JAMA | US Preventive Services Task Force | RECOMMENDATION STATEMENT

Screening for Cardiovascular Disease Risk With Electrocardiography

US Preventive Services Task Force Recommendation Statement

US Preventive Services Task Force

IMPORTANCE Cardiovascular disease (CVD), which encompasses atherosclerotic conditions such as coronary heart disease, cerebrovascular disease, and peripheral arterial disease, is the most common cause of death among adults in the United States. Treatment to prevent CVD events by modifying risk factors is currently informed by CVD risk assessment with tools such as the Framingham Risk Score or the Pooled Cohort Equations, which stratify individual risk to inform treatment decisions.

OBJECTIVE To update the 2012 US Preventive Services Task Force (USPSTF) recommendation on screening for coronary heart disease with electrocardiography (ECG).

EVIDENCE REVIEW The USPSTF reviewed the evidence on whether screening with resting or exercise ECG improves health outcomes compared with the use of traditional CVD risk assessment alone in asymptomatic adults.

FINDINGS For asymptomatic adults at low risk of CVD events (individuals with a 10-year CVD event risk less than 10%), it is very unlikely that the information from resting or exercise ECG (beyond that obtained with conventional CVD risk factors) will result in a change in the patient's risk category as assessed by the Framingham Risk Score or Pooled Cohort Equations that would lead to a change in treatment and ultimately improve health outcomes. Possible harms are associated with screening with resting or exercise ECG, specifically the potential adverse effects of subsequent invasive testing. For asymptomatic adults at intermediate or high risk of CVD events, there is insufficient evidence to determine the extent to which information from resting or exercise ECG adds to current CVD risk assessment models and whether information from the ECG results in a change in risk management and ultimately reduces CVD events. As with low-risk adults, possible harms are associated with screening with resting or exercise ECG in asymptomatic adults at intermediate or high risk of CVD events.

CONCLUSIONS AND RECOMMENDATION The USPSTF recommends against screening with resting or exercise ECG to prevent CVD events in asymptomatic adults at low risk of CVD events. (D recommendation) The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of screening with resting or exercise ECG to prevent CVD events in asymptomatic adults at intermediate or high risk of CVD events. (I statement)

Editorial page 2277

Author Audio Interview

Related article page 2315 and JAMA Patient Page page 2346

CME Quiz at jamanetwork.com/learning and CME Questions page 2331

Related articles at jamainternalmedicine.com jamacardiology.com

Author/Group Information: The US Preventive Services Task Force (USPSTF) members are listed at the end of this article.

Corresponding Author: Susan J. Curry, PhD, University of Iowa, 111 Jessup Hall, Iowa City, IA 52242 (chair@uspstf.net).

JAMA. 2018;319(22):2308-2314. doi:10.1001/jama.2018.6848

The US Preventive Services Task Force (USPSTF) makes recommendations about the effectiveness of specific clinical preventive services for patients without obvious related signs or symptoms.

It bases its recommendations on the evidence of both the benefits and harms of the service and an assessment of the balance. The USPSTF does not consider the costs of providing a service in this assessment.

The USPSTF recognizes that clinical decisions involve more considerations than evidence alone. Clinicians should understand the evidence but individualize decision making to the specific patient or situation. Similarly, the USPSTF notes that policy and coverage decisions involve considerations in addition to the evidence of clinical benefits and harms.

Summary of Recommendations and Evidence

The USPSTF recommends against screening with resting or exercise electrocardiography (ECG) to prevent cardiovascular disease (CVD) events in asymptomatic adults at low risk of CVD events (D recommendation) (**Figure 1**).

The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of screening with resting or exercise ECG to prevent CVD events in asymptomatic adults at intermediate or high risk of CVD events. (I statement)

See the Clinical Considerations section for suggestions for practice regarding the I statement.

Rationale

Importance

Cardiovascular disease, which encompasses atherosclerotic conditions such as coronary heart disease, cerebrovascular disease, and peripheral arterial disease, is the most common cause of death among adults in the United States. Treatment to prevent CVD events by modifying risk factors is currently informed by CVD risk assessment with tools such as the Framingham Risk Score or the Pooled Cohort Equations, which stratify individual risk to inform treatment decisions. If existing CVD risk assessment tools could be improved, treatment might be better targeted, thereby maximizing the benefits of and minimizing the harms of screening.

Detection

The USPSTF found inadequate evidence to determine whether adding resting or exercise ECG to conventional risk factor assessment leads to improved risk stratification of persons to inform treatment decisions.

Benefits of Early Detection and Intervention and Treatment

The USPSTF found inadequate evidence to determine whether the incremental information offered by resting or exercise ECG (beyond that obtained with traditional CVD risk factors) can be used to guide treatment decisions and ultimately reduce CVD events.

Based on the epidemiology and natural history of CVD and established treatment strategies based on risk stratification, it is unlikely that the benefits of screening with resting or exercise ECG in asymptomatic adults at low risk of CVD events are greater than small.

See the Clinical Considerations section for definition of risk categories and assessment of risk.

Harms of Early Detection and Intervention and Treatment

The USPSTF found adequate evidence that screening with resting or exercise ECG in asymptomatic adults leads to harms that are at least small and may be moderate, including unnecessary invasive procedures, overtreatment, and labeling.

USPSTF Assessment

The USPSTF concludes with moderate certainty that the potential harms of screening with resting or exercise ECG to prevent CVD events equal or exceed the potential benefits in asymptomatic adults at low risk of CVD events.

The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of screening with resting or exercise ECG to prevent CVD events in asymptomatic adults at intermediate or high risk of CVD events.

Clinical Considerations

Patient Population Under Consideration

This recommendation applies to adults without symptoms of or a diagnosis of CVD (**Figure 2**).

Suggestions for Practice Regarding the I Statement

In deciding whether to screen with resting or exercise ECG in asymptomatic adults at intermediate or high risk of CVD events, clinicians should consider the following information.

Potential Preventable Burden

Although evidence is insufficient to determine whether screening with ECG in adults is beneficial, those who may be at increased risk of CVD events might have the greatest potential for net benefit. Reclassification into a higher-risk category might lead to more intensive medical management that could lower the risk of CVD events but might also result in harms, including adverse medication effects such as gastrointestinal bleeding and hepatic injury. Regardless of ECG findings, persons who are already at high risk of CVD events should receive intensive risk factor modification. Persons who are classified as low risk are unlikely to benefit from screening with ECG.

For persons in certain occupations, such as pilots and operators of heavy equipment, for whom sudden incapacitation or death may endanger the safety of others, considerations other than the health benefit to the patient may influence the decision to screen with ECG to prevent CVD events.

Potential Harms

In all risk groups, an abnormal ECG finding (a true-positive or false-positive result) can lead to invasive confirmatory testing and treatment that have the potential for serious harm, including unnecessary radiation exposure. Two studies of asymptomatic adults with diabetes reported that 6% and 12% of patients who were screened with exercise ECG subsequently underwent angiography, and 3% to 5% underwent revascularization, without evidence of benefit to the study patients.[1,2] Angiography and revascularization are associated with harms, including bleeding, contrast-induced nephropathy, cardiac

Figure 1. US Preventive Services Task Force (USPSTF) Grades and Levels of Certainty

What the USPSTF Grades Mean and Suggestions for Practice

Grade	Definition	Suggestions for Practice
A	The USPSTF recommends the service. There is high certainty that the net benefit is substantial.	Offer or provide this service.
B	The USPSTF recommends the service. There is high certainty that the net benefit is moderate, or there is moderate certainty that the net benefit is moderate to substantial.	Offer or provide this service.
C	The USPSTF recommends selectively offering or providing this service to individual patients based on professional judgment and patient preferences. There is at least moderate certainty that the net benefit is small.	Offer or provide this service for selected patients depending on individual circumstances.
D	The USPSTF recommends against the service. There is moderate or high certainty that the service has no net benefit or that the harms outweigh the benefits.	Discourage the use of this service.
I statement	The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of the service. Evidence is lacking, of poor quality, or conflicting, and the balance of benefits and harms cannot be determined.	Read the Clinical Considerations section of the USPSTF Recommendation Statement. If the service is offered, patients should understand the uncertainty about the balance of benefits and harms.

USPSTF Levels of Certainty Regarding Net Benefit

Level of Certainty	Description
High	The available evidence usually includes consistent results from well-designed, well-conducted studies in representative primary care populations. These studies assess the effects of the preventive service on health outcomes. This conclusion is therefore unlikely to be strongly affected by the results of future studies.
Moderate	The available evidence is sufficient to determine the effects of the preventive service on health outcomes, but confidence in the estimate is constrained by such factors as the number, size, or quality of individual studies. inconsistency of findings across individual studies. limited generalizability of findings to routine primary care practice. lack of coherence in the chain of evidence. As more information becomes available, the magnitude or direction of the observed effect could change, and this change may be large enough to alter the conclusion.
Low	The available evidence is insufficient to assess effects on health outcomes. Evidence is insufficient because of the limited number or size of studies. important flaws in study design or methods. inconsistency of findings across individual studies. gaps in the chain of evidence. findings not generalizable to routine primary care practice. lack of information on important health outcomes. More information may allow estimation of effects on health outcomes.
The USPSTF defines certainty as "likelihood that the USPSTF assessment of the net benefit of a preventive service is correct." The net benefit is defined as benefit minus harm of the preventive service as implemented in a general, primary care population. The USPSTF assigns a certainty level based on the nature of the overall evidence available to assess the net benefit of a preventive service.	

arrhythmia, stroke, myocardial infarction, coronary artery dissection, allergic reaction to the contrast agent, and death.

Current Practice

Although many guideline groups recommend cardiovascular risk assessment, there are few data on how this is applied in clinical practice. Only 41% of respondents in a survey of more than 900 US clinicians reported using cardiovascular risk prediction equations in practice.[3] There are few data on the use of ECG to assess CVD risk in asymptomatic patients in the United States. A Canadian retrospective cohort study from 2010 to 2015 found that 21.5% of low-risk primary care patients had an ECG within 30 days of an annual health examination, and the proportion of patients who had an ECG ranged across clinics from 1.8% to 76.1%.[4]

Assessment of Risk

Accurate identification of persons at high risk of CVD events provides the opportunity for more intensive risk factor management to reduce the likelihood of such an event. In addition, identifying persons at low risk may allow for a reduction in interventions among patients not likely to benefit from them.

Several factors are associated with an increased risk of CVD events, including older age, male sex, high blood pressure, current smoking, abnormal lipid levels, diabetes, obesity, and physical inactivity. Risk factors are combined in many ways to estimate a person's risk of a CVD event. Several calculators and models are available to quantify a person's 10-year risk of CVD events. The Framingham Risk Score,[5] based on data from the Framingham Heart Study, was one of the first widely used CVD risk assessment tools. Persons with a 10-year CVD event risk greater than

Figure 2. Clinical Summary: Screening for Cardiovascular Disease Risk With Electrocardiography

Population	Adults at low risk of CVD events	Adults at intermediate or high risk of CVD events
Recommendation	Do not screen with resting or exercise ECG. Grade: D	No recommendation. Grade: I (insufficient evidence)

Risk Assessment	Risk factors for CVD events include older age, male sex, high blood pressure, current smoking, abnormal lipid levels, diabetes, obesity, and physical inactivity. Several calculators and models are available to quantify a person's 10-year risk of CVD events; the USPSTF recommends that clinicians use the Pooled Cohort Equations to assess CVD risk.
Screening Tests	Resting ECG records cardiac electrical activity while the patient is at rest, over a short period. Exercise ECG records cardiac electrical activity during physical exertion, often at a prespecified intensity level. The most common method of exercise ECG is the treadmill test. Both resting and exercise ECG look for markers of previous myocardial infarction, myocardial ischemia, and other cardiac abnormalities (such as left ventricular hypertrophy, bundle branch block, or arrhythmia) that may be associated with CVD or predict future CVD events.
Treatments	Asymptomatic adults at increased risk of CVD events are usually treated with a combination of diet and exercise modifications, lipid-lowering medications, aspirin, hypertension management, and interventions to encourage tobacco cessation.
Other Relevant USPSTF Recommendations	The USPSTF has made recommendations on many factors related to CVD prevention, including screening for high blood pressure, use of statins, counseling on smoking cessation, and counseling to promote healthful diet and physical activity. In addition, the USPSTF recommends low-dose aspirin use in certain persons at increased risk of CVD events.

For a summary of the evidence systematically reviewed in making this recommendation, the full recommendation statement, and supporting documents, please go to https://www.uspreventiveservicestaskforce.org.

U.S. Preventive Services TASK FORCE

JAMA

CVD indicates cardiovascular disease; ECG, electrocardiography; USPSTF, US Preventive Services Task Force.

20% are generally considered high risk, those with a 10-year CVD event risk less than 10% are considered low risk, and those with a 10-year CVD event risk of 10% to 20% are considered intermediate risk. The Pooled Cohort Equations, introduced by the American College of Cardiology and American Heart Association in 2013, include the same variables as the Framingham Risk Score as well as race/ethnicity and diabetes. Persons with a 10-year CVD event risk less than 7.5% are considered at low risk, and those with a 10-year CVD event risk of 7.5% or greater are considered at elevated risk.[6] The USPSTF recommends that clinicians use the Pooled Cohort Equations to assess CVD risk.

Screening Tests

Both resting and exercise ECG are used for the diagnostic evaluation of suspected CVD, which has led to the suggestion that ECG could also be used to screen asymptomatic persons to identify those who would benefit from earlier, more intensive management of modifiable risk factors, preventive interventions, or both. Resting ECG records cardiac electrical activity while the patient is at rest, over a short period of time. Standard ECG testing is performed with 12 leads, although some tests use fewer leads. More recently, ECG leads have been built into blood pressure cuffs, smartphones, and other devices. Exercise ECG records cardiac electrical activity during physical exertion, often at a prespecified intensity level. The most common method of exercise ECG is the treadmill test, but other methods, such as those using bicycles and ergometers, have also been used. Both resting and exercise ECG look for markers of previous myocardial infarction, myocardial ischemia, and other cardiac abnormalities (such as left ventricular hypertrophy, bundle branch block, or arrhythmia) that may be associated with CVD or predict future CVD events.

Treatment and Interventions

Asymptomatic adults at increased risk of CVD events are usually treated with a combination of diet and exercise modifications, lipid-lowering medications, aspirin, hypertension management, and interventions to encourage tobacco cessation. Recommendations for diet and exercise modifications, lipid-lowering medications, and aspirin are based on level of cardiovascular risk. Recent guidelines also recommend risk stratification of hypertension treatment[7]; the recommendation for tobacco cessation applies to all persons regardless of CVD risk.

Useful Resources

The USPSTF has made recommendations on many factors related to CVD prevention, including screening for high blood pressure,[8] use of statins,[9] counseling on smoking cessation,[10] and counseling to promote healthful diet and physical activity.[11] In addition, the USPSTF recommends low-dose aspirin use in certain persons at increased risk of CVD events.[12]

Other resources are also available from the National Heart, Lung, and Blood Institute[13]; Centers for Disease Control and Prevention[14]; and Healthy People 2020.[15]

Other Considerations

Research Needs and Gaps

A considerable number of studies have reported hazard ratios and other measures of association between ECG changes and cardiovascular outcomes, so additional studies of this nature are unlikely to

advance the field. Studies are needed that assess the incremental value of adding ECG to current CVD risk assessment tools or instruments to directly inform decision making; studies that examine patient outcomes would be most useful. Failing that, studies are needed that assess the added value of ECG for risk reclassification across clinically relevant risk thresholds. Any study of CVD risk assessment should also evaluate the harms associated with assessment as well as those related to additional testing and treatment. Studies that measure risk reclassification should report total, event, and nonevent Net Reclassification Indices, with corresponding confidence intervals, as well as measures of calibration and discrimination.

Discussion

Burden of Disease

Cardiovascular disease is the most common cause of death among adults in the United States, accounting for 1 in 3 deaths. Although CVD remains a significant cause of illness and death, mortality from CVD has been decreasing over time in the United States. Currently, the annual incidence of new cases of myocardial infarction and cerebral vascular accident in the United States is 580 000 and 610 000, respectively.[16]

Scope of Review

In 2012, the USPSTF recommended against screening for coronary heart disease with ECG in low-risk adults (D recommendation) and issued an I statement for intermediate- and high-risk adults.[17] To update the prior recommendations, the USPSTF requested the current evidence review.[18,19] In recognition of how the field has advanced, the current evidence review did not include association studies but addressed whether the addition of screening with resting or exercise ECG improves health outcomes compared with traditional CVD risk assessment in asymptomatic adults.

Accuracy of Screening Tests

The USPSTF reviewed the evidence on whether screening with resting or exercise ECG improves calibration, discrimination, or risk reclassification when added to CVD risk assessment models using traditional risk factors. The USPSTF focused on evidence that ECG adds to current CVD risk assessment with the Framingham Risk Score or the Pooled Cohort Equations, because this could lead to change in treatments for patients.

The USPSTF identified 5 cohort studies (2 of which overlap with the previous review) that evaluated whether adding exercise ECG to current CVD risk assessment models improves calibration, discrimination, or reclassification. Four studies assessed whether exercise ECG improved calibration; 2 studies evaluated adding exercise ECG to the Framingham Risk Score,[20,21] and the other 2 studies evaluated adding exercise ECG to other risk assessment models.[22,23] The studies used different measures and showed mixed effects on calibration. Three studies assessed whether adding exercise ECG to the Framingham Risk Score[21] or other risk assessment models[22,24] improved discrimination, and all found only small absolute improvements in area under the curve or C statistic (0.02-0.03). Only 1 risk assessment model development study evaluated whether adding exercise ECG improved risk reclassification. However, the study did not apply risk thresholds that currently determine treatment and only reported overall reclassification, not event and nonevent net reclassification.[22]

The USPSTF identified 9 cohort studies (1 of which overlapped with the previous review) that evaluated whether adding resting ECG to current CVD risk assessment models improves calibration, discrimination, or reclassification; 5 of these studies evaluated multiple ECG changes and 4 evaluated a single ECG change. Five studies evaluated adding resting ECG to the Framingham Risk Score,[25-29] and 1 of these studies[29] also evaluated adding resting ECG to the Pooled Cohort Equations. Adding resting ECG to existing CVD risk assessment models improved calibration for several CVD outcomes, although the strength of evidence was low and resulted in small or very small improvements in discrimination (absolute improvement in area under the curve or C statistic, 0.001-0.050). Two studies reported net reclassification when resting ECG was added to the Framingham Risk Score,[18,26,27] and 1 study[29] evaluated adding resting ECG to both the Framingham Risk Score and the Pooled Cohort Equations. There was a small to moderate improvement in reclassification but the studies did not present the full reclassification data, so it is difficult to determine whether the reclassification would change treatment. No 2 studies evaluated the same CVD risk assessment model, risk category threshold, or outcome.

Effectiveness of Early Detection and Treatment

The USPSTF identified no studies that directly assessed whether adding resting ECG to current CVD risk assessment models improves cardiovascular outcomes for any risk group.[18,19] The USPSTF identified 2 fair-quality randomized clinical trials of screening with exercise ECG in persons with diabetes (and therefore at increased risk of CVD) that found no difference in mortality or cardiovascular events.[1,2] However, both trials fell far short of their intended enrollment and therefore were underpowered and had a relatively short time period (mean, 3.5 years) to detect a difference in cardiovascular outcomes.

Potential Harms of Screening and Treatment

Resting ECG has the potential for anxiety and labeling; however, the USPSTF was unable to find relevant studies on these harms. Exercise ECG has more potential for direct harms (eg, triggering a cardiovascular event or musculoskeletal injury), but survey data of symptomatic patients suggests that these harms are very rare.[30,31] The primary concern for both types of ECG screening is the harm of subsequent procedures or interventions initiated as a result of screening (eg, angiography or revascularization procedures). Only 1 study reported harms of subsequent testing (1/12 patients referred for revascularization had a nonfatal myocardial infarction)[2]; therefore, the USPSTF included a broader range of study designs in its evaluation to estimate potential harms.

Angiography rates after screening with exercise ECG in asymptomatic populations are generally less than 3% (range, 0.6%-13%). The majority of patients undergoing angiography in these studies did not have angiographically demonstrable coronary artery stenosis, but some did undergo revascularization (0.1%-0.5%).[18] Based on large population-based registries that include symptomatic persons, angiography is associated with a serious harm rate of 1.7%, including arrhythmia (0.40%), death (0.10%), stroke (0.07%), and myocardial infarction (0.05%). Revascularization increases the risk of periprocedural myocardial infarction (1.7%), coronary artery dissection (1.3%), bleeding events within 72 hours (1.3%), vascular complications (0.4%),

renal failure (0.4%), stroke (0.1%), and death on day of procedure (<0.01%).[18] The USPSTF did not find any recent studies that directly addressed the potential harms of anxiety or labeling.

Estimate of Magnitude of Net Benefit

For asymptomatic adults at low risk of CVD events (defined as 10-year CVD event risk <10%), it is very unlikely that the information from resting or exercise ECG (beyond that obtained with conventional CVD risk factors) will result in a change in the patient's risk category that would lead to a change in treatment and ultimately improve health outcomes. Serious possible harms are associated with screening with resting or exercise ECG, specifically the potential adverse effects of subsequent invasive testing. Therefore, the USPSTF concludes with moderate certainty that screening with ECG in asymptomatic adults at low risk of CVD events has no net benefit.

For asymptomatic adults at intermediate or high risk of CVD events (defined as a 10-year CVD event risk of 10%-20% or >20%, respectively), there is insufficient evidence to determine the extent to which information from resting or exercise ECG adds to current CVD risk assessment models (ie, Pooled Cohort Equations) and whether it results in a change in risk management and ultimately reduces CVD events. As with low-risk adults, serious possible harms are associated with screening with resting or exercise ECG in asymptomatic adults at intermediate or high risk of CVD events. The USPSTF concludes that there is insufficient evidence to estimate the net benefit of screening with ECG in asymptomatic adults at intermediate or high risk of CVD events.

How Does Evidence Fit With Biological Understanding?

There is substantial and consistent evidence that identifying and treating traditional, modifiable CVD risk factors such as high blood pressure, abnormal lipid levels, diabetes, current smoking, physical inactivity, and diet improve cardiovascular outcomes. These risk factors are linked to the biological understanding of the pathophysiology of CVD. Electrocardiography measures the electrical activity in the heart and results can be abnormal for many reasons, only some of which are attributable to atherosclerotic CVD. In low-risk patients, these abnormalities are unlikely to result from atherosclerotic CVD; in intermediate- and high-risk patients, they are more likely to result from atherosclerotic CVD, but there is no evidence that targeting these abnormalities in addition to modifiable risk factors has benefit.

Response to Public Comment

A draft version of this recommendation statement was posted for public comment on the USPSTF website from December 19, 2017, to January 22, 2018. In response to public comments, the USPSTF clarified the definition of CVD and the preferred CVD risk assessment tool.

Update of Previous USPSTF Recommendation

This recommendation is an update of the 2012 USPSTF recommendation. As in 2012, the USPSTF continues to recommend against screening with ECG in adults at low risk, and the evidence remains insufficient on screening in adults at increased risk.[17]

Recommendations of Others

The American College of Physicians recommends against screening for CVD with resting or stress ECG in asymptomatic, low-risk adults.[32] The American College of Cardiology concludes that exercise ECG is rarely appropriate in asymptomatic adults at low global risk of CVD events, may be an appropriate option for adults at intermediate risk, and is appropriate for adults at high risk.[33] In 2012, the American Academy of Family Physicians recommended against screening with ECG in asymptomatic, low-risk persons.[34] The American College of Preventive Medicine recommends against routinely screening with resting or exercise ECG in the general adult population.[35]

ARTICLE INFORMATION

Accepted for Publication: May 2, 2018.

The US Preventive Services Task Force (USPSTF) members: Susan J. Curry, PhD; Alex H. Krist, MD, MPH; Douglas K. Owens, MD, MS; Michael J. Barry, MD; Aaron B. Caughey, MD, PhD; Karina W. Davidson, PhD, MASc; Chyke A. Doubeni, MD, MPH; John W. Epling Jr, MD, MSEd; Alex R. Kemper, MD, MPH, MS; Martha Kubik, PhD, RN; C. Seth Landefeld, MD; Carol M. Mangione, MD, MSPH; Michael Silverstein, MD, MPH; Melissa A. Simon, MD, MPH; Chien-Wen Tseng, MD, MPH, MSEE; John B. Wong, MD.

Affiliations of The US Preventive Services Task Force (USPSTF) members: University of Iowa, Iowa City (Curry); Fairfax Family Practice Residency, Fairfax, Virginia (Krist); Virginia Commonwealth University, Richmond (Krist); Veterans Affairs Palo Alto Health Care System, Palo Alto, California (Owens); Stanford University, Stanford, California (Owens); Harvard Medical School, Boston, Massachusetts (Barry); Oregon Health & Science University, Portland (Caughey); Columbia University, New York, New York (Davidson); University of Pennsylvania, Philadelphia (Doubeni); Virginia Tech Carilion School of Medicine, Roanoke (Epling); Nationwide Children's Hospital, Columbus, Ohio (Kemper); Temple University, Philadelphia, Pennsylvania (Kubik); University of Alabama at Birmingham (Landefeld); University of California, Los Angeles (Mangione); Boston University, Boston, Massachusetts (Silverstein); Northwestern University, Evanston, Illinois (Simon); University of Hawaii, Honolulu (Tseng); Pacific Health Research and Education Institute, Honolulu, Hawaii (Tseng); Tufts University, Medford, Massachusetts (Wong).

Author Contributions: Dr Curry had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. The USPSTF members contributed equally to the recommendation statement.

Conflict of Interest Disclosures: All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Authors followed the policy regarding conflicts of interest described at https://www.uspreventiveservicestaskforce.org/Page/Name/conflict-of-interest-disclosures. All members of the USPSTF receive travel reimbursement and an honorarium for participating in USPSTF meetings. No other disclosures were reported.

Funding/Support: The USPSTF is an independent, voluntary body. The US Congress mandates that the Agency for Healthcare Research and Quality (AHRQ) support the operations of the USPSTF.

Role of the Funder/Sponsor: AHRQ staff assisted in the following: development and review of the research plan, commission of the systematic evidence review from an Evidence-based Practice Center, coordination of expert review and public comment of the draft evidence report and draft recommendation statement, and the writing and preparation of the final recommendation statement and its submission for publication. AHRQ staff had no role in the approval of the final recommendation statement or the decision to submit for publication.

Disclaimer: Recommendations made by the USPSTF are independent of the US government. They should not be construed as an official position of AHRQ or the US Department of Health and Human Services.

Additional Contributions: We thank Howard Tracer, MD, and Elizabeth Kato, MD, MRP (AHRQ), who contributed to the writing of the manuscript, and Lisa Nicolella, MA (AHRQ), who assisted with coordination and editing.

REFERENCES

1. Lièvre MM, Moulin P, Thivolet C, et al; DYNAMIT Investigators. Detection of silent myocardial ischemia in asymptomatic patients with diabetes: results of a randomized trial and meta-analysis assessing the effectiveness of systematic screening. *Trials*. 2011;12:23. doi:10.1186/1745-6215-12-23

2. Turrini F, Scarlini S, Mannucci C, et al. Does coronary atherosclerosis deserve to be diagnosed early in diabetic patients? the DADDY-D trial: screening diabetic patients for unknown coronary disease. *Eur J Intern Med*. 2015;26(6):407-413. doi:10.1016/j.ejim.2015.05.006

3. National Heart, Lung, and Blood Institute. Assessing Cardiovascular Risk: Systematic Evidence Review From the Risk Assessment Work Group. https://www.nhlbi.nih.gov/health-topics/assessing-cardiovascular-risk. Published 2013. Accessed April 24, 2018.

4. Bhatia RS, Bouck Z, Ivers NM, et al. Electrocardiograms in low-risk patients undergoing an annual health examination. *JAMA Intern Med*. 2017;177(9):1326-1333. doi:10.1001/jamainternmed.2017.2649

5. Framingham Heart Study. Cardiovascular disease (10-year risk) calculator. https://www.framinghamheartstudy.org/fhs-risk-functions/cardiovascular-disease-10-year-risk/. 2018. Accessed April 24, 2018.

6. Goff DC Jr, Lloyd-Jones DM, Bennett G, et al; American College of Cardiology/American Heart Association Task Force on Practice Guidelines. 2013 ACC/AHA guideline on the assessment of cardiovascular risk. *J Am Coll Cardiol*. 2014; 63(25, pt B):2935-2959. doi:10.1016/j.jacc.2013.11.005

7. Whelton PK, Carey RM, Aronow WS, et al. ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCN guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines [published online November 7, 2017]. *J Am Coll Cardiol*. doi:10.1016/j.jacc.2017.11.006

8. Siu AL; U.S. Preventive Services Task Force. Screening for high blood pressure in adults: U.S. Preventive Services Task Force recommendation statement. *Ann Intern Med*. 2015;163(10):778-786. doi:10.7326/M15-2223

9. Bibbins-Domingo K, Grossman DC, Curry SJ, et al. Statin use for the primary prevention of cardiovascular disease in adults: US Preventive Services Task Force recommendation statement. *JAMA*. 2016;316(19):1997-2007. doi:10.1001/jama.2016.15450

10. Siu AL; U.S. Preventive Services Task Force. Behavioral and pharmacotherapy interventions for tobacco smoking cessation in adults, including pregnant women: U.S. Preventive Services Task Force recommendation statement. *Ann Intern Med*. 2015;163(8):622-634. doi:10.7326/M15-2023

11. LeFevre ML; U.S. Preventive Services Task Force. Behavioral counseling to promote a healthful diet and physical activity for cardiovascular disease prevention in adults with cardiovascular risk factors: U.S. Preventive Services Task Force Recommendation Statement. *Ann Intern Med*. 2014;161(8):587-593. doi:10.7326/M14-1796

12. Bibbins-Domingo K; U.S. Preventive Services Task Force. Aspirin use for the primary prevention of cardiovascular disease and colorectal cancer: U.S. Preventive Services Task Force recommendation statement. *Ann Intern Med*. 2016;164(12):836-845. doi:10.7326/M16-0577

13. National Heart, Lung, and Blood Institute. NHLBI Online Catalog. https://www.nhlbi.nih.gov/health-topics/publications-and-resources. Accessed April 24, 2018.

14. Prevention Works: CDC Strategies for a Heart-Healthy and Stroke-Free America. https://www.cdc.gov/dhdsp/prevention_works.htm. Updated 2013. Accessed April 24, 2018.

15. Healthy People 2020. Evidence-Based Resources. https://www.healthypeople.gov/2020/tools-resources/Evidence-Based-Resources. Accessed April 24, 2018.

16. Benjamin EJ, Blaha MJ, Chiuve SE, et al. Heart disease and stroke statistics—2017 update: a report from the American Heart Association. *Circulation*. 2017;135(10):e146-e603. doi:10.1161/CIR.0000000000000485

17. Moyer VA; U.S. Preventive Services Task Force. Screening for coronary heart disease with electrocardiography: U.S. Preventive Services Task Force recommendation statement. *Ann Intern Med*. 2012;157(7):512-518.

18. Jonas DE, Reddy S, Middleton JC, et al. *Screening for Cardiovascular Disease Risk With Electrocardiography: An Evidence Review for the U.S. Preventive Services Task Force: Evidence Synthesis No. 163*. Rockville, MD: Agency for Healthcare Research and Quality; 2018. AHRQ publication 17-05235-EF-1.

19. Jonas DE, Reddy S, Middleton JC, et al. Screening for cardiovascular disease risk with resting or exercise electrocardiography: evidence report and systematic review for the US Preventive Services Task Force [published June 12, 2018]. *JAMA*. doi:10.1001/jama.2018.6897

20. Cournot M, Taraszkiewicz D, Galinier M, et al. Is exercise testing useful to improve the prediction of coronary events in asymptomatic subjects? *Eur J Cardiovasc Prev Rehabil*. 2006;13(1):37-44. doi:10.1097/00149831-200602000-00006

21. Cournot M, Taraszkiewicz D, Cambou JP, et al. Additional prognostic value of physical examination, exercise testing, and arterial ultrasonography for coronary risk assessment in primary prevention. *Am Heart J*. 2009;158(5):845-851. doi:10.1016/j.ahj.2009.08.017

22. Chang SM, Nabi F, Xu J, et al. Value of CACS compared with ETT and myocardial perfusion imaging for predicting long-term cardiac outcome in asymptomatic and symptomatic patients at low risk for coronary disease. *JACC Cardiovasc Imaging*. 2015;8(2):134-144. doi:10.1016/j.jcmg.2014.11.008

23. Erikssen G, Bodegard J, Bjørnholt JV, et al. Exercise testing of healthy men in a new perspective: from diagnosis to prognosis. *Eur Heart J*. 2004;25(11):978-986. doi:10.1016/j.ehj.2004.04.009

24. Aktas MK, Ozduran V, Pothier CE, et al. Global risk scores and exercise testing for predicting all-cause mortality in a preventive medicine program. *JAMA*. 2004;292(12):1462-1468. doi:10.1001/jama.292.12.1462

25. Denes P, Larson JC, Lloyd-Jones DM, et al. Major and minor ECG abnormalities in asymptomatic women and risk of cardiovascular events and mortality. *JAMA*. 2007;297(9):978-985. doi:10.1001/jama.297.9.978

26. Badheka AO, Patel N, Tuliani TA, et al. Electrocardiographic abnormalities and reclassification of cardiovascular risk: insights from NHANES-III. *Am J Med*. 2013;126(4):319-326. doi:10.1016/j.amjmed.2012.10.020

27. Auer R, Bauer DC, Marques-Vidal P, et al; Health ABC Study. Association of major and minor ECG abnormalities with coronary heart disease events. *JAMA*. 2012;307(14):1497-1505. doi:10.1001/jama.2012.434

28. Badheka AO, Patel NJ, Grover PM, et al. ST-T wave abnormality in lead aVR and reclassification of cardiovascular risk (from the National Health and Nutrition Examination Survey-III). *Am J Cardiol*. 2013;112(6):805-810. doi:10.1016/j.amjcard.2013.04.058

29. Shah AJ, Vaccarino V, Janssens AC, et al. An electrocardiogram-based risk equation for incident cardiovascular disease from the National Health and Nutrition Examination Survey. *JAMA Cardiol*. 2016;1(7):779-786. doi:10.1001/jamacardio.2016.2173

30. Myers J, Arena R, Franklin B, et al. Recommendations for clinical exercise laboratories: a scientific statement from the American Heart Association. *Circulation*. 2009;119(24):3144-3161. doi:10.1161/CIRCULATIONAHA.109.192520

31. American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 10th ed. Philadelphia, PA: Wolters Kluwer; 2017.

32. Chou R; High Value Care Task Force of the American College of Physicians. Cardiac screening with electrocardiography, stress echocardiography, or myocardial perfusion imaging: advice for high-value care from the American College of Physicians. *Ann Intern Med*. 2015;162(6):438-447. doi:10.7326/M14-1225

33. Wolk MJ, Bailey SR, Doherty JU, et al. ACCF/AHA/ASE/ASNC/HFSA/HRS/SCAI/SCCT/SCMR/STS 2013 multimodality appropriate use criteria for the detection and risk assessment of stable ischemic heart disease: a report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Heart Association, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, and Society of Thoracic Surgeons. *J Am Coll Cardiol*. 2014;63(4):380-406. doi:10.1016/j.jacc.2013.11.009

34. American Academy of Family Physicians. Clinical preventive service recommendation: coronary heart disease, adults. https://www.aafp.org/patient-care/clinical-recommendations/all/cvd.html. 2012. Accessed April 27, 2018.

35. Lim LS, Haq N, Mahmood S, Hoeksema L. Atherosclerotic cardiovascular disease screening in adults: American College of Preventive Medicine position statement on preventive practice. *Am J Prev Med*. 2011;40(3):381.e1-381.e10. doi:10.1016/j.amepre.2010.11.021