Screening for Coronary Heart Disease With Electrocardiography: U.S. Preventive Services Task Force Recommendation Statement

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Description: Update of the 2004 U.S. Preventive Services Task Force (USPSTF) recommendation statement on screening for coronary heart disease (CHD).

Methods: The USPSTF reviewed new evidence on the benefits of screening with electrocardiography (ECG) in asymptomatic adults to reduce the risk for CHD events versus not screening, the effect of identifying high-risk persons on treatment to reduce risk, the accuracy of stratifying individuals into risk categories, and the harms of screening.

Recommendations: The USPSTF recommends against screening with resting or exercise ECG for the prediction of CHD events in asymptomatic adults at low risk for CHD 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 for the prediction of CHD events in asymptomatic adults at intermediate or high risk for CHD events (I statement).


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* For a list of the members of the USPSTF, see the Appendix (available at www.annals.org).

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The U.S. Preventive Services Task Force (USPSTF) makes recommendations about the effectiveness of specific clinical preventive services for patients without 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) for the prediction of coronary heart disease (CHD) events in asymptomatic adults at low risk for CHD 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 for the prediction of CHD events in asymptomatic adults at intermediate or high risk for CHD events (I statement).

See the Figure for a summary of the recommendations and suggestions for clinical practice.

Table 1 describes the USPSTF grades, and Table 2 describes the USPSTF classification of levels of certainty about net benefit.

RATIONALE

Importance

Coronary heart disease is the leading cause of death in the United States in both men and women, accounting for nearly 16% of all deaths each year. More than 1 million Americans have nonfatal or fatal myocardial infarction (MI) or sudden death from CHD annually. For some people, these events are the first manifestations of CHD.

Detection

The USPSTF found adequate evidence that many resting and exercise ECG abnormalities are associated with an increased risk for a serious CHD event, after controlling for conventional risk factors.

There is inadequate evidence that adding ECG to conventional risk factor assessment leads to improved stratification of individuals into high-, intermediate-, or low-risk groups to guide risk management.
Benefits of Detection and Early Intervention

For asymptomatic adults at low risk for CHD events, the USPSTF found adequate evidence that the incremental information offered by resting or exercise ECG (beyond that obtained with conventional CHD risk factors) is highly unlikely to result in changes in risk stratification that would prompt interventions and ultimately reduce CHD-related events. The USPSTF based this conclusion on the epidemiology of CHD, the natural history of CHD, and established treatment strategies based on risk stratification.

For asymptomatic adults at intermediate or high risk for CHD events, the USPSTF found inadequate evidence to determine the extent to which the incremental information offered by resting or exercise ECG (beyond that obtained with conventional CHD risk factors) results in changes in risk stratification that would prompt interventions and ultimately reduce CHD-related events.

Harms of Detection and Early Intervention

There is adequate evidence that screening asymptomatic adults with resting or exercise ECG leads to harms that are at least small, including unnecessary invasive procedures, overtreatment, and labeling.

USPSTF Assessment

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

The USPSTF concludes that evidence is lacking and the balance of benefits and harms of screening for CHD with exercise or resting ECG in asymptomatic adults at intermediate or high risk for CHD events cannot be determined.

CLINICAL CONSIDERATIONS
Patient Population Under Consideration

This recommendation applies to adult men and women without symptoms of heart disease or a diagnosis of cardiovascular disease (CVD). In this recommendation,
CHD refers to coronary artery disease and ischemic heart disease.

Assessment of Risk

Accurate identification of persons at high risk for CHD events, particularly nonfatal MI and CHD death, provides the opportunity to intensify risk factor management to reduce the likelihood of one of these events. In addition, identifying people at low risk may allow for a reduction in interventions with a low benefit–risk ratio in this risk stratum. Several factors are associated with higher risk for CHD events, including older age, male sex, high blood pressure, smoking, abnormal lipid levels, diabetes, obesity, and sedentary lifestyle.

Risk factors can be combined in many ways to allow classification of a person’s risk for a CHD event as low, intermediate, or high. Several calculators and models are available to quantify a person’s 10-year risk for CHD events. The calculator from the Framingham Adult Treatment Panel III (http://hp2010.nhlbihin.net/atpiii/calculator.asp) performs well for the U.S. population. Persons with a 10-year risk greater than 20% are generally considered high-risk, those with a 10-year risk less than 10% are considered low-risk, and those in the 10% to 20% range are considered intermediate-risk.

Screening Tests

Many resting and exercise ECG abnormalities have been associated with an increased risk for CHD events, such as MI and CHD death. Although exercise ECG is considered more sensitive for detecting coronary artery stenosis, the magnitude of increased risk for CHD events, as well as the sensitivity of ECG abnormalities for predicting future events, is similar for resting and exercise ECG (1, 2). Performing baseline ECG so that results may be compared with future ECG findings is considered screening by the USPSTF and is not recommended for asymptomatic adults at low risk for CHD; evidence is insufficient about its usefulness in adults at increased risk.

For asymptomatic adults at low risk for CHD events, a resting or exercise ECG is unlikely to provide additional information about CHD risk beyond that obtained with conventional CHD risk factors (that is, Framingham risk factors) and result in changes in risk stratification that would prompt interventions and ultimately reduce CHD-related events. False-positive results may cause harms in low-risk asymptomatic adults; for more information about

## Table 1. What the USPSTF Grades Mean and Suggestions for Practice

<table>
<thead>
<tr>
<th>Grade</th>
<th>Grade Definitions</th>
<th>Suggestions for Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>The USPSTF recomends the service. There is high certainty that the net benefit is substantial.</td>
<td>Offer/provide this service.</td>
</tr>
<tr>
<td>B</td>
<td>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.</td>
<td>Offer/provide this service.</td>
</tr>
<tr>
<td>C</td>
<td>Note: The following statement is undergoing revision. Clinicians may provide this service to selected patients depending on individual circumstances. However, for most individuals without signs or symptoms, there is likely to be only a small benefit from this service.</td>
<td>Offer/provide this service only if other considerations support offering/providing the service in an individual patient.</td>
</tr>
<tr>
<td>D</td>
<td>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.</td>
<td>Discourage the use of this service.</td>
</tr>
<tr>
<td>I statement</td>
<td>The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of the service. Evidence is lacking, or poor quality, or conflicting, and the balance of benefits and harms cannot be determined.</td>
<td>Read the Clinical Considerations section of the USPSTF Recommendation Statement. If offered, patients should understand the uncertainty about the balance of benefits and harms.</td>
</tr>
</tbody>
</table>

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 on the basis of the nature of the overall evidence available to assess the net benefit of a preventive service.
harms, go to the Suggestions for Practice Regarding the I Statement and the Discussion sections.

**Treatment**

Regardless of ECG findings, asymptomatic adults at increased risk for CHD are usually managed with a combination of diet and exercise modifications, lipid-lowering medications, aspirin, hypertension management, and tobacco cessation. The net benefit of the use of aspirin and the intensity of lipid-lowering therapy depends on a person’s baseline risk for CHD.

**Useful Resources**

The USPSTF has made recommendations on the use of aspirin to prevent CVD, screening for lipid disorders, the use of additional risk factors to determine intermediate CHD risk, and screening for hypertension. These recommendations and their supporting evidence are available on the USPSTF Web site (www.uspreventiveservicestaskforce.org).

**Suggestions for Practice Regarding the I Statement**

In deciding whether to screen with resting or exercise ECG in asymptomatic adults who are at intermediate or high risk for CHD events, clinicians should consider the following.

**Potential Preventable Burden**

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

For persons in certain occupations, such as pilots and heavy equipment operators, for whom sudden incapacitation or sudden death may endanger the safety of others, considerations other than the health benefit to the individual patient may influence the decision to screen for CHD. Although some exercise programs initially screen asymptomatic participants with exercise ECG, evidence is insufficient to determine the balance of benefits and harms of this practice.

**Potential Harms**

In all risk groups, an ECG abnormality (as a result of a true- or false-positive result) can lead to invasive confirmatory testing and treatments that have the potential for serious harm, including unnecessary radiation exposure and the associated risk for cancer. Studies report that up to 3% of asymptomatic patients with an abnormal exercise ECG result receive angiography and up to 0.5% undergo revascularization, even though revascularization has not been shown to reduce CHD events in asymptomatic persons. Angiography and revascularization are associated with risks, including bleeding, contrast-induced nephropathy, and allergic reactions to the contrast agent.

**Current Practice**

Screening with resting or exercise ECG in low-risk patients is not recommended by any organization. However, evidence on current clinical use of screening for CHD with resting or exercise ECG in asymptomatic patients is sparse. Anecdotal evidence suggests that it is performed with some frequency.

**Costs**

Although the cost of resting ECG may be low, the downstream costs of resulting diagnostic testing and treatments can be substantial.

**Other Considerations**

**Research Needs and Gaps**

Studies that use a conventional risk stratification algorithm and evaluate the changes in risk classification, treatment, and CHD outcomes that occur as a result of adding resting or exercise ECG are needed. There is a particular need for evidence to help understand restratification of persons at intermediate risk. Any study of screening should also evaluate harms associated with screening as well as those related to additional testing and therapies.

**Discussion**

**Burden of Disease**

Coronary heart disease is the leading cause of death in the United States, with more than 406,000 deaths reported in 2007 (3). One third of all deaths among persons older than 35 years are caused by CHD (4). It also causes significant morbidity, with a prevalence approaching 50% among middle-aged men and 33% among middle-aged women (5). The annual cost of CHD was expected to exceed $300 billion in 2010 (6).

**Scope of Review**

In 2004, the USPSTF recommended against screening for CHD with resting or exercise ECG or electron-beam computed tomography in low-risk, asymptomatic adults. It concluded that evidence was insufficient to make any recommendation about screening asymptomatic adults in the intermediate- and high-risk categories. In 2009, the USPSTF requested a review of the evidence for the purpose of updating its 2004 recommendations. The current review addressed the following issues related to screening with ECG in asymptomatic adults to reduce the risk for CHD events: the benefits of screening versus not screen-
ing, the effect of identifying high-risk persons on treat-
ments to reduce risk, the accuracy of stratifying persons
into risk categories, and the harms of screening (1, 2). The
USPSTF looked for evidence on 3 types of potential harms
in its review: direct harms associated with screening tests;
adverse events associated with further testing, such as cor-
onary arterial angiography or percutaneous coronary angio-
plasty, that may be performed in response to positive
screening results; and psychological harms, such as anxiety
and labeling. Screening with electron-beam computed to-
mography was not addressed in the systematic review be-
cause it is addressed in a separate USPSTF recommenda-
tion. The USPSTF also requested a separate systematic
review of CVD risk assessment tools.

Accuracy of Screening Tests

The USPSTF reviewed the evidence on the accuracy
of screening with both resting and exercise ECG for strat-
ifying individuals into high-, intermediate-, and low-risk
groups. The USPSTF was most interested in evidence that
ECG adds to traditional risk assessment with Framingham
risk factors, because this could lead to change in treatments
for individuals.

The USPSTF found no studies on whether adding
ECG to traditional risk factor assessment accurately re-
stratifies adults into risk categories (1, 2). The review did
find many prospective cohort studies of resting and exercise
ECG abnormalities that reported associations with CHD
outcomes. The duration of follow-up in these studies
ranged from 3 to 56 years, and they were generally of fair
or good quality. Several resting ECG abnormalities, in-
cluding ST-segment and T-wave abnormalities, left ven-
tricular hypertrophy, left-axis deviation, and bundle branch
block, were associated with subsequent CHD events
(pooled hazard ratios ranged from 1.5 to 1.9). Exercise
ECG abnormalities were also associated with subsequent
CHD events. These abnormalities include ST-segment de-
pression with exercise, inability to reach 85% or 90% of
maximum predicted heart rate, and abnormal heart rate
recovery after exercise (pooled hazard ratios ranged from
1.4 to 2.1).

A recent systematic review (6) summarized the current
state of CVD risk assessment tools, with a focus on the
U.S. asymptomatic patient population. Overall, the Fra-
mingham risk score (FRS) models performed well in U.S.
populations but had problems with absolute risk prediction
when they were applied to substantially different popula-
tions from the source cohort. Although all FRS models
were developed from a cohort that is not entirely repre-
sentative of the U.S. population, the 2001 Framingham Adult
Treatment Panel III version demonstrated several benefits
over the older FRS models, including a focus on hard
CHD outcomes, exclusion of patients with diabetes, and
incorporation of more current FRS data. Diabetes-specific
process measurement variables were significantly related to
cardiovascular outcome risk among patients with diabetes,
and risk models that incorporated these factors outper-
formed general risk prediction models when applied to
these patients. When applied to nondiabetic cohorts, mod-
els that excluded patients with diabetes outperformed gen-
eral risk prediction models that had included these patients
in their development. External validation of diabetes-
specific risk models was lacking, particularly among U.S.
cohorts.

Effectiveness of Detection

As discussed, resting and exercise ECG can detect ab-
normalities associated with increased risk for CHD events
and death. Although many studies report an association
between resting and exercise ECG abnormalities and CHD
events, there is no evidence that this helps to stratify adults
into risk categories that guide risk management. This pre-
vents the USPSTF from drawing conclusions about how
resting and exercise ECG screening might change the man-
agement of an intermediate- or high-risk patient and ulti-
ately change that patient’s CHD outcome. For asympto-
tomatic adults at low risk for CHD events, the incremental
information offered by resting or exercise ECG (beyond
that obtained with conventional CHD risk factors) is
highly unlikely to result in a change in risk stratification
that would prompt interventions and ultimately reduce
CHD-related events.

Potential Harms of Detection

Adverse events directly associated with resting ECG
are extremely rare and largely related to cutaneous allergic
reactions to ECG pads and adhesives or anxiety about test
outcome. The USPSTF is not aware of any recent studies
that report harms directly associated with resting ECG
screening. In low-risk asymptomatic populations, most
positive ECG results occur in persons who will not have a
CHD event in the next 5 to 10 years (7). One study (8)
reported that 71% of asymptomatic adults with abnormal
exercise treadmill ECG results had no angiographically de-
monstrable coronary artery stenosis. Adverse events associ-
ated with exercise ECG may include the triggering of a
cardiovascular event, musculoskeletal injury, and anxiety
about test outcome. The overall risk for a serious adverse
event (one that requires hospitalization or causes sudden
dearth) is estimated to be 1 in 10 000 tests (9).

Harms are associated with follow-up testing or inter-
ventions that follow resting or exercise ECG screening. 
Older studies, mostly from the 1980s and 1990s, report
rates of 0.6% to 2.9% for angiography in asymptomatic
adults after an abnormal exercise ECG result. Two studies
reported rates of 0.1% and 0.5% for subsequent revas-
cularization. On the basis of large, population-based registries
that include symptomatic persons (10), the risk for any
serious adverse event from angiography is about 1.7%,
including risk for death (0.1%), MI (0.05%), stroke
(0.07%), or arrhythmia (0.4%). The USPSTF did not find
any recent studies that directly address the potential harms
of anxiety or labeling.
Screening for CHD With Electrocardiography

Estimate of Magnitude of Net Benefit

For asymptomatic adults at low risk for CHD events, it is very unlikely that the information offered by resting or exercise ECG (beyond that obtained with conventional CHD risk factors) will result in a change in the patient’s risk category (for example, from low to high risk) that would lead to a change in the patient’s treatment and ultimately improve health outcomes. Serious possible harms are associated with resting or exercise ECG screening. The most important harm is exposure to potential adverse effects of invasive tests. Therefore, the USPSTF concluded with moderate certainty that screening ECG provides no net benefit for asymptomatic, low-risk patients.

For asymptomatic adults at intermediate or high risk for CHD events, there is no evidence to determine the extent to which resting or exercise ECG adds to the usual ascertainment of conventional CHD risk factors (that is, Framingham risk factors) and that it results in a change in risk management and ultimately reduces CHD-related events. As with low-risk adults, serious possible harms are associated with resting or exercise ECG in asymptomatic adults at intermediate or high risk and thus the USPSTF could not assess the net benefit of ECG screening.

How Does Evidence Fit With Biological Understanding?

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

Response to Public Comments

A draft version of this recommendation was posted on the USPSTF Web site from 27 September to 25 October 2011 and again from 30 November to 13 December 2011. A few comments were received on the lack of information about the harms of ECG screening in asymptomatic adults. More information on the harms of screening was added to the Clinical Considerations section. Several comments requested clarification about whether the recommendation applied to both men and women and whether it applied to baseline ECG. The USPSTF revised the statement to clarify that it applies to both men and women and that baseline ECG is considered screening and is included in this recommendation. A few comments requested clarification that this recommendation applies to screening for coronary artery disease and ischemic heart disease and not to other forms of heart disease; this was clarified in the Clinical Considerations section.

Update of Previous USPSTF Recommendation

This recommendation updates the 2004 recommendation. As in 2004, the USPSTF continues to recommend against screening in low-risk adults and found insufficient evidence on screening in adults at increased risk. The current recommendation differs from the 2004 recommendation in the screening interventions that were reviewed; the current recommendation excluded evidence on electron-beam computed tomography because it is addressed in another USPSTF recommendation (11) published in 2009.

Recommendations of Others

The American College of Cardiology Foundation and the American Heart Association state that resting ECG is “reasonable for cardiovascular risk assessment in asymptomatic adults with hypertension or diabetes.” They further state that exercise ECG “may be considered for cardiovascular risk assessment in intermediate-risk asymptomatic adults (including sedentary adults considering starting a vigorous exercise program), particularly when attention is paid to non-ECG markers such as exercise capacity” (12). The American Academy of Family Physicians does not recommend use of routine ECG in asymptomatic adults at low risk for CHD and found insufficient evidence for adults at increased risk for CHD (13).

From the U.S. Preventive Services Task Force, Rockville, Maryland.

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Requests for Single Reprints: Reprints are available from the USPSTF Web site (www.uspreventiveservicestaskforce.org).

References


www.annals.org

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APPENDIX: U.S. PREVENTIVE SERVICES TASK FORCE

Members of the U.S. Preventive Services Task Force at the time this recommendation was finalized† are Virginia A. Moyer, MD, MPH, Chair (Baylor College of Medicine, Houston, Texas); Michael L. LeFevre, MD, MSPH, Co-Vice Chair (University of Missouri School of Medicine, Columbia, Missouri); Albert L. Siu, MD, MSPH, Co-Vice Chair (Mount Sinai School of Medicine, New York, and James J. Peters Veterans Affairs Medical Center, Bronx, New York); Linda Ciofu Baumann, PhD, RN (University of Wisconsin, Madison, Wisconsin); Kirsten Bibbins-Domingo, PhD, MD (University of California, San Francisco, San Francisco, California); Susan J. Curry, PhD (University of Iowa College of Public Health, Iowa City, Iowa); Mark Ebell, MD, MS (University of Georgia, Athens, Georgia); Glenn Flores, MD (University of Texas Southwestern, Dallas, Texas); Adelita Gonzales Cantu, RN, PhD (University of Texas Health Science Center, San Antonio, Texas); David C. Grossman, MD, MPH (Group Health Cooperative, Seattle, Washington); Jessica Herzstein, MD, MPH (Air Products, Allentown, Pennsylvania); Joy Melnikow, MD, MPH (University of California, Davis, Sacramento, California); Wanda K. Nicholson, MD, MPH, MBA (University of North Carolina School of Medicine, Chapel Hill, North Carolina); Douglas K. Owens, MD, MS (Veteran Affairs Palo Alto Health Care System, Palo Alto, and Stanford University, Stanford, California); Carolina Reyes, MD, MPH (Virginia Hospital Center, Arlington, Virginia); and Timothy J. Wilt, MD, MPH (University of Minnesota Department of Medicine and Minneapolis Veteran Affairs Medical Center, Minneapolis, Minnesota). Sanford Schwartz, MD, a former USPSTF member, also contributed to the development of this recommendation.

† For a list of current Task Force members, go to www.uspreventiveservicestaskforce.org/about.htm.