anthyptensive medication users, and 4.8% of OC medication users had at least 1 cigarette co-purchase (Table). Across all medication classes, patients with a cigarette co-purchase made an average of twice as many monthly store visits (1.9 vs 0.9 in all patients). Among patients who purchased cigarettes, the median number of store visits with a cigarette purchase was 2; 25% of asthma and COPD medication users had 4 to 53 visits, OC users had 4 to 94 visits, and antihypertensive medication users had 4 to 125 visits. Approximately 10% of patients with cigarette purchases were taking medications in 2 or 3 of the classes.

Discussion | Using a novel data source that links retail pharmacy purchase data to prescription dispensing data, we found that 1 in 20 patients who were taking medications in 3 classes purchased cigarettes at the pharmacy. On average, these patients made a cigarette purchase at the pharmacy every other month.

Our analysis is limited by potentially incomplete purchasing information because individuals may not use their loyalty cards for every purchase, and these data do not capture cigarette purchases made at other locations. Some of the cigarette purchases may have been made for or by another household member with whom the patient shares their loyalty card.

Nevertheless, our results highlight an opportunity to improve outcomes for patients receiving widely used treatments. The decision of some pharmacies, including CVS, to stop selling cigarettes has been met with widespread support from public health and medical organizations.6 Similar actions by other pharmacies may help prevent cigarette purchasing by individuals at greatest risk.

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LESS IS MORE

Computer-Aided Detection in Mammography: Downstream Effect on Diagnostic Testing, Ductal Carcinoma In Situ Treatment, and Costs

Since 2001, Medicare has reimbursed computer-aided detection (CAD) during screening mammography. The CAD software tool is used by radiologists to identify lesions suggestive of malignant disease. Research suggests that CAD use increases the rate of false-positive findings of screening mammography and the detection of ductal carcinoma in situ (DCIS).1 Increased DCIS detection could lead to overdiagnosis of breast cancer, particularly among older women at risk for competing causes of death. We estimated the fraction of diagnostic tests, DCIS treatments, and costs attributable to CAD dissemination within the Medicare population, among whom the risk for overdiagnosis may be elevated.

Methods | This study was approved by the institutional review board of the University of California, Davis. Informed consent was waived. Using Surveillance, Epidemiology, and End Results Medicare-linked data from January 1, 2001, through December 31, 2009, we identified screening mammograms performed on female Medicare enrollees aged 67 to 89 years,2 classified mammograms by CAD use, and computed the annual prevalence of CAD use. Using annual prevalences and CAD-associated incident rate ratios from a Medicare cohort study,3 we estimated annual attributable fractions for diagnostic mammography, ultrasonography of the breast, biopsy of the breast, and DCIS diagnoses. We also computed the attributable fraction assuming 100% CAD prevalence because nearly all US mammography units are now digital,3 and digital units typically have integrated CAD.

Extrapolating to the entire US fee-for-service Medicare population, we used incidence rate differences to estimate the
number of women who underwent diagnostic testing for breast cancer or who were diagnosed as having DCIS on account of CAD use each year. We used 2013 mean Medicare reimbursement rates and published diagnostic and treatment costs (adjusted to 2013 US dollars) to estimate annual Medicare costs attributable to CAD.4

Results

From January 1, 2001, through December 31, 2009, annual CAD prevalence among Medicare screening mammograms increased from 3.5% to 79.7%. By 2009, 18.2% of diagnostic mammograms, 5.3% of breast ultrasonograms, 7.4% of breast biopsies, and 11.9% of DCIS diagnoses were attributable to CAD (Table 1). From 2001 through 2009, 4612 additional fee-for-service Medicare enrollees were treated for DCIS on account of CAD. If CAD were applied to all Medicare screening mammograms, 14.5% of all DCIS diagnoses would be attributable to CAD, and 1118 additional Medicare enrollees would undergo DCIS treatment each year.

From 2001 through 2009, Medicare total costs for CAD use totaled $278 564 950, including $163 443 470 for supplemental fees, $53 812 033 for downstream diagnostic and interventional procedures, and $61 690 112 for DCIS treatments. If CAD were used on all Medicare screening mammograms, CAD-associated Medicare costs would exceed $67 million annually (Table 2).

Discussion

Among Medicare enrollees undergoing screening mammography in 2009, approximately 1 in 6 diagnostic mammograms, 1 in 14 breast biopsies, and 1 in 9 DCIS diagnoses were attributable to CAD. From 2001 through 2009, CAD use cost Medicare more than $278 million, most of which accrued in the latter years as CAD prevalence approached 80%. The annual Medicare costs of CAD use would exceed $67 million if CAD were used on all mammograms, representing an approximately 7% increase in the approximate $1 billion annual Medicare costs for breast cancer screening.5

The long-term implications of increased DCIS detection in the Medicare population are uncertain. On one hand, the intent of screening is to detect breast cancers earlier when treatments can be curative and less morbid. However, many DCIS lesions may be overdiagnosed, particularly in an older population.

Our cost analysis takes the perspective of the Medicare program; fiscal effects of CAD across the entire screening popu-

### Table 1. Diagnostic Tests and DCIS Treatments Attributable to CAD Among Medicare Enrollees, 2001-2009

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Incidence Rate Without CAD per 1000 Mammograms, %</th>
<th>CAD-Associated IRRA</th>
<th>2001 (CAD 3.5% Prevalent)</th>
<th>2005 (CAD 49.8% Prevalent)</th>
<th>2009 (CAD 79.7% Prevalent)</th>
<th>2010 100% Prevalent</th>
<th>Expected No. Undergoing Testing or Treatment Without CAD</th>
<th>Additional Medicare Enrollees Undergoing Testing or Treatment Because of CAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic mammography</td>
<td>58.4</td>
<td>1.28</td>
<td>1.0</td>
<td>12.2</td>
<td>18.2</td>
<td>21.9</td>
<td>2 028 526</td>
<td>265 432</td>
</tr>
<tr>
<td>Breast ultrasonography</td>
<td>38.0</td>
<td>1.07</td>
<td>0.2</td>
<td>3.4</td>
<td>5.3</td>
<td>6.5</td>
<td>1 319 932</td>
<td>43 476</td>
</tr>
<tr>
<td>Breast biopsy</td>
<td>13.3</td>
<td>1.10</td>
<td>0.3</td>
<td>4.7</td>
<td>7.4</td>
<td>9.1</td>
<td>461 976</td>
<td>21 248</td>
</tr>
<tr>
<td>DCIS diagnosis</td>
<td>1.7</td>
<td>1.17</td>
<td>0.6</td>
<td>7.8</td>
<td>11.9</td>
<td>14.5</td>
<td>56 233</td>
<td>4612</td>
</tr>
</tbody>
</table>

Abbreviations: CAD, computer-aided detection; DCIS, ductal carcinoma in situ; IRR, incidence rate ratio.

a Adjusted for age, race/ethnicity, rural vs urban residence, median income of elderly householders in the same zip code, time since prior mammography, use of CAD on previous examination, presence of stable and unstable comorbidities, digital (vs radiographic) mammography, year of examination, and Surveillance, Epidemiology and End Results (SEER) region. Analysis also accounts for clustering of mammograms within providers and for the sampling design.

b In analyses of SEER Medicare-linked data, 97.3% of Medicare enrollees diagnosed as having DCIS are treated with surgery or radiotherapy.

### Table 2. Medicare Costs Attributable to CAD Use

<table>
<thead>
<tr>
<th>Costs by Service</th>
<th>2001-2009, 47.2% Overall Prevalence</th>
<th>2009, 79.7% CAD Prevalence</th>
<th>Annual Attributable Costs Assuming 100% CAD Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fees for CAD use during screening</td>
<td>163 443 470</td>
<td>31 575 860</td>
<td>39 618 400</td>
</tr>
<tr>
<td>Diagnostic testing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diagnostic mammography</td>
<td>24 457 336</td>
<td>4 723 180</td>
<td>5 928 396</td>
</tr>
<tr>
<td>Breast ultrasonography</td>
<td>4 347 600</td>
<td>839 600</td>
<td>1 053 800</td>
</tr>
<tr>
<td>Breast biopsy</td>
<td>24 626 432</td>
<td>4 755 377</td>
<td>5 969 304</td>
</tr>
<tr>
<td>Treatment of DCIS</td>
<td>61 690 112</td>
<td>11 918 016</td>
<td>14 954 368</td>
</tr>
<tr>
<td>Total CAD-related cost</td>
<td>278 564 950</td>
<td>53 812 033</td>
<td>67 524 268</td>
</tr>
</tbody>
</table>

Abbreviations: CAD, computer-aided detection; DCIS, ductal carcinoma in situ.
lation are likely to be much higher.6 CAD-associated incident rate ratios may reflect the clinical effect of CAD use early in its dissemination1; longer-term effects may differ.

Because of broad dissemination in the United States, CAD likely accounts for a substantial fraction of diagnostic breast imaging, breast biopsies, and DCIS diagnoses among the Medicare population, with high resultant costs.

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Presentation of Prescription and Nonprescription Opioid Overdoses to US Emergency Departments

Opioid overdose is a leading cause of injury-related mortality in the United States.1,2 However, little is known nationally regarding the characteristics of opioid overdose presentations to emergency departments (EDs).

Methods | We analyzed the 2010 Nationwide Emergency Department Sample3 using diagnostic codes and mechanism of injury codes from the International Classification of Diseases, Ninth Revision, Clinical Modification, to define opioid overdose events. We tabulated ED visits by opioid type and aggregated charges and health care utilization data for the ED and inpatient care of patients presenting to the ED with opioid overdose. Nationwide Emergency Department Sample weights were applied to generate national estimates, and estimates for charges were generated with adjusted sample weights to account for missing data. We evaluated ED characteristics, demographic and clinical characteristics of the patients, and outcomes for prescription and nonprescription drug overdose events.

Results | In 2010, 135 971 weighted ED visits for opioid overdose were coded. Prescription opioids (including methadone) were involved in 67.8% of all overdoses, heroin in 16.1%, unspecified opioids in 13.4%, and multiple opioid types in 2.7% (Table 1). The proportion of visits resulting in death was highest for overdoses involving multiple opioids (2.2%) and lowest for prescription opioids (1.1%). For prescription overdoses, the greatest proportion occurred in urban areas (84.1%), in the South (40.2%), and among women (53.0%). Several comorbidities were common in our sample of overdose patients, including chronic mental (33.9%), circulatory (29.1%), and respiratory (25.6%) diseases. Of all overdose patients, 50.6% were admitted. Inpatient and ED charges for patients in our sample totaled nearly $2.3 billion (Table 2).

Discussion | Opioid overdose exacts a significant financial and health care utilization burden on the US health care system. Most patients in our sample overdosed on prescription opioids, suggesting that further efforts to stem the prescription opioid overdose epidemic are urgently needed. We observed marked regional variation in overdose patterns, with the highest burdens of prescription overdose found in the South and West.

Our study identified high rates of several comorbidities among patients presenting with overdose. This finding suggests that health care providers who prescribe opioid analgesics to patients with these comorbidities should do so with care and counsel all patients about the risk for overdose. In addition, acute benzodiazepine intoxication was recorded in 22.2% of all overdose patients, which highlights the need for cautious prescribing of opioids in conjunction with other sedating medications.4

Identification of trends in ED use for opioid overdose is also critical for planning overdose prevention efforts. For example, targeted interventions such as prescription monitoring programs and concomitantly prescribed take-home naloxone (an antidote for opioid overdose) may be particularly...