Annals of Internal Medicine REVIEW

Cardiovascular Risk Assessment

A Systematic Review of Guidelines

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Background: Many guidelines exist for screening and risk assessment for the primary prevention of cardiovascular disease in apparently healthy persons.

Purpose: To systematically review current primary prevention guidelines on adult cardiovascular risk assessment and highlight the similarities and differences to aid clinician decision making.

Data Sources: Publications in MEDLINE and CINAHL between 3 May 2009 and 30 June 2016 were identified. On 30 June 2016, the Guidelines International Network International Guideline Library, National Guideline Clearinghouse, National Library for Health Guidelines Finder, Canadian Medical Association Clinical Practice Guidelines Infobase, and Web sites of organizations responsible for guideline development were searched.

Study Selection: 2 reviewers screened titles and abstracts to identify guidelines from Western countries containing recommendations for cardiovascular risk assessment for healthy adults.

Data Extraction: 2 reviewers independently assessed rigor of guideline development using the Appraisal of Guidelines for Research and Evaluation II instrument, and 1 extracted the recommendations.

Data Synthesis: Of the 21 guidelines, 17 showed considerable rigor of development. These recommendations address assessment of total cardiovascular risk (5 guidelines), dysglycemia (7 guidelines), dyslipidemia (2 guidelines), and hypertension (3 guidelines). All but 1 recommendation advocates for screening, and most include prediction models integrating several relatively simple risk factors for either deciding on further screening or guiding subsequent management. No consensus on the strategy for screening, recommended target population, screening tests, or treatment thresholds exists.

Limitation: Only guidelines developed by Western national or international medical organizations were included.

Conclusion: Considerable discrepancies in cardiovascular screening guidelines still exist, with no consensus on optimum screening strategies or treatment threshold.

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Many national and international bodies highlight primary prevention of cardiovascular disease (CVD) through risk factor reduction as a potential solution to reduce future burden (1). The optimal target group and intervention that maximizes benefit, however, remains unclear. Cardiovascular screening during health checks is now widely implemented in many Western countries to systematically detect high-risk persons who may require aggressive risk reduction through pharmacotherapy or lifestyle interventions. Guidelines advocate use of screening with the aim of improving the health of an already healthy population and reducing risk factors for future CVD. The Institute of Medicine defines clinical practice guidelines as "systematically developed statements to assist practitioners and patient decisions about the appropriate health care for specific clinical circumstances" (2). However, to date, an internationally agreed-on guideline for cardiovascular health checks does not exist.

Primary care physicians maintain a central role in the prevention of CVD but still find implementation of prevention strategies challenging, and management of persons with increased CVD risk remains suboptimal (3). Time constraints, lack of perceived usefulness, inadequate knowledge, and inconsistency in published recommendations have been cited as common reasons for not using CVD prevention guidelines or global CVD risk assessment tools (4). Concerns exist about poor uptake of the National Health Service Health Check program; only about 50% of those invited—much lower than the 75% government target—attended (5). In addition, a Cochrane review and subsequent Danish randomized, controlled trial (6, 7) raised doubts about the morbidity and mortality benefits from such programs.

Ferket and colleagues (8) performed a systematic review in 2010, which identified differences among guidelines that would lead to variations in allocation of resources for prevention among Western health care systems. Since then, the reviewed guidelines were revised and replaced, and new evidence has also become available on statin and blood pressure–lowering therapy for low-risk persons (9, 10). This systematic review revisits the CVD risk assessment guidelines and the selection of appropriate screening interventions based on currently available evidence.

METHODS

Data Sources and Searches

We conducted an updated systematic review, using our previous search strategy (8), of guidelines containing recommendations for CVD risk assessment in the apparently healthy adult population not already receiving treatment for high-risk cardiovascular condi-

See also:

Web-Only

CME quiz

tions, such as diabetes, hypertension, and hypercholesterolemia. We searched for published guidelines using MEDLINE and CINAHL between 3 May 2009 and 30 June 2016 (**Appendix**, available at www.annals.org). The 4 following guideline-specific databases supplemented our search: National Guideline Clearinghouse (Untied States), National Library for Health Guidelines Finder (United Kingdom), Canadian Medical Association Clinical Practice Guidelines Infobase, and Guidelines International Network International Guideline Library. We also searched many Web sites of guideline development organizations, including those affiliated with all of the guidelines included in our previous publication, to find relevant additional or updated guidelines (**Appendix Table 1**, available at www.annals.org). Our search was restricted to national guidelines from the United States, Canada, United Kingdom, Australia, and New Zealand and international guidelines written in English.

Study Selection

References that met the Institute of Medicine's definition of a guideline were included. Guidelines were excluded if they did not contain recommendations involving the healthy adult population, were entirely focused on early detection of CVD, were not produced on behalf of a professional organization, or were not applicable to Western countries. In addition, only guidelines produced or updated as of May 2009 were eligible for inclusion to avoid overlap with our previous systematic review and ensure that only current guidelines were included.

Data Extraction and Quality Assessment

Titles and abstracts were assessed by 2 independent reviewers (M.Y.K. and V.V.S.B.). Articles were excluded only if both reviewers agreed that they were ineligible. Discrepancies were resolved by consensus after discussion. Both reviewers performed the final selection for full data extraction.

We used the latest 23-item Appraisal of Guidelines for Research and Evaluation (AGREE) II instrument to determine the rigor of development for each guideline (11). This domain considers reporting of methods to search for evidence; criteria for selection of evidence; strengths and limitations of the body of evidence; methods for formulating the recommendations; health benefits, side effects, and risks; explicit link between recommendations and evidence; procedures for external expert peer review; and the updating process. Each item is rated on a 7-point Likert scale. Conforming to the instructions of the AGREE II tool, 2 reviewers (M.Y.K. and C.N.V.) independently rated the items. Both reviewers assessed background information on the guideline development process from developers' Web sites. Average rigor scores were obtained by expressing the sum of the individual scores as a percentage of the maximum possible score. Reproducibility of the 2 reviewers' scores was good, with an interclass correlation of 0.75. We ranked the guidelines according to their scores. Editorial independence from the funding body, external funding, and disclosure of relationships with the industry by individual guideline group members were also assessed.

Data Synthesis and Analysis

One reviewer (M.Y.K.) extracted all of the relevant recommendations from the guidelines that had an AGREE II score greater than 50%. General lifestyle advice was not included. A recommendation matrix was produced and grouped by the conditions being detected by screening. Each matrix was divided into methods, target group and delivery of screening, recommended screening test, and follow-up thresholds. Consistent with our previous format, the strength of recommendation was classified as "for," "consider," "not for not against," "insufficient evidence," and "against." If feasible, cardiovascular risk factors were classified into major, underlying, and emerging risk factors according to the World Heart and Stroke Forum scientific statement (12).

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RESULTS

Our search retrieved 3553 titles, of which 180 were identified as potentially eligible. On the basis of the abstract review, we excluded 133 articles. After we reviewed the full reports, 26 more were excluded. Such guidelines as the U.S. Preventive Services Task Force (USPSTF) recommendations on aspirin use were excluded because they did not include recommendations on screening healthy adults (13). We included 21 guidelines on cardiovascular risk assessment (**Appendix Figure**, available at www.annals.org). **Table 1** summarizes the selected guidelines, along with rigor scores and conflicts of interest.

Seventeen of the 21 guidelines had a rigor score of 50% or greater. Guidelines were categorized according to the main purpose of the screening. These included 5 guidelines for total cardiovascular screening (**Table 2**), 7 guidelines for dysglycemia screening (**Appendix Table 2**, available at www.annals.org), 2 guidelines for dyslipidemia screening (**Appendix Table 3**, available at www.annals.org), and 3 guidelines for hypertension screening (**Appendix Table 4**, available at www.annals.org).

Areas of Agreement

Recommendations from 16 of the 17 guidelines supported CVD risk assessment, either as the primary approach (5 guidelines) or a secondary step (11 guidelines). There was a consensus on how screening tests

Table 1. Characteristics of 21 Guidelines

Study, Year (Reference)	Organization Responsible for Guideline Development	Country Applied	AGREE II Rigor Score, %	Conflicts of Interest
Total cardiovascular risk				
National Clinical Guideline Centre, 2014 (14)	National Institute for Health and Care Excellence	United Kingdom	86	EI, SCI*†
Piepoli et al, 2016 (15)	European Society of Cardiology	Europe	86	SCI*
National Vascular Disease Prevention Alliance, 2012 (16)	National Vascular Disease Prevention Alliance	Australia	85	EI, SCI†
Stone et al, 2014 (17) Goff et al, 2014 (18) Eckel et al, 2014 (19)	American College of Cardiology	United States	83	SCI*†
Mosca et al, 2011 (20)	Centers for Disease Control and Prevention	United States	65	EI, SCI*†
JBS3 Board, 2014 (21)	British Cardiovascular Society	United Kingdom	45	SCI*
New Zealand Guidelines Group, 2012 (22)	New Zealand Guidelines Group	New Zealand	20	EI, SCI‡
Dyslipidemia				
Reiner et al, 2011 (23)	European Society of Cardiology	Europe	72	SCI*
Jellinger et al, 2012 (24)	American Association of Clinical Endocrinologists	United States	64	SCI*
Anderson et al, 2013 (25)	Canadian Cardiovascular Society	Canada	42	EI, SCI*
Dysglycemia				
Diabetes Australia, 2010 (26)	Australian Diabetes Society	Australia	87	SCI‡
Booth et al, 2013 (27)	Canadian Diabetes Association	Canada	83	EI, FIP, SCI*†
American Diabetes Association, 2016 (28)	American Diabetes Association	United States	68	SCI*
Siu, 2015 (29)	U.S. Preventive Services Task Force	United States	76	EI, SCI
National Institute for Health and Care Excellence, 2012 (30)	National Institute for Health and Care Excellence	United Kingdom	73	–
Pottie et al, 2012 (31)	Canadian Task Force on Preventive Health Care	Canada	68	EI, SCI*
Rydén et al, 2013 (32)	European Society of Cardiology	Europe	66	SCI*
International Diabetes Federation Guideline Development Group, 2014 (33)	International Diabetes Federation	International	47	FIP, SCI§
Hypertension				
Dasgupta et al, 2014 (34) Daskalopoulou et al, 2015 (35)	Hypertension Canada	Canada	90	EI, SCI*†
Siu, 2015 (36)	U.S. Preventive Services Task Force	United States	79	EI, SCI
Lindsay et al, 2013 (37)	Canadian Task Force on Preventive Health Care	Canada	78	SCI

AGREE II = Appraisal of Guidelines for Research and Evaluation II; EI = editorial with independence declared; FIP = funding by industrial partner reported; SCI = statement about conflicts of interest of group members present.
* Relationship with industry was reported by any group member.
† A group member was reported recused when a relevant area was under discussion.
‡ Conflicts of interest available only on request.
§ Conflicts of interest reported only to the group.

should be administered in the general population. A selective screening system based on knowledge of prior patient characteristics (record-based screening) or that used during nonpreventive patient visits (case finding or opportunistic screening) was advocated in 14 of the 17 guidelines. Two guidelines did not explicitly specify a screening method (1 from the Centers for Disease Control and Prevention [CDC]/American Heart Association [AHA] and another from the USPSTF on hypertension).

Most guidelines recommended integrating age, sex, smoking, blood pressure, and lipid levels into CVD risk assessment by using prediction models. However, there was no consensus on which prediction model to use. All 7 dysglycemia guidelines recommended selecting individuals at high risk for type 2 diabetes mellitus through formal short-term (10-year) or informal diabetes risk algorithms based on antecedent risk factors, along with the often used threshold of 40 years. Diabetes risk algorithms were also used to decide whether further formal diabetes screening with blood testing was required. The most commonly mentioned risk assessment tool for diabetes was the Finnish Type 2 Diabetes Risk Assessment Form or a modified version tailored to the country implementing it.

Most guidelines agreed on the need to consider ethnicity as a risk factor for CVD and cited specific high-risk ethnic groups. The U.K. (National Institute for Health and Clinical Excellence [NICE]) and U.S. (American College of Cardiology [ACC]/AHA) guidelines use ethnicity in algorithms for global CVD risk score. The U.K.-based CVD risk score calculator (QRISK2) advo-

Table 2. Recommendations for Screening for Total CVD Risk in 5 Guidelines

Variable	European Society of Cardiology	National Institute for Health and Care Excellence	National Vascular Disease Prevention Alliance	American College of Cardiology/American Heart Association	Centers for Disease Control and Prevention/ American Heart Association
Country	Europe	United Kingdom	Australia	United States	United States
Year	2016	2014	2012	2013	2011
AGREE II rigor score, %	86	86	85	83	65
Method to evaluate evidence	Systematic review	Systematic review	Systematic review	Systematic review	Systematic review
Method to formulate recommendations	Formal consensus	Formal consensus	Formal consensus	Formal consensus	Formal consensus and voting
Consideration of costs	Review of CEAs	Systematic review of published literature/ performed CEA	Review of CEAs	Not performed	Review of CEAs
Target group	Men aged >40 y and women aged >50 y or who are postmenopausal	Persons aged 40–74 y (National Health Service Health Check)	All adults aged >45 y or Aboriginal and Torres Strait Islanders aged >35 y	Persons aged ≥21 y	Women aged ≥20 y
Strategy	Opportunistic screening/case finding	Opportunistic screening/case finding/record-based	Opportunistic screening/case finding	Opportunistic screening/case finding	NR
Strength of recommendation	For	For	For	For	Not for and not against
Prediction model	Systematic Coronary Risk Evaluation; general atherosclerotic CVD mortality at 10 y	QRISK2; CHD/stroke/TIA events at 10 y	FRS; CHD/stroke events at 5 y	Pooled cohort equations; CHD/ stroke events at 10 y if aged 40–79 y or lifetime (30-y) risk for persons aged 20–59 y with 10-y risk ≤7.5%	FRS/Reynolds Risk Score; CHD/stroke at 10 y
Risk factors					
Age	*	*	*	*	*
Sex	*	*	*	*	*
BP	*	*	*	*	*
Total cholesterol level	*	*	*	*	*
LDL cholesterol level	†	†	†	–	–
HDL cholesterol level	*	*	*	*	*
Total cholesterol–HDL cholesterol ratio	*	*	*	*	–
Smoking	*	*	*	*	*
Glucose levels	–	†	†	–	–
Underlying risk factors					
Overweight/obesity	†	*	†	–	*
Physical inactivity	†	–	†	–	*
Atherogenic diet	–	–	–	–	–
Socioeconomic factors	†	*	†	–	–
Family history of premature CVD	†	*	†	‡	*
Genetic/racial factors	†	*	†	*	*
DM	†	*	*	*	*
Antihypertensives	†	*	–	*	–
Emerging risk factors					
Triglyceride levels	†	†	†	–	–
Renal function	†	*	†	–	*
Heart rate	†	–	–	–	–
Apolipoprotein/lipoprotein levels	§	–	–	–	–
Glucose therapy for insulin resistance	–	–	–	–	–
Prothrombotic markers	§	–	–	–	–
C-reactive protein level	§	–	–	‡	–
Subclinical atherosclerosis	§ (ankle–brachial index; coronary artery calcium score; and carotid ultrasonography for plaque)	–	* (left ventricular hypertrophy)	‡ (ankle–brachial index and coronary artery calcium score)	–

(*continued on following page*)

Table 2–Continued

Variable	European Society of Cardiology	National Institute for Health and Care Excellence	National Vascular Disease Prevention Alliance	American College of Cardiology/American Heart Association	Centers for Disease Control and Prevention/ American Heart Association
Thresholds					
Aspirin	Not recommended in primary prevention	NA	Not recommended in primary prevention	NA	May be useful in women aged ≥65 y depending on benefit vs. risk assessment; reasonable in DM
Statins	10-y CVD mortality ≥10% and LDL cholesterol level ≥1.8 mmol/L (70 mg/dL); 10-y risk of 5%–10% and LDL cholesterol level ≥2.5 mmol/L (100 mg/dL); consider if 10-y risk <5% and LDL cholesterol level >2.9 mmol/L (115 mg/dL); type 2 DM or type 1 DM and age >40 y	10-y CHD/stroke/TIA risk ≥10%; type 2 DM and 10-y CVD risk ≥10%‖; type 1 DM; CKD with estimated glomerular filtration rate <60 mL/min/1.73 m^2	5-y CHD/stroke risk ≥15%; persistent BP ≥160/100 mm Hg; total cholesterol level >7.5 mmol/L (290 mg/dL); 5-y CHD/stroke risk of 10%–15% and family history of premature CVD	40–75 y with 10-y CHD/stroke risk ≥7.5% and LDL cholesterol level of 1.8–4.8 mmol/L (70–189 mg/dL); aged 40–75 y with DM and LDL cholesterol level of 1.8–4.8 mmol/L (70–189 mg/dL); LDL cholesterol level ≥4.9 mmol/L (190 mg/dL)	10-y risk >20%; DM
Antihypertensives	10-y CVD mortality ≥10% and BP ≥140/90 mm Hg; consider if 10-y risk of 5%–10% and BP ≥140/90 mm Hg; type 1 DM or type 2 DM and BP ≥140/85 mm Hg; age >60 y and systolic BP >150 mm Hg or age >80 y and systolic BP >160 mm Hg; BP ≥180/110 mm Hg	NR	5-y FRS ≥15%; FRS 10%–15% and BP persistently ≥160/100 mm Hg or family history of premature CVD or high-risk ethnicity; consider if FRS <10% but BP persistently ≥160/100 mm Hg	NR	BP ≥140/90 mm Hg; >130/85 mm Hg in CKD and DM
Intensive lifestyle counseling	10-y CVD mortality >1% or LDL cholesterol level >2.5 mmol/L (100 mg/dL)	10-y CHD/stroke/TIA risk ≥10%	5-y CHD/stroke risk ≥10%	10-y CHD/stroke risk ≥7.5% and LDL cholesterol level of 1.8–4.8 mmol/L (70–189 mg/dL); type 1 or 2 DM; LDL cholesterol level ≥4.9 mmol/L (190 mg/dL)	NR
High-risk monitoring	NR	NR	Monitor risk profile according to clinical context if 5-y CHD/ stroke risk ≥15%; monitor risk profile every 6–12 mo if 5-y CHD/stroke risk is 10%–15%	NR	NR
Screening intervals	NR	Further risk assessment on an ongoing basis; 5 yearly per National Service Framework	Further risk assessment every 2 y if 5-y CHD/stroke risk <10%	Further risk assessment every 4–6 y if 10-y CHD/stroke risk <7.5%	NR

AGREE II = Appraisal of Guidelines for Research and Evaluation II; BP = blood pressure; CEA = cost-effectiveness analysis; CHD = coronary heart disease; CKD = chronic kidney disease; CVD = cardiovascular disease; DM = diabetes mellitus; FRS = Framingham Risk Score; HDL = high-density lipoprotein; LDL = low-density lipoprotein; NA = not applicable; NR = not reported; TIA = transient ischemic attack.
* Formal screening test (included in the prediction model).
† Additional screening test.
‡ In selected persons who are not in 1 of the 4 main statin benefit groups and for whom a decision to initiate statin therapy is otherwise unclear, additional factors may be considered to inform treatment decision making. These factors include a primary LDL cholesterol level ≥4.144 mmol/L (160 mg/dL) or other evidence of genetic hyperlipidemia; a first-degree relative with premature atherosclerotic CVD; a high-sensitivity C-reactive protein level >19.0 nmol/L; a coronary artery calcium score ≥300 Ag units or categorization in the ≥75th percentile for age, sex, and ethnicity; an ankle–brachial index <0.9; or an elevated lifetime risk for atherosclerotic CVD.
§ Novel biomarkers have only limited additional value when added to CVD risk assessment with the Systematic Coronary Risk Evaluation algorithm in limited cases.
‖ According to the UKPDS (United Kingdom Prospective Diabetes Study) tool.

cated by NICE includes several ethnic groups. In the dysglycemia guidelines, the U.K., Australian, and Canadian diabetes risk assessment questionnaires all incorporate ethnicity in the prediction of type 2 diabetes onset.

There was a consensus on the limited role of novel biomarkers (for example, C-reactive protein, apolipoprotein, and prothrombin markers) and markers of subclinical atherosclerosis (for example, ankle–brachial index, coronary artery calcium score, and carotid ultrasonography result). The European Society of Cardiology (ESC) and ACC/AHA are the 2 main guidelines that consider the use of these markers in limited situations. The ACC/AHA suggests that in selected individuals who are not in 1 of the 4 statin benefit groups and for whom a decision to initiate statin therapy is otherwise unclear, additional factors may be considered to inform treatment decision making. These factors include a high-sensitivity C-reactive protein level greater than 2 mg/L; coronary artery calcium score of 300 Agatston units or greater or categorization in the 75th percentile or higher for age, sex, and ethnicity; and an ankle–brachial index less than 0.9. The ESC states that routine use of novel biomarkers is not recommended for refinement of CVD risk stratification. Carotid ultrasonography for atheroma detection, measurement of coronary artery calcification, and the ankle–brachial index may be considered as risk modifiers in CVD risk assessment but are useful only in persons near thresholds for risk categorization.

Thresholds for initiating treatment are predominantly based on 5- or 10-year absolute risk for CVD or the combination of age and additional CVD risk factors. There were often exceptions made for persons with extreme levels of a single risk factor or those considered to be in a high-risk category (such as those with kidney disease or diabetes mellitus).

Guidelines advocate a conservative approach to aspirin use for primary prevention. Of the 8 guidelines that make recommendations on aspirin use, 3 do not recommend routine use for primary prevention, 3 of the dysglycemia guidelines recommend considering aspirin therapy but only in the presence of additional factors putting patients in a high-risk category, and only 2 guidelines based the recommendation on age alone. The CDC/AHA guideline, which is the only guideline in this review that is sex-specific, makes recommendations for women only and suggests aspirin use in those older than 65 years; however, the Canadian Hypertension Education Program (Hypertension Canada) recommends aspirin use in hypertensive patients older than 55 years. Both guidelines have the caveat that aspirin use should be guided by individual factors. The latest USPSTF guideline on aspirin use for primary prevention, in contrast, recommends aspirin for all adults aged 50 to 59 years who have a 10-year CVD risk of 10% or greater, are not at increased risk for bleeding, and have a life expectancy of more than 10 years (13).

There was a consensus on the importance of addressing lifestyle factors in all target groups independent of pharmacotherapy. Recommendations on who should receive intensive lifestyle counseling differed among the guidelines, with no consensus based on global risk scores. However, the dysglycemia guidelines advocate that all persons at high risk for diabetes (impaired fasting glucose or impaired glucose tolerance) should receive intensive lifestyle intervention to prevent its onset.

There were no firm statements regarding screening intervals. The total CVD risk guidelines advocated rescreening, but intervals varied from 2 to 6 years in low-risk persons. Recommended dysglycemia screening intervals in persons without evidence of diabetes was 3 to 5 years. One dyslipidemia guideline recommended screening every 5 years for adults younger than 45 years and every 1 to 2 years for those older than 45 years. For those identified as having impaired fasting glucose or impaired glucose tolerance, the consensus was that subsequent annual monitoring should be done.

Areas of Disagreement

There was no consensus on the target population for screening. The U.S. guidelines for total cardiovascular risk (ACC/AHA and CDC/AHA), dyslipidemia (American Association of Clinical Endocrinologists), and dysglycemia (American Diabetes Association) along with the Canadian guidelines for dysglycemia (Canadian Task Force on Preventive Health Care) and hypertension (Canadian Hypertension Education Program and Canadian Task Force on Preventive Health Care) advocate screening at a younger age (20 years). The European, U.K., and Australian guidelines advocate an older target population of persons older than 40 years.

Although guidelines mostly agree on the use of prediction models as part of the risk assessment process or in guiding therapy, there is no consensus on which model to use, particularly for total CVD risk. All 5 total CVD risk guidelines use different calculators, including the QRISK2 (NICE), Systematic COronary Risk Estimation (ESC), 5-year Framingham Risk Score (National Vascular Disease Prevention Alliance), Pooled Cohort Equation (ACC/AHA), and 10-year Framingham Risk Score or Reynolds Risk Score (CDC/AHA). These risk models differ in the end points and risk factors they consider in their development.

Guidelines on total cardiovascular risk differ about when to initiate statin treatment. There was no consensus about CVD risk threshold, although direct comparison is challenging because all 5 guidelines used different risk prediction models. The more recent ACC/AHA and NICE recommendations on total cardiovascular risk have lowered their threshold for initiation of statins. However, these 2 updated guidelines have also changed the CVD risk equations that they now use, which makes direct comparison to older thresholds difficult because of different data sets or end points that are used in developing the algorithms. The NICE guideline now advocates for the QRISK2 algorithm, and the ACC/AHA now advocates for the Pooled Cohort Equation for predicting general CVD. Previously, they both used the Framingham Risk Score. The 2016 ESC

guideline has maintained the same statin thresholds as recommended in the 2012 version. Statin recommendations were made in 3 of the 7 dysglycemia guidelines, with only 1 using age older than 40 years as the sole deciding factor in persons diagnosed with diabetes.

Recommendations on initiating antihypertensive medication varied, and there was no consensus on global risk or blood pressure thresholds. However, most of the guidelines agreed on the importance of considering antihypertensive medications in diabetic patients but again varied on the blood pressure threshold used for guidance.

There was no consensus on the use of lifetime or relative risk in young adults to overcome the problem of 5- to 10-year time horizons for predictions. The ACC/AHA advocates the use of lifetime risk to guide intensive lifestyle intervention in young adults. The ESC recommends the use of relative risk charts for informing young adults of risk, whereas the NICE guideline generally advises against using lifetime risk tools.

There was no agreement among the guidelines on which subclinical atherosclerosis screening test to use. Only 2 guidelines on total CVD risk (ACC/AHA and ESC) suggested using imaging tests (coronary artery calcium scoring and carotid ultrasonography for atheroma detection), but only in selected individuals to guide management decisions. The Australian guideline (National Vascular Disease Prevention Alliance) was the only total CVD guideline to recommend assessing left ventricular hypertrophy in the primary risk assessment.

DISCUSSION

We identified 21 guidelines, of which 17 were rigorously developed, on cardiovascular screening interventions that could be done within a cardiovascular health check program. The aim of this systematic review was not to provide a comprehensive integration of the guidelines but rather a summary of rigorously developed national and international guidelines available to physicians in the form of a quick reference, which allows for easy comparison. There was a consensus on performing CVD risk screening and using prediction models for risk stratification and guiding treatment. The guidelines also agreed on the use of relatively simple risk markers, including age, sex, ethnicity, and smoking history. Novel biomarkers or markers of subclinical atherosclerosis are generally not recommended, except in a very select subgroup of individuals. The guidelines advocate a conservative approach to aspirin initiation for primary prevention, and there was a general agreement on intervals for repeated screening. Guidelines on selection of the ideal target population, which risk prediction model to use, and which thresholds to use to initiate statin or antihypertensive treatment differ.

We performed a broad search using major medical publication repositories, guideline library Web sites, and individual guideline development group Web sites (through manual search). In contrast to our previous article, this review summarizes only recommendations from guidelines. Other reports, such as position and scientific statements, are not in the remit of the AGREE II instrument and were excluded. All of the guidelines included in this review were published in the past 7 years and represent the most recent recommendations. None of the current 21 guidelines were included in our previous review.

Guidelines generally recommend basing management decisions on global cardiovascular risk that considers multiple risk factors. However, they differ with regard to risk thresholds. This is partly because the risk models advocated in the guidelines vary over data set use, the predictors used, and their end points. The Systematic COronary Risk Estimation model (ESC) uses only hard end points of CVD mortality, whereas the Framingham Risk Score (CDC/AHA and the National Vascular Disease Prevention Alliance) uses the broadest end points, consisting of coronary death, myocardial infarction, coronary insufficiency, angina, ischemic stroke, hemorrhagic stroke, transient ischemic attack, peripheral artery disease, and heart failure. Furthermore, the 7.5% risk threshold for initiating a statin used by the ACC/AHA is based on the newer Pooled Cohort Equation, which uses the 10-year nonfatal myocardial infarction, coronary heart disease death, or stroke end points (18). This variability can lead to the same groups receiving different treatment, makes comparison among several health care systems challenging, and could also lead to health care inequality. The AHA/ACC guidelines, for example, would recommend statins for nearly all men and two thirds of women older than 55 years. This exceeds the proportion that would be eligible based on other guidelines, such as the ESC, when tested in a European cohort (38). Standardization of various risk scoring systems, with validation and calibration, may help improve clinical outcomes in persons at risk for CVD (39). Risk scoring systems would need to be developed or updated for different countries because of country- and region-specific differences in event rates and mortality.

Programs attempting to provide population-based interventions that determine the overall effect achieved face many challenges. The diversity in CVD guidelines may partly reflect the uncertainty of the benefits of screening. Although evidence supports the effectiveness of particular interventions to appropriate persons, screening programs face such difficulties as achievement of sufficiently high uptake rates to invitations, ability to deliver effective interventions, and patient adherence to recommendations.

Most guidelines recommended a selective screening strategy, with some newer guidelines advocating a lower threshold for initiating treatment, such as statin therapy, and citing recent meta-analysis and the reduced costs of statins due to patent expiry as the main reasons for this shift (9). Thresholds used for determining high risk are often arbitrary and at best decided on by mathematical modeling. Studies that show modest benefit have mainly been based on improvements in surrogate markers rather than CVD events, with inherent limitations (40).

A MEDLINE search identified 4 previous systematic reviews, published between 1 January 2009 and 30 June 2016, that were relevant to our study (**Appendix**). Two were from our group, including our previous (now outdated) review, and another focused on guidelines of screening only for peripheral vascular disease (8, 41). The remaining 2 publications were limited to guidelines on primary CVD prevention in older adults (searches up to December 2013) (42) or the diagnosis, assessment, and management of hypertension (searches up to September 2011).

This systematic review represents contemporary guidelines with a broad inclusion of conditions eligible for cardiovascular risk assessment in apparently healthy adults and an assessment of the guidelines' rigor of development. Compared with our previous publication from 6 years ago, the target populations, risk prediction models, and their consequences are still areas of disagreement across guidelines (8). Over the past 6 years, there has been a trend toward advocating a lower threshold for initiating intensive lifestyle modification and statin therapy. Risk prediction models have been updated with a move away from the Framingham Risk Score, which previously predominated. Guidelines have a more conservative approach to aspirin, with most generally advocating against it for primary prevention. The use of tests for assessment of subclinical atherosclerosis has been further restricted.

The optimal strategy for systematic screening of the apparently healthy population remains to be found. Some groups advocate continuing with the current strategy of screening with the aim of trying to mold it into a system that eventually shows benefit, whereas others are asking for the programs to be halted until such a time that the evidence of benefit justifies the resources invested (43, 44). Recent publications addressing some of these gaps and future research in identifying the most effective strategies will help shape future guideline recommendations (45–47).

Some limitations could bias our findings and limit generalizability. Only guidelines developed by Western national or international medical organizations were reviewed. We controlled for selection bias by having a comprehensive search strategy, as previously generated with a librarian, and the articles were selected and appraised by 2 independent researchers. However, researchers were not blinded to the organization names or countries of origin. Of note, we considered the guideline development process but did not assess the clinical validity of recommendations or review them for specific lifestyle interventions because it was beyond the scope of this review.

Cardiovascular screening guidelines still have considerable discrepancies, with no consensus on optimum screening strategies or treatment threshold. Physicians should assess the strength of the recommendations and the level of evidence to decide which of the recommendations they should implement.

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Appendix: Search Strategy for Guidelines

The MEDLINE search syntax, as previously described, served as a basis for all search strategies. In brief, the syntax had the 3 following elements intersected by the Boolean term "AND": subject headings and free-text terms for the interventions about the health check contents (that is, risk assessment, screening, early detection, early diagnosis, early intervention, periodic evaluation, periodic examination, periodic check-up, prevention, and risk management), subject heading and free-text terms for the conditions that could define high risk for CVD and CVD outcomes that should be prevented (that is, arteriosclerosis, atherosclerosis, hypertension, hyperlipidemia, diabetes, cardiovascular disease, coronary heart disease, heart failure, and aortic aneurysm), and publication types and title words that cover the clinical practice guidelines (that is, practice guidelines, guideline, guidance, standards, statement, position paper, position stand, recommendation, and consensus).

The references retrieved from the search were considered guidelines if they met the definition of the Institute of Medicine. Only guidelines recommending cardiovascular risk assessment specifically aimed to prevent the first CVD event were considered. Guidelines were excluded if they did not contain recommendations involving the apparently healthy general adult population, were entirely focused on early detection of CVD only, were not produced on behalf of a professional organization, or were not relevant or applicable to Western countries. Only guidelines published from 2009 onward were included; thus, only recent or current guidelines were selected.

Search Example

CINAHL (EBSCOhost):

((MH "Cardiovascular Diseases") OR (MH "Aortic Aneurysm+") OR (MH "Myocardial Ischemia+") OR (MH "Arteriosclerosis+") OR (MH "Cerebrovascular Disorders+") OR (MH "Peripheral Vascular Diseases") OR (MH "Heart Failure, Congestive+") OR (TX (cardiovascular N3 disease*)) OR (TX (coronary N3 disease*)) OR (TX heart disease*) OR (TX (stroke* or cerebrovasc* or cva*)) OR (TX (aort* N5 aneurysm)) OR (TX (abdominal N5 aneurysm)) OR (TX (thoracoabdominal N5 aneurysm)) OR (TX (arteri* N3 occlusi*)) OR (TX (arteri* N3 stenosis)) OR (TX (peripher* N5 occlusi*)) OR (TX (peripher* N5 arteri*)) OR (TX (peripher* N5 vascular)) OR (TX heart failure) OR (TX atherosclerosis) OR (TX arteriosclerosis) OR (MH "Hypertension") OR (MH "Hyperlipidemia") OR (MH "Diabetes Mellitus") OR (TX hypertension) OR (TX hyperlipid?emia) OR (TX dyslipid?emia) OR (TX cholesterol) OR (TX diabetes) OR (TX metabolic syndrome))

AND

((MH "Cardiovascular Diseases/PC") OR (MH "Preventive Health Care") OR (MH "Health Screening") OR (MH "Risk Assessment") OR (MH "Cardiovascular Risk Factors") OR (MH "Early Intervention") OR (TX prevent*) OR (TX (risk N3 reduc*)) OR (TX (risk N3 manage*)) OR (TX (risk N3 managing)) OR (TX (risk N3 intervent*)) OR (TX (risk N3 assess*)) OR (TX early N3 interven*) OR (TX early N3 detect*) OR (TX early N3 diagnos*) OR (TX screen*) OR (TX (periodic N3 exam*)) OR (TX (periodic N3 evaluat*)) OR (TX (periodic N3 check*)))

AND

((PT Practice Guidelines) OR (TI guideline*) OR (TI guidance*) OR (TI (position paper or position stand)) OR (TI statement*) OR (TI recommendation*) OR (TI consensus) OR (TI practice parameter*) OR (TI standards))

NOT

((PT commentary) OR (PT letter) OR (PT editorial))

Limit results to English language

Search Strategy for Recent Relevant Systematic Reviews Similar to Ours

1 systematic review.m_titl. (41410)

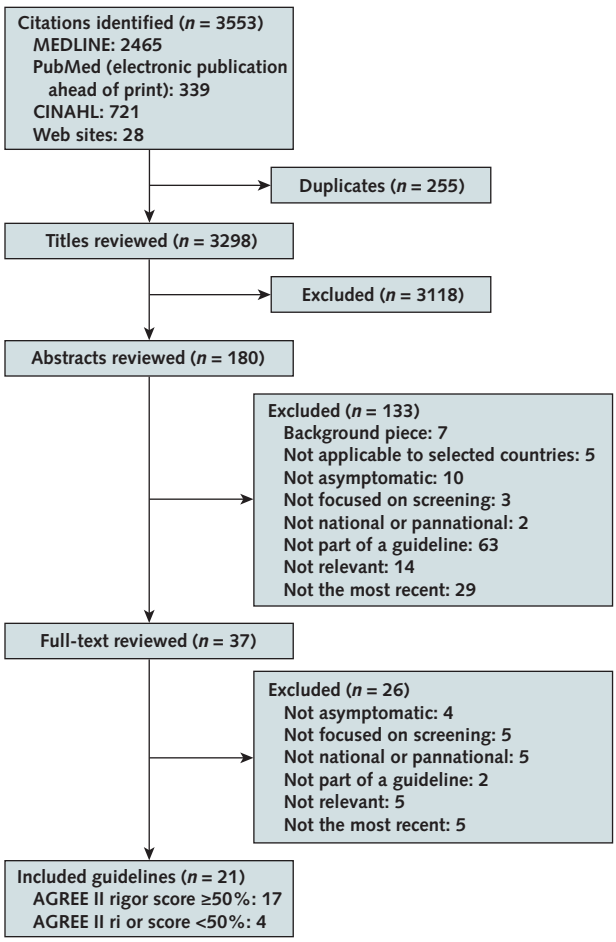
2 guidelines.m_titl. (34941)

3 (cardiovascular disease or hypertension or diabetes or cardiovascular risk or dyslipidemia).af. (593940)

4 1 and 2 and 3 (20)

5 limit 4 to (english language and yr="2009-Current") (19)

Appendix Figure. Summary of the guideline search and review process.



The number of guidelines at each step is indicated. AGREE II = Appraisal of Guidelines for Research and Evaluation II.

Appendix Table 1. Web Site Searches of Guideline Development Organizations, Including Web Sites Affiliated With All the Guidelines Included in Our Previous Publication

Organization Responsible for Guideline Development	Country	Web Site Searched
American Academy of Family Physicians	United States	www.aafp.org/online/en/home.html
American Association of Clinical Endocrinologists	United States	www.aace.com
American College of Cardiology	United States	www.acc.org
American College of Physicians	United States	www.acponline.org/
American College for Preventive Medicine	United States	www.acpm.org
American Diabetes Association	United States	www.diabetes.org/
American Geriatrics Society	United States	www.americangeriatrics.org/
American Heart Association	United States	www.americanheart.org/
American Medical Association	United States	www.ama-assn.org/
American Stroke Association	United States	www.strokeassociation.org/
Australian Diabetes Society	Australia	www.diabetessociety.com.au/
Australian Medical Association	Australia	www.ama.com.au/web.nsf/
British Cardiac Society	United Kingdom	www.bcs.com/pages/default.asp
British Hypertension Society	United Kingdom	www.bhsoc.org/default.stm
Canadian Diabetes Association	Canada	http://guidelines.diabetes.ca
Canadian Hypertension Society	Canada	www.hypertension.ca
Canadian Task Force on Preventive Health Care	Canada	http://canadiantaskforce.ca
Cardiac Society of Australia and New Zealand	Australia	www.csanz.edu.au
Centers for Disease Control and Prevention/American Heart Association	United States	www.cdc.gov
Department of Health	United Kingdom	www.dh.gov.uk/en/index.htm
European Society of Cardiology	Europe	www.escardio.org/
International Diabetes Federation	International	www.idf.org/
International Society of Hypertension	International	www.ish-world.com/
National Health and Medical Research Council	Australia	www.nhmrc.gov.au/index.htm
National Heart Foundation	Australia	www.heartfoundation.org.au/index.htm
National Heart Lung and Blood Institute	United States	www.nhlbi.nih.gov/guidelines/index.htm
National Institute for Health and Care Excellence	United Kingdom	www.nice.org.uk/
New Zealand Guidelines Group	New Zealand	www.nzgg.org.nz/index.cfm
Royal College of General Practitioners	United Kingdom	www.rcgp.org.uk/default.aspx
Scottish Intercollegiate Guidelines Network	United Kingdom	www.sign.ac.uk
U.S. Preventive Services Task Force	United States	www.ahrq.gov/clinic/uspstfix.htm
World Heart Federation	International	www.world-heart-federation.org
World Health Organization	International	www.who.int/en
World Hypertension League	International	www.worldhypertensionleague.org/Pages/Home.aspx
International Diabetes Federation European Region	International	http://diabetespreventionforum.org/index.php/projects/6-image-project

Appendix Table 2. Recommendations for Screening for Dysglycemia in 7 Guidelines

Variable	DAGDC	CDA	ADA	USPSTF	NICE PH38	CTFPHC	ESC
Country	Australia	Canada	United States	United States	United Kingdom	Canada	Europe
Year	2009	2013	2016	2015	2012	2012	2013
AGREE II rigor score, %	87	83	82	76	73	68	66
Method to evaluate evidence	Systematic review	Systematic review	Systematic review	Systematic review	Systematic review	Systematic review	Systematic review
Methods to formulate recommendations	Formal consensus	Formal consensus	Formal consensus	Consensus	Consensus	Formal consensus	Formal consensus
Consideration of costs	Review of CEAs	Review of CEAs	Review of CEAs	Review of CEAs	Review of CEAs	Systematic review of published literature/ performed CEA	NR
Target group	All adults aged ≥40 y or Aboriginal and Torres Strait Islanders ≥18 y	All adults aged ≥40 y or high-risk groups using risk calculator	All adults over 45 y or all adults with BMI ≥25 kg/m^2 (or ≥23 kg/m^2 in Asian Americans) and 1 additional DM risk factor	Adults aged 40-70 y with BMI ≥25 kg/m^2	>40 y; 25-39 y South Asian, Chinese, black with high-risk scores	Asymptomatic adults	FINDRISC ≥15/26 (high risk for DM)
Strategy	Opportunistic screening	Opportunistic screening/case finding	Opportunistic screening/case finding	Opportunistic screening	Opportunistic screening including during NHS Health Checks; case finding/record-based	Opportunistic screening	Case finding/patient completed questionnaire-based information
Strength of recommendation	For	For	For	For—moderate overall benefit for screening and implementing intensive lifestyle intervention	For—only in high-risk groups	For—only in high-risk groups	For—only in high-risk group
Prediction model	Diabetes risk assessment, e.g., AUSDRISK ≥15 high risk	Diabetes risk assessment	Diabetes risk assessment	NR	Diabetes UK score	FINDRISC, 10-y DM risk or other validated risk score (e.g., CANRISK)	FINDRISC, 10-y DM risk
Risk factors							
Age	*	*	*	*	*	*	*
Sex	*			*	*	*	*
BP			*				*
Total cholesterol level							
HDL cholesterol level	†	*	*				
Total cholesterol–HDL cholesterol ratio				*			
Smoking	*		*	*			
Glucose levels	†	* (or hemoglobin A_{1c})	*		† (or hemoglobin A_{1c})	† (or hemoglobin A_{1c})	
Underlying risk factors							
Overweight/obesity	*	*	*	*	*	*	*
Physical inactivity	*		*	*		*	*
Atherogenic diet						*	
Family history of premature CVD		*	*				
Genetic/racial factors	*	*	*	*	*	*	
Antihypertensive therapy	*	*	*	*		*	*
Emerging risk factors							
TG levels	†	*	*				
Renal function							

(*continued on following page*)

Appendix Table 2–Continued

Variable	DAGDC	CDA	ADA	USPSTF	NICE PH38	CTFPHC	ESC
Thresholds							
Aspirin	NR	Not routinely recommended. May be used in presence of other CVD risk factors	Consider if DM with 10-y ASCVD risk ≥10%. Consider aspirin in women ≥50 y. Clinical judgment required for antiplatelet use if <50 y with multiple risk factors and 10-y ASCVD risk 5-10%	Not recommended	NR	NR	Consider in high-risk DM patients on an individual basis
Statins	NR	If found diabetic in men >40 y; <40 y with microvascular complications, diabetes for >15 y and age >30 y	Consider moderate- or high-intensity statin if DM and 40-75 y, DM and >75 y or if DM and <40 y with ≥1 other ASCVD risk factors (family history of premature ASCVD, hypertension, smoking, overweight or obese, LDL cholesterol >100 mg/dL; high-intensity statin if 40-75 y with additional ASCVD risk factor. Moderate- to high-intensity statin if >75 y and additional ASCVD risk factors	NR	NR	NR	Very high risk; severe renal disease, 1 other CVD risk factor or target organ damage and LDL cholesterol >70 mg/dL; type 2 DM and LDL cholesterol >100 mg/dL
Antihypertensives	NR	If found diabetic and BP >130/80 mm Hg	DM and BP >140/90 mm Hg	NR	NR	NR	DM and BP >140/85 mm Hg
Intensive lifestyle counseling	IFG; IGT	IFG; IGT	IGT or IFG or hemoglobin A_{1c} 5.7-6.4 mmol/L	For those with abnormal blood glucose (IGT, IFG or diabetes); BMI >25 kg/m^2 and additional CVD risk factors; BMI ≥30 kg/m^2	High risk and IFG/hemoglobin A_{1c} 42-47 mmol/mol	NR	High risk for DM
High-risk monitoring	Yearly if IFG/IGT	Yearly if IFG/IGT	Annual screening if IGT or IFG or hemoglobin A_{1c} 5.7-6.4 mmol/L	NR	Every year if high risk and IFG or hemoglobin A_{1c} 42-47 mmol/mol	Annual screening if very high risk (e.g., FINDRISC >20)	Depending on clinical context
Screening intervals	3 y; annual if IFG/IGT	3 y; annual if IFG/IGT	3 y if normal; 6-12 mo postpartum if GDM, then every 3 y if normal	3 y if normal glucose levels	At least 5 y starting with risk assessment tool for low risk; 3 yearly for those at moderate risk for diabetes	3-5 y	NR

ADA = American Diabetes Association; AGREE II = Appraisal of Guidelines for Research and Evaluation II; ASCVD = atherosclerotic cardiovascular disease; AUSDRISK = Australian Type 2 Diabetes Risk Assessment Tool; BMI = body mass index; BP = blood pressure; CANRISK = Canadian Diabetes Risk Questionnaire; CDA = Canadian Diabetes Association; CEA = cost-effectiveness analysis; CTFPHC = Canadian Task Force on Preventive Health Care; CVD = cardiovascular disease; DAGDC = Diabetes Australia Guideline Development Consortium; DM = diabetes mellitus; ESC = European Society of Cardiology; FINDRISC = Finnish Diabetes Risk Score; GDM = gestational diabetes mellitus; HDL = high-density lipoprotein; IFG = impaired fasting glucose; IGT = impaired glucose tolerance; LDL = low-density lipoprotein; NHS = National Health Service; NICE PH38 = National Institute for Health and Care Excellence public health guidance 38; NR = not reported; T2DM = type 2 diabetes mellitus; TG = triglyceride; USPSTF = U.S. Preventive Services Task Force.

* Formal screening test (included in the prediction model).

† Additional screening test.

Appendix Table 3. Recommendations for Screening for Dyslipidemia in 2 Guidelines

Variable	ESC	AACE
Country	Europe	United States
Year	2011	2012
AGREE II rigor score, %	72	64
Method to evaluate evidence	Systematic review	Review of published systematic reviews and RCTs; literature identified by panel members
Methods to formulate recommendations	Formal consensus	Formal consensus
Consideration of costs	NR	Review of CEA studies
Target group	DM, hypertension, smokers, BMI ≥30 kg/m^2, FHx of premature CVD, FHx of familial hypercholesterolemias, CKD, chronic inflammatory conditions, men >40 y, women >50 y or postmenopausal	Aged ≥20 y
Strategy	Opportunistic screening/case finding	Opportunistic screening/case finding
Strength of recommendation	For	For
Prediction model	SCORE, general ASCVD mortality at 10 y	FRS/Reynolds Risk Score, CHD/stroke at 10 y
Risk factors		
Age	*	*
Sex	*	*
BP	*	*
Total cholesterol level	*	*
LDL cholesterol level	*	*
HDL cholesterol level	*	*
Total cholesterol–HDL cholesterol ratio	*	*
Smoking	*	*
Underlying risk factors		
Family history of premature CVD		*
Diabetes		*
Emerging risk factors		
TG levels	*	†
Apolipoprotein/lipoprotein levels	†	†
Glucose therapy for insulin resistance		*
Prothrombotic markers		‡
C-reactive protein level		‡
Thresholds		
Aspirin	NR	NR
Statins	10-y CVD mortality risk ≥10% and LDL cholesterol level ≥70 mg/dL; 10-y CVD mortality 5%-9% and LDL cholesterol level ≥100 mg/dL; (type 1 DM or type 2 DM) and LDL cholesterol level ≥70 mg/dL; very high CV risk (type 2 DM, type 1 DM with target organ damage, CKD)	LDL cholesterol to <100 mg/dL for persons at risk of CHD, if average or elevated LDL; other parameters based on target levels; lipid goals should be personalized by levels of risk
Antihypertensives	NR	NR
Intensive lifestyle counseling	10-y CVD mortality >1% or LDL cholesterol >100 mg/dL	10-y risk ≥20%
High-risk monitoring	NR	NR
Screening intervals	NR	Every 5 y if aged ≥20 y, but more frequently if other CHD risk factors or FHx of premature CHD present; every 1-2 y if aged ≥45 y male or aged ≥55 y female with more frequent assessment if multiple other risk factors present

AACE = American Association of Clinical Endocrinologists; AGREE II = Appraisal of Guidelines for Research and Evaluation II; ASCVD = atherosclerotic cardiovascular disease; BMI = body mass index; BP = blood pressure; CEA = cost-effectiveness analysis; CHD = coronary heart disease; CKD = chronic kidney disease; CV = cardiovascular; CVD = cardiovascular disease; DM = diabetes mellitus; ESC = European Society of Cardiology; FHx = family history; FRS = Framingham Risk Score; HDL = high-density lipoprotein; LDL = low-density lipoprotein; NR = not reported; RCT = randomized, controlled trial; SCORE = Systematic Coronary Risk Evaluation; TG = triglyceride.

* Formal screening test (included in the prediction model).

† Additional screening test.

‡ In selected persons who are not in 1 of the 4 main statin benefit groups and for whom a decision to initiate statin therapy is otherwise unclear, additional factors may be considered to inform treatment decision making. These factors include primary LDL cholesterol level ≥160 mg/dL or other evidence of genetic hyperlipidemias; first-degree relative with premature ASCVD; high-sensitivity C-reactive protein >2 mg/L; coronary artery calcium score ≥300 Ag units or ≥75th percentile for age, sex, and ethnicity; ankle–brachial index <0.9; or elevated lifetime risk for ASCVD.

Appendix Table 4. Recommendations for Screening for Hypertension in 3 Guidelines

Variable	CHEP	USPSTF	CTFPHC
Country	Canada	United States	Canada
Year	2015	2015	2013
AGREE II rigor score, %	90	79	78
Method to evaluate evidence	Systematic review	Systematic review	Systematic review
Methods to formulate recommendations	Formal consensus	Consensus	Consensus
Consideration of costs	NR	NR	NR
Target group	All adults	≥18 y with increased risk for high BP: high-normal BP (130-139/85-89 mm Hg), overweight or obese, and African Americans	≥18 y
Strategy	Opportunistic screening at "appropriate visits"	NR	Opportunistic screening at "appropriate visits"/case finding
Strength of recommendation	For	For	For
Prediction model	SCORE-Canada, general ASCVD mortality at 10 y	NR	NR
Risk factors			
Age	*	*	*
Sex	*		
BP	*	*	*
Total cholesterol level	*		
HDL cholesterol level	*		
Smoking	*		
Underlying risk factors			
Overweight/obesity	*	*	
Physical inactivity	*		
Atherogenic diet	*		
Family history of premature CVD			
Genetic/racial factors		*	*
Diabetes	*		
Emerging risk factors			
Renal function	*		
Subclinical atherosclerosis	LVH/resting ECG		LVH/resting ECG
Thresholds			
Aspirin	Consider if ≥50 y and hypertensive	NR	NR
Statins	If ≥3 of: male/≥55 y/smoking/type 2 DM/total cholesterol–HDL cholesterol ratio ≥ 6/FHx CVD/LVH/ ECG abnormalities/microalbuminuria/PVD	NR	NR
Antihypertensives	If DM and BP >130/80 mm Hg; high risk for DM and BP >140/90 mm Hg; low risk and BP >160/100 mm Hg; ≥80 y and systolic BP >160 mm Hg	NR	NR
Intensive lifestyle counseling	In all with hypertension	NR	NR
High-risk monitoring	Annual if BP high normal (≥130/85 mm Hg)	Annually if ≥40 y and at increased risk for high BP	Annual if BP high normal (≥130/85 mm Hg)
Screening intervals	NR	Annually if ≥40 y and at increased risk for high BP. Every 3 to 5 y if 18-39 y with normal BP (<130/85 mm Hg) and not other risk factors.	Further risk assessment based on clinical judgment

AGREE II = Appraisal of Guidelines for Research and Evaluation II; ASCVD = atherosclerotic cardiovascular disease; BP = blood pressure; CHEP = Canadian Hypertension Education Program; CTFPHC = Canadian Task Force on Preventive Health Care; CVD = cardiovascular disease; DM = diabetes mellitus; ECG = electrocardiography; FHx = family history; HDL = high-density lipoprotein; LVH = left ventricular hypertrophy; NR = not reported; PVD = peripheral vascular disease; SCORE = Systematic Coronary Risk Evaluation; USPSTF = U.S. Preventive Services Task Force.
* Formal screening test (included in the prediction model).