Evaluation of the Duplication of Staging CT Scans for Localized Colon Cancer in a Medicare Population

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Background: To quantify and characterize duplicated tests performed during the staging of localized colon cancer in the Medicare population.

Methods: We used the SEER-Medicare linked database to select patients diagnosed with localized colon cancer between the years 1996 and 2009. We considered a patient as adequately staged after having received a colonoscopy, an abdominal computed tomography (CT) scan, and a pelvic CT scan. Abdominal and pelvic CT scans performed between complete staging and first cancer-directed treatment, if not ordered due to an acute condition, were considered duplicates. We characterized the institutions providing the tests and evaluated the association with survival using a weighted pooled logistic regression adjusted by baseline and time-varying confounders.

Results: Of 36,291 patients with a complete staging, 2680 (7.4%) had at least 1 duplicated test. Patients receiving a duplicate had a higher comorbidity score, were more symptomatic, and had more visits to the emergency department and clinical evaluations. They also were treated with surgery less frequently and had worse survival (hazard ratio 1.22, 95% confidence interval, 1.16–1.28). The type of institution involved in the staging (nonprofit/government centers, proprietary centers, free-standing facilities) was not associated with receiving duplicated tests.

Conclusions: We found a low frequency of duplicated abdominal or pelvic CT scans in the staging of colon cancer in the Medicare population.

Key Words: colon cancer, CAT scan, SEER-Medicare, staging, prognosis

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Every year >100,000 cases of colon cancer are diagnosed in the United States.[1] Appropriate staging of these tumors is necessary for informed therapeutic decisions. Clinical staging is intended to detect metastatic disease that rules out the ability to perform curative intent surgical resection of tumor. Clinical guidelines for the diagnosis and staging of colon cancer recommend the use of colonoscopy, abdominal and pelvic computed tomography (CT) scans,[2–7] and pathologic examination of the surgical specimen for localized tumors.

Health care costs in the United States are projected to account for 20% of the gross domestic product in 2020.[8] A key measure to cut down costs is the avoidance of services that do not benefit patients.[9,10] The "Choosing Wisely" campaign explicitly points at the elimination of duplicated tests as a benefit of promoting conversations between physicians and patients.[11] Thus, avoidance of unnecessary tests for the diagnosis and staging of colon cancer might be a potential target for cost-containment measures.

Medicare patients receive coverage for all tests required for diagnosis and staging of colon cancer. While imposing no restrictions on the number of tests covered, Medicare encourages patients to avoid unnecessary duplication of tests.[12] The proportion of duplicated tests is, however, unknown. If diagnostic workup includes duplicative workup, there is a potential strategy for improving care quality while also controlling health care costs. Here we quantify and characterize the frequency of duplicated tests performed in the fee for service Medicare population during the clinical staging of early-stage colon cancer.

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This study used the linked SEER-Medicare database. The interpretation and reporting of these data are the sole responsibility of the authors.

The ideas and opinions expressed herein are those of the author(s) and endorsement by the State of California, Department of Public Health the National Cancer Institute, and the Centers for Disease Control and Prevention or their Contractors and Subcontractors is not intended nor should be inferred.

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METHODS

Study Population

The study cohort was identified from the SEER-Medicare database, which is a linkage of patient demographic and tumor-specific variables collected by 17 SEER cancer registries across 12 states with Medicare claim files from the Centers for Medicare and Medicaid Services.[13] SEER data are summarized in the Patient Entitlement and Diagnosis Summary File (PEDSF), which is linked with 100% of Medicare claims. For the current study we used Medicare claims from the Inpatient, Outpatient, Home Health Agency, Durable Medical Equipment (DME), Medpar, and National Claims History (NCH) files. Provider characteristics are extracted from the Hospital files, which contain information on hospital characteristics for years 1996, 1998, and 2000 to 2009.

Our analysis includes patients 66 years (to allow for at least 1 y of claims before diagnosis) or older, with a histologic diagnosis of invasive colon adenocarcinoma between 1996 (when hospital information first became available) and 2009 in a SEER area. We excluded rectal cancer and rectosigmoid tumors (which may require additional staging like magnetic resonance imaging or endoscopic ultrasound) and cancers for which the reporting source was nursing home/hospice, autopsy, or death certificate. To ensure complete ascertainment of health services, patients had to be enrolled in parts A and B and not in an HMO during the 6 months before and after diagnosis. We excluded patients diagnosed in Louisiana in 2005 because of the disruption of data collection following hurricane Katrina.

We considered a patient as adequately staged and ready for a therapeutic decision after having received a colonoscopy, an abdominal CT scan, and a pelvic CT scan, as prescribed by the National Comprehensive Cancer Network and European Society for Medical Oncology.[2–7] We did not require a chest CT scan, which is considered by some guidelines,[6] but not others[7,14] (see Table, Supplemental Digital Content 1, http://links.lww.com/MLR/A803, for codes used to identify these tests). Tests are extracted from the claims 6 months before and after SEER date of diagnosis.

Definition of Duplicated Test

Any abdominal CT scan or pelvic CT scan received between the date when the patient was completely staged (see above) and the date of first treatment was considered a duplicate, with the exception of scans performed because of acute conditions[15] (see Table, Supplemental Digital Content 2, http://links.lww.com/MLR/A804, for the list of conditions and codes). Treatment of colon cancer was defined as colon surgery, radiotherapy, or chemotherapy (see Table, Supplemental Digital Content 1, http://links.lww.com/MLR/A803, for codes used to identify these treatments). Tests performed beyond 90 days of complete staging were not considered duplicates under the assumption that restaging might be appropriate if a patient has not been treated within 90 days.

Covariates

Demographic characteristics (age, sex, race, marital status, urbanicity), tumor features (TNM stage, grade of tumor differentiation, date of diagnosis), and census tract features (census region, percentage of black population, percentage of residents living below the poverty level, percentage of residents aged 25 or older with <12 y of education, percentage of residents speaking English not well/not at all at age 65+, median income) were extracted from the PEDSF file. Comorbidities were summarized using the Deyo-Charlson-Klabunde comorbidity index,[16] derived from the inpatient and outpatient Medicare claims for the period between 12 months and 1 month before diagnosis. To assess health services utilization, we computed a "preventive score,"[17] the number of "low complexity visits" in the 24 months 1 year before diagnosis, and emergency room visits.

The provider performing the tests was linked with the institution information on the Hospital file. The Outsaf and Medpar files, but not the NCH file, contain a variable that allows linkage of providers with institutions without identifiers. NCH claims can correspond to either a test performed by a free-standing facility or to a professional service performed at an institutional provider (and thus also recorded in the Outsaf or Medpar files). We thus classified patients according to the type of institution involved in their staging workup: all tests performed in institutional nonprofit/government centers, at least 1 test in a proprietary center, and all tests in free-standing facilities or free-standing facilities plus nonprofit/government centers (see Table in Supplemental Digital Content 1, http://links.lww.com/MLR/A803, for the codes used to extract this information).

Mortality Analysis

For each patient, follow-up started at complete staging (see above) and ended at date of death or administrative cutoff date (in PEDSF file, December 31, 2010), whichever occurred earlier. We estimated the mortality hazard ratio (HR) for "receiving at least 1 duplicated test" versus "not receiving any duplicated test" within 3 months of complete staging. To do so, we fit a weighted pooled logistic model that included an indicator for duplicated tests, a flexible function of time (restricted cubic splines to estimate the baseline hazard), and the baseline covariates described above. We calculated robust standard errors to compute conservative 95% confidence intervals (CIs) for the effect estimate.

As in previous analyses of exposures that are not fully determined at baseline, we used data replication, censoring, and inverse probability weighting[18,19] to adjust for the time-varying covariates: visits to the emergency room, clinical evaluations, change in comorbidity index, and development of large bowel obstruction. We then stabilized the weights to emulate a uniform duplicated test administration during 3 months.[20] Like previous applications of inverse probability weighting,[21–23] we truncated weights at percentile 99. All analyses were conducted with SAS, version 9.3 (SAS Institute, Cary, NC).

RESULTS

Of 75,840 eligible patients, 36,291 had complete staging: 25% stage I, 43% stage II, and 33% stage III (Fig. 1). We found that 2680 (7.4%) patients had at least 1

duplicated CT scan. Of the 2680 patients with duplicated tests, 68% received 1 duplicated abdominal CT scan plus 1 duplicated pelvic CT scan, and only 8% received >2 duplicated tests (see Table, Supplemental Digital Content 3, http://links.lww.com/MLR/A805). After complete staging, a colonoscopy was repeated in 5.5% of the patients.

Table 1 shows the baseline characteristics of the patients. Patients receiving a duplicated CT scan had a higher comorbidity score; lived in census areas with a higher percentage of high-school dropouts, residents below poverty line, black race/ethnicity, and lower median incomes; and were more likely to have anemia, asthenia, and gastrointestinal symptoms in the 6 months before diagnosis.

Patients with duplicated CT scans had more clinical evaluations and were more likely to visit the emergency department in the timespan from being completely staged to first treatment (Table 2). Patients with duplicated CT scans also had a longer median time from staging to first treatment (17 d, interquartile range from 7 to 35 vs. 9 d, interquartile range from 3 to 20). First treatment received was surgery in 89% and 96% of the patients with and without duplicates, respectively. The use of chemotherapy or radiotherapy as first treatment was marginal (Table 2).

Fifty percent of patients received complete staging in nonprofit/government centers, 8% received at least 1 staging test in a proprietary center, and 42% received staging tests in

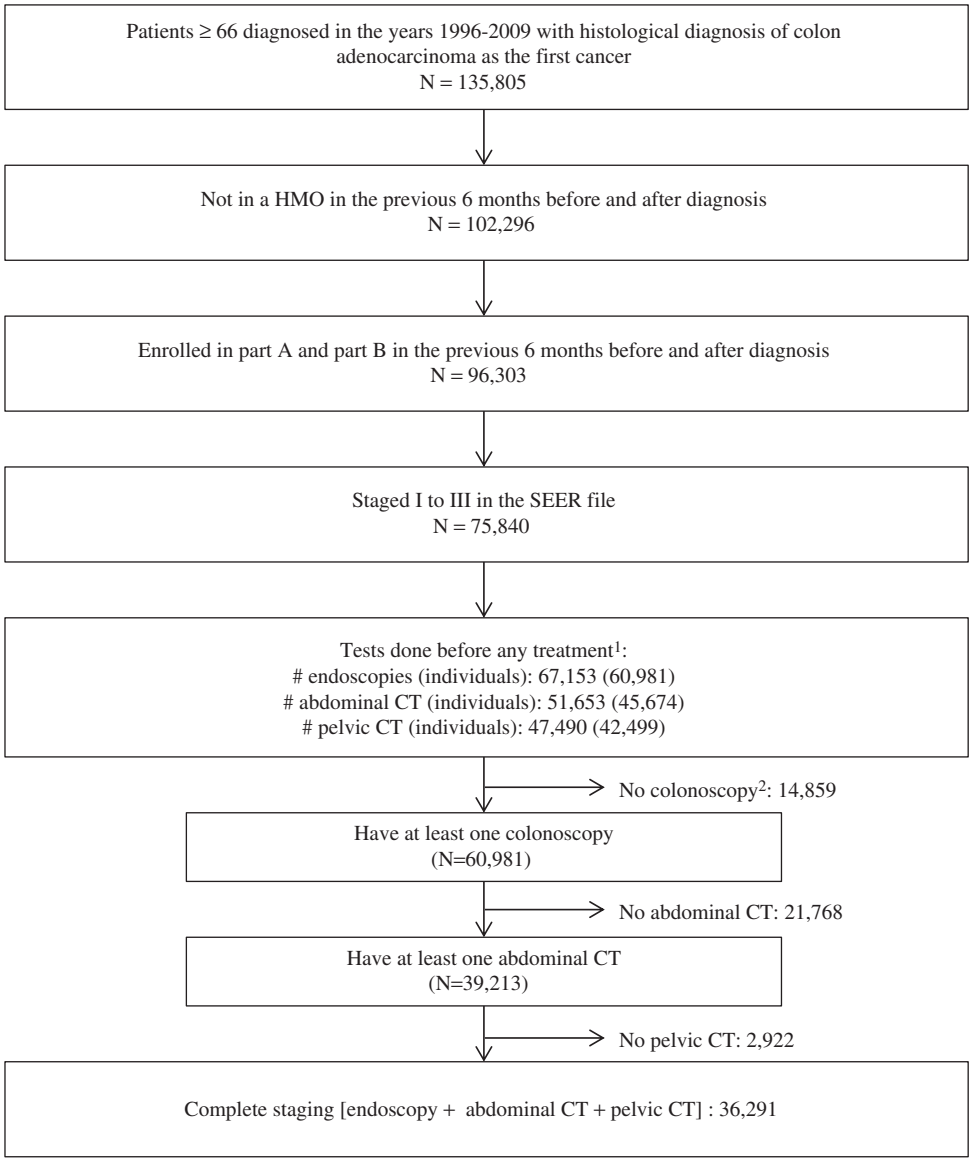

FIGURE 1. Flowchart of colon cancer patients. [1]Time frame for diagnostic tests: −180 to +180 days/first treatment since diagnosis (see the Methods section). [2]4795 patients presented a diagnosis of large bowel obstruction and 1199 presented a diagnosis of large bowel perforation, both contraindications for colonoscopy.

TABLE 1. Baseline Characteristics of Patients With Early Colon Cancer 66 Years or Older at Diagnosis, Enrolled in Part A and B of Medicare, Not in an HMO and With Complete Staging (N = 36,291)

	Not Receiving Any Duplicate Scan (N = 33,611)	Receiving at Least 1 Duplicate Scan (N = 2680)
Sentinel symptom (%)		
Anemia	26,007 (77)	2202 (82)
Gastrointestinal symptoms*	15,194 (45)	1540 (57)
Large bowel obstruction	6993 (21)	794 (30)
Abnormal weight loss	5775 (17)	629 (23)
Asthenia	14,015 (42)	1391 (52)
Comorbidity score (%)		
0	17,645 (53)	1117 (42)
1	8514 (25)	717 (27)
2+	6121 (18)	743 (28)
Unknown	1331 (4)	103 (4)
Median age when staged (range)	78.4 (65.9–106.3)	78.6 (65.8–99.2)
Female (%)	19,620 (58)	1564 (58)
Race (%)		
White, NOS	27,947 (83)	2171 (81)
White, Spanish origin or surname	1384 (4)	117 (4)
African American	2590 (8)	250 (9)
Asian/Pacific islander	1526 (5)	131 (5)
Other/unknown/ unspecified	164 (0)	11 (0)
Stage (%)		
I	8623 (25)	671 (25)
II	14,449 (43)	1088 (41)
III	10,899 (32)	921 (34)
Grade of differentiation (%)		
Well differentiated	2711 (8)	201 (8)
Moderately differentiated	22,841 (68)	1749 (65)
Poorly differentiated	6907 (21)	589 (22)
Unknown	1152 (3)	141 (5)
Median number of low complexity visits (Q1–Q3)†	7 (2–13)	7 (3–15)
Median preventive score (Q1–Q3)‡	2 (1–3)	2 (1–3)
Urbanicity (%)		
Big metro (≥ 1 million population)	19,361 (58)	1595 (60)
Metro (250,000–1 million)	9135 (27)	650 (24)
Urban (20,000–250,000)	1821 (5)	127 (5)
Less urban (2500–20,000)	2672 (8)	246 (9)
Rural (rural or <2500 population)	622 (2)	62 (2)
Marital status (%)		
Single	2593 (8)	219 (8)
Married	16,168 (48)	1176 (44)
Separated/divorced	2059 (6)	173 (6)
Widowed	11,446 (34)	1021 (38)
Unknown	1345 (4)	101 (4)
SEER registry census region (%)		
West	11,309 (34)	867 (32)
Northeast	9897 (29)	809 (30)
Midwest	5203 (15)	395 (15)
South	6741 (20)	588 (22)
Pacific	461 (1)	21 (1)
Year of diagnosis (%)		
1996–2000	5,580 (17)	318 (12)
2001–2005	15,812 (47)	1,184 (44)
2006–2009	12,219 (36)	1,178 (44)
Census tract features§ [median (Q1–Q3)]		
% did not complete high school	15.7 (9.4–25.5)	17.1 (10.4–27.5)
% below poverty line	7.6 (4.1–14.3)	8.2 (4.4–15.9)
% black race/ethnicity	2.1 (0.6–7.7)	2.4 (0.7–9.5)
% English not well/at all at 65+	1.6 (0–5.5)	1.5 (0–5.8)
Median income (USD)	46,163 (34,742–61,152)	44,712 (33,099–60,007)

*Gastrointestinal symptoms include abdominal distention, change in bowel habit, constipation, irritable bowel syndrome, diarrhea, obstruction, anemia, abnormal weight loss, asthenia.

†Low complexity visits (as defined by CPT codes, see Table, Supplemental Digital Content 1, http://links.lww.com/MLR/A803) during the years −2 and −3 of diagnosis.

‡See the Methods section for details.

§Census tract features are missing for 218 individuals.

free-standing facilities with or without tests in institutional nonprofit/government centers. The percentage of patients receiving duplicates was 6%, 9%, and 8% in these 3 groups, respectively.

The all-cause mortality HR for having received a duplicated CT scan was 1.22 (95% CI, 1.16–1.28). The corresponding HR for colon cancer–specific mortality was 1.23 (95% CI, 1.14–1.32) (see Table, Supplemental Digital Content 4, http://links.lww.com/MLR/A806, for more details on the survival analysis).

DISCUSSION

We found that 7% of abdominal or pelvic CT scans were duplicated in the staging of localized colon cancer in Medicare patients. Compared with patients without duplicated CT scans, those with duplicates had a higher comorbidity index, were more symptomatic, visited the emergency room more often, and received surgery as first treatment less often. These findings suggest that patients receiving duplicate tests were more frail and complex, which may warrant the additional testing.

The higher mortality among patients receiving duplicate CT scans also suggests that the duplicates may often be clinically indicated for reasons not captured in the Medicare data, such as performance status and abnormal test results. This explanation is further supported by the attenuation of the mortality HR after adjusting for baseline and time-varying confounders, together with the smaller attenuation observed for cancer-specific mortality (see Table, Supplemental Digital

TABLE 2. Cancer Treatment–related Interventions and Outcomes by Duplicates

	Not Receiving Any Duplicate Scan (N = 33,611)	Receiving at Least 1 Duplicate Scan (N = 2680)
Median (Q1–Q3) time from complete staging to first duplicate (d)	NA	4 (1–14)
Median (Q1–Q3) time from complete staging to first treatment (d)	9 (3–20)	17 (7–35)
Patients with a clinical evaluation between complete staging and first treatment* (%)	26,564 (79)	1930 (72)
Median (Q1–Q3) number of evaluations	2 (2–4)	4 (2–6)
Patients visiting the emergency department between complete staging and first treatment (%)	3587 (11)	788 (29)
Median (Q1–Q3) number of visits	1 (1–1)	1 (1–1)
First treatment (%)		
Surgery	32,190 (96)	2383 (89)
Chemotherapy	78 (0)	32 (1)
Radiotherapy	99 (0)	21 (1)
No cancer-specific therapy	1244 (4)	244 (9)
Months of follow-up	1,885,882	119,649
No. deaths (%)	18,296 (54)	1697 (63)
No. colon cancer deaths (%)	6596 (20)	673 (25)
Adjusted rate ratio for all-cause mortality	Reference	1.22 (1.16–1.28)
Adjusted rate ratio for colon cancer mortality	Reference	1.23 (1.14–1.32)

*Clinical evaluation consists on any of the following: new outpatient, established outpatient, hospital observation services, new inpatient, established inpatient, observation/inpatient care services, outpatient consultation, inpatient consultation, follow-up inpatient consultation, confirmatory consultation, nursing facility services, and team conference.

Content 4, http://links.lww.com/MLR/A806, for more details on the survival analysis).

The short timespan from complete staging to the first treatment (median 9 d) indicates a timely administration of treatment to patients with localized colon cancer. Although patients receiving duplicates are treated a few days later on average, it is unlikely that this delay can explain the association between duplicated CT scans and mortality.

The cost of cancer care is estimated to grow from $125 billion in 2010 to $173 billion in 2020 in the United States.[24] Aging of the US population is argued as one of the drivers of this cost increase[25] and, in the case of colorectal cancer, the 12 months after diagnosis account for most of the expenses.[24] Our analysis targeted elderly population in the initial phase of colorectal cancer diagnosis, and provided reassurance of an adequate use of Medicare resources in this population.

Our analysis has the data limitations inherent to claim-based analyses and is restricted to patients over 66 years residing in SEER states. There is a possibility of occasional coding of rectal cancer as colon cancer, or vice versa. However, the small proportion of radiotherapy as first therapy suggests that this potential miscoding would have been infrequent. Some diagnostic tests may have been missed if some patients were using health care providers outside Medicare. However, when we restricted the analysis to the 27,158 individuals with an evaluation for a colon cancer–related symptom in the 6 months before diagnosis (ie, those more likely to have been diagnosed and staged within Medicare), results did not change materially.

In summary, we found a 7% frequency of duplicated CT scans for disease staging, which may be partly explained by the higher complexity of these patients, and timely delivery of treatment among elderly Medicare patients with localized colon cancer.

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