N, et al. Family history of hypertension and arterial elasticity characteristics in healthy young people. *Hypertens Res Clin Exp* 2008;31(5):833-9. PMID:18712037 OVID-Medline.
Exclude: Not Screening

Zhuo S, Wen W, Li-Yuan M, et al. Home blood pressure measurement in prehypertension and untreated hypertension: comparison with ambulatory blood pressure monitoring and office blood pressure. *Blood Pres Monit* 2009;14(6):245-50. PMID:19918171 OVID-Medline.
Exclude: No Comparator

Zimmerman RS, Safer MA, Leventhal H, et al. The effects of health information in a worksite hypertension screening program. *Health Educ Q* 1986;13(3):261-80. PMID:3759479 Exclude: Not Screening

Modeling Studies Evaluations

Table 4. Characteristics of potentially included Modeling studies

Step 3: Characteristics of potentially included modeling studies			
Author	Ohkubo	Norinder	Deng
Year	1998	2002	2007
Country	Japan	Sweden	Taiwan
Screening for	Hypertension	Cardiovascular disease (including hypertension)	Hypertension in the elderly
Screening mechanism	Blood pressure	Unclear	Blood pressure measurement in hospital combined with history and antihypertensive use
Screening programs	Home measurement Opportunistic screening	Compares those invited to screening versus those not	Compares attendees to program versus non attendees
Model format	None	None	Simple decision tree looking at probability treated for hypertension
Time horizon	N/A	Unclear	Unclear
How risk of disease modeled	N/A	Total resource use (not hypertension specific)	Incidence rates of stroke with and without treatment
Quality of model	N/A	N/A	Limited
How time to detection modeled	N/A	N/A	Not included
Other risk factors changing prior to detection	N/A	N/A	Not included
Treatment at point of diagnosis	N/A	Unclear	Unclear
Results	Not relevant	Only costs – cardiovascular screening not cost saving	Screening the elderly is cost saving and effective
Funding source	Public	Public	Public
Conclusion Step 3			
Overall assessment of the quality of the model (very well done, well done, fair, poor)	Poor	Poor	Fair
Limitations assessment (minor, potentially serious, and very serious)	Very serious limitations	Very serious limitations	Very serious limitations
Provide details of limitations	Not an economic evaluation	No consideration of outcomes – only cost Can't separate effects of hypertension screening from screening for other diseases	Ignores accuracy issue of single test Very old data used to estimate life expectancy effects of disease – accuracy to the elderly population unclear Very old data used to estimate stroke rates with and without treatment

Table 4. Characteristics of potentially included Modeling studies (cont'd)

Step 3: Characteristics of potentially included modeling studies		
Author	Maclosek	Field
Year	2008	1995
Country	USA	UK
Screening for	Hypertension	Hypertension (as well as other cardiac risk factors)
Screening mechanism	Annual blood pressure	Blood pressure as well as personal history
Screening programs	Blood pressure	Blood pressure and natural history – if at risk also other factors screened
Model format	Not a standard economic model	Simulation model using Framingham parametric models
Time horizon	Lifetime	10 years
How risk of disease modeled	Measures clinically preventable burden	Using risk equations modeled risk of CVD events
Quality of model	Poor	Good
How time to detection modeled	Unclear	Unclear
Other risk factors changing prior to detection	Unclear	Yes – used population data
Treatment at point of diagnosis	Anti-hypertensive drug therapy	Anti-hypertensive drug therapy +
Results	\$31, 465 per QALY gained	In 1995 – ICUR of £4,730 for females and £1,240 for men
Funding source	Public	Public
Conclusion Step 3		
Overall assessment of the quality of the model (very well done, well done, fair, poor)	Fair	Well done
Limitations assessment (minor, potentially serious, and very serious)	Very serious limitations	Potentially serious limitations
Provide details of limitations	Unclear model framework – seems to be of poor technical quality Limited description of data sources and assumptions – lacks transparency Authors recognize weaknesses and that a Markov model framework would be better Lack of peer review	Uses Framingham risk equations to model outcomes – newer data available Study is quite old – newer treatments are available - impact on CE of screening unclear Hypertension screening not considered as a single strategy - combined with history Unclear that clinical detection is incorporated

Table 4. Characteristics of potentially included Modeling studies (cont'd)

Step 3: Characteristics of included modeling studies			
Author	Howard	Van Buuren	
Year	2010	2006	
Country	Australia	Netherlands	
Screening for	Diabetes, Hypertension and CKD	Hypertension	
Screening mechanism	Hypertension: blood pressure measurement in general practice	Hypertensive medication use/ repeat blood pressure measurements	
Screening programs	GP screening – methods unclear/ frequency unclear	Dutch hypertension guidelines	
Model format	Markov model	Simulation model similar to Field	
Time horizon	Lifetime	10 years	
How risk of disease modeled	Hypertension related events plus CKD	Cardiovascular events – deaths/MI/stroke etc.	
Quality of model	Good	Good	
How time to detection modeled	Modeled clinical diagnosis for non-screened	Unclear	
Other risk factors changing prior to detection	Yes	Unclear	
Treatment at point of diagnosis	Anti-hypertensive drug therapy	Anti-hypertensive drug therapy	
Results	Dominant to \$1,557 per QALY	Continuing screening program is cost saving and more effective than stopping screening and clinical detection	
Funding source	Public	Public	
Conclusion Step 3			
Overall assessment of the quality of the model (very well done, well done, fair, poor)	Well done	Fair	
Limitations assessment (minor, potentially serious, and very serious)	Minor limitations	Potentially serious limitations	
Provide details of limitations	Hypertension only one facet of screening but possible to tease out results solely for it. Lack of information on screening program Complex study so data and methods are difficult to reproduce	Uses Framingham risk equations to model outcomes – newer data available A number of alternative scenarios are presented but it is impossible to tease out the cost effectiveness of these Unclear that clinical detection is incorporated Non screening also includes no clinical detection	

Abbreviations: CE = cost effectiveness; CKD = chronic kidney disease; GP = general practitioner; ICUR = incremental cost-utility ratio; N/A = not applicable; QALY = quality adjusted life years

Table 5. Selecting the Modeling studies that will be incorporated into the evidence

Step 4: Selecting the studies that will be incorporated into the evidence			
	Field 1995	Howard 2010	Van Buuren 2006
Relevance of the model's focus to the key questions and contextual questions addressed by the guideline: High/Medium/Low Reason – explain:	Low	Medium	Low
	Model relates to multiple screening strategies for coronary risk factors not just hypertension Age of study means applicability to current context may be limited	Focus is on various screening strategies for chronic disease which might lead to kidney disease However, the analysis specific to hypertension screening alone may be helpful – although insufficient details provided of disease progression within hypertension	Relates to Dutch hypertension guidelines – limited applicability to Canadian setting
Relevance of the model's sensitivity and scenario analyses to the key questions and contextual questions addressed by the guideline: High/Medium/Low Reason – explain:	Low Very limited sensitivity analysis with no scenario analyses	Medium Includes probabilistic analysis as well as scenario analyses relating to age and uptake	Low Many scenario analyses but impossible to interpret due to inadequate presentation
Capacity to use the model for de novo analyses relevant to our KQ and CQ Reason – explain:	None Insufficient details of modeling to allow replication Age of analysis and applicability to Canadian setting appears limited	Limited Insufficient details of modeling to allow replication May be feasible to Canadianize model if access allowed	None Insufficient details of modeling to allow replication Unlikely to be able to be adapted to the Canadian setting
Is the model up to date? Yes/No	No	Yes	Unclear – limited effectiveness data provided
Other considerations? List other reasons why the selected model is the best to move forward with.	No additional supporting arguments	May be most up to date model May be model with best design framework	No additional supporting arguments

Evidence Set 1

KQ1: Does screening for hypertension in primary care practice reduce the risk of cardiovascular morbidity (which includes stroke, heart disease, renal disease, peripheral arterial disease, and retinal disease), cardiovascular mortality, and all-cause mortality? Does it lead to sustained reductions in blood pressure?

- Table 6: GRADE Evidence Profile Table-KQ1 Does screening for hypertension in primary care practice reduce the risk of cardiovascular morbidity (which includes stroke, heart disease, renal disease, peripheral vascular disease, and retinal disease), cardiovascular mortality, and all-cause mortality? Does it lead to sustained reductions in blood pressure? (Assessed with Individual Hospital Admission Rates)
- Table 7: GRADE Summary of Findings Table-KQ1 (Assessed with Individual Hospital Admission Rates)
- Table 8: GRADE Evidence Profile Table-KQ1 Does screening for hypertension in primary care practice reduce the risk of cardiovascular morbidity (which includes stroke, heart disease, renal disease, peripheral vascular disease, and retinal disease)? Does it lead to sustained reductions in blood pressure? (Assessed with Cumulative Hospital Admission Rates)
- Table 9: GRADE Summary of Findings Table-KQ1 (Assessed with Cumulative Hospital Admission Rates)

Table 6. GRADE Evidence Profile Table-KQ1a- Does screening for hypertension in primary care practice reduce the risk of cardiovascular morbidity, cardiovascular mortality, and all-cause mortality? Does it lead to sustained reductions in blood pressure? (Assessed with Hospital Admission Rates). Studies included: Kaczorowski et al (2011)³⁵

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Screening	No Screening	Relative (95% CI)	Absolute		
Composite (follow-up mean 1 years; assessed with: Individual Hospital Admission Rates)												
1 ¹	randomised trials	no serious risk of bias ²	no serious inconsistency ³	serious ⁴	no serious imprecision	none ⁵	1639/69942 (2.3%) ⁶	1829/75499 (2.4%) ⁶	RR 0.9512 (0.8969 to 1.0088) ⁷	1182 fewer per 1,000,000 (from 2498 fewer to 213 more)	AAO MODERATE	CRITICAL
Acute Myocardial Infarction (follow-up mean 1 years; assessed with: Individual Hospital Admission Rates)												
1 ¹	randomised trials	no serious risk of bias ²	no serious inconsistency ³	serious ⁴	no serious imprecision	none ^{5,8}	571/69942 (0.82%) ⁶	705/75499 (0.93%) ⁶	RR 0.8869 (0.7885 to 0.9976) ⁷	1056 fewer per 1,000,000 (from 22 fewer to 1975 fewer)	AAO MODERATE	CRITICAL
Congestive Heart Failure (follow-up mean 1 years; assessed with: Individual Hospital Admission Rates)												
1 ¹	randomised trials	no serious risk of bias ²	no serious inconsistency ³	serious ⁴	no serious imprecision	none ⁵	619/69942 (0.89%) ⁶	703/75499 (0.93%) ⁶	RR 0.9704 (0.8628 to 1.0915) ⁷	276 fewer per 1,000,000 (from 1278 fewer to 852 more)	AAO MODERATE	CRITICAL
Stroke (follow-up mean 1 years; assessed with: Individual Hospital Admission Rates)												
1 ¹	randomised trials	no serious risk of bias ²	no serious inconsistency ³	serious ⁴	no serious imprecision	none ⁵	506/69942 (0.72%) ⁶	495/75499 (0.66%) ⁶	RR 1.0101 (0.8806 to 1.1586) ⁷	66 more per 1,000,000 (from 783 fewer to 1040 more)	AAO MODERATE	CRITICAL
All Cause Mortality (follow-up mean 1 years; assessed with: Individual Hospital Admission Rates)												
1 ¹	randomised trials	no serious risk of bias ²	no serious inconsistency ³	serious ⁴	no serious imprecision	none ⁵	2377/69942 (3.4%) ⁶	2608/75499 (3.5%) ⁶	RR 0.9802 (0.9242 to 1.0396) ⁷	684 fewer per 1,000,000 (from 2618 fewer to 1368 more)	AAO MODERATE	CRITICAL

¹ Kaczorowski, 2011.

² There are no concerns regarding lack of blinding as blinding is part of the intervention and therefore there is no risk of bias.

³ Single study, therefore inconsistency not applicable.

⁴ In addition to hypertension screening, the intervention included comprehensive cardiovascular risk assessment and education sessions. The efficacy of hypertension screening in isolation was not directly assessed. Only persons 65 years of age and older were included in this study.

⁵ Insufficient number of studies to assess publication bias.

⁶ Calculation based on data presented in Table 3 of study (individual hospital admission rates).

⁷ This outcome represents the effect of CHAP to Control. Outcome measures reported have been adjusted for hospital admission rates in the year before the intervention.

⁸ Statistically significant reduction in favour of the intervention communities in hospital admissions.

Table 7. GRADE Summary of Findings Table-KQ1: Screening compared to Control (No Screening) for Hypertension (Assessed with Hospital Admission Rates)

Patient or population: patients with Hypertension (KQ1)

Settings:

Intervention: Screening

Comparison: No Screening

Outcomes	Illustrative comparative risks* (95% CI)	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk No Screening	Corresponding risk Screening			
Composite Individual Hospital Admission Rates Follow-up: mean 1 years	24225 per 1000000¹	23043 per 1000000 (21728 to 24439) ¹	RR 0.9512 (0.8969 to 1.0088) ²	14544 ¹ (1 study ³)	⊕⊕⊕⊖ moderate ^{4,5,6,7}
Acute Myocardial Infarction Individual Hospital Admission Rates Follow-up: mean 1 years	9338 per 1000000¹	8282 per 1000000 (7363 to 9315) ¹	RR 0.8869 (0.7885 to 0.9976) ²	14544 ¹ (1 study ³)	⊕⊕⊕⊖ moderate ^{4,5,6,7,8}
Congestive Heart Failure Individual Hospital Admission Rates Follow-up: mean 1 years	9311 per 1000000¹	9036 per 1000000 (8034 to 10163) ¹	RR 0.9704 (0.8628 to 1.0915) ²	14544 ¹ (1 study ³)	⊕⊕⊕⊖ moderate ^{4,5,6,7}
Stroke Individual Hospital Admission Rates Follow-up: mean 1 years	6556 per 1000000¹	6623 per 1000000 (5774 to 7596) ¹	RR 1.0101 (0.8806 to 1.1586) ²	14544 ¹ (1 study ³)	⊕⊕⊕⊖ moderate ^{4,5,6,7}
All Cause Mortality Individual Hospital Admission Rates Follow-up: mean 1 years	34544 per 1000000¹	33860 per 1000000 (31925 to 35911) ¹	RR 0.9802 (0.9242 to 1.0396) ²	14544 ¹ (1 study ³)	⊕⊕⊕⊖ moderate ^{4,5,6,7}

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; RR: Risk ratio.

GRADE Working Group grades of evidence

High quality: Further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: We are very uncertain about the estimate.

¹ Calculation based on data presented in Table 3 of study (individual hospital admission rates).

² This outcome represents the effect of CHAP to Control. Outcome measures reported have been adjusted for hospital admission rates in the year before the intervention.

³ Kaczowski, 2011.

⁴ There are no concerns regarding lack of blinding as blinding is part of the intervention and therefore there is no risk of bias.

⁵ Single study, therefore inconsistency not applicable.

⁶ In addition to hypertension screening, the intervention included comprehensive cardiovascular risk assessment and education sessions. The efficacy of hypertension screening in isolation was not directly assessed. Only persons 65 years of age and older were included in this study.

⁷ Insufficient number of studies to assess publication bias.

⁸ Statistically significant reduction in favour of the intervention communities in hospital admissions.

Table 8. GRADE Evidence Profile Table-KQ1 Does screening for hypertension in primary care practice reduce the risk of cardiovascular morbidity? Does it lead to sustained reductions in blood pressure? (Assessed with Cumulative Admission Rates) Studies included: Kaczorowski et al (2011)³⁵

Quality assessment							No of patients		Effect		Quality		Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	KQ1 Screening	Control (No Screening Table 2)	Relative (95% CI)	Absolute			
Composite (follow-up mean 1 years; assessed with: Cumulative Hospital Admission Rates)													
1	randomised trials	no serious risk of bias ¹	no serious inconsistency ²	serious ³	no serious imprecision	none ⁴	1951/69942 (2.8%) ⁵	2275/75499 (3%) ⁵	RR 0.91 (0.86 to 0.97) ⁶	2712 fewer per 1,000,000 (from 904 fewer to 4219 fewer)	⊕⊕⊕O MODERATE		CRITICAL
Acute MI (follow-up mean 1 years; assessed with: Cumulative Hospital Admission Rates)													
1 ⁷	randomised trials	no serious risk of bias ¹	no serious inconsistency ²	serious ³	no serious imprecision	none ⁴	667/69942 (0.95%) ⁵	816/75499 (1.1%) ⁵	RR 0.87 (0.79 to 0.97) ⁶	1405 fewer per 1,000,000 (from 324 fewer to 2270 fewer)	⊕⊕⊕O MODERATE		CRITICAL
CHF (follow-up mean 1 years; assessed with: Cumulative Hospital Admission Rates)													
1 ⁷	randomised trials	no serious risk of bias ¹	no serious inconsistency ²	serious ³	no serious imprecision	none ⁴	735/69942 (1.1%) ⁵	923/75499 (1.2%) ⁵	RR 0.90 (0.81 to 0.99) ⁶	1223 fewer per 1,000,000 (from 122 fewer to 2323 fewer)	⊕⊕⊕O MODERATE		CRITICAL
Stroke (follow-up mean 1 years; assessed with: Cumulative Hospital Admission Rates)													
1	randomised trials	no serious risk of bias ¹	no serious inconsistency ²	serious ³	no serious imprecision	none ⁴	550/69942 (0.79%) ⁵	536/75499 (0.71%) ⁵	RR 0.99 (0.88 to 1.12) ⁶	71 fewer per 1,000,000 (from 852 fewer to 852 more)	⊕⊕⊕O MODERATE		CRITICAL

¹ There are no concerns regarding lack of blinding as blinding is part of the intervention and therefore there is no risk of bias.

² Single study, therefore inconsistency not applicable.

³ In addition to hypertension screening, the intervention included comprehensive cardiovascular risk assessment and education sessions. The efficacy of hypertension screening in isolation was not directly assessed. Only persons 65 years of age and older were included in this study.

⁴ Insufficient number of studies to assess publication bias.

⁵ Calculation based on data presented in Table 2 of study (cumulative hospital admission rates).

⁶ This outcome represents the effect of CHAP to Control. Outcome measures reported have been adjusted for hospital admission rates in the year before the intervention.

⁷ Kaczorowski, 2011

Table 9. GRADE Summary of Findings Table-KQ1a: Screening compared to Control (No Screening) for Hypertension – Assessed with Cumulative Hospital Admission Rates

KQ1 Screening compared to Control (No Screening) Table 2 for Control – Assessed with Cumulative Admission Rates

Patient or population: patients with Control

Settings:

Intervention: KQ1 Screening

Comparison: Control (No Screening) Table 2

Outcomes	Illustrative comparative risks* (95% CI) Assumed risk Control (No Screening) Table 2 KQ1 Screening	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
Composite					
Cumulative Hospital Admission Rates	30133 per 1000000¹	27421 per 1000000 (25914 to 29229) ¹	RR 0.91 (0.86 to 0.97) ²	145441 (1 study)	⊕⊕⊕⊖ moderate ^{3,4,5,6}
Follow-up: mean 1 years					
Acute MI					
Cumulative Hospital Admission Rates	10808 per 1000000¹	9403 per 1000000 (8538 to 10484) ¹	RR 0.87 (0.79 to 0.97) ²	145441 (1 study) ⁷	⊕⊕⊕⊖ moderate ^{3,4,5,6}
Follow-up: mean 1 years					
CHF					
Cumulative Hospital Admission Rates	12225 per 1000000¹	11003 per 1000000 (9903 to 12103) ¹	RR 0.90 (0.81 to 0.99) ²	145441 (1 study) ⁷	⊕⊕⊕⊖ moderate ^{3,4,5,6}
Follow-up: mean 1 years					
Stroke					
Cumulative Hospital Admission Rates	7099 per 1000000¹	7028 per 1000000 (6247 to 7951) ¹	RR 0.99 (0.88 to 1.12) ²	145441 (1 study)	⊕⊕⊕⊖ moderate ^{3,4,5,6}
Follow-up: mean 1 years					

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; RR: Risk ratio.

GRADE Working Group grades of evidence

High quality: Further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: We are very uncertain about the estimate.

¹ Calculation based on data presented in Table 2 of study which is based on cumulative admission rates.

² This outcome represents the effect of CHAP to Control. Outcome measures reported have been adjusted for hospital admission rates in the year before the intervention.

³ There are no concerns regarding lack of blinding as blinding is part of the intervention and therefore there is no risk of bias.

⁴ Single study, therefore inconsistency not applicable.

⁵ In addition to hypertension screening, the intervention included comprehensive cardiovascular risk assessment and education sessions. The efficacy of hypertension screening in isolation was not directly assessed. Only persons 65 years of age and older were included in this study.

⁶ Insufficient number of studies to assess publication bias.

⁷ Kaczorowski, 2011

Evidence Set 2

Table 10: KQ1: Does screening for hypertension in primary care practice reduce the risk of cardiovascular morbidity (which includes stroke, heart disease, renal disease, peripheral arterial disease, and retinal disease), cardiovascular mortality, and all-cause mortality? Does it lead to sustained reductions in blood pressure? Modified GRADE Evidence Profile Table-KQ1 (Howard et al 2010)

Table 10. Modified GRADE Evidence Profile and Summary of Modeling Study Findings Table
Howard et al (2010)

Quality Assessment							Summary of Findings				Importance	
No. of Studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other Considerations	No of patients		Effect			Quality
							Screening	Control	Relative (95% CI)	Absolute		
1*	modeling study	Minor Hypertension only one facet of screening but possible to tease out results solely for it. Lack of information on screening program. Complex study so data and methods are difficult to reproduce.	NA Cannot assess consistency as there is only 1 study – although three studies covered in step 4 give consistent results favouring effectiveness and cost effectiveness.	Unclear Recent Australian study potentially relevant to Canada – requires access to base model.	NA	Well-designed study looking at a broader context. Unclear if model of disease progression is detailed enough. Appropriate sensitivity and scenario analyses.	NA	NA	NA	NA	Very low	CRITICAL

*Given no other studies eligible only Howard study taken forward to step 5.

Evidence Set Three

KQ3: Excluding harms directly related to treatment of hypertension, what are the harms associated with screening to identify hypertension?

- Table 11: GRADE Evidence Profile Table-KQ3 (Rostrup 1991 and 1990)
- Table 12: GRADE Summary of Findings Table-KQ3 (1991 and 1990)

Table 11. GRADE Evidence Profile Table-KQ3 Excluding harms directly related to treatment of hypertension, what are the harms associated with screening to identify hypertension?
Studies included: Rostруп et al (1991, 1990)^{48,49}

Quality assessment							No of patients		Effect		Quality	Importance to HTN Working Group
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Screening	Control	Relative (95% CI)	Absolute		
KQ3 1991 - Systolic Blood Pressure (measured with: mercury sphygmomanometer; Better indicated by lower values)												
¹	randomised trials	no serious risk of bias	no serious inconsistency ²	very serious ^{3,4}	serious ⁵	none ⁶	18	18	-	MD 0 higher (1.3066 lower to 1.3066 higher)	⊕○○○ VERY LOW	NOT IMPORTANT
KQ3 1991 - Diastolic Blood Pressure (measured with: mercury sphygmomanometer; Better indicated by lower values)												
¹	randomised trials	no serious risk of bias	no serious inconsistency ²	very serious ^{3,4}	serious ⁵	none ⁶	18	18	-	MD 2 lower (3.96 to 0.04 lower)	⊕○○○ VERY LOW	NOT IMPORTANT
KQ3 1990 - Systolic Blood Pressure (measured with: Automatic auscultatory device with a hidden printer; Better indicated by lower values)												
¹	randomised trials	no serious risk of bias	no serious inconsistency ²	very serious ^{3,4}	serious ⁵	none	16	13	-	MD 15.8000 higher (13.1957 to 18.4043 higher)	⊕○○○ VERY LOW	NOT IMPORTANT
KQ3 1990 - Diastolic Blood Pressure (measured with: Automatic auscultatory device with a hidden printer; Better indicated by lower values)												
¹	randomised trials	no serious risk of bias	no serious inconsistency ²	very serious ^{3,4}	serious ⁵	none ⁶	16	13	-	MD 9.5000 higher (7.2427 to 11.7673 higher)	⊕○○○ VERY LOW	NOT IMPORTANT

¹ Rostруп, 1991.

² Single study, therefore inconsistency not applicable.

³ Homogenous population of 19 year old Norwegian male military recruits in this study is unrepresentative of the general hypertension screening population (Indirectness).

⁴ The study design did not actually compare screening with not screening, but rather simulated the effect of not screening by not disclosing screening results to half of the participants.

⁵ Total population size is less than 400 (a threshold rule-of-thumb value) and there was no effect.

⁶ Insufficient number of studies to assess publication bias.

⁷ Rostруп, 1990.

Table 12. GRADE Summary of Findings Table- KQ3

Patient or population: patients with Hypertension (KQ3)

Settings:

Intervention: Screening

Outcomes	Illustrative comparative risks* (95% CI) Assumed risk Corresponding risk	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
KQ3 1991 - Systolic Blood Pressure mercury sphygmomanometer	Control	Screening			
	The mean kq3 1991 - systolic blood pressure in the intervention groups was 0 higher (1.3066 lower to 1.3066 higher)		36 (1 study ¹)	⊕⊕⊕⊕ 2,3,4,5,6 very low	
KQ3 1991 - Diastolic Blood Pressure mercury sphygmomanometer					
	The mean kq3 1991 - diastolic blood pressure in the intervention groups was 2 lower (3.96 to 0.04 lower)		36 (1 study ¹)	⊕⊕⊕⊕ 2,3,4,5,6 very low	
KQ3 1990 - Systolic Blood Pressure Automatic auscultatory device with a hidden printer					
	The mean kq3 1990 - systolic blood pressure in the intervention groups was 15,8000 higher (13.1957 to 18.4043 higher)		29 (1 study ⁷)	⊕⊕⊕⊕ 2,3,4,5 very low	
KQ3 1990 - Diastolic Blood Pressure Automatic auscultatory device with a hidden printer					
	The mean kq3 1990 - diastolic blood pressure in the intervention groups was 9,5000 higher (7.2427 to 11.7673 higher)		29 (1 study ⁷)	⊕⊕⊕⊕ 2,3,4,5,6 very low	

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval;

GRADE Working Group grades of evidence

High quality: Further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: We are very uncertain about the estimate.

¹ Rostrup, 1991.

² Single study, therefore inconsistency not applicable.

³ Homogenous population of 19 year old Norwegian male military recruits in this study is unrepresentative of the general hypertension screening population (Indirectness).

⁴ The study design did not actually compare screening with not screening, but rather simulated the effect of not screening by not disclosing screening results to half of the participants.

⁵ Total population size is less than 400 (a threshold rule-of-thumb value) and there was no effect.

⁶ Insufficient number of studies to assess publication bias.

⁷ Rostrup, 1990.