Impact of the Screening Abdominal Aortic Aneurysms Very Efficiently (SAAAVE) Act on Abdominal Ultrasonography Use Among Medicare Beneficiaries

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Background: Since January 1, 2007, Medicare has covered abdominal aortic aneurysm (AAA) screening for new male enrollees with a history of smoking under the Screening Abdominal Aortic Aneurysms Very Efficiently (SAAAVE) Act. We examined the association between this program and abdominal ultrasonography for AAA screening, elective AAA repair, hospitalization for AAA rupture, and all-cause mortality.

Methods: We used a 20% sample of traditional Medicare enrollees from 2004 to 2008 to identify 65-year-old men eligible for screening and 3 control groups not eligible for screening (70-year-old men, 76-year-old men, and 65-year-old women). We used logistic regression to examine the change in outcomes at 365 days for eligible vs ineligible beneficiaries before and after SAAAVE Act implementation, adjusting for comorbidities, state-level smoking prevalence, geographic variation, and time trends.

Results: Fewer than 3% of abdominal ultrasonography claims after 2007 were for SAAAVE-specific AAA screening. There was a significantly greater increase in abdominal ultrasonography use among SAAAVE-eligible beneficiaries (2.0 percentage points among 65-year-old men, from 7.6% in 2004 to 9.6% in 2008; 0.7 points [8.9% to 9.6%] among 70-year-old men; 0.7 points [10.8% to 11.5%] among 76-year-old men; and 0.9 points [7.5% to 8.4%] among 65-year-old women) (P < .001 for all comparisons with 65-year-old men). The SAAAVE Act was associated with increased use of abdominal ultrasonography in 65-year-old men compared with 70-year-old men (adjusted odds ratio [AOR], 1.15; 95% CI, 1.11–1.19) (P < .001), and this increased use remained even when SAAAVE-specific AAA screening was excluded (AOR, 1.12; 95% CI, 1.08–1.16) (P < .001). Implementation of the SAAAVE Act was not associated with changes in rates of AAA repair, AAA rupture, or all-cause mortality.

Conclusions: The impact of the SAAAVE Act on AAA screening was modest and was based on abdominal ultrasonography use that it did not directly reimburse. The SAAAVE Act had no discernable effect on AAA rupture or all-cause mortality.


ABDOMINAL AORTIC ANEURYSMS (AAAs) are present in 4% to 9% of men older than 65 years.1,2 Most AAAs are asymptomatic, but rupture is associated with an estimated mortality rate between 65% and 85%.3 Abdominal ultrasonography can reliably visualize AAAa and potentially allow for surgical intervention that might prevent future rupture. The risk from AAA, and thus the benefit of screening, is increased for men who have ever smoked more than 100 cigarettes. Several randomized trials have shown that screening for AAA with abdominal ultrasonography reduces AAA-related mortality, but not all-cause mortality, and is cost-effective among male current and former smokers.6-13

In 2005, the United States Preventive Services Task Force (USPSTF) made a Grade B recommendation for AAA screening of men between the ages of 65 and 75 years who ever smoked 100 cigarettes or more.14 Prior to 2007, screening for AAA was not a covered Medicare benefit, requiring those desiring screening to pay out of pocket. On January 1, 2007, Medicare began coverage of AAA screening under the Screening Abdominal Aortic Aneurysms Very Efficiently (SAAAVE) Act.15

See Invited Commentary at end of article
Under the Act, Medicare covers a 1-time screening abdominal ultrasonographic examination at age 65 years for men who have smoked at least 100 cigarettes, or women who have a family history of AAA disease, as part of the Welcome to Medicare package. For Medicare to cover the screening, the Welcome to Medicare physical examination and screening ultrasonography must take place during the first year of enrollment in Medicare.

The effect of the SAAAVE Act on screening for AAA is uncertain. Although expanding coverage would be expected to increase screening rates, many at-risk beneficiaries may not be screened because the SAAAVE Act only covers abdominal ultrasonography performed in association with a single, specific visit. Therefore, the objective of this study was to examine the effect of the SAAAVE Act on use of abdominal ultrasonography among male beneficiaries newly enrolled in Medicare.

METHODS

DATA SOURCES

This study used data from 2003-2009 Medicare claims records from a 20% random sample of traditional, fee-for-service Medicare beneficiaries. Health care utilization measures were derived from carrier claims (physician and supplier files [Part B]) and inpatient claims (MEDPAR files [Part A]). These files contain information about physician-provided services and hospitalizations billed to Medicare. Diagnosis codes use the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). Procedures were identified by Current Procedural Terminology (CPT) codes in the carrier files and by ICD-9-CM codes in the inpatient files. Medicare enrollment information, demographic data, and date of death were obtained from denominator files.

Data from the 2004-2008 Behavioral Risk Factor Surveillance System were used to estimate the prevalence of smoking at least 100 cigarettes among male respondents, aged 65 to 70 years, by state. Sampling weights were used to adjust for non-responses and disproportionate sampling of subgroups relative to the state’s population. The median response rate to the survey during the study period was 50% to 53%.

Median household income data from the 2000 US Census were linked to each beneficiary based on zip code and were available for approximately 95% of Medicare beneficiaries. Income data were not available for beneficiaries who had a post office box address or lived in areas with fewer than 300 people.

EPISODES OF CARE

Beneficiaries were included in the study if their eligibility for Medicare was age-based and not for disability or end-stage renal disease. Part B claims from 2003 to 2008 were used to identify new male enrollees. The date of the first claim ever billed between January 1, 2004, and December 31, 2008, was defined as the index date for Medicare enrollment. Beneficiaries with index enrollment dates during this time period, and who were aged 65 years at the time of their index date, were selected for inclusion in the study treatment group. The claims were used to document receipt of abdominal ultrasonography and other outcomes for the 365 days following the index date. The G0389 code was created specifically for SAAAVE Act AAA screening, effective January 1, 2007, with reimbursement similar to traditional abdominal ultrasonography (eTable 1; http://www.archinternmed.com). This code accounted for fewer than 3% of abdominal ultrasonography claims from 2007 to 2009, so all CPT codes for abdominal ultrasonography were included in the analysis (76700, 76705, 76770, 76775, 93975, 93976, 93978, 93979, and G0389).

To account for underlying secular trends in imaging use, episodes of care were identified among 5 control groups of Medicare beneficiaries not eligible for AAA screening: 70-year-old men, 76-year-old men (also not eligible for USPSTF AAA screening), and 65-year-old women, for whom the index dates were set as male beneficiary’s 70th birthday, male beneficiary’s 76th birthday, and female beneficiary’s date of first claim billed, respectively. We did not have data on whether 65-year-old women had a family history of AAA and therefore would be eligible for SAAAVE screening, but we assumed that the proportion was small.

Hospitalizations for rupture of AAA within 365 days of the index date were identified in the inpatient claims with the ICD-9-CM diagnosis code 441.3. Elective repair of AAA was identified with the diagnosis code 441.4 and a procedural code for open surgical repair (38.44 or 39.25) or for endovascular repair (39.71). The date of death listed in the denominator files was used to track all-cause mortality.

We excluded beneficiaries who received abdominal magnetic resonance imaging (MRI) (CPT codes 74181-74185 and 72195-72198) or computed tomography (CT) (72191-72194, 74150-74178, and 74261-74263) during the study period because these advanced imaging techniques also identify AAA and may be used in lieu of a screening abdominal ultrasonography. We also excluded beneficiaries with index dates in 2006 because the 365-day follow-up period included the exact date on which the SAAAVE Act was implemented, possibly confounding results.

STATISTICAL ANALYSIS

The primary analysis used 65-year-old male beneficiaries as the treatment group and 70-year-old male beneficiaries as the control group. Descriptive statistics (χ² test for categorical variables, t test for means, and Mann-Whitney test for medians) were used to compare the characteristics of 65-year-old men with those of 70-year-old men and to compare 65-year-old men before and after SAAAVE Act implementation.

We used a difference-in-differences approach to evaluate the association of the SAAAVE Act with use of abdominal ultrasonography for AAA screening. We used multivariable logistic regression models to measure the difference in screening rates and outcomes between 65-year-old men who enrolled in Medicare before and after the SAAAVE Act was implemented on January 1, 2007, compared with changes in rates among 70-year-old men (or 76-year-old men or 65-year-old women) ineligible for SAAAVE over the same time period. The outcomes of interest were use of abdominal ultrasonography, elective surgical repair of AAA, hospitalization for AAA rupture, or all-cause mortality within 365 days. We used model coefficients, presented as odds ratios (ORs), to measure the degree to which outcomes changed in SAAAVE-eligible vs ineligible beneficiaries after adjusting for differences in care across states and trends in care over time.

Models controlled for the beneficiary’s age at the time of the index date; race (white, non-white Hispanic, black, other); Medicaid coverage status (dual-eligible for any of the calendar year of the index test, or not); comorbid conditions during the study period; median household income from 2000 Census data; and state-level prevalence of ever smoking among men aged 65 to 70 years according to 2004-2008 Behavioral Risk Factor Surveillance System data. Median in-
come by zip code (median income, $41,114; interquartile range [IQR], $33,264-$53,207) and smoking history by state (median, 65.6%; IQR, 63.3%-69.2%) were coded as categorical variables by quartiles. The models also included dummy variables for year and month to capture secular trends in screening and outcomes and dummy variables for state to control for underlying characteristics, such as patient preferences, that were fixed over time.

Although the primary analyses excluded data from episodes of care beginning in 2006 or involving abdominal CT or MRI, we conducted sensitivity analyses that included these episodes. The results were similar and are listed in eTable 2.

All hypothesis tests were performed on a 2-sided basis at $\alpha=0.05$. The lowest $P$ value reported was $<.001$. Statistical analyses were performed using SAS software, version 9.1.3 (SAS Institute) for data extraction and management and Stata software, version 11.2 (StataCorp LP) for model estimation.

This study was approved by the institutional review board at Stanford University School of Medicine.

## RESULTS

### ENROLLEES

Of the 3.5 million male beneficiaries in the 20% random sample of fee-for-service beneficiaries between 2004 and 2008, 536,632 had their 65th birthday and became eligible for Medicare during the study period, and 606,642 had their 70th birthday (Figure 1). About 7% of the population was excluded owing to receipt of abdominal CT or MRI, magnetic resonance imaging.

![Figure 1. Study flowchart. CT Indicates computed tomography; MRI, magnetic resonance imaging.](image)

Trends in unadjusted rates of abdominal ultrasonography use over time among 65-year-old and 70-year-old male Medicare beneficiaries, as well as 76-year-old male and 65-year-old female beneficiaries, are shown in **Figure 2**. There was a significantly greater increase in abdominal ultrasonography use among SAAAVE-eligible 65-year-old men (2.0 percentage points, from 7.6% in 2004 to 9.6% in 2008) than among the 3 control groups (0.7 percentage points among 70-year-old men, from 8.9% to 9.6% [P < .001]; 0.7 percentage points among 76-year-old men, from 10.8% to 11.5% [P < .001]; and 0.9 percentage points among 65-year-old women, from 7.5% to 8.4% [P < .001]).

To investigate whether the SAAAVE Act had a broader influence on abdominal ultrasonography use in Medicare, we calculated population-level rates of abdominal ultrasonography receipt among all beneficiaries per year by age and sex. Trends in abdominal ultrasonography use did not appear to change after implementation of the SAAAVE Act on January 1, 2007 (Figure 3). Of note, the SAAAVE-specific code for AAA screening made up 0.9% of all ultrasonography codes among 65-year-old to 75-year-old male beneficiaries in 2007, and 1.4% of all ultrasonography codes among 65-year-old to 75-year-old male beneficiaries in 2009.

The mean prevalence of ever-smoking by state in 2004 and 2008 did not correlate with changes in ultrasonography rates from 2004 to 2008 among 65-year-old beneficiaries ($r = -0.12$). In other words, states with higher rates of ever-smoking among 65-year-old to 70-year-old men did not experience greater increases in abdominal ultrasonography use among new male Medicare beneficiaries after the SAAAVE Act.

After multivariable adjustment, we found that the association of the SAAAVE Act with receipt of abdominal ultrasonography was statistically significant but of modest size (Table 2 and eTable 3). Adjusted odds of abdominal ultrasonography receipt among new male Medicare enrollees were statistically significant compared with each of the control groups (adjusted OR [AOR] with 70-year-old men as the reference group, 1.15; 95% CI, 1.11-1.19 [P < .001]; AOR with 76-year-old men as the reference group, 1.17; 95% CI, 1.13-1.21 [P < .001]; AOR with 65-year-old women as the reference group, 1.11; 95% CI, 1.08-1.15 [P < .001]). The results did not change when we excluded the SAAAVE-specific code for AAA screening and therefore evaluated the association between the SAAAVE Act and abdominal ultrasonography not reimbursable by SAAAVE.

The number of hospitalizations for AAA rupture was low: 17 65-year-old men (<0.01%), 45 70-year-old men (<0.01%), 37 76-year-old men (<0.01%), and 0 65-year-old women. The number of elective AAA repairs was also low. There were 238 elective AAA repairs among 65-year-old men (0.06%), 401 among 70-year-old men (0.10%), 410 among 76-year-old men (0.12%), and 39 among 65-year-old women (<0.01%). In 2004, approximately 40% of elective repairs among 65-year-old and 70-year-old men were endovascular, but by 2008, over 60% of elective repairs were endovascular. There were 5015...
65-year-old men (1.3%), 10 447 70-year-old men (2.6%), 12 983 76-year-old men (3.86%), and 3487 65-year-old women (0.72%) who died from all causes during the study period.

For new male Medicare enrollees, the SAAAVE Act was not associated with changes in 365-day rates of hospitalization for ruptured AAA, elective AAA repair, or all-cause mortality (Table 2 and eTable 3). There was no statistically significant change in outcomes when the reference group in the multivariable model was 70-year-old men, 76-year-old men, or 65-year-old women.

Although the SAAAVE Act appears to have increased the rate of abdominal ultrasonography use among 65-year-old men joining Medicare, its overall impact was modest. There was an 11% to 17% relative increase in abdominal ultrasonography use compared with 3 different control groups and adjusted for confounding factors. Furthermore, although two-thirds of men aged 65 years were eligible for AAA screening because of a history of ever smoking, fewer than 10% of men in this age group received any abdominal ultrasonography after 2007. Consequently, most men who qualified for SAAAVE Act AAA screening did not undergo it.

We found that the modest impact of the SAAAVE Act was due to an increase in abdominal ultrasonography use that was not reimbursed under the program. After 2007, there was a significant increase in abdominal ultrasonography use during the first year of enrollment for male beneficiaries, but fewer than 3% of scans were reimbursed using the SAAAVE-specific CPT code. Multivariable results were similar when the SAAAVE-specific code was excluded. One possible explanation is that the SAAAVE Act encouraged physicians to order, or enrollees to request, AAA screening, even if enrollees were not eligible for SAAAVE-reimbursable screening (for example, no smoking history). Another possibility is that enrollees were eligible for SAAAVE, and AAA screening was ordered, but the screening was billed as non-SAAAVE abdominal ultrasonography because it did not meet the complex criteria for reimbursement, which required screening to take place after the Welcome to Medi-
While AAA screening reduces AAA-related mortality by up to 50% in randomized trials, it has not been shown to reduce all-cause mortality. The efficacy of AAA screening is similar to that of other screening programs, such as mammography for breast cancer and fecal occult blood testing for colorectal cancer, which at the population level reduce disease-specific mortality but not all-cause mortality. In contrast to breast cancer and colon cancer, AAA-related deaths are only a small fraction of overall deaths (<1%), so reducing these deaths would have relatively little impact on all-cause mortality. Well-informed beneficiaries might decline AAA screening because of this modest effect on outcomes. Nevertheless, AAA screening has been shown to be cost-effective, with an estimated cost-effectiveness ratio of $19,500 per life-year gained. Further research on the overall benefit of AAA screening will need to be conducted, especially as the population ages, the prevalence of smoking decreases, and the efficacy of endovascular repair of AAA improves.

We did not find any clinical benefit associated with coverage of AAA screening for new male Medicare beneficiaries. We found no evidence that implementation of

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**Table 2. Adjusted Association Between the SAAAVE Act and 365-Day Clinical Outcomes in SAAAVE-Eligible vs SAAAVE-Ineligible Medicare Beneficiaries, 2004-2008**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>AOR (95% CI)</th>
<th>SAAAVE Eligible vs SAAAVE Ineligible Medicare Beneficiaries&lt;sup&gt;a&lt;/sup&gt;</th>
<th>P Value&lt;sup&gt;b&lt;/sup&gt;</th>
<th>AOR (95% CI)</th>
<th>SAAAVE Eligible vs SAAAVE Ineligible Medicare Beneficiaries&lt;sup&gt;a&lt;/sup&gt;</th>
<th>P Value&lt;sup&gt;b&lt;/sup&gt;</th>
<th>AOR (95% CI)</th>
<th>SAAAVE Eligible vs SAAAVE Ineligible Medicare Beneficiaries&lt;sup&gt;a&lt;/sup&gt;</th>
<th>P Value&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>AU including SAAAVE Code</td>
<td>1.15 (1.11-1.19)</td>
<td>&lt;.001</td>
<td></td>
<td>1.17 (1.13-1.21)</td>
<td>&lt;.001</td>
<td></td>
<td>1.11 (1.08-1.15)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>AU excluding SAAAVE Code</td>
<td>1.12 (1.08-1.16)</td>
<td>&lt;.001</td>
<td></td>
<td>1.14 (1.10-1.18)</td>
<td>&lt;.001</td>
<td></td>
<td>1.10 (1.08-1.14)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>AAA repair</td>
<td>0.76 (0.55-1.05)</td>
<td>.10</td>
<td></td>
<td>0.75 (0.54-1.04)</td>
<td>.09</td>
<td></td>
<td>0.97 (0.49-1.93)</td>
<td>.94</td>
<td></td>
</tr>
<tr>
<td>AAA rupture</td>
<td>0.91 (0.29-3.24)</td>
<td>.99</td>
<td></td>
<td>1.04 (0.32-3.32)</td>
<td>.95</td>
<td></td>
<td>0.37 (0.07-1.93)</td>
<td>.24</td>
<td></td>
</tr>
<tr>
<td>All-cause mortality</td>
<td>0.98 (0.91-1.05)</td>
<td>.61</td>
<td></td>
<td>0.99 (0.93-1.07)</td>
<td>.69</td>
<td></td>
<td>1.06 (0.97-1.17)</td>
<td>.19</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: AAA, abdominal aortic aneurysm; AOR, adjusted odds ratio; AU, abdominal ultrasonography; SAAAVE, screening abdominal aortic aneurysms very efficiently.

<sup>a</sup>SAAAVE-eligible Medicare beneficiaries were 65-year-old men; SAAAVE-ineligible Medicare beneficiaries were 70-year-old men, 76-year-old men, and 65-year-old women. AORs were calculated from logistic regression models controlling for demographics, Medicaid status, comorbid conditions, household income, state-level smoking prevalence, and year, month, and state fixed effects.

<sup>b</sup>For results of the multivariable model.
the SAAAVE Act reduced hospitalizations for AAA rupture or all-cause mortality. However, the number of these events in our study was quite low, limiting statistical power. In addition, longer follow-up is likely needed to show any effect on these outcomes because most aneurysms detected by screening programs are small and have low short-term rates of rupture: aneurysms less than 4.0 cm in diameter are unlikely to rupture at 5 years, and aneurysms 4.0 to 5.0 cm rupture 1% to 7% at 5 years. Randomized trials of AAA screening have shown that the reduction in AAA-related mortality does not begin for at least 1 year after the initial AAA screening.7

The lack of correlation between smoking prevalence at the state level and rates of abdominal ultrasonography use among male Medicare beneficiaries is concerning. Smoking is a strong risk factor for development and rate of growth of AAA. The lack of correlation may suggest that other variables are more strongly associated with the decision to receive abdominal ultrasonography. It is possible that our measurement of smoking at the state level was not precise enough to detect a correlation. On the other hand, it may be that the claims cannot sufficiently distinguish between screening ultrasonography for AAA and abdominal ultrasonography for other indications, such as liver or kidney disease. A correlation may be detected once there is more widespread adoption of the CPT code specific for AAA screening.

There are limitations to this study. Our analysis examined abdominal imaging use among a subset of traditional, fee-for-service Medicare beneficiaries and not did include individuals in prepaid health plans, which may have higher use of preventive clinical services. As in all studies based on administrative claims, we had no data on clinical symptoms or test findings of the beneficiaries, and so we could not assess the indications for abdominal ultrasonography or its diagnostic performance. We did not have data on whether the men who received abdominal ultrasonography had a history of smoking, so we had to use state-level rates of smoking. While statistical adjustment for observable confounders should minimize the risk of bias, we cannot rule out the possibility that unobserved differences among beneficiaries could have affected our findings.

Implementation of the SAAAVE Act is still in its early stages, but the results of our study suggest that at 3 years, its impact on AAA screening is modest and is based upon abdominal ultrasonography use that it does not directly reimburse. The low rate of abdominal ultrasonography use in this group of Medicare beneficiaries suggests that simply providing coverage for a screening test may not be sufficient to lead to widespread adoption.

Accepted for Publication: June 18, 2012.
Published Online: September 17, 2012. doi:10.1001/archinternmed.2012.4268
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Author Contributions: Drs Shreibati and Baker had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Shreibati and Mell.

Acquisition of data: Baker. Analysis and interpretation of data: Shreibati, Hlatky, and Mell. Drafting of the manuscript: Shreibati. Critical revision of the manuscript for important intellectual content: Shreibati, Baker, Hlatky, and Mell. Statistical analysis: Shreibati. Obtained funding: Hlatky. Administrative, technical, and material support: Baker. Study supervision: Hlatky and Mell.

Financial Disclosure: None reported.

Funding/Support: This study was funded by the Stanford Cardiovascular Institute, Stanford, California, and the American Heart Association, Dallas, Texas.

Role of the Sponsors: The Stanford Cardiovascular Institute and the American Heart Association had no role in the design and conduct of the study; the collection, management, analysis, and interpretation of the data; or the preparation, review, or approval of the manuscript.

Previous Presentation: Research for this article was presented as a poster at the American Heart Association Quality of Care and Outcomes Research 2012 Scientific Sessions; May 11, 2012; Atlanta, Georgia.


REFERENCES


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INVITED COMMENTARY

Time to Rethink Screening for Abdominal Aortic Aneurysm?

The 2011 Institute of Medicine report titled “Clinical Practice Guidelines We Can Trust” recommends that guidelines be updated at a prespecified time and that new evidence be reviewed regularly to determine the need for earlier updating. New evidence, however, is not the only reason for updating guidelines. Another is to reconceptualize benefits and harms with the advantage of more experience and new understanding. This would seem to be the essence of critical thinking, of avoiding the cognitive “confirmation” bias whereby we simply continue to think the way we have, without serious questioning. An article in this issue of the Archives considers screening for abdominal aortic aneurysm (AAA). Both new evidence about benefits and new concepts of harms suggest that it may now be time to rethink AAA screening.

See also page 1442

The most recent US Preventive Services Task Force (USPSTF) recommendation for screening for AAA was in 2005. At that time, a systematic review of the evidence found 4 randomized controlled trials (RCTs) of screening for AAA using the open aneurysm repair (OAR) technique for AAs of at least 5.5 cm in diameter. Pooled results showed that screening reduced AAA-associated mortality by a relative 43% over about 5 years; absolute risk reduction among higher-risk men (ages 65 to 75 who had ever smoked) was from about 4% to about 2.6 AAA-associated deaths for every 1000 men over 5 years. There was no difference in all-cause mortality between screened and unscreened groups. Based on these findings, the USPSTF recommended a 1-time ultrasonographic screening