

UCSF

UC San Francisco Previously Published Works

Title

External Validation of Medicare Claims Codes for Digital Mammography and Computer-Aided Detection

Permalink

<https://escholarship.org/uc/item/7dt682gj>

Journal

Cancer Epidemiology Biomarkers & Prevention, 21(8)

ISSN

1055-9965

Authors

Fenton, Joshua J
Zhu, Weiwei
Balch, Steven
[et al.](#)

Publication Date

2012-08-01

DOI

10.1158/1055-9965.epi-12-0406

Peer reviewed



Published in final edited form as:

Cancer Epidemiol Biomarkers Prev. 2012 August ; 21(8): 1344–1347. doi:
10.1158/1055-9965.EPI-12-0406.

External Validation of Medicare Claims Codes for Digital Mammography and Computer-Aided Detection

Joshua J. Fenton¹, Weiwei Zhu², Steven Balch², Rebecca Smith-Bindman³, Karen K. Lindfors⁴, and Rebecca A. Hubbard^{2,5}

¹Departments of Family and Community Medicine, Radiology, the Center for Healthcare Research and Policy, University of California, Davis, Sacramento, CA

²Group Health Research Institute, Seattle, WA

³Departments of Radiology, Epidemiology and Biostatistics, University of California, San Francisco, San Francisco, CA

⁴Department of Radiology, University of California, Davis, Sacramento, CA

⁵Department of Biostatistics, University of Washington, Seattle, WA

Abstract

Background—While Medicare claims are a potential resource for clinical mammography research or quality monitoring, the validity of key data elements remains uncertain. Claims codes for digital mammography and computer-aided detection (CAD), for example, have not been validated against a credible external reference standard.

Methods—We matched Medicare mammography claims for women who received bilateral mammograms from 2003 to 2006 to corresponding mammography data from the Breast Cancer Surveillance Consortium (BCSC) registries in four U.S. states (N=253,727 mammograms received by 120,709 women). We assessed the accuracy of the claims-based classifications of bilateral mammograms as either digital vs. film and CAD vs. non-CAD relative to a reference standard derived from BCSC data.

Results—Claims data correctly classified the large majority of film and digital mammograms (97.2% and 97.3%, respectively), yielding excellent agreement beyond chance ($\kappa=0.90$). Claims data correctly classified the large majority of CAD mammograms (96.6%) but a lower percentage of non-CAD mammograms (86.7%). Agreement beyond chance remained high for CAD classification ($\kappa = 0.83$). From 2003 to 2006, the predictive values of claims-based digital and CAD classifications increased as the sample prevalences of each technology increased.

Conclusion—Medicare claims data can accurately distinguish film and digital bilateral mammograms and mammograms performed with and without CAD.

Impact—The validity of Medicare claims data regarding film vs. digital mammography and computer-aided detection suggests that these data elements can be useful in research and quality improvement.

Correspondence to: Joshua Fenton, MD, MPH, Department of Family and Community Medicine, University of California, Davis, 4860 Y Street, Suite 2300, Sacramento, CA 95817, (916) 734-3164; Fax (916) 734-5641, Joshua.fenton@ucdmc.ucdavis.edu.

Conflicts of Interest: None declared.

INTRODUCTION

Over one-half of incident breast cancers occur among Medicare-enrolled women,(1) and Medicare enrollees receive approximately one-third of all screening mammograms nationwide (~13 million annual mammograms).(2, 3) Thus, improving the quality of screening mammography received by Medicare enrollees remains a public health priority. In 2001, Congress extended Medicare coverage to digital mammography and the application of computer-aided detection (CAD) during screening and diagnostic mammography. Because Medicare pays supplemental fees for digital mammography and CAD, evaluation of the clinical and economic impact of the dissemination of these technologies within the Medicare population is needed. Although Medicare claims could be a fruitful data source for such evaluation, uncertainty remains about validity of the claims procedure codes signifying use of these technologies.

An internal validation study found substantial agreement for Medicare claims-based classification of mammograms as digital vs. film and CAD vs. non-CAD in the Carrier Claims and Outpatient Medicare claims files.(4) Because accurate data must be internally consistent, the findings are consistent with accurate coding, but validation using an external reference standard is necessary for a high degree of confidence in data validity. The internal validation study was also conducted with claims from 2001 to 2003, and validation in more recent years is desirable. In addition, dual reimbursement for both digital mammography and CAD was not allowed by Medicare until 2004, so the validity of CAD codes on digital mammograms was not assessed.

We therefore capitalized on a recently developed data infrastructure – the linked Breast Cancer Surveillance Consortium (BCSC)-Medicare data – to externally validate more recent Medicare claims data for digital mammography and CAD against a BCSC-derived reference standard.

METHODS

Data

We used data from the Carrier Claims and Outpatient Medicare claims files which were linked with BCSC mammography data derived from four regional mammography registries (Carolina Mammography Registry; New Hampshire Mammography Network; San Francisco Mammography Registry; and Vermont Breast Cancer Surveillance System). Data for this study were obtained from the BCSC Data Resource.(5) The BCSC includes both community-based and academic mammography facilities that serve a geographically and ethnically diverse patient population. BCSC facilities transmit prospectively collected patient and mammography data to regional registries, which link the data to breast cancer outcomes ascertained from regional or Surveillance, Epidemiology, and End Results cancer registries.

The BCSC has established standard definitions for key variables and multiple levels of data quality control and monitoring.(6) BCSC sites have received institutional review board approval for active or passive consenting processes or a waiver of consent to enroll participants, link data, and conduct research. All procedures are Health Insurance Portability and Accountability Act compliant, and BCSC sites have received a Federal Certificate of Confidentiality to protect the identities of patients, physicians, and facilities.

Claims and mammography data were matched using a deterministic algorithm derived by the National Center for Health Statistics that is based on social security numbers (when available), names, and birthdates. Among women aged 65 years and older with fee-for-

service Medicare with a BCSC mammogram between 1998 and 2006, 82.8% had a matching Medicare mammography claim within seven days (99.1% of which matched on the same date).

Subjects

We identified a matched sample of bilateral mammograms captured in both Medicare claims and the BCSC among women who were aged 65 or older on mammography dates from January 1, 2003 to December 31, 2006. We identified bilateral mammograms based upon Medicare claims with Healthcare Common Procedural Coding System (HCPCS) codes 76091, 76092, G0202-G0205 (encompassing film-screen and digital screening and diagnostic mammograms) and considered mammograms to have matching BCSC records if claims and BCSC records had the same date of service. We did not assess claims prior to 2003, because dual reimbursement for digital mammography and CAD was not allowed, leading to potential under ascertainment of CAD codes on digital mammograms prior to 2003. We excluded mammograms with missing or uncertain BCSC data regarding film vs. digital mammography, and for validation of CAD codes, missing or uncertain BCSC data on CAD status.

Reference Standard

During the study period, BCSC facilities have reported the use of film vs. digital mammography at the level of the individual mammogram. While most BCSC registries report CAD use at the mammogram level, one reported CAD use at the mammography facility level. To maximize the accuracy of the reference standard, we only included mammograms with mammogram-level BCSC data on CAD use. We used these BCSC data to classify each mammogram as either film or digital and CAD vs. non-CAD.

Claims-Based Classifications

We used HCPCS codes to classify mammograms as digital vs. film and CAD vs. non-CAD based Medicare data. Mammograms with codes G0202, G0204 were classified as digital and otherwise as film, while mammograms with codes 76082, 76083, 76085, G0203, G0205, and G0236 were classified as CAD and otherwise as non-CAD.

Analyses of Classification Accuracy

We quantified accuracy by computing: 1) the proportion of reference standard film, digital, non-CAD, and CAD mammograms that were correctly classified by claims as such; 2) the predictive value (PV), or the proportion of mammograms classified by claims codes as film, digital, CAD, or non-CAD that were likewise classified by the reference standard); and 3) Cohen's kappa. We also evaluated accuracy over time by stratifying analyses by year, screening vs. diagnostic/other purpose (according to the BCSC data), and for the CAD analysis, by film vs. digital. All 95% confidence intervals around point estimates were negligibly small, so we report only point estimates. We performed statistical analyses using R, version 2.12.0 (R Foundation for Statistical Computing, Vienna, Austria) The study was approved by the Institutional Review Boards at University of California, Davis and Group Health Research Institute.

RESULTS

We identified a sample of 253,727 mammograms with matched Medicare claims and BCSC records and complete digital vs. film mammography data. The mammograms were obtained from 120,709 women who received an average of 2.1 mammograms during the study period (range: 1–7). On the date of mammography, women had a mean age of 73.5 years (SD: 6.1).

Approximately 78% of the women were white, non-Hispanic; 8% were black, non-Hispanic; 4% were Asian; 3% other races; and 7% had missing race/ethnicity data. Of all mammograms, 87% were designated by the BCSC as having a screening purpose, while the remainder had a diagnostic/other purpose. From this sample, 186,417 (73.5%) mammograms had BCSC data on CAD use for analyses of CAD coding.

In validation analyses of digital mammography classification, 97.2% of digital and 97.3% of film mammograms were correctly classified by claims, and the kappa statistic (0.90) indicated excellent agreement beyond chance (Table 1). A high proportion of non-CAD and CAD mammograms were also correctly classified by claims (86.7% and 96.6%, respectively), and claims-based classification of CAD use also had high agreement beyond chance (kappa=0.83). The predictive values of a digital or CAD classification (87.0% and 86.3%, respectively) were lower than the predictive values of a film or non-CAD designation (99.4% and 96.7%, respectively), because of the lower sample prevalences of digital mammography and CAD.

While correct classification of film and digital mammograms were similarly high across the study period, PV for digital and kappa increased over the study period as the sample prevalence of digital mammography rose (Table 2). Due to relatively low prevalence of digital mammography in 2003 and 2004 (<15% in each year), PVs during these years were each below 80%. Despite a sample prevalence of CAD of 27.8% in 2003, the PV of CAD designation in that year was 75.8%. As CAD prevalence increased from 2004 to 2006, the PV of a CAD designation exceeded 85% in each year.

The accuracy of claims-based classifications for digital mammography and CAD were similarly high in mammograms performed for screening as compared to diagnostic/other purposes (data not shown). However, the PV of a CAD designation was lower among film mammograms (83.5%) than among digital mammograms (94.1%).

DISCUSSION

Using an external reference standard derived from high-quality mammography registry data, we validated Medicare claims codes for digital mammography and CAD. Analyses demonstrated that Medicare claims codes can distinguish digital from film mammograms and mammograms performed with and without CAD with a high overall accuracy from 2003 to 2006.

The PVs of claims codes for digital mammography were below 80% in 2003 and 2004, when digital mammography prevalence was below 15%. It is possible that coding errors may have been more common early during digital mammography dissemination when some facilities may have used both film and digital machines simultaneously. While investigators should recognize the potential for greater misclassification during this time period, the PV of digital designation was 92.8% in 2005 when the sample prevalence of digital mammography was 19.0%, and digital mammography has since disseminated broadly in the U.S. From 2007 to 2012, the proportion of Mammography Quality Standards Act certified mammography facilities with digital machines increased from 29% to 82%.⁽⁷⁾ Thus, the PV of a claims-based digital designation is likely to be very high during this period.

CAD is also more widely used now than during the study period. In 2008, CAD was used on approximately three-quarters of Medicare mammograms.⁽⁸⁾ Thus, the high PVs of a claims-based CAD designation (>80% from 2004–2006) are likely to persist in later claims. Nevertheless, the potential for misclassification of CAD status may be greater in claims prior to 2004. In addition, across the study period, the claims-based designation of CAD use was somewhat non-specific; over 13% of mammograms classified as non-CAD by the

reference standard were classified as CAD by claims codes, leading to an overall PV of a CAD designation of 86.3%.

Strengths of this study include the linkage of high-quality mammography data to large samples of Medicare mammography claims, enabling well-powered external validation of the claims codes against a credible reference standard. Although study data derive from 2003–2006, study results likely generalize to more recent claims owing to the rising prevalence of digital mammography and CAD in subsequent years.

Study data derive from Medicare enrollees receiving mammography within regional registries in four U.S. states, and results may not generalize to other U.S. regions or to mammography claims data for non-Medicare populations (e.g., private insurance plans). Although the BCSC data provide a credible reference standard, inaccuracies in BCSC classification of mammograms by digital or CAD status may have introduced error. Although a high percentage of BCSC women enrolled in fee-for-service Medicare could be matched to mammography claims (82.8%), the accuracy of mammography claims coding could be lower among women who could not be matched.

Medicare claims data are a potentially powerful resource for mammography research or quality monitoring. This study suggests that Medicare claims codes for digital mammography and CAD use are sufficient for accurate classification of mammograms by the use of these modalities, particularly in the context of broad uptake of each technology after 2005.

Acknowledgments

We thank the participating women, mammography facilities, and radiologists for the data they have provided for this study. A list of the BCSC investigators and procedures for requesting BCSC data for research purposes are provided at: <http://breastscreening.cancer.gov/>.

Sources of support: This work was supported by the National Cancer Institute-funded Breast Cancer Surveillance Consortium (U01CA63740, U01CA86076, U01CA86082, U01CA63736, U01CA70013, U01CA69976, U01CA63731, U01CA70040, HHSN261201100031C) and the National Cancer Institute grant R21CA158510. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Cancer Institute or the National Institutes of Health.

REFERENCES

1. Ries, LAG.; Melbert, D.; Krapcho, M.; Mariotto, A.; Miller, BA.; Feuer, EJ., et al., editors. SEER Cancer Statistics Review, 1975–2004. Bethesda, MD: National Cancer Institute; 2007.
2. U.S. Census Bureau [Internet]. [cited 2008 July 5] Annual Estimates of the Population by Sex and Five-Year Age Groups for the United States: April 1, 2000 to July 1, 2007 (NC-EST2007-01). Available from: www.census.gov/popest/national/asrh/NC-EST2007/NC-EST2007-01.xls
3. Smith RA, Cokkinides V, Brawley OW. Cancer screening in the United States, 2008: a review of current American Cancer Society guidelines and cancer screening issues. *CA Cancer J Clin.* 2008; 58:161–179. [PubMed: 18443206]
4. Fenton JJ, Green P, Baldwin LM. Internal validation of procedure codes on Medicare claims for digital mammography and computer-aided detection. *Cancer Epidemiol Biomarkers Prev.* 2009; 18:2186–2189. [PubMed: 19661075]
5. Breast Cancer Surveillance Consortium [Internet]. National Cancer Institute; Available from: <http://breastscreening.cancer.gov/>
6. Ballard-Barbash R, Taplin SH, Yankaskas BC, Ernster VL, Rosenberg RD, Carney PA, et al. Breast Cancer Surveillance Consortium: a national mammography screening and outcomes database. *AJR Am J Roentgenol.* 1997; 169:1001–1008. [PubMed: 9308451]

7. U.S. Food and Drug Administration [Internet]. [cited 2012 May 11] Radiation-Emitting Products. Mammography Quality Standards Act and Program. 2012. Available from: <http://www.fda.gov/Radiation-EmittingProducts/MammographyQualityStandardsActandProgram/DocumentArchives/ucm289914.htm>
8. Rao VM, Levin DC, Parker L, Cavanaugh B, Frangos AJ, Sunshine JH. How widely is computer-aided detection used in screening and diagnostic mammography? *J Am Coll Radiol*. 2010; 7:802–805. [PubMed: 20889111]

Table 1

Accuracy of Medicare Claims-based Classifications of Digital Mammography and Computer-Aided Detection, 2003–2006

BCSC Reference Standard	Correct Claims-based Classification, n (%)	Predictive Value (%)	Kappa
Film (N =214,097)	208,315 (97.2)	99.4	0.90
Digital (N =39,630)	38,536 (97.3)	87.0	
Non-CAD (N =99,674)	86,403 (86.7)	96.7	0.83
CAD (N =86,743)	83,815 (96.6)	86.3	

Abbreviations: BCSC=Breast Cancer Surveillance Consortium; CAD=computer-aided detection

Table 2
Accuracy of Claims-based Classification of Digital Mammography and Computer-Aided Detection by Year

	2003	2004	2005	2006
Digital Mammograms				
Total annual mammograms	70,786	64,847	61,329	56,776
Digital prevalence, %	8.3	13.9	19.0	23.1
Predictive Value, %	73.7	78.3	92.8	96.4
Kappa	0.81	0.84	0.94	0.96
Computer-aided Detection (CAD)				
Total annual mammograms	32,803	50,672	52,545	50,397
CAD prevalence, %	27.8	43.9	50.9	56.7
Predictive Value, %	75.8	86.6	88.5	87.8
Kappa	0.76	0.84	0.85	0.81