

# Internal Validation of Procedure Codes on Medicare Claims for Digital Mammograms and Computer-Aided Detection

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## Abstract

**Background:** Billing data, such as Medicare claims, are a potential data source for evaluative studies of new digital mammography technologies, such as digital mammography and computer-aided detection (CAD).

**Objective:** To assess the internal validity of procedure codes on Medicare claims for screening mammography interpreted with either digital mammography or CAD. **Study Design:** We assessed agreement of procedure coding for digital versus film mammography and CAD use versus nonuse for mammograms with claims appearing in two independent Medicare claims files (the Carrier Claims and Outpatient files).

**Subjects and Setting:** Women enrolled in fee-for-service Medicare who received screening mammography in 2001 to 2003 within Surveillance, Epidemiology, and End Results regions, representing 25% of the U.S. pop-

ulation ( $n = 35,642$  women who received 57,632 total mammograms).

**Measures:** Coding agreement beyond chance ( $\kappa$ ), overall, and by year.

**Results:** Overall coding agreement was excellent for both digital versus film mammography [ $\kappa = 0.81$  (95% confidence interval, 0.80-0.83)] and for CAD use versus nonuse [ $\kappa = 0.82$  (95% confidence interval, 0.81-0.83)]. However, in 2001, agreement was only moderate ( $\kappa = 0.51$  for digital versus film and  $\kappa = 0.50$  for CAD use versus nonuse) but increased to higher levels in 2002 and 2003 ( $\kappa > 0.80$  for both technologies).

**Conclusions:** High internal agreement in procedure codes for digital mammography technologies is consistent with accurate coding on Medicare claims after 2001, although external validation remains desirable. (Cancer Epidemiol Biomarkers Prev 2009;18(8):2186-9)

## Introduction

Digital technology is now applied on a significant percentage of U.S. screening mammograms (1, 2). Although analogue film mammograms remain common, 38% of mammography facilities have now installed direct digital machines (1). Many facilities also apply computer-aided detection (CAD) technology during screening mammography (3). CAD is software that analyzes mammograms for patterns associated with underlying cancer, alerting radiologists to abnormalities that may have been missed on initial review.

Congress extended Medicare coverage for digital mammography and CAD beginning in April 1, 2001 (4), and Medicare enrollees constitute approximately one-third of the U.S. population that undergoes mammography each year (including over 13 million mammograms per year). Because research suggests that both digital mammography and CAD can influence the outcomes and costs of screening mammography (3, 5-8), careful assessment of the clinical and fiscal impacts of these technologies within the Medicare population would have both public health and policy implications. Medicare claims have previously been

used for policy-relevant mammography research (9, 10), but use of these data requires consideration of the validity of key data elements. With regard to new mammography technologies, it is fundamental to consider whether claims data can accurately distinguish digital from film mammograms or CAD from non-CAD mammograms.

External validation would be the ideal way to assess the validity of mammography claims data. Mammography registry data have been used to confirm that Medicare claims accurately reflect mammography use and that Medicare claims can be used to distinguish screening from diagnostic mammography (11). Mammography registry data could conceivably allow external validation of Medicare claims data regarding digital technologies but would require significant resources to undertake complex data linkage and analysis. To our knowledge, such a validation has not been undertaken. Thus, following Baron et al. (12), we internally validated mammography procedure codes as an interim assessment of data quality. In an internal validation, agreement in procedure codes is assessed when claims are present for the same procedure in two separate Medicare claims files. Because the two claims files represent separate data streams, one would expect a high level of concordance in the presence of accurate procedure coding.

## Materials and Methods

**Data Source.** Study data were derived from the linked Surveillance, Epidemiology, and End Results (SEER)-Medicare database. The SEER-Medicare database

Received 4/14/09; revised 5/15/09; accepted 6/8/09; published online 8/6/09.

**Grant support:** American Cancer Society Mentored Research Scholars Grant (MRSCT-05-214-01-CPFB).

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doi:10.1158/1055-9965.EPI-09-0338

includes clinical data from cancer registries in 14 U.S. states joined with Medicare claims. Approximately 25% of the U.S. population reside in SEER regions. Compared with the entire Medicare population, the Medicare population within SEER regions is similar with regard to age and sex but has slightly greater representation of non-White and urban residents (13).

Using these data, we compiled annual 5% random samples of all Medicare enrollees in SEER regions from 2001 to 2003 (including subjects with and without cancer diagnoses). The Medicare program identifies the 5% random sample based on final two digits of enrollees' social security numbers, which are assigned randomly by the Social Security Administration (13). The 5% sample includes enrollees both with and without cancer diagnoses. We included patients with previous cancer diagnoses because cancer survivors comprise ~15% of the U.S. Medicare population (14, 15). The study period began in 2001 because no claims with codes for use of digital technologies would have been present before April 1, 2001 (the first day of Medicare reimbursement for the technologies).

Mammography claims can appear in two Medicare claims files. The first file—the Outpatient file—includes mammography claims from hospital outpatient facilities. The second file—the Carrier Claims—includes mammography claims from physicians (typically interpreting radiologists) and free-standing mammography facilities. Although many mammograms are done in private physicians' offices and are represented only in the Carrier Claims, a substantial fraction of mammograms are done in hospital outpatient facilities (11), so are represented in both the Outpatient file (facility fee) and the Carrier Claims (physician interpretation fee). Thus, whether a mammogram appears in both files or the Carrier Claims file alone is mainly determined by site of care rather than patient or clinical factors. Our goal was to compare the coding data on the mammograms with claims present in both files within a population-based sample.

Medicare mammography claims include Health Common Procedure Coding System (HCPCS) codes that identify the purpose of the mammogram (screening versus diagnostic) and whether the mammogram was unilateral or bilateral. Digital mammograms are denoted by distinct HCPCS codes. During the initial year of Medicare coverage for CAD (from April 1, 2001 to December 31, 2001), CAD use was denoted by distinct HCPCS codes. Subsequently, CAD was denoted by "add-on" codes that are included in addition to the primary mammogram code.

**Samples.** We used a two-step process to identify annual samples of screening mammograms for which claims were present in both claims files from April 1, 2001 to December 31, 2003, comprising the period during which digital technologies were covered by Medicare from 2001 to 2003.

In the first step, we identified all screening mammograms in the two files by adapting a validated algorithm that distinguishes screening from diagnostic bilateral mammograms (11). After identifying bilateral mammograms (HCPCS codes 76091, 76092, and G0202-G0205), we excluded presumably diagnostic mammograms based on the following: (a) receipt of mammography during the previous 9 mo; (b) whether the mammogram codes signified a screening purpose (e.g., 76092); (c) presence on claims during the prior 3 mo of International Classifi-

cation of Diseases, 9th Revision, Clinical Modification diagnostic codes for breast symptoms or signs (611.7x) or HCPCS codes for breast biopsy procedures (19100-19103, 19120, 19125, 10021, 10022); and (d) presence of International Classification of Diseases, 9th Revision, Clinical Modification codes for breast cancer during the prior year or within 1 y of mammography (174, 2330, or V103). To allow complete assessment for diagnoses and procedures, we required patients to be enrolled in fee-for-service Medicare (part B) for 1 y before each mammogram and for one subsequent year.

In the second step, we identified those individuals with claims for the same screening mammogram in both files, defined as screening mammogram claims with dates of service within 10 calendar days of each other.

**Classification by Digital Technology Use.** Mammograms were classified as direct digital if signified by HCPCS codes G0202 or G0204. Mammograms were otherwise classified as film mammograms. Mammograms were classified as having CAD if: (a) signified by a primary mammography code for CAD (G0203, G0205); or (b) if an add-on code for CAD application was present (76085, G0236). Mammograms were otherwise classified as not having CAD applied.

Before April 1, 2003, Medicare would reimburse providers either for digital mammography or CAD use, but not both. However, supplemental Medicare reimbursement for digital (compared with film) mammography was ~\$30 greater than the supplemental reimbursement for CAD use. Thus, it is likely that most providers who used CAD on digital mammograms would have billed for digital mammography rather than CAD (16), and CAD codes would not be present on these claims even if it was applied. In the assessment of CAD coding, we therefore excluded mammograms that were coded as digital in either of the claims files (3.0% of total) because systematic undercoding of CAD use on digital mammograms may have led to a spurious increase in overall agreement in CAD coding among all mammograms.

**Analyses.** We computed the concordance (i.e., percent agreement) in mammogram classifications as digital versus film and having CAD versus not having CAD applied in the two claims files. We also computed Cohen's  $\kappa$  to quantify agreement beyond chance. We calculated statistics across all 3 y of claims and also with mammograms stratified by year to assess whether reliability of coding changed over time. Analyses were done with Statistical Analysis System software, version 9.1 (Statistical Analysis System Institute, Inc.). The study was approved by the Institutional Review Boards at the authors' institutions.

## Results

During the 3 study years, we identified 106,702 individual screening mammograms of which 57,632 (54%) had claims present in both data files. The mammograms with claims in both files were received by 35,642 women (average of 1.6 mammograms per woman). Overall, 1,183 (2.1%) were coded as digital in both of the claims files. Among the mammograms coded as film in both files ( $n = 55,916$ ), 5,359 (9.6%) were coded in both files as having CAD applied.

**Table 1. Agreement in Medicare coding for digital technologies, 2001 to 2003**

Presence of codes by claims file, <i>n</i> (%)	Digital mammography ( <i>n</i> = 57,632 mammograms)	CAD ( <i>n</i> = 55,916 mammograms)
Outpatient file only	296 (0.5)	840 (1.5)
Carrier claims only	237 (0.4)	1,175 (2.1)
Both files	1,183 (2.1)	5,359 (9.6)
Neither file	55,916 (97.0)	48,542 (86.8)
Concordance (%)	99.1	96.4
$\kappa$ (95% CI)	0.81 (0.80-0.83)*	0.82 (0.81-0.83)*

\* $P < 0.001$ .

Across the 3 years, agreement in coding mammograms as digital as opposed to film and CAD versus non-CAD was very high (Table 1). Indeed, concordance in coding mammograms as digital versus film exceeded 99%, and concordance was >96% for CAD coding. However, the higher concordance in coding for digital mammography may have been partly owing to the relatively low prevalence of digital mammography compared with CAD use. Across the entire study period,  $\kappa$ s for classifications as digital versus film and CAD use versus nonuse were 0.81 and 0.82, respectively.

When mammograms were stratified by year, concordance remained high in each year for both digital versus film and CAD use versus nonuse (Table 2). However,  $\kappa$  for classification by each modality was significantly lower in 2001 compared with 2002 and 2003. In 2001,  $\kappa$  for classification as digital versus film was 0.51 [95% confidence interval (95% CI), 0.44-0.59], whereas  $\kappa$  for classification for CAD use versus nonuse was 0.50 (95% CI, 0.46-0.54). In 2002 and 2003,  $\kappa$ s for classification of each modality exceeded 0.80.

## Discussion

Among Medicare enrollees receiving screening mammography, we found a high level of agreement between two Medicare claims files in coding for digital versus film mammography and for the use of CAD technology (CAD). Agreement beyond chance was especially high in 2002 and 2003, whereas agreement in 2001—the initial year of Medicare coverage for the two technologies—was only moderate. The high level of internal agreement in coding provides some reassurance regarding data quality in 2002 and 2003. However, researchers should be aware that data quality may not permit accurate classification of mammograms by the use of digital technologies in 2001.

When Medicare initiated coverage for digital technologies in 2001, new codes were introduced to represent use

of digital mammography and CAD. Coding discrepancies during this year may have arisen because of provider or facility unfamiliarity with coding requirements. For example, providers may have been slow to substitute new primary codes for mammography for familiar older codes, as was required for both digital mammography and CAD in 2001. After 2001, billing for CAD required a CAD code to be added to a primary mammography code, complicating CAD billing slightly compared with billing for digital mammography. Nevertheless, coding agreement improved to a similar extent from 2001 to 2002 for both digital mammography and CAD.

Internal validation requires comparison of independent data sources within the same program. In the setting of haphazard or unreliable coding, agreement between the two data sources would be expected to decrease proportionately. Even so, physicians and institutions may tend to submit mammogram claims with the same errors, which would allow claims files to have a higher degree of internal than external validity. Validation of procedure codes for digital mammography and CAD use against an external reference standard would further enhance confidence in the quality of the claims data.

Additional limitations of this validation warrant consideration. We analyzed mammogram claims for fee-for-service Medicare enrollees whose claims were present in both the Carrier Claims and the Outpatient Medicare files. Results may not generalize to younger women who are not enrolled in Medicare or to managed care settings that do not submit claims to Medicare. Claims from free-standing mammography institutions will appear only in the Carrier Claims and not in the Outpatient file, so we advise caution in extending our findings to these mammography facilities. Finally, we only assessed the validity of coding for CAD use on film mammograms and did not evaluate the internal validity of CAD coding on digital mammograms.

Within two Medicare claims files, agreement in coding for new digital mammography technologies was high

**Table 2. Agreement in coding for digital mammography technologies in Medicare claims files by year**

		2001*	2002	2003
Digital mammography	No. mammograms	15,608	20,891	21,133
	Digital codes in both Medicare files, <i>n</i> (%) <sup>†</sup>	69 (0.4)	465 (2.2)	649 (3.1)
	Concordance, %	99.2	99.1	99.0
	$\kappa$ (95% CI)	0.51 (0.44-0.59) <sup>‡</sup>	0.83 (0.81-0.86) <sup>‡</sup>	0.85 (0.83-0.87) <sup>‡</sup>
CAD	No. mammograms	15,410	20,244	20,262
	CAD codes in both Medicare files, <i>n</i> (%) <sup>†</sup>	219 (1.4)	1,589 (7.9)	3,551 (17.5)
	Concordance, %	97.3	97.0	95.1
	$\kappa$ (95% CI)	0.50 (0.46-0.54) <sup>‡</sup>	0.82 (0.81-0.83) <sup>‡</sup>	0.85 (0.84-0.86) <sup>‡</sup>

\*Claims filed from April 1, 2001 to December 31, 2001.

<sup>†</sup>Coding comparisons made between the Outpatient claims and the Carrier Claims files.<sup>‡</sup> $P < 0.001$ .

after the initial year that Medicare reimbursed for their use. The high level of agreement in coding for these technologies suggests that claims data after 2001 may be of sufficient quality to allow accurate classification of mammograms by the use of digital mammography and CAD.

### Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

### Acknowledgments

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*Cancer Epidemiol Biomarkers Prev* 2009;18:2186-2189.

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