Screening for Abdominal Aortic Aneurysm

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This report summarizes estimates of health impact and cost-effectiveness that were created to assess the relative value of most of the clinical preventive services recommended by the United States Preventive Services Task Force (USPSTF) and the Advisory Committee on Immunization Practices (ACIP). This ranking of clinical prevention priorities is guided by the National Commission on Prevention Priorities (NCPP).

A. USPSTF Recommendation

In 2014, the U.S. Preventive Services Task Force (USPSTF) updated and reaffirmed its recommendation of one-time ultrasound screening for abdominal aortic aneurysm (AAA) for men aged 65 to 75 who have ever smoked.[1] The USPSTF concludes with high certainty that screening for AAA with ultrasonography in this population has moderate net benefit (B recommendation). The recommendation was based on a systematic evidence review.[2,3] This recommendation updates and reaffirms the 2005 recommendation,[4] which was supported by a best-evidence review[5] and a synthesis of cost-effectiveness studies.[6]

B. Choice of Population

The USPSTF gave a B recommendation of one-time AAA screening for men aged 65 to 75 who had smoked least 100 cigarettes in a lifetime. For men aged 65 to 75 who have never smoked, the USPSTF concludes with moderate certainty that net benefit from screening for AAA with ultrasonography is small (C recommendation). The Task Force found insufficient evidence to assess the net benefit of ultrasound screening for AAA among women who have ever smoked (I statement), and recommends against screening among women who have never smoked (D recommendation).

Therefore, we evaluated the clinically preventable burden and cost-effectiveness of a one-time screening for AAA for men aged 65 who had ever smoked in a birth cohort of four million.

C. Model Type

We estimated clinically preventable burden and cost-effectiveness based on previously published results of a Markov model. We adjusted the published to reflect a birth cohort of four million and incorporated patient time costs into the cost-effectiveness analysis.

D. Literature Search and Abstraction

D1. Burden and Effectiveness Literature

Four randomized clinical trials have evaluated the prevalence and effectiveness of AAA screening. A study in Chichester, UK randomized nearly 16,000 men and women ages 65 to 80 into invited for ultra-sound screening or control groups during 1998 through 1993.[7] Nearly 70% accepted the screening and AAA of 3 cm or more was found in 7.6% of men, 1.3% of women. The study found a decrease in rupture and death from rupture in men invited to screening, compared to controls, but no difference in mortality from all causes. In addition to efficacy of the screen,[8] data from that study has been used to estimate incidence of AAA,[9] aneurysm size growth rates, [10,11] risk factors associated with AAA,[12] and frequency of screening.[13] Analysis also found that the prevalence of AAA was six times lower in women than in men and that after 5 and 10 years, the incidence of rupture for women was the same as the screened and control group.[14]

Nearly 13,000 men ages 65 to 73 in Viborg county, Denmark were randomized into invited for ultra-sound screening for AAA or control groups during 1994 through 1998.[15] After repeated invitation, 76% accepted screening and 4% were found to have an AAA of 3 cm or more. Mortality from causes other than AAA was not significantly different between the invited and control groups, however AAA-related mortality was reduced by 67%.[16] Cost benefit analyses[17] and long-term mortality outcomes from that trial have been published.[18]

A multi-site study in the UK randomized nearly 68,000 men aged 65 to 74 into a group invited to be screened by ultra-sound and a control group during 1997 through 1999.[19] Of the 33,839 men invited to screening, 80% accepted and AAA of 3 cm or more was found in 4.9%. Analysis of these data found that those who accepted screening were generally healthier than those who declined. AAA-related deaths were reduced by 42% in the invited group, compared to the control group.

The fourth study took place in Western Australia from 1996 through 1998. Nearly 20,000 men ages 65 to 83 years were randomized into invitation for ultra-sound screening for AAA or control group.[20] Of those invited and eligible, 70% accepted the screen and AAA of 3 cm or more was found in 7.2%. Analyses of the data collected concluded that selective screening would miss about 25% of AAAs[21] and , as found in other controlled trials, overall death rates were not reduced by screening.[22]

Two large screening programs in the US Veterans Affairs medical centers provided estimates of AAA prevalence for males and ever smokers compared to females and never smokers.[23,24] The studies found smoking to be the risk factor most strongly associated with AAA ; a history of smoking was associated with a 3- to 5-fold increase in prevalence and the excess prevalence associated with smoking accounted for 75% of all AAAs 4 cm or larger in the total population. The prevalence of AAA among females was about 30% of the male prevalence, regardless of smoking status. A follow-up study estimated the annual incidence of AAA rupture by AAA size and found that the risk of rupture increases with AAA size, from 9.4% for 5.5 to 5.9 cm up to 32.5% for 7 cm or more.[25]

The studies described relied on ultra-sound screening to identify AAA. The accuracy of ultra-sound screening has been evaluated in two studies, and both concluded that the screen was valid, with sensitivity of 87-99% and specificity of nearly 100%.[26,27]

D.2 Cost-effectiveness Literature

We identified eleven articles that evaluated the cost-effectiveness of routine AAA ultra-sound screening.[18,28-37] They were evaluated using several criteria to determine their applicability for the Prevention Priorities Study. Because of time constraints, we hoped to produce CPB and CE estimates from previously published studies rather than develop our own models and estimates.

Studies that were conducted and estimated outside of the US were judged not applicable for our use because of differences in medical practice and pricing of medical treatments between the study country and the US. Modeling studies that assumed 100% compliance with screening were also considered to be unacceptable. Modeled age and frequency of screening needed to be similar to the USPSTF recommendation and the time horizon should have been 20 years or until death. Studies needed to use parameter values that were based on published evidence, the best of which came from the RCTs described above. Finally, the results needed to be published with enough detail so that we could select the outcomes of interest and produce a cost-effectiveness ratio consistent to the other estimates in the Prevention Priorities Study.

Eight studies produced estimates of cost-effectiveness outside of the US.[18,30,31,33-37] Two modeling studies assumed 100% compliance with screening.[28,29] Two studies used time horizons less than 20 years and one evaluated clinical trial outcomes with an average follow-up of 13 years.[18,30,37] All modeling studies based parameter values on the published literature, but cost estimates of screening and treatment were developed from country-specific cost analyses.

One study met most of our criteria.[32] A Markov model was used to estimate the cost-effectiveness of ultra-sound screening compared to usual care for white men, with screening at age 65 and outcomes projected for 20 years. Parameter values were based on the evidence published from randomized controlled trials and cost estimates were from US based analyses. The study population was defined as white men, whereas the USPSTF recommendation is screening for ever-smokers aged 65 to 75. However, the base value for prevalence in the model was 6%, a value that is similar to a published estimate of AAA prevalence among US male smokers.[23] Therefore, because the model met most of our criteria and the AAA prevalence value was a good estimate for ever-smokers, we used results from the model to estimate CPB and CE for our Prevention Priorities Study.

E. Clinically Preventable Burden (CPB) Estimate

Our estimate of CPB was based on findings from Silverstein et al., who reported an incremental gain of 19 quality-adjusted days per person invited for AAA screening.[32]

The CPB estimate was for a birth cohort of four million, or 1,019,714 males aged 65 who had ever smoked. Our target screening population was computed using the number alive at age 65 from the 2009 Life Table,[38] the percentage of males from the 2009 US population,[39] and assuming that 63.8% of 65-year old males were ever-smokers.[40] We assume that 80% of this population will accept screening.

CPB from offering ultrasound screening to a birth cohort of four million was 42,465 QALYs (1,019,714 x 0.8 x 19 / 365). When varying the incremental gain from 14 to 24 (approximately -/+ 25%) quality-adjusted days per person, the CPB estimate ranges from 31,290 to 53,640 QALYs. When varying the screening acceptance rate from 60%-100%, the CPB estimate ranges from 31,849 to 53,081 QALYs. Combined, we found a sensitivity range for CPB of 23,467 to 67,050 QALYs.

F. Cost-effectiveness (CE) Estimate

Our estimate of CE was based on findings from Silverstein et al.,[32] who reported an incremental CE ratio of $15,723.

We adjusted the Silverstein et al. estimate by inflating to 2012 and incorporating the cost of patient time to receive the screening. The Silverstein et al. study was published in 2005, and the costs used in the study were assumed to be from 2003. The published study did not clarify the year. We inflated the published CE ratio from 2003 to 2012 using the medical care CPI.[41]

Keeping with our Prevention Priorities methods, we included patient travel time and time to receive the screening.[42] The amount of patient time was estimated as three hours, based on Wanhainen et al.'s estimate of a two hour exam and assuming one hour travel time.[33] Patient time was valued at $31.00 per hour. [43]

After adjusting for inflation and patient time, the CE estimate was $30,343 per QALY gained. We tested the sensitivity of the result by varying the patient time assumed from one to four hours. The CE ratio changed by -6% to 3%, from $28,571 to $31,228 per QALY. When combined with our sensitivity range for CPB, we found a sensitivity range of $12,167 to $56,508 per QALY.

G. Limitations

This evaluation relies on a previously published Markov model of AAA screening. That work assumed a one-time screening for men at age 65 and did not target screening of ever smokers. However, the assumptions used in the model were well within the range of appropriate estimates and the results published allowed us to estimate CPB and CE for preventive services ranking.

H. References

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