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ORIGINAL RESEARCH

# Patient, Hospital, and Geographic Disparities Associated With Comanagement During Hospitalization for Colorectal Cancer Surgery

Simone de Vries, MSc[1], Donna B. Jeffe, PhD[1,2], Sandi L. Pruitt, PhD[3,4], Nicholas O. Davidson, MD[2,5], Mario Schootman, PhD[2,6]*

[1]Department of Medicine, Division of Health Behavior Research, Washington University School of Medicine, St. Louis, Missouri; [2]Alvin J. Siteman Cancer Center at Barnes-Jewish Hospital and Washington University School of Medicine, St. Louis, Missouri; [3]Department of Clinical Sciences, University of Texas–Southwestern Medical Center, Dallas, Texas; [4]Harold C. Simmons Cancer Center, Dallas, Texas; [5]Department of Medicine, Division of Gastroenterology, Washington University School of Medicine, St. Louis, Missouri; [6]Department of Epidemiology, Saint Louis University College for Public Health and Social Justice, St. Louis, Missouri.

**BACKGROUND:** Comanagement of surgical patients has increased, but information regarding detailed characteristics of patients receiving comanagement during hospitalization for colorectal cancer (CRC) surgery is lacking.

**OBJECTIVE:** To examine the use of and characteristics associated with comanagement of patients hospitalized for CRC surgery.

**DESIGN:** This study used a population-based cross-sectional design.

**SETTING:** We used the linked 2000 to 2005 Surveillance, Epidemiology, and End Results and Medicare claims data.

**PATIENTS:** We included 37,065 patients aged 66 years or older, hospitalized for definitive CRC surgery following stage I to III diagnosis.

**MEASUREMENTS:** The outcome of interest was comanagement during hospitalization for CRC surgery, and we examined the association between several patient and hospital characteristics. Comanagement was defined as having a relevant physician (ie, internal medicine hospitalist/generalist) submit a claim for evaluation and management services on 70% or more of the days of hospitalization of the patient.

**RESULTS:** During hospitalization for CRC surgery, 27.6% of patients were comanaged, but this percentage varied widely across hospitals (from 1.9% to 83.2%). Several patient and hospital characteristics were associated with the use of comanaged care, of which important characteristics included older age at diagnosis, presence of comorbidity, emergency surgery, and hospital volume.

**CONCLUSIONS:** Extensive variability existed in comanagement use across patients and hospitals, likely reflecting the lack of evidence for its clinical effectiveness. *Journal of Hospital Medicine* 2014;9:226–231. © 2014 Society of Hospital Medicine

Colorectal cancer (CRC) is the second most common malignancy in the United States. In 2013, an estimated 142,820 men and women will be newly diagnosed, and 50,830 patients will die from colon or rectal cancer.[1] The majority of patients are aged 65 years or older at diagnosis, and with a growing elderly population, the CRC burden assumes increasing importance in this patient population.[1] Surgery remains the most important treatment option; however, surgical management of older CRC patients is often complicated because of the attendant comorbidities.[2,3]

Recently, comanagement of surgical patients during their hospital stay has increased substantially in an effort to provide care to complex patients.[4,5] Comanagement includes daily assessment of acute issues and comorbidities, and communication with surgeons by physicians including hospitalists and internists.[6] The presumed benefits of this comanaged approach to patient care include increased prescribing of evidence-based treatments,[7] reduced time to surgery,[8] fewer transfers to an intensive care unit,[9] fewer postoperative complications,[9–11] shortened length of hospital stay,[12,13] and lower readmission rates.[7] Information regarding detailed characteristics of patients receiving comanagement during hospitalization, specifically for CRC surgery, is lacking. This is an important consideration because comanagement may be particularly beneficial for CRC patients, who tend to be older at diagnosis and may have multiple comorbidities.[5] Hospitalists may be especially important for postoperative management of CRC patients, depending upon the complexity of the surgery and also the need for close medical and surgical monitoring in the perioperative setting, particularly among older CRC patients. Many CRC patients develop complications following surgery,[14] and it is possible that these patients may be rescued by comanagement with hospitalist physicians. Our aim was to assess the use of and characteristics associated with comanagement of patients undergoing surgical intervention for CRC.

## METHODS

We obtained data from an existing linkage of 2000 to 2005 National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program data with

*Address for correspondence and reprint requests: Mario Schootman, PhD, Department of Epidemiology, Saint Louis University College for Public Health and Social Justice, 3545 Lafayette Ave., Saint Louis, MO 63104; Telephone: 314-977-8133; Fax: 314-977-3234; E-mail: schootm@slu.edu

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1999 to 2005 Medicare claim files from the Centers for Medicare and Medicaid Services (CMS).[15] In this study, data from 16 tumor registries and 1242 hospitals were included, covering approximately 28% of the US population. We selected patients aged 66 years or older with a first primary stage I to III colon or rectal cancer diagnosis between 2000 and 2005. Patients were eligible for inclusion when they had both Medicare parts A and B coverage and underwent surgical treatment for CRC. We excluded patients identified from autopsy or death certificate only, patients for whom the month of diagnosis was not available, and patients who were members of a Health Maintenance Organization and thereby lacking Medicare claims data. We excluded patients who were only eligible for Medicare because they were disabled or had end-stage renal disease (ie, patients younger than 65 years of age). The age restriction of 66 years of age or older allowed for 1 year of Medicare claims data prior to CRC diagnosis to determine preexisting comorbidity. We used 1999 Medicare data to obtain information about comorbidity for CRC patients who were diagnosed in 2000. Definitive surgery for CRC was measured by searching inpatient, outpatient, and carrier claims using previously identified Healthcare Common Procedure Coding System and/or International Classification of Diseases, 9th Revision (ICD-9). In the event of multiple surgical interventions in 1 patient record, the date on which the most invasive surgery was performed was used.[16]

### Comanagement Use

The outcome of interest was whether or not CRC patients received comanaged care during hospitalization following surgical treatment (comanagement prior to surgery was not included). Comanagement was defined as having a relevant physician (ie, internal medicine hospitalist/generalist) submit a claim for evaluation and management services on 70% or more of the days of hospitalization of the patient, including partial days of admission and discharge. To identify inpatient physician claims, we used the Common Procedure Terminology–Evaluation and Management codes 99221 to 99223, 99251 to 99255, and 99231 to 99233.[5,17]

### Covariates

Characteristics potentially associated with comanagement use included patient, tumor, treatment, and hospital characteristics based on previous work.[4,5] Patient sociodemographic characteristics included sex, age, race/ethnicity, comorbidity, dual eligibility for Medicare and Medicaid, and year of CRC diagnosis. Comorbidity was measured by searching inpatient or carrier claims for multiple chronic diseases occurring 1 to 12 months prior to diagnosis. We categorized comorbidity as a score of 0, 1, or 2 or more and computed an index score[18] to examine nonlinear trends. Dual Medicare–Medicaid participation was present if a patient had Medicaid coverage for at least 1 month during the year before diagnosis. We used census-tract poverty rate as a measure of neighborhood economic condition, Which was defined as the percentage of the population living in poverty in the census tract of the patient's residence at the time of diagnosis and was derived from the 2000 census. Tumor characteristics included American Joint Commission on Cancer (AJCC) tumor stage, grade, location, and histology. Treatment characteristics included mode of presentation, type of surgery, length of hospital stay, and presence of complications during hospitalization.[19,20] Complications (eg, postoperative pneumonia, surgical-site infection, deep vein thrombosis) during hospitalization but following CRC surgery were identified from Medicare data using a previously developed algorithm.[19] The complications algorithm was developed by clinical experts and consists of ICD-9 diagnosis and procedure codes representing CRC-resection complications and their treatment, including additional operations. Surgical interventions after emergency admission were defined as emergency surgery; all other surgical treatments were classified as elective. Additionally, characteristics of the hospital where the patient's surgery took place included number of hospital beds, obtained from the Healthcare Cost Report and the Provider of Service files from CMS, and surgeon caseload, based on the number of CRC surgeries performed during the study period. The hospital's surgery volume was calculated using the number of CRC surgeries performed during the study period and categorized into quartiles.

### Statistical Analysis

Proportions of comanaged patients were calculated for each covariate. Univariable logistic regression analyses were performed to assess the association between comanagement use and each covariate separately. All analyses were adjusted for nesting of CRC patients within hospitals, using a 2-level model with a random intercept. Next, we fitted a multivariable model that included covariates associated with comanagement in univariable analysis based on the likelihood ratio test ($P < 0.05$). Inclusion of covariates in the final multivariable model was based on statistically significant associations with comanagement. Adjusted odds ratios (ORs) were calculated with 95% confidence intervals. Variability across hospitals was calculated using the intraclass coefficient (ICC) for logistic regression.[21] The ICC ranges from 0.0 (no variability across hospitals) to 1.0 (extreme variability across hospitals). In addition, we calculated adjusted values for comanagement to describe the hospital variability. These adjusted values were computed based on the multivariable model by averaging the patient-level probabilities for all patients who resided in that hospital. We conducted a series of analyses to

challenge the robustness of our results. To investigate the potential effect of a different definition of comanagement, we defined comanagement as both (1) having a relevant physician submit a claim for evaluation and management services on 50% or more of the days of the patient's hospitalization, and (2) having a relevant hospitalist or generalist physician submit a claim for evaluation and management services on 100% of the days of hospitalization. All analyses were performed using Stata (version 12.0; StataCorp, College Station, TX).

## RESULTS

There were 47,828 patients aged 66 years or older who were diagnosed with a first primary CRC between 2000 and 2005, had both Medicare parts A and B, and were not members of a Health Maintenance Organization during the study period. We excluded patients for whom we were unable to calculate complications (n = 2649), surgery or hospital volume (n = 6415), or who had missing data (n = 238). Finally, we excluded CRC patients with in situ, stage IV, or missing stage information, resulting in 37,065 patients in the study population. Patients in the study population were typically aged 75 to 84 years, were female, had 1 or more comorbid condition, lived in areas with the population poverty rate <10%, were diagnosed with AJCC stage II, had elective surgery, and were treated with partial colectomy (Table 1). During 2000 to 2005, 10,230 (27.6%) of 37,065 patients were comanaged during hospitalization for CRC surgery. In a model with no covariates, variability of comanagement across hospitals was significant (ICC = 0.382). All patient and hospital characteristics except for sex and race/ethnicity were significantly associated with comanagement use, when adjusted for clustering within hospitals. The most common characteristics associated with comanagement were emergency surgery (40.4%), complications (39.7%), and having 2 or more comorbid conditions (37.1%). Comanagement was less common among those with no comorbidity (21.0%), unknown tumor grade (21.9%), and other surgery (18.6%). Furthermore, comanagement increased from 24.8% in 2000 to 30.1% in 2005 ($P$ for trend < 0.001; Table 1).

Table 2 shows the adjusted ORs of the covariates associated with comanagement. This model includes only variables independently associated with comanagement. Increasing age was associated with increased odds of receiving comanagement, with OR = 1.22 for patients aged between 75 and 84 years, and OR = 1.52 for patients aged 85 years and older. Comorbidity scores of 1 or 2 or more were associated with increased odds of comanagement use following CRC surgery compared to patients without comorbidities (OR = 1.39 and OR = 1.92, respectively). Patients who received Medicaid were more likely to receive comanagement (OR = 1.11) compared with patients without Medicaid insurance. Higher AJCC stage was associated with increased use of comanagement, as was poor tumor differentiation. Patients undergoing surgery for colon versus rectal cancer were more likely to be comanaged during their hospital stay (OR = 1.23). Surgery after emergency admission was associated with an increased use of comanagement (OR = 1.95). The odds of comanagement increased slightly with increasing length of hospital stay (OR = 1.03), but were higher for patients who developed 1 or more complications during hospitalization compared with patients without complications (OR = 1.38). Compared with CRC patients treated in small hospitals (<200 beds), patients treated in hospitals with 200 to 349 beds were more likely to receive comanaged care (OR = 1.51), whereas patients treated in high-volume hospitals with ≥500 beds were less likely to receive comanaged care during hospitalization (OR = 0.65). While census-tract poverty rate was associated with comanagement in univariable analysis, no significant association was observed when adjusting for other covariates in the multivariable model. In a model with all covariates listed (Table 2), variability of comanagement across hospitals was significant (ICC = 0.376), suggesting that extensive variability across hospitals remained. The adjusted value of CRC patients receiving comanaged care varied widely, from 1.9% to 83.2% across hospitals. Our sensitivity analysis showed that odds ratios and confidence intervals were generally unchanged when using different definitions of comanagement.

## DISCUSSION

In all, 27.6% of CRC patients were comanaged during hospitalization, but large disparities existed across patient, hospital, and geographic characteristics. Our finding that more complex patients are more likely to receive comanaged care (eg, increasing age and comorbidity, higher tumor stage and grade, emergency presentation, and complications) are in line with other studies.[5] Importantly, there was a wide range in hospital use of comanagement; the variability across hospitals accounted for 37.6% of the total variability in comanagement use. In some hospitals, almost none of the patients received comanaged care, whereas in other hospitals 83.2% of patients received such care. One reason for the large variability across hospitals may be the lack of evidence about the effectiveness of comanagement. Although comanaged care may benefit orthopedic patients,[7–11] to our knowledge, no studies have shown benefit to CRC patients. Typically, procedures for which there is more ambiguity about its effectiveness show greater variability across hospitals and geographic areas.[22] Similar to a previous study,[5] we found that patients treated in midsize hospitals were more likely to receive comanagement, and patients treated at high-volume hospitals were less

**TABLE 1.** Frequencies and Unadjusted Associations Between Patient and Hospital Characteristics and Comanagement of Colorectal Cancer Patients, Adjusted for Clustering of Patients Within Hospitals

| Covariates | Total, N = 37,065 | Comanaged, n (%), n = 10,230 (27.6%) |
|---|---|---|
| Sociodemographics | | |
| Age, y | | |
| 66–74 | 13,197 | 3,014 (22.8) |
| 75–84 | 6,958 | 4,736 (27.9) |
| 85+ | 6,910 | 2,480 (35.9) |
| Sex | | |
| Male | 15,744 | 4,345 (27.6) |
| Female | 21,321 | 5,885 (27.6) |
| Race* | | |
| White | 31,958 | 8,579 (26.8) |
| African American | 2,641 | 745 (28.2) |
| Other | 2,466 | 906 (36.7) |
| Comorbidity* | | |
| 0 | 15,905 | 3,342 (21.0) |
| 1 | 10,860 | 3,068 (28.3) |
| 2+ | 10,300 | 3,820 (37.1) |
| Medicaid* | | |
| No | 31,099 | 8,000 (25.7) |
| Yes | 5,966 | 2,230 (37.4) |
| Year of diagnosis* | | |
| 2000 | 6,041 | 1,497 (24.8) |
| 2001 | 6,193 | 1,624 (26.2) |
| 2002 | 6,289 | 1,692 (26.9) |
| 2003 | 6,489 | 1,829 (28.2) |
| 2004 | 6,219 | 1,832 (29.5) |
| 2005 | 5,834 | 1,756 (30.1) |
| Neighborhood characteristic | | |
| Poverty rate* | | |
| <10% | 21,772 | 5,698(26.2) |
| 10%–19% | 9,458 | 2,722(28.8) |
| ≥20% | 5,835 | 1,810(31.0) |
| Tumor characteristics | | |
| AJCC stage* | | |
| I | 9,996 | 2,402 (24.0) |
| II | 14,662 | 4,287 (29.2) |
| III | 12,407 | 3,541 (28.5) |
| Tumor grade/differentiation* | | |
| Well | 3,278 | 799 (24.4) |
| Moderate | 25,129 | 6,905 (27.5) |
| Poor | 6,898 | 2,107 (30.6) |
| Undifferentiated | 350 | 110 (31.4) |
| Unknown | 1,410 | 309 (21.9) |
| Tumor location* | | |
| Rectum | 6,977 | 1,616 (23.2) |
| Proximal colon | 14,811 | 4,252 (28.7) |
| Transverse colon | 5,650 | 1,679 (27.9) |
| Distal colon | 9,627 | 2,683 (23.2) |
| Tumor histology* | | |
| Mucinous adenocarcinoma | 32,109 | 8,766 (27.3) |
| Other adenocarcinoma | 4,761 | 1,407 (29.6) |
| Nonadenocarcinoma | 195 | 57 (29.2) |
| Treatment characteristics | | |
| Mode of presentation* | | |
| Elective | 28,673 | 6,836 (23.8) |
| Emergency | 8,392 | 3,394 (40.4) |
| Type of surgery* | | |
| Total (procto)colectomy | 1,475 | 372 (25.2) |
| Subtotal (hemi)colectomy | 18,840 | 5,367 (28.5) |
| Partial colectomy† | 16,017 | 4,298 (26.8) |
| Colectomy NOS | 647 | 177 (27.4) |
| Other surgery | 86 | 16 (18.6) |
| Length of stay, days*,‡ | | 12.8 (8.3) |
| Complications during hospitalization | | |
| None | 28,580 | 6,863 (24.0) |
| Yes | 8,485 | 3,367 (39.7) |
| Hospital characteristics | | |
| Hospital volume (no. of beds)* | | |
| 1–199 | 9,326 | 2,382 (25.5) |
| 200–349 | 10,446 | 3,153 (30.2) |
| 350–499 | 8,963 | 2,590 (28.9) |
| 500+ | 8,330 | 2,105 (25.3) |
| Hospital surgery volume* | | |
| 1–20 | 8,429 | 2,445 (29.0) |
| 21–38 | 8,294 | 2,389 (28.8) |
| 39–65 | 8,115 | 2,257 (27.8) |
| 66+ | 8,453 | 2,013 (23.8) |
| Unknown | 3,774 | 1,126 (29.8) |

NOTE: **Abbreviations:** AJCC, American Joint Commission on Cancer; NOS, not otherwise specified.

*$P<0.05$.

†Partial colectomy category includes patients who received local tumor excision.

‡Mean (standard deviation).

likely to receive comanagement compared to smaller hospitals. However, because the variability was similar between the model without any variables and the full multivariable model, other variables not available in SEER–Medicare data likely played a role in explaining this large interhospital variability. Quality of cancer care may be improved by reducing variation in underuse of effective and necessary care, variation that indicates misuse of preference-sensitive care (ie, care that offers equivalent options to be chosen by the patient), and variation that indicates overuse of supply-sensitive care (ie, care influenced by medical capacity).[23] Examining and reducing variability in medical care has been an important policy consideration for almost 30 years.[24,25] Future studies should examine additional reasons for variability in comanagement across hospitals, including variables at the level of the patient, provider, and hospital. Cost-effective interventions should subsequently target modifiable factors to reduce use of unnecessary care among patients unlikely to benefit from comanagement.

Our study benefits from using a population-based SEER–Medicare cohort of older CRC patients, representing the diversity of geographic areas and hospitals across the United States. Furthermore, we were able to include a variety of covariates available in the SEER–Medicare data, including patient, hospital, and area characteristics. Whereas most studies examining the use or effectiveness of comanagement include single institutions or a variety of surgical patients,[5,8,11,17] we examined the use of and characteristics associated with comanagement throughout the United States for a specific patient population.

**TABLE 2.** Multilevel Multivariable Logistic Regression Analysis of the Odds of Receiving Comanagement During Hospitalization for Colorectal Cancer Surgery

| Covariates | OR | 95% CI |
|---|---|---|
| Age, y | | |
| 66–74 | 1.00 | — |
| 75–84 | 1.22 | 1.15–1.30 |
| 85+ | 1.52 | 1.42–1.64 |
| Comorbidity | | |
| 0 | 1.00 | — |
| 1 | 1.39 | 1.30–1.48 |
| 2+ | 1.92 | 1.80–2.05 |
| Medicaid | | |
| No | 1.00 | — |
| Yes | 1.11 | 1.03–1.20 |
| Year of diagnosis, per year | 1.07 | 1.06–1.09 |
| AJCC stage | | |
| I | 1.00 | — |
| II | 1.11 | 1.04–1.19 |
| III | 1.10 | 1.02–1.18 |
| Tumor grade/differentiation | | |
| Well | 1.00 | — |
| Moderate | 1.08 | 0.98–1.19 |
| Poor | 1.17 | 1.04–1.31 |
| Undifferentiated | 1.14 | 0.85–1.52 |
| Unknown | 0.89 | 0.75–1.06 |
| Tumor location | | |
| Rectal | 1.00 | — |
| Colon | 1.23 | 1.15–1.32 |
| Mode of presentation | | |
| Elective | 1.00 | — |
| Emergency | 1.95 | 1.84–2.08 |
| Length of stay, per day | 1.03 | 1.02–1.03 |
| Complications during stay | | |
| No | 1.00 | |
| Yes | 1.38 | 1.29–1.48 |
| Hospital volume (no. of beds) | | |
| 1–199 | 1.00 | — |
| 200–349 | 1.51 | 1.22–1.86 |
| 350–499 | 1.26 | 0.98–1.62 |
| 500+ | 0.65 | 0.49–0.86 |

NOTE: **Abbreviations:** AJCC, American Joint Commission on Cancer; CI, confidence interval; OR, odds ratio.

We recognize several limitations in this study. Our study specifically assessed comanagement among hospitalized CRC patients aged 65 years and older without managed care insurance. Generalizabilty of our findings to other surgical patients, to younger CRC patients, and those with managed care insurance may therefore be limited. With regard to the definition of comanagement, we used a cutoff point of submitting a claim for management and evaluation on 70% or more of the days of hospitalization for CRC. This cutoff is somewhat arbitrary, but different cutoffs did not influence the results. However, in a prior study, changes in the cutoff used in this definition only affected the proportion of comanaged patients and did not change the observation of increasing trends in the use of comanagement.[5] In addition, we examined a CRC population diagnosed between 2000 and 2005. Because an increasing trend in use of comanagement was observed, it is possible that comanagement use has increased further in more recent years. Our findings of lower use of comanaged care in larger hospitals may be related to the increased use of hospitalists as consultants, whose care may not be accurately or completely captured in claims data. We do not report data regarding the use of physician extenders (nurse practitioners and physician assistants). Although their use is increasing in some contexts, in our data, if we counted patients comanaged by physician extenders, we would only add 79 additional CRC patients (0.6%) to our analyses, which is unlikely to influence our findings.

In conclusion, more complex patients are more likely to receive comanaged care following CRC surgery. Extensive variability existed across patients and hospitals likely due to the lack of evidence about the clinical effectiveness of comanagement for patients undergoing CRC surgery. Future studies should examine additional reasons for variability in comanagement across hospitals, including variables at the level of the patient, provider, and hospital.

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