Identifying Favorable-Value Cardiovascular Health Services

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A consensus is building to increase "value" as a guiding principle for US health reform[1]; indeed, value is used repeatedly throughout the health reform law as a unifying principle and as a descriptor for various new incentives that will be applied to providers and clinicians. At the same time, there is a complementary emphasis on the emerging role of consumers as active participants in their care, who engage in shared decision making with their clinicians and health organizations.[1] As a result, it may be argued that health reform can be advanced by incentivizing and increasing consumer knowledge about high-value health services or health systems that deliver favorable value. In addition, emphasizing value rather than cost control may reduce the likelihood of rationing decisions that harm health by restricting high-value services.[2]

Although there is no consensus on how to define and measure value, the health reform law consistently juxtaposes the use of the word *value* with statements about the importance of improving quality or lowering cost.[1] One published definition of value that is notably close to that embedded in the health reform law is the ratio of incremental benefits to incremental costs.[3] In lay terms, this definition corresponds to the notion of "bang for the buck," and in technical terms, this definition corresponds to the inverse of the incremental cost-effectiveness ratio.

The Cost-Effectiveness Analysis Registry[4] summarizes and reviews published original English-language analyses that estimate incremental cost-effectiveness ratios using various methods (eg, mathematical modeling and primary data analysis). In principle, this registry should be an essential tool for informing the measurement of value and facilitating its use in US health reform. However, there are several important barriers to the use of this registry for policy decisions. First, the quality of analyses in the registry is not measured using a reproducible and validated approach, and the strength of evidence underlying particular analyses is sometimes questionable. This is a particularly important consideration because of the lack of transparency underlying assumptions in mathematical models of cost-effectiveness and because there sometimes is little high-quality evidence to inform model results.[5] Second, analyses do not have expiration dates; therefore, an included analysis might concern a treatment that is obsolete or might involve a comparison that is no longer relevant. Third, analyses may often reach differing conclusions, rendering it difficult to know how to use conflicting analyses to inform policy. Fourth, some payers might argue that industry-funded analyses may present

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Objective: To identify cardiovascular health services with a high level of evidence to suggest that they deliver favorable value.

Study Design: Evidence synthesis using the Cost-Effectiveness Analysis Registry.

Methods: We queried the registry to identify published cost-effectiveness analyses of cardiovascular health services in the United States. In addition to searching the registry, we performed supplementary searches of published literature for cost-effectiveness studies of cardiovascular interventions that were endorsed by guidelines of national medical and scientific societies. We defined favorable value as an incremental cost-effectiveness ratio of $100,000 or less per quality-adjusted life-year.

Results: Our initial review of cardiovascular health services in the United States revealed 174 separate peer-reviewed studies. Of those, 157 studies did not meet our inclusion criteria, leaving 17 studies for further evaluation that covered the following services with potentially high value: statins to prevent myocardial infarction (for primary and secondary prevention), screening for and treatment of high blood pressure (diuretics or β-blockers and angiotensin-converting enzyme inhibitors in the case of diabetes) to prevent myocardial infarction and stroke, warfarin sodium and low-molecular-weight heparin to prevent pulmonary emboli, implantable cardiac defibrillators for patients at high risk of sudden death, antiplatelet drugs (aspirin and clopidogrel bisulfate) to prevent future myocardial infarction, β-blockers for patients who have had myocardial infarction, warfarin to prevent future stroke in persons with nonvalvular atrial fibrillation, and percutaneous procedures to relieve claudication symptoms.

Conclusion: We describe a new way of synthesizing cost-effectiveness evidence for use by consumers, payers, and other decision makers.

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Take-Away Points

Our study identifies cardiovascular health services with a high level of evidence to suggest that they deliver favorable value. This information has many potential uses for consumers, payers, and other decision makers.

- The data show how health improvements are usually expensive even when we focus on those with the highest value.
- If the healthcare system does not produce systematic ways to encourage high-value care and discourage low-value care, health insurance premiums will continue to outpace inflation, causing multiple economic problems for consumers.
- Because few cardiovascular services have been demonstrated to have a favorable value, it is important to support funding of comparative effectiveness research.

important conflicts of interest, which make their results hard to interpret because of the importance of subjective judgments in constructing the models that underlie their results. Fifth, analyses in the registry often include a wide range of healthcare settings and patient characteristics, and decision makers may want to base their decisions only on those analyses with similar settings and patients.

Herein, we describe an approach using the Cost-Effectiveness Analysis Registry that helps address these challenges. We used this registry to identify a subset of cardiovascular health services with a high level of evidence to suggest that they deliver favorable value. Identifying high-value services has many benefits for consumers in that they can be encouraged to use them when clinically appropriate, can engage in more informed health discussions with their clinicians, and can seek health plans that offer these services without barriers, such as copayments, deductibles, or burdensome administrative procedures.

This work was performed at the request of Consumers Union, publisher of *Consumer Reports*. The study objective was to provide comparisons and ratings of heart and vascular disease services that Consumers Union is pursuing.

METHODS

We first describe how we identified cardiovascular health services with known value; second, how we applied quality-of-evidence standards together with nonobsolescence standards; third, how we applied consistency of evidence standards for high value; and fourth, how we applied additional inclusion criteria to ensure relevance to consumers. Through these stepwise filters, we identified a list of cardiovascular health services with particularly robust evidence to suggest high value and high relevance to consumers.

We adopted stringent standards for evidence. In other words, we sought to identify a limited number of health services that we are confident represent favorable value rather than seeking to identify a broader number of health services with less certain value estimations. We defined services broadly, including prevention, diagnosis, treatment, and management.

Identifying a Pool of Cardiovascular Health Services With Known Value

To identify a pool of cardiovascular health services potentially meeting high-value criteria, we queried the Cost-Effectiveness Analysis Registry[4] to identify all published cost-effectiveness analyses of cardiovascular health services in the United States. The registry summarizes and reviews original English-language cost-utility analysis articles and can be searched by type of health services, such as cardiovascular, and by country of analysis, such as the United States. The articles undergo a screening and review process before being included in the registry. A MEDLINE search is performed using the keywords *QALYs*, *quality*, and *cost-utility analysis*, and then the Cost-Effectiveness Analysis Registry team screens the article abstracts to determine if the articles contain an original cost-utility estimate. Studies are excluded if they are reviews, editorials, or methodological articles, as well as cost-effectiveness analyses that do not measure health effects in quality-adjusted life-years (QALYs). These methods are described in more detail at the Cost-Effectiveness Analysis Registry Web site (http://www.cearegistry.org).

When synthesizing evidence, it is often necessary to supplement algorithm-based database searches with manual searches of journals that are likely to publish relevant articles and of bibliographies from select review articles. Accordingly, we supplemented our algorithm-based search of the Cost-Effectiveness Analysis Registry with manual searches of select national medical and scientific guidelines (eg, US Preventive Services Task Force, American Heart Association, and American College of Physicians), focusing our attention on those that were published in peer-reviewed scientific journals and that used explicit and standardized evidence syntheses. In addition, we searched select review articles for cost-effectiveness studies.[3,6] We reviewed the titles or abstracts of all studies, and we obtained the source publications to evaluate quality-of-evidence standards and inclusion criteria. Finally, we searched other disease fields of the registry that might overlap with cardiovascular health services (*endocrine* for diabetes and lipids and *smoking* and *tobacco* for smoking).

Although value has many plausible alternative definitions and perspectives, we defined value for the purposes herein as the ratio of additional benefits to additional costs or, equivalently, as the inverse of the incremental cost-effectiveness

ratio. We chose this definition because it is consistent with the scientific literature[3] and because it corresponds to lay concepts (bang for the buck and best buy).

Published work suggests that the acceptable threshold for healthcare value in the United States is unlikely to be lower (eg, more restrictive) than the value of modern healthcare in aggregate (approximately $100,000 per quality-adjusted life-year or per life-year, in 2003 US dollars)[7] and may be substantially higher (up to $265,000 per quality-adjusted life-year).[8] Consequentially, we conservatively use $100,000 per quality-adjusted life-year or per life-year as our criterion threshold for high value in this proposal. However, because some prior published cost-effectiveness analyses have used an even more restrictive threshold of $50,000 per quality-adjusted life-year to demarcate high value, we performed sensitivity analyses incorporating this alternative threshold.[9]

A quality-adjusted life-year is a unit that simultaneously measures quality and quantity of life and reflects the idea that individuals often are willing to trade off some quantity of life if they can substantially improve their quality of life. Therefore, a year of life in high-quality health should "count for" more than a year of life in poor-quality health. Quality-adjusted life-years enable value to be compared across different healthcare interventions and represent an attempt to integrate all the benefits, harms, and burdens of interventions other than cost into a single number.

Quality of Evidence and Nonobsolescence Standards

We reviewed articles for quality of evidence by applying the Quality of Health Economic Studies, a validated instrument for measuring the quality of cost-effectiveness analyses.[10] Scores vary from 0 to 100, and 75 is a commonly used cutoff for high quality.[11] Each study was reviewed by at least 1 author, and studies were considered only if their Quality of Health Economic Studies score met this cutoff (in a comparison scoring of 20 randomly selected articles, our κ value was .68).

We reviewed studies for robustness of clinical effectiveness and for nonobsolescence by verifying that services with favorable value were also favored or by using the most up-to-date clinical guidelines of a medical or scientific society. Because clinical guidelines are proliferating rapidly and are of varying quality, evidentiary basis, and health effect, we considered only those clinical guidelines that were published in peer-reviewed journals and used explicit evidence rating scales for level of endorsement and underlying evidence. (While it may be argued that peer review does not itself guarantee quality, we regarded peer review as a reasonable first step given the absence of standard quality metrics for clinical guidelines.) To meet criteria for robustness of clinical effectiveness, services had to receive the highest grade of supporting evidence (eg, level A in the case of American Heart Association guidelines) and the strongest recommendation in favor (eg, level 1 in the case of American Heart Association guidelines). To identify clinical guidelines meeting these criteria, we used the search tools of the National Guideline Clearinghouse,[12] a repository of clinical guidelines from a wide variety of sources (eg, health plans and government, professional, and specialty organizations) that is supported by the Agency for Healthcare Research and Quality.

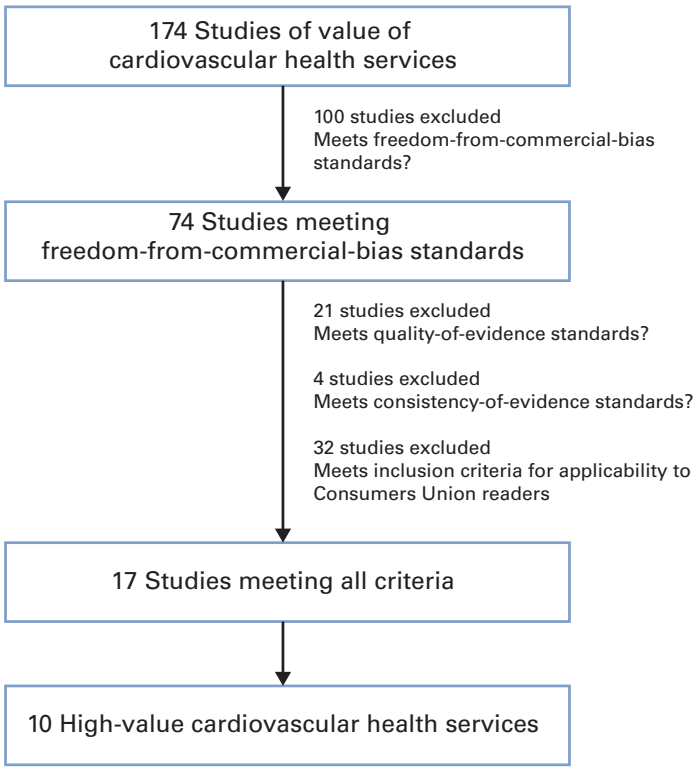
Consistency of Evidence Standards

We sought to include only services that were supported by consistent evidence. The following 2 criteria were used: (1) there should not be conflicting results if more than 1 high-quality published study addresses the same question and (2) the results of each study should be robust with regard to alternative but plausible assumptions.

Consistency was assessed by asking whether there was a different implication for decision making rather than asking whether a particular number was different outside the realm of chance. For example, 2 studies analyzing the same cardiovascular health service with results of $40,000 per life-year and $70,000 per life-year would be regarded as consistent because they were on the same side of the relevant decision threshold (≤$100,000 per life-year denotes high value) and would yield the same inference for decision making (the service is high value and should be encouraged). In contrast, 2 studies with results of $40,000 per life-year and $140,000 per life-year would not be regarded as consistent because they were on opposite sides of the decision threshold and yielded inconsistent inferences for decision making (one suggesting high value and encouragement, with the other suggesting low value and an alternative decision).

Similarly, robustness of results was assessed based on whether varying assumptions across plausible ranges would cause the results to cross a decision threshold and produce a different implication for decision making. For example, if varying one assumption in a study caused the result to vary between $40,000 and $70,000 per life-year, that result would be interpreted as robust because any number in this range has the same implication for decision making (the service is high value and should be encouraged). In contrast, if varying one assumption in a study caused the result to vary between $40,000 and $140,000, that result would be interpreted as not being robust because numbers within this range may have different implications for decision making. When necessary, we inflation-adjusted incremental cost-effectiveness

Figure 1. Base-Case Analysis Algorithm for Identifying High-Value Cardiovascular Health Services in the United States



ratios so that their cost measurements were consistent across studies based on the Consumer Price Index for All Urban Consumers (http://www.bls.gov/news.release/cpi.t01.htm).

Relevance to Consumers

To maximize the relevance of our study to health consumers interested in cardiovascular care, we required that studies address health services that were likely to have substantial health effect, as judged by meaningful influence on quality or quantity of life. We required that studies address health problems that were not rare and address health services that could be standardized across different health settings (eg, a particular medication or procedure). We required that studies address decisions in which consumer preferences may be reasonably expected to influence decision making; therefore, we excluded studies that addressed health services in which the decision would need to be made immediately or was of sufficiently technical nature that it would be an unlikely candidate for shared decision making between patient and clinician (eg, different types of stents for angioplasties). Finally, we required that studies analyze services that are applicable to adults and would be considered within the cardiovascular domain by lay and professional audiences.

Sensitivity Analyses

Because some payers and consumer groups do not regard applying quality ratings as a sufficiently sensitive screen for excluding conflict-of-interest bias, our base-case analysis excluded from consideration all studies that were partially or completely industry funded or that did not explicitly state their funding source. However, it can be argued that this is an arbitrary criterion, as industry-funded studies may be of high quality and without commercial bias. For this reason, we performed a sensitivity analysis in which we included industry-funded studies on services that were favored by high-grade evidence in the most up-to-date clinical guidelines (grade A) of the US Preventive Services Task Force.

RESULTS

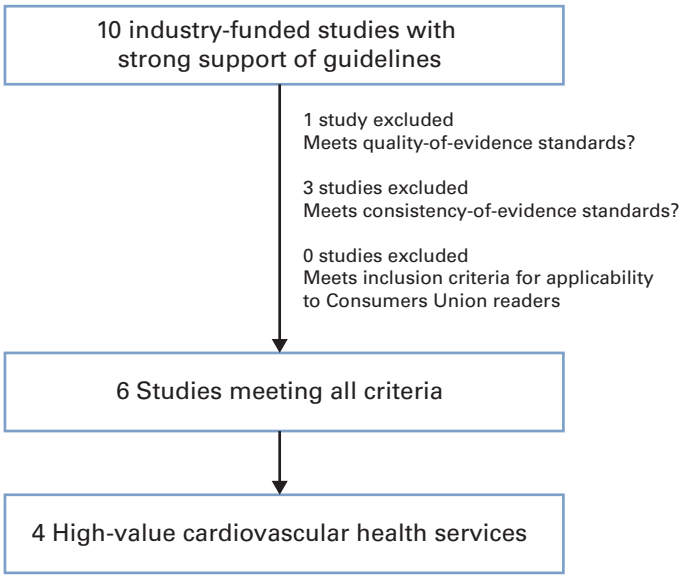
Our initial review of cardiovascular health services in the United States revealed 174 separate peer-reviewed studies of their value (**Figure 1**). Of those, 157 studies did not meet our inclusion criteria for quality of evidence, consistency of evidence, relevance to consumers, and low potential for commercial bias, leaving 17 studies for further evaluation that covered the following 10 services with potentially high value[13-38]: (1) statins to prevent myocardial infarction (for primary and secondary prevention), (2) screening for and treatment of high blood pressure (diuretics or β-blockers and angiotensin-converting enzyme inhibitors in the case of diabetes) to prevent myocardial infarction and stroke, (3) warfarin sodium to prevent pulmonary emboli, (4) low-molecular-weight heparin to prevent pulmonary emboli, (5) implantable cardiac defibrillators for patients at high risk of sudden death, (6) aspirin to prevent future myocardial infarction, (7) clopidogrel bisulfate to prevent future myocardial infarction, (8) β-blockers for patients who have had myocardial infarction, (9) warfarin to prevent future stroke in persons with nonvalvular atrial fibrillation, and (10) percutaneous procedures to relieve claudication symptoms.

We performed a sensitivity analysis in which we also considered industry-funded studies on services that were favored by high-grade evidence in the most up-to-date clinical guidelines of a medical or scientific society. Of 100 industry-funded studies, 10 were candidates for inclusion in this analysis (**Figure 2**). Of those, 4 studies were excluded because they did not meet our criteria for quality or consistency of evidence, leaving 6 studies for consideration that covered 4 services with potentially high value[39-45]: (1) smoking cessation counseling and therapy (including nicotine and drug therapies), (2) clopidogrel to prevent

future stroke in patients who have had stroke or transient ischemic attack, (3) aspirin to prevent future stroke in patients who have had stroke or transient ischemic attack, and (4) aspirin to prevent myocardial infarction in middle-aged men who have a moderate or higher risk of myocardial infarction (>5% over the next 10 years) and who do not have an unusually high risk of bleeding.

Finally, we performed sensitivity analyses in which we used $50,000 per quality-adjusted life-year as a threshold for high value rather than $100,000 per quality-adjusted life-year, as in our base-case analysis. We found that 8 of 10 services identified from non–industry-funded studies continued to satisfy criteria for high value (Table 1) and that 3 of 4 services identified from industry-funded studies continued to satisfy criteria for high value (Table 2).

Figure 2. Sensitivity Analysis Algorithm for Identifying High-Value Cardiovascular Health Services[a]



[a]Sensitivity analyses included the considered industry-funded studies if on services that were favored by high-grade evidence in the most up-to-date clinical guidelines of the US Preventive Services Task Force.

DISCUSSION

When using stringent standards for quality of evidence, consistency of evidence, and relevance to consumers, several cardiovascular health services met our criteria for demonstrated high value. Identifying these services has practical importance because consumers can be encouraged to use them when clinically appropriate, can engage in more informed health discussions with their clinicians, and can seek health plans that offer these services without barriers, such as copayments, deductibles, or burdensome administrative procedures.[2] Indeed, because there are many alternative health system approaches for encouraging the use of high-value services, whether financial (eg, eliminating copayments and deductibles) or nonfinancial (eg, integration with other services and administrative streamlining), future work is needed to compare which approaches are most effective and lead to better patient outcomes.

It is important to note that our study does not evaluate an exhaustive list of high-value cardiovascular health services, as few services have been studied in all relevant patient groups. Indeed, the sparse results highlight the importance of expanding comparative effectiveness research[46] that asks which health services work in which patients at which times and assesses the comparative benefits and costs of a wider range of services in a wider range of patient populations.

The Cost-Effectiveness Analysis Registry[4] has potential as a resource that can inform decision making by consumers, clinicians, health plans, and policy experts. It is a searchable repository of cost-effectiveness results that include a wide range of interventions, delivery system innovations, and public health measures. However, some decision makers may find this registry difficult to use because its quality ratings for included studies are subjective rather than objective, it does not indicate whether included studies are based on robust and high-quality evidence, and it does not indicate when analyses have become obsolete. Our study describes a strategy for using the registry to inform decision making that may mitigate these limitations. However, other limitations of the registry are unaffected by our strategy, namely, the possibility of publication bias and restriction to studies reporting a particular outcome (quality-adjusted life-years) in a particular database (MEDLINE).

Our study provides a sobering account of how health improvements are usually expensive (and drive up health insurance premiums) even when we restrict our attention to health improvements with the highest value. If the healthcare system does not produce systematic ways to encourage high-value care and discourage low-value care, health insurance premiums will continue to outpace inflation, causing multiple economic problems for consumers. More optimistically, this review underscores the numerous ways in which cardiovascular care can prevent myocardial infarction and stroke, which is an important reason why deaths from these 2 occurrences have decreased dramatically in the United States over the last few decades. Greater attention to healthcare value has the potential to accelerate these benefits, while effectively controlling rising healthcare costs and premiums.

Table 1. Base-Case Analysis of Cardiovascular Health Services Likely to Be High Value

Cardiovascular Health Service	Goal of Service	Persons for Whom Value Is Likely High	Does It Save Society Money?	Scientific Source	Supporting Clinical Guideline
Statin	Prevent myocardial infarction	Persons with known coronary heart disease	No	Prosser et al,[13] 2000; Ganz et al,[14] 2000	Adult Treatment Panel III,[32] 2002
Statin[a]	Prevent myocardial infarction	Persons with moderately or severely high cholesterol (low-density lipoprotein cholesterol level >130 mg/dL) and with 10-y coronary heart disease risk >5% (including all individuals with diabetes)	No	Prosser et al,[13] 2000; Pletcher et al,[15] 2009; CDC Diabetes Cost-Effectiveness Group,[16] 2002; Pignone et al,[18] 2006	Adult Treatment Panel III,[32] 2002
Screening for high blood pressure and treating it with diuretic, β-blocker, or angiotensin-converting enzyme inhibitor (in case of diabetes)	Prevent myocardial infarction and stroke	Persons with known hypertension	No for persons without diabetes; yes for persons with diabetes	CDC Diabetes Cost-Effectiveness Group,[16] Edelson et al,[17] 1990; Heidenreich et al,[19] 2008; Littenberg,[20] 1995	Joint National Committee,[33] 2003
Warfarin and sodium and necessary laboratory testing for 6 mo	Prevent pulmonary emboli	Persons with first deep venous thrombosis without known reason	No	Aujesky et al,[21] 2005	American College of Chest Physicians,[34] 2008
Low-molecular-weight heparin	Prevent pulmonary emboli	Persons recently diagnosed as having deep venous thrombosis	Yes	Gould et al,[22] 1999	American College of Chest Physicians,[34] 2008
Implantable cardiac defibrillator[a]	Prevent cardiopulmonary arrest	Persons who have congestive heart failure because of myocardial infarction (ejection fraction <30%) and who do not have heart failure symptoms at rest (New York Heart Association classes 1-3)	No	Chan et al,[23] 2007; Sanders et al,[24] 2001; Owens et al,[25] 2002	American Heart Association,[35] 2008
Aspirin	Prevent future myocardial infarction	Persons who have coronary heart disease	No	Gaspoz et al,[26] 2002	American Heart Association,[36] 2006
Clopidogrel bisulfate for 12 mo	Prevent future myocardial infarction	Persons who have had myocardial infarction or other acute coronary event	No	Schleinitz et el,[27] 2004	American Heart Association,[36] 2006
β-Blockers	Prevent future myocardial infarction	Persons who have had coronary heart disease	No	Phillips et al,[28] 2000	American Heart Association,[37] 2006
Warfarin sodium and necessary laboratory testing	Prevent future stroke	Persons with nonvalvular atrial fibrillation and ≥1 previous stroke, age ≥75 y, hypertension, congestive heart failure, or diabetes	No	Gage et al,[29] 1995	American Heart Association,[38] 2006; American Heart Association,[45] 2006
Percutaneous procedure with balloon compression and possibly stent insertion	Relief of claudication symptoms	Persons who have lifestyle-limiting symptoms	No	Bosch et al,[30] 2000	American Heart Association,[37] 2006

SI conversion factor: To convert cholesterol level to millimoles per liter, multiply by 0.0259.
[a]Intervention may not have favorable value if $50,000 per quality-adjusted life-year threshold is substituted for $100,000 per quality-adjusted life-year.

Table 2. Sensitivity Analyses of Cardiovascular Health Services Likely to Be High Value[a]

Cardiovascular Health Service	Goal of Service	Persons for Whom Value Is Likely High	Does It Save Society Money?	Scientific Source	Supporting Clinical Guideline
Smoking cessation with counseling, nicotine and drug therapies	Stop smoking and consequently reduce risk of cardiovascular and other diseases	All smokers	Possibly	Eddy et al,[39] 2009; Fiscella and Franks,[40] 1996; Howard et al,[41] 2008; Smith et al,[42] 2007	US Preventive Services Task Force,[44] 2009
Clopidogrel bisulfate	Prevent stroke	Persons who have had stroke or transient ischemic attack	No	Matchar et al,[43] 2005	American Stroke Association/American Heart Association,[45] 2006
Aspirin	Prevent stroke	Persons who have had stroke or transient ischemic attack	No	Matchar et al,[43] 2005	American Stroke Association/American Heart Association,[45] 2006
Aspirin	Prevent myocardial infarction	Middle-aged men with 10-y coronary heart disease risk >5% without increased bleeding risk	Possibly	Pignone et al,[18] 2006	US Preventive Services Task Force,[44] 2009

[a]Sensitivity analyses included the considered industry-funded studies if on services that were favored by high-grade evidence in the most up-to-date clinical guidelines of the US Preventive Services Task Force.

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