Development and validation of an algorithm for classifying colonoscopy indication

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Background: Accurate determination of colonoscopy indication is required for managing clinical programs and performing research; however, existing algorithms that use available electronic databases (eg, diagnostic and procedure codes) have yielded limited accuracy.

Objective: To develop and validate an algorithm for classifying colonoscopy indication that uses comprehensive electronic medical data sources.

Design: We developed an algorithm for classifying colonoscopy indication by using commonly available electronic diagnostic, pathology, cancer, and laboratory test databases and validated its performance characteristics in comparison with a comprehensive review of patient medical records. We also evaluated the influence of each data source on the algorithm's performance characteristics.

Setting: Kaiser Permanente Northern California healthcare system.

Patients: A total of 300 patients who underwent colonoscopy between 2007 and 2010.

Interventions: Colonoscopy.

Main Outcome Measurements: Algorithm's sensitivity, specificity, and positive predictive value (PPV) for classifying screening, surveillance, and diagnostic colonoscopies. The reference standard was the indication assigned after comprehensive medical record review.

Results: For screening indications, the algorithm's sensitivity was 88.5% (95% confidence interval [CI], 80.4%-91.7%), specificity was 91.7% (95% CI, 87.0%-95.1%), and PPV was 83.3% (95% CI, 74.7%-90.0%). For surveillance indications, the algorithm's sensitivity was 93.4% (95% CI, 86.2%-97.5%), specificity was 92.8% (95% CI, 88.4%-95.9%), and PPV was 85.0% (95% CI, 76.5%-91.4%). The algorithm's sensitivity, specificity, and PPV for diagnostic indications were 81.4% (95% CI, 73.0%-88.1%), 96.8% (95% CI, 93.2%-98.8%), and 93.9% (95% CI, 87.2%-97.7%), respectively.

Limitations: Validation was confined to a single healthcare system.

Conclusion: An algorithm that uses commonly available modern electronic medical data sources yielded a high sensitivity, specificity, and PPV for classifying screening, surveillance, and diagnostic colonoscopy indications. This algorithm had greater accuracy than the indication listed on the colonoscopy report. (Gastrointest Endosc 2015;81:575-82.)

Abbreviations: CRC, colorectal cancer; ICD-9, International Classification of Diseases Ninth Revision; KPNC, Kaiser Permanente Northern California; PPV, positive predictive value.

DISCLOSURE: *J. Lee received a grant from the National Institute of Diabetes and Digestive and Kidney Diseases (T32 DK007007), and D. Corley, T. Levin, A. Zauber, and C. Doubeni received a grant from the National Cancer Institute (U54 CA163262). All other authors disclosed no financial relationships relevant to this article.*

0016-5107/$36.00
http://dx.doi.org/10.1016/j.gie.2014.07.031

Received May 12, 2014. Accepted July 10, 2014.

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Colonoscopy is a widely used procedure for colorectal cancer (CRC) screening, surveillance, and diagnostic work-up and is one of the most commonly performed medical procedures in the United States.[1] Observational studies have shown that colonoscopy reduces the incidence and mortality of CRC.[2-4] In 2006, the task force of the American Society for Gastrointestinal Endoscopy and the American College of Gastroenterology published a list of quality indicators for colonoscopy, including physician adenoma detection rate for screening examinations, adherence to recommended after-polypectomy surveillance intervals, cecal intubation rates, withdrawal times, and reducing examination-related perforation rates.[5] Of the 14 recommended colonoscopy quality indicators, several (eg, adenoma detection rate, adherence to surveillance intervals, and perforation rate) require knowledge of examination indication. However, identifying examination indication from endoscopy reports or progress notes within electronic medical records can be difficult because of the text-based nature of reports in many settings, uncertainty regarding the accuracy of codes taken only from procedure reports, and the high cost, potential for reviewer bias, and fatigue associated with manual chart review.

An accurate and accessible method for classifying colonoscopy indication is crucial for measuring colonoscopy quality indicators, performing colonoscopy-related research, and monitoring CRC screening rates. To date, 5 studies have tested algorithms by using electronically available administrative, diagnostic, and procedure codes to classify colonoscopy indication; the reported accuracy of these algorithms varied widely, with sensitivity for screening indications ranging from 29% to 84% and specificity ranging from 58% to 93%.[6-10] Also, these algorithms were limited in their ability to differentiate surveillance examinations from screening or diagnostic examinations because of their inability to link administrative, procedure, and diagnostic codes with pathology and cancer registry data.

The availability of electronically accessible databases makes it possible to integrate diagnostic and procedure codes with pathology and laboratory test data. Thus, the aim of our study was to use these resources to develop and validate a comprehensive algorithm for classifying colonoscopy indication and to evaluate the influence of each data source on the algorithm's overall performance.

METHODS

Study setting

This cross-sectional study was conducted among members of Kaiser Permanente Northern California (KPNC), an integrated healthcare delivery organization with over 3.3 million members across 21 medical centers and hospitals in urban, suburban, and semirural regions within a large geographic area.[11] This study was conducted as part of the National Cancer Institute funded consortium, Population-Based Research Optimizing Screening through Personalized Regimens. The overall aim of this consortium is to conduct multiple-site, coordinated, transdisciplinary research to evaluate and improve cancer screening processes. This research was approved by the KPNC Institutional Review Board.

Evaluation of electronic data sources

KPNC uses the EPIC platform (Epic Systems Corp, Verona, Wis) for healthcare diagnoses, procedure codes, and laboratory test results; the EPIC platform soon will cover approximately half of the population in the United States.[12] Pathology data use the Cerner CoPathPlus (Cerner Corp, Kansas City, Kan) platform and Systematized Nomenclature of Medicine coding; this system is used by over 250 medical centers in the United States.[13] Additional data sources included an electronic consult and/or referral database for the gastroenterology specialty and procedure referrals and the KPNC cancer registry. Prior validation studies were conducted to evaluate whether the electronic data elements were capturing the desired procedures and laboratory data, compared with the results from manual medical record review (details not shown). These evaluations confirmed a very high level of agreement and/or sensitivity for capture of colonoscopy examination performance compared with manual procedure log books (99%); and assignment of adenoma and CRC status from pathology and cancer registry databases compared with text-based reports, respectively (100%).[11]

Development of an algorithm to classify colonoscopy indication

Algorithm development. An expert panel that included gastroenterologists, internists, a family medicine physician, and data analysts was convened to identify diagnoses, pathology findings, laboratory test values, and procedures associated with screening, diagnostic, and surveillance indications for colonoscopy. Electronic definitions of these factors were developed by using International Classification of Diseases Ninth Revision (ICD-9) procedure and diagnostic codes, Current Procedural Terminology codes, KPNC laboratory codes, Systematized Nomenclature of Medicine codes, and International Classification of Diseases (Oncology) codes from the KPNC cancer registry (Supplementary Tables 1-4, available online at www.giejournal.org). For the electronic gastroenterology referral system unique to KPNC, referral reasons were condensed into 17 standardized indication categories (eg, abdominal pain, occult blood in stool, diarrhea), which corresponded to screening, surveillance, or diagnostic indications.

An algorithm was designed to classify examination indications hierarchically: diagnostic indications took precedence over surveillance indications, which took precedence over screening indications (Fig. 1). The algorithm was refined by using a development set of 150