RESEARCH LETTER

Population Trends From 2000-2011 in Nuclear Myocardial Perfusion Imaging Use

Nuclear myocardial perfusion imaging (MPI) accounted for much of the rapid growth in cardiac imaging that occurred from the 1990s through the middle 2000s.1 Factors potentially discouraging use (including publication of appropriate use criteria) have since emerged,3 and recent data reveal modest declines in MPI use in the Medicare fee-for-service population.4

We investigated temporal trends in MPI use within a large, community-based population that included persons younger than 65 years and explored whether increasing use of other noninvasive imaging modalities potentially offset declining MPI use.

Methods | Patient-level data for MPI performed from 2000-2011 were obtained for members aged 30 years or older from the clinical databases of Kaiser Permanente Northern California, an integrated health care delivery system providing comprehensive inpatient and outpatient care for more than 2.3 million adults. We calculated age- and sex-adjusted annual rates of MPI tests/100 000 person-years using direct adjustment methods with 2011 as the reference year.

Denominators were member-months of membership in individuals with at least 1 month of membership during the year of interest. Linear trends in rates were assessed using the Cochran-Armitage test. Logistic regressions were used to assess interactions of age, sex, setting (outpatient vs inpatient), and prior coronary revascularization (for outpatients) on trends with a random-effects term included to account for clustering by facility. As a surrogate for incident coronary disease, trends in myocardial infarction (MI) were determined using previously described methods.5 Two-sided P values of less than .05 were considered significant.

To assess potential substitution of other imaging modalities for MPI, annual rates of cardiac computed tomography and stress echocardiography from 2007-2011 were estimated using a referrals database. Manual audits of randomly selected referrals were performed to determine the positive predictive value (with 95% confidence intervals) of a referral resulting in a test being performed. Use of perfusion positron emission tomography and perfusion magnetic resonance imaging was negligible.

Analyses were performed using SAS version 9.3 (SAS Institute Inc). The institutional review board of the Kaiser Foundation Research Institute approved this study with a waiver of informed consent.

Results | Overall, MPI was used in 302 506 members during 23.2 million person-years of follow-up at 19 facilities. From 2000 until 2006, MPI use increased by 41% (95% CI, 39%-44%; $P < .001$ for trend) (Figure). In 2006, a reduction began that continued through 2011, with MPI use declining by 51% (95% CI, 50%-52%; $P < .001$ for trend) (adjusted odds ratio, 0.51 [95% CI, 0.44-0.60] for undergoing MPI in 2011 vs 2006). Relative declines from 2006 to 2011 did not differ by sex or revascularization history, but were greater for outpatients than inpatients (58% vs 31%; $P < .001$ for interaction) and for persons younger than 65 years vs those aged 65 years or older (56% vs 47%; $P < .001$ for interaction) (Table).

Stress echocardiography use (tests/100 000 person-years) was unchanged with 189 (95% CI, 180-199) in 2007 and 182 (95% CI, 173-191) in 2011 ($P = .93$). Cardiac computed tomography use (tests/100 000 person-years) increased from 37 (95% CI, 35-39) in 2007 to 73 (95% CI, 69-77) in 2011 ($P = .01$), and could have accounted for 5% of the observed decline in overall MPI use if performed as a substitute. During the period of declining MPI use, incident MI declined by 27% (95% CI, 24%-30%; $P < .001$) in the population from 286 (95% CI, 279-293) events/100 000 person-years to 208 (95% CI, 202-214) events/100 000 person-years.

Discussion | After increasing from 2000 to 2006, MPI use abruptly declined through 2011 within our population. Declines for persons aged 65 years or older exceeded those for the Medicare fee-for-service population during the same period4 and were even greater for younger persons. These declines could not be explained by increasing use of alternative modalities.

Although the abrupt nature of the decline suggests changing physician behavior played a major role, incident coronary disease, as assessed by MI, also declined. We could not determine the relative effects of these factors on MPI use.

![Figure. Age- and Sex-Adjusted Annual Rates of Nuclear Myocardial Perfusion Imaging Tests From 2000-2011](chart.png)

Error bars indicate 95% confidence intervals.
Our findings should be interpreted in the context of other limitations. The observed decline occurred in the context of a health care delivery system without direct financial incentives to perform tests. Nevertheless, the substantial reduction in MPI use demonstrates the ability to reduce testing on a large scale with anticipated reductions in health care costs.

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COMMENT & RESPONSE

Antithrombotic Therapy After Transcatheter Aortic Valve Replacement

To the Editor A solid evidence base for appropriate antithrombotic therapy in patients with complex transcatheter aortic valve replacement (TAVR) is not yet established. This is especially important because approximately 40% of patients with TAVR from both the Society of Thoracic Surgeons/American College of Cardiology Transcatheter Valve Therapy (STS/ACC TVT) registry and the Placement of Aortic Transcatheter Valves (PARTNER) trial cohorts had baseline diagnosis of atrial fibrillation (AF) and may have had an indication for anticoagulation.

Table. Myocardial Perfusion Imaging (MPI) Trends

<table>
<thead>
<tr>
<th>Clinical setting</th>
<th>2000 (Baseline)</th>
<th>2006 (Peak Use)</th>
<th>2011</th>
<th>Change in Rate, % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Rate (95% CI)</td>
<td>No.</td>
<td>Rate (95% CI)</td>
</tr>
<tr>
<td>Total MPI</td>
<td>19 326</td>
<td>1239 (1223 to 1256)</td>
<td>32 514</td>
<td>1748 (1730 to 1767)</td>
</tr>
<tr>
<td>Sex*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>8998</td>
<td>586 (570 to 601)</td>
<td>15 940</td>
<td>859 (841 to 877)</td>
</tr>
<tr>
<td>Male</td>
<td>10 328</td>
<td>653 (636 to 671)</td>
<td>16 574</td>
<td>889 (870 to 908)</td>
</tr>
<tr>
<td>Age, y*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;65</td>
<td>9100</td>
<td>578 (565 to 590)</td>
<td>15 224</td>
<td>784 (770 to 798)</td>
</tr>
<tr>
<td>≥65</td>
<td>10 226</td>
<td>661 (634 to 688)</td>
<td>17 290</td>
<td>964 (934 to 995)</td>
</tr>
<tr>
<td>Clinical setting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>4459</td>
<td>287 (279 to 295)</td>
<td>8470</td>
<td>455 (445 to 464)</td>
</tr>
<tr>
<td>Outpatient</td>
<td>14 867</td>
<td>952 (938 to 966)</td>
<td>24 044</td>
<td>1294 (1278 to 1310)</td>
</tr>
<tr>
<td>Received PCI or</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CABG*</td>
<td>4207</td>
<td>273 (266 to 281)</td>
<td>8833</td>
<td>482 (472 to 491)</td>
</tr>
<tr>
<td>No</td>
<td>10 660</td>
<td>679 (666 to 691)</td>
<td>15 211</td>
<td>812 (799 to 825)</td>
</tr>
</tbody>
</table>

Abbreviations: CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention.

* Adjusted annual rates of tests per 100 000 person-years.

b Received PCI or CABG since 1996.