

# Patterns of Colorectal Cancer Care in the United States and Canada: A Systematic Review

Eboneé N. Butler, Neetu Chawla, Jennifer Lund, Linda C. Harlan, Joan L. Warren, K. Robin Yabroff

**Correspondence to:** K. Robin Yabroff, PhD, MBA, Health Services and Economics Branch/Applied Research Program, Division of Cancer Control and Population Sciences, National Cancer Institute, 9609 Medical Center Dr 3E436, Rockville, MD 20850 (e-mail: [yabroff@mail.nih.gov](mailto:yabroff@mail.nih.gov)).

Colorectal cancer is the third most common cancer in the United States and Canada. Given the high incidence and increased survival of colorectal cancer patients, prevalence is increasing over time in both countries. Using MEDLINE, we conducted a systematic review of the literature published between 2000 and 2010 to describe patterns of colorectal cancer care. Specifically we examined data sources used to obtain treatment information and compared patterns of cancer-directed initial care, post-diagnostic surveillance care, and end-of-life care among colorectal cancer patients diagnosed in the United States and Canada. Receipt of initial treatment for colorectal cancer was associated with the anatomical position of the tumor and extent of disease at diagnosis, in accordance with consensus-based guidelines. Overall, care trends were similar between the United States and Canada; however, we observed differences with respect to data sources used to measure treatment receipt. Differences were also present between study populations within country, further limiting direct comparisons. Findings from this review will allow researchers, clinicians, and policy makers to evaluate treatment receipt by patient, clinical, or system characteristics and identify emerging trends over time. Furthermore, comparisons between health-care systems in the United States and Canada can identify disparities in care, allow the evaluation of different models of care, and highlight issues regarding the utility of existing data sources to estimate national patterns of care.

J Natl Cancer Inst Monogr 2013;46:13–35

Colorectal cancer is the third most common cancer (1) in the United States and Canada. In 2012, approximately 140 000 new patients were expected to be diagnosed in the United States (2) and 22 000 were expected in Canada (3). Although curable when detected early, colorectal cancer is the second leading cause of cancer death in North America, resulting in approximately 58 000 deaths per year (1). Recent improvements in the early diagnosis and treatment of colorectal cancer have led to increased survival (4–6). However, changes in treatment, especially the use of new chemotherapeutic agents, have been linked to increased costs for care (7). Given the high incidence and increased survival of colorectal cancer patients, it is beneficial for researchers, clinicians, and policy makers to characterize treatment receipt, identify populations of patients who do not receive optimal care, and quantify economic and health-care system resources needed to treat this growing population.

Although similar demographically, both with sizeable immigrant populations, the United States' multipayer system and Canada's universal single-payer system offer differing platforms to explore how patient treatment data are collected, managed, and used to measure care patterns. Comparisons across country and health-care systems will allow the evaluation of different models of care delivery and can highlight issues regarding health-care practices and standards of care. In this systematic review of the literature, we describe patterns of care for patients diagnosed with colorectal cancer in the United States and Canada and evaluate data resources for capturing and measuring treatment patterns in both countries. Findings from this study may have implications for health-care

delivery, treatment, and outcomes for patients diagnosed with colorectal cancer.

## Methods

We used the MEDLINE database to identify articles on colorectal cancer care published in English between January 2000 and December 2010. Our search strategy combined the Medical Subject Heading (MeSH) term “Colorectal Neoplasms” with additional headings or text strings related to patterns of care, yielding 717 articles (see Appendix 1 for more details). Articles were hierarchically excluded for the following reasons: 1) the article did not report original research on receipt of colorectal cancer care; 2) the study was based on biological specimens, a nonhuman population, simulation model, or hypothetical cohort; 3) the study did not report receipt of cancer-directed initial care, postdiagnostic surveillance care, or end-of-life care; 4) the article reported results from a clinical study or controlled trial evaluating a specific treatment; 5) the study did not include information on patterns of care; 6) the study included fewer than 200 cancer patients; 7) the study did not report data for colorectal cancer care separately. After exclusions, we selected studies that were conducted in the United States or Canada. Studies conducted in Europe, Australia, and New Zealand are evaluated in a separate article (8). The reference lists of the retained articles ( $n = 52$ ) were examined to identify additional studies and were evaluated by the exclusion criteria described above. An additional 21 studies

were identified from reference lists and a total of 73 studies are included in this systematic review of the literature.

For each article, we used a standard format to record cohort characteristics (ie, tumor site, stage, year of diagnosis or year of death in studies of end-of-life care, sample size, age distribution); health-care delivery setting and data sources used to identify patients and their health services (ie, cancer registry data, medical records, claims, surveys); and a summary of key findings on the receipt of care. Items were recorded as “Not Reported” if the information was not explicitly stated or could not be reasonably inferred from the summary statistics presented. Four reviewers participated in data abstraction. To ensure consistency between reviewers, we completed three quality control checks, where each reviewer abstracted the same three studies and compared abstracted findings.

With respect to patterns of colorectal cancer care, we abstracted the proportion of patients receiving specific types of initial care, postdiagnostic surveillance care, and end-of-life care. Cancer-directed initial care consisted of surgery, radiotherapy, chemotherapy, and multicomponent care where multiple types of care were reported together and could not be abstracted separately. The summaries of postdiagnostic surveillance and end-of-life care patterns are presented in the text only, given the small number of studies. We also documented patient population and health-care provider characteristics that were associated with receipt of care and whether the associations were positive or negative. These characteristics included patient sex, race and/or ethnicity, marital status, stage of disease at diagnosis, delivery setting, and provider practice patterns (eg, cancer patient volume). We reported patterns of care across the continuum of care from initial treatment following diagnosis to postdiagnostic surveillance and, finally, end-of-life care. When appropriate, we attempted to identify when care was guideline-concordant. In each table, studies are ordered by date of publication.

## Results

### Study Characteristics

Of the 73 studies included in this review (9–81), 62 were conducted in the United States and 11 were conducted in Canada (Table 1). The number of published articles on colorectal cancer care increased across the study period more rapidly in Canada, with a majority published between 2008 and 2010. Patterns of cancer-directed initial care represented the greatest number of studies for both the United States (76%) and Canada (82%), followed by studies on postdiagnostic surveillance care. Studies that reported end-of-life care were only identified in the United States (8%). With respect to cancer-directed initial care, nearly half of US studies reported on the receipt of chemotherapy (48%); in Canada, surgery, radiotherapy, and chemotherapy were assessed in similar proportions. Several studies that included a description of cancer-directed initial care fell into two or more categories used to describe “Type of care reported” or “Type of initial care reported.” Thus, these two study characteristics were not mutually exclusive.

Most colorectal cancer patients and health services data were identified by registry data linked to medical records, insurance claims, or physician surveys in the United States (53%); in Canada,

all studies were conducted using data of this type (100%). Registry data alone accounted for patient and health services information in 18% of US studies. The remaining data sources in the United States included medical claims alone (5%) or other data sources, including special studies designed to assess treatment receipt and outcomes for cancer patients (24%). In both countries, similar numbers of studies assessed treatment for colon, rectal, and colorectal tumors, where “colorectal tumors” describe studies that assessed both colon and rectal tumor sites together and could not be abstracted separately. Several studies assessed two or more tumor sites; thus, our cohort characteristic titled “Tumor site reported” is not mutually exclusive. Several studies were represented across multiple tables or multiple times within a single table. In the United States, the majority of studies included 5000 or more patients. And in Canada, all study populations included less than 5000 patients. Health services data sources for the United States and Canada are described in Tables 2 and 3.

### Cancer-Directed Initial Care—Surgery, Radiotherapy, Chemotherapy, and Multicomponent Care

The receipt of surgical care for colorectal cancer was reported in 16 US studies and 4 Canadian studies (Table 4). Health services data were obtained from a variety of sources, including state or provincial registries with or without linkage to medical claims or patient records, hospital discharge data (eg, the Healthcare Cost and Utilization Project [HCUP]), or the National Cancer Data Base. Study cohorts were drawn from single institutions and national-, state-, or provincial-based populations. Most studies reported receipt of surgery near or above 80% in both the United States and Canada. Surgery as the sole treatment modality decreased across time, giving way to treatment plans that included neoadjuvant or adjuvant therapy (13,31). Older and uninsured patients had the highest proportions of emergency resections (23), and several studies reported an increasing trend over time for the proportion of rectal cancer patients receiving sphincter-sparing surgery. Surgery receipt varied by anatomical location of the tumor, race, sex, and age.

Twenty-one studies reported patterns of care for the receipt of radiotherapy in the United States and Canada (Table 5). Surveillance, Epidemiology, and End Results (SEER) registries alone or linked to Medicare claims were used to identify radiotherapy receipt for a plurality of US studies. Similarly, all studies of radiotherapy use in Canada obtained data from provincially based cancer registries augmented by treatment data from medical records (ie, CancerCare Manitoba and the British Columbia Cancer Agency). Patients with stage II–III, local, or regional rectal cancer had the greatest representation within studies of radiotherapy; for this subset, rates of radiotherapy use increased from approximately 15% in the mid-1970s to 50% or greater in the first decade of the 21st century. This upward trend was evident in both Canada and the United States (13,35) and is in accordance with findings from randomized controlled trials that have demonstrated survival benefits from the use of radiotherapy in the treatment of early-stage rectal cancer (82).

Patterns of care for the receipt of chemotherapy were reported in 29 US studies and 5 Canadian studies (Table 6).

**Table 1.** Characteristics of studies examining the receipt of colorectal cancer in the United States and Canada

Characteristic	United States (n = 62)		Canada (n = 11)	
	No.	%	No.	%
Study publication year				
2000–2003	18	29.0	3	27.3
2004–2007	24	38.7	1	9.1
2008–2010	20	32.3	7	63.6
Patient identification and health services data source				
Registry-linked medical records/claims/surveys	33	53.2	11	100.0
Registry only	11	17.7	0	0.0
Medical claims only	3	4.8	0	0.0
Other	15	24.2	0	0.0
Type of care reported*				
Initial care	47	75.8	9	81.8
Postdiagnostic surveillance care	11	17.7	2	18.2
End-of-life care	5	8.1	0	0.0
Type of initial care reported*				
Surgery	15	24.2	5	45.5
Radiation	17	27.4	4	36.4
Chemotherapy	30	48.4	5	45.5
Multicomponent	13	21.0	4	36.4
Lower bound for year of diagnosis				
Prior to 1990	8	12.9	4	36.4
1990–1999	41	66.1	4	36.4
2000 and later	9	14.5	3	27.3
Not reported	4	6.5	0	0.0
Tumor site reported*				
Colon	22	35.5	3	27.3
Rectum	19	30.6	5	45.5
Colorectal	24	38.7	4	36.4
Lower bound for age for inclusion				
<65	32	51.6	8	72.7
≥65	29	46.8	0	0.0
Not reported	1	1.6	3	27.3
Number of cancer patients				
<500	8	12.9	5	45.5
500–999	6	9.7	1	9.1
1000–4999	14	22.6	5	45.5
5000–9999	12	19.4	0	0.0
≥10 000	22	35.5	0	0.0

\* Not mutually exclusive.

SEER–Medicare or state registry data linked to Medicare claims provided treatment information for a majority of studies in the United States. The remaining US studies obtained data through hospital registries, a health maintenance organization (HMO) insurance network, or special studies of cancer patients (eg, the National Comprehensive Cancer Network’s (NCCN) Colon/Rectum Cancer Outcomes Database). As in other studies of initial care for Canada, chemotherapy treatment data were obtained from provincial registries linked to supplemental data sources. Several methods and definitions were used to assess chemotherapy receipt, even within studies, yielding a wide range of estimates. In the United States, lower use of chemotherapy was observed among patients with Medicaid coverage and those with comorbidities. And although black and white patients received consultation with an oncologist in similar proportions, white patients were significantly more likely to receive chemotherapy compared with black patients (34,50).

Seventeen studies reported receipt of multicomponent care for the treatment of colorectal cancer in the United States or Canada (Table 7). Among studies that referenced published guidelines for the receipt of adjuvant therapy, adherence ranged between approximately 50% and 80%. Patients and health services data were identified from various sources, including SEER Patterns of Care, the National Cancer Data Base, and provincial registries in Canada.

#### Postdiagnostic Surveillance Care

Patterns of care for the postdiagnostic surveillance of colorectal cancer were reported in 13 studies and were most commonly discussed in the context of achieving various guideline recommendations. Eleven studies were conducted in the United States (52,66–70,74,77–79,81) and two studies were conducted in Canada (65,72). SEER–Medicare data were used to assess postdiagnostic surveillance for a majority of the US studies. Data for the remaining studies in both the United States and Canada were obtained

**Table 2.** Characteristics of data sources used to measure patterns of colorectal cancer care in the United States\*

Percentage of studies	Data source	Data type	Population coverage	Patient data			Health services data			
				Date of diagnosis	Stage at diagnosis	Surgery	Radiotherapy	Chemotherapy	Post-diagnosis surveillance	End of life
40%	SEER–Medicare	Registry linked to Medicare claims	≥65 y diagnosed and treated in SEER regions	✓	✓	✓	✓	✓	✓	✓
10%	SEER	Registry	17 US regions	✓	✓	✓	✓	✓	✓	✓
10%	State registry linked <sup>†</sup>	Registry linked to supplemental data source	State	✓	✓	✓	✓	✓	✓	✓
8%	State registry alone <sup>†</sup>	Registry	State	✓	✓	✓	✓	✓	✓	✓
7%	HCUP–NIS	Hospital discharge data	Nation	✓	✓	✓	✓	✓	✓	✓
7%	Special study (eg, CanCORS) <sup>†</sup> ‡	Varies	Varies	✓	✓	✓	✓	✓	✓	✓
5%	Single institution <sup>†</sup>	Hospital medical records	Institution	✓	✓	✓	✓	✓	✓	✓
5%	Medical claims alone	Medical claims	Medical insurance beneficiaries	✓	✓	✓	✓	✓	✓	✓
3%	NCI Patterns of Care	Registry linked to physician surveys	17 US regions	✓	✓	✓	✓	✓	✓	✓
3%	NCDB	Chart review	Nation	✓	✓	✓	✓	✓	✓	✓
3%	NCCN CRC outcomes database	Chart review	Patients treated at 8 NCI comprehensive cancer centers	✓	✓	✓	✓	✓	✓	✓

\* CanCORS = Cancer Care Outcome Research and Surveillance Consortium; CRC = colorectal cancer; HCUP–NIS = Healthcare Cost and Utilization Project–Nationwide Inpatient Sample; NCCN = National Comprehensive Cancer Network; NCDB = National Cancer Data Base; NCI = National Cancer Institute; SEER = Surveillance, Epidemiology, and End Results.

† Availability of health services data may vary by state, study, or institution.

‡ Availability of patient data may vary by study.

**Table 3.** Characteristics of data sources used to measure patterns of colorectal cancer care in Canada\*

Percentage of studies	Data source	Data type	Population coverage	Patient data			Health services data			
				Date of diagnosis	Stage at diagnosis	Surgery	Radiotherapy	Chemotherapy	Postdiagnosis surveillance	End of life
18%	Multiple provincial registry data linked†	Registry linked to chart review or EHRs	Multiple provinces	✓	✓	✓	✓	✓	✓	✓
18%	British Columbia Cancer Agency	Registry linked to medical insurance claims	Province	✓	✓	✓	✓	✓	✓	✓
18%	CancerCare Manitoba	Registry linked to medical insurance claims	Province	✓	✓	✓	✓	✓	✓	✓
18%	Alberta Cancer Registry linked	Registry linked to EHRs, hospital discharge records, or other administrative records	Province	✓	✓	✓	✓	✓	✓	✓
18%	Single institutions†	Registry linked to medical records	Institution	✓	✓	✓	✓	✓	✓	✓
9%	Ontario Cancer Registry linked	Registry linked to pathology reports	Province	✓	✓	✓	✓	✓	✓	✓

\* EHR = electronic health record.

† Availability of health services data may vary by province or institution.

**Table 4.** Patterns of care for the initial receipt of surgery for colorectal cancer in the United States and Canada\*

Site	First author, year (ref.)	Country	Stage	Diagnosis year	Sample size	Age, y, %†	Health delivery setting and data sources	Findings
Colon	Hardiman, 2009 (9)	United States	Any	1998–2004	10 433	≥80, 30	Oregon; patients and health services data identified through the Oregon State Cancer Registry	Overall, patients aged ≥80 were as likely to receive surgery as were younger patients; older patients were less likely to have surgery if they had regional, distant, or unknown disease
Rectal	Pisu, 2010 (10)	United States	I–III	1999–2003	675	≥65, 100	Alabama; patients identified through registry; health services data from Medicare claims	Overall, 90% of patients received surgery; surgery receipt increased with increased stage (stage I: 85%, stage II: 93%, stage III: 95%)
	Ricciardi, 2010 (11)	United States	NR	NR	19 912	NR	Multiple states; patients and health services data identified through the HCUP–NIS	50% of discharges had a sphincter-sparing procedure; county-level data showed geographical variability in the receipt of sphincter-sparing techniques; one-fourth of counties treated ≥60% of patients with nonrestorative surgical techniques
	Latosinsky, 2009 (12)	Canada	I–III	1984–1997	333	Range 22–88	Manitoba; patients and health services data obtained through CancerCare Manitoba, which houses registry and treatment data	47% of patients received anterior resection, 51% received APR, 2% of patients received a permanent stoma
	Demers, 2008 (13)	Canada	NR	1985–1999	2925	≥60, 79	Manitoba; patients and health services data obtained through CancerCare Manitoba, which houses registry and treatment data	74% of patients received surgery; surgery alone was the most common treatment modality across the study period, though surgery alone decreased from 60% to 40% between 1985 and 1999
	Esnaola, 2008 (14)	United States	I–III	2003–2005	35 695	≥65, 51	Multiple states; patients identified from the NCDB; health services data obtained by medical record abstraction	Older patients (≥75) were less likely to receive surgery compared with younger patients (<55); older patients were more likely to receive local excision instead of definitive, segmental resection; compared with white patients, black patients were less likely to receive surgery
	Chang, 2007 (15)	United States	I–III	1991–2002	21 390	Median 68	Multiple states; patients and health services data identified from SEER	11% of patients did not receive cancer-directed surgery, 15% of patients received local excision, 44% of patients received LAR, 26% of patients received APR, and 4% of patients received multivisceral resection
	Ricciardi, 2007 (16)	United States	NR	NR	117 773	Mean 66	Multiple states; patients and health services data identified through the HCUP–NIS	Among patients who received surgery, 40% received sphincter-sparing procedures; the proportion of sphincter-sparing surgery increased from approximately 30% in 1988 to approximately 50% in 2003

(Table continues)

**Table 4 (Continued).**

Site	First author, year (ref.)	Country	Stage	Diagnosis year	Sample size	Age, y, %†	Health delivery setting and data sources	Findings
	Morris, 2006 (17)	United States	I–IV	1992–1999	10 940	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare	Segmental resection was performed on 56% of black patients and 62% of white patients ( $P = .005$ ); APR was more common among blacks (30%) than whites (28%); the proportion of transanal resection was similar in both groups
	Purves, 2005 (18)	United States	NR	NR	477	≥65, 25	Multiple states; patients and health services data identified through the HCUP–NIS	46% of patients had an APR and 54% had a sphincter-sparing procedure; patients treated by surgeons who had higher caseloads were more likely to undergo a sphincter-sparing procedure
	Morris, 2004 (19)	United States	Any	1988–1999	52 864	≥35, 100	Multiple states; patients and health services data identified from SEER	96% of white patients and 94% of black patients received surgery; among these, 63% and 57% of white and black patients, respectively, received a sphincter-sparing procedure; overall, black patients were less likely to receive any type of surgery
	Phang, 2003 (20)	Canada	0–IV	1996	481	Median 70	British Columbia; patients identified through the British Columbia Cancer Agency; health services data from chart review and physician surveys	The majority of rectal cancers were resected: 51% by anterior resection, 33% by APR, 5% by Hartmann's procedure, and 1% by proctocolectomy
	Shroen, 2001 (21)	United States	I–IV	1994–1996	637	Range 22–94	California; patients and health services data identified from the Cancer Surveillance Program (Sacramento)	More than 93% of patients received surgery; 22% of patients with middle rectum tumors and 55% of those with lower rectum tumors received APR; LAR was associated with female sex, tumor location, and treatment at a major teaching hospital
	Colorectal Chan, 2010 (22)	Canada	IV	2000–2002	411	≥70, 40	British Columbia; patients and health services data identified through the British Columbia Cancer Agency	70% of patients underwent resection of the primary tumor; those who did not receive resection were more likely to have rectal tumors
	Diggs, 2007 (23)	United States	Any	2002	26 269	≥65, 79	Multiple states; patients and health services data identified through the HCUP–NIS	Patients ≥85 y were most likely to undergo emergency resection; for patients aged <65 y, emergency resection receipt was highest among those who were uninsured
	Cook, 2005 (24)	United States	IV	1988–2000	17 658	≥50, 91	Multiple states; patients and health services data identified from SEER	66% of patients received resection; women, blacks, rectal cancer patients, and patients with leftsided colon cancers were less likely to have surgery

*(Table continues)*

**Table 4 (Continued).**

Site	First author, year (ref.)	Country	Stage	Diagnosis year	Sample size	Age, y, %†	Health delivery setting and data sources	Findings
	Temple, 2004 (25)	United States	IV	1990–1991	9011	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare	72% of patients received cancer-directed surgery; age ≥75 y, rectal lesions, left-sided colon tumors, and lower SES were associated with decreased likelihood of undergoing surgery
	Wudel, 2002 (26)	United States	I–IV	1990–1999	668	Median 69, 74‡	Tennessee; data were collected through cancer registry databases at a university medical center and a city hospital in the Nashville area	There was no difference in curative resection by race or hospital; at the university hospital, 74% of black patients and 81% of white patients received curative surgery; at the city hospital, 73% of black patients and 78% of white patients received curative surgery
	Roetzheim, 2000 (27)	United States	Any	1994	9551	Mean 72	Florida; patients identified through the Florida Cancer Data System; health services data from statewide hospital and ambulatory surgical centers, freestanding RT centers, and diagnostic imaging centers	Overall, 80% of patients received surgery; a higher proportion of female, married, Medicare HMO, regional stage, and colon cancer patients received surgery
	Simunovic, 2000 (28)	Canada	NR	1990	1072	≥20, 100	Ontario; patients identified through the registry and health services data from pathology report review	31% of patients received APRs; 32% of all procedures were performed in high-volume hospitals

\* APR = abdominoperineal resection; HCUP–NIS = Healthcare Cost and Utilization Project–Nationwide Inpatient Sample; HMO = health maintenance organization; LAR = lower anterior resection; NCDB = National Cancer Data Base; NR = not reported; RT = radiotherapy; SEER = Surveillance, Epidemiology, and End Results; SES = socioeconomic status.

† For studies where age distributions were not explicitly stated, we include measures of mean, median, or range as reflected in the original study's presentation.

‡ Median shown at university medical center, city hospital, respectively.



**Table 5. Patterns of care for the initial receipt of radiotherapy for colorectal cancer in the United States and Canada\***

Site	First author, year (ref.)	Country	Stage	Diagnosis year	Sample size	Age, y, %†	Health delivery setting and data sources	Findings
Colon	Dunn, 2010 (29)	United States	I–III	1988–2005	187 004	≥60, 81	Multiple states; patients and health services data identified from SEER	Less than 10% of nonmetastatic patients received RT; patients diagnosed in 1988 were 2.5 times more likely to receive RT than those diagnosed in 2005
Rectal	Kuo, 2010 (30)	United States	II	1994–2003	329	Range 28–93	California; patients and health services data identified through the registry's Desert Sierra Cancer Surveillance Program	54% of patients received pelvic RT; among these, 71% received RT postoperatively
	Lin, 2010 (31)	United States	II–III	1998–2005	8978	≥18, 100	Multiple states; patients and health services data identified from SEER	31% of patients received preoperative RT, 37% received postoperative RT, and 31% received no RT
	Pisu, 2010 (10)	United States	I–III	1999–2003	675	≥65, 100	Alabama; patients identified through registry; health services data from Medicare claims	15% of patients received neoadjuvant RT, 25% received adjuvant RT; over time, a higher proportion of patients received preoperative RT compared with postoperative RT
	Latosinsky, 2009 (12)	Canada	I–III	1984–1997	333	Range 22–88	Manitoba; patients and health services data obtained through CancerCare Manitoba, which houses registry and treatment data	47% of patients received adjuvant RT; receipt of RT increased by stage; 1% of patients received neoadjuvant RT
	Romanus, 2009 (32)	United States	I–IV	2005–2008	2042	≥65, 50	Multiple states; patients and health services data obtained from the NCCN Outcomes Database Project	93% of stage III patients aged ≤80 y and who underwent curative surgery received RT within 6 mo of diagnosis
	Demers, 2008 (13)	Canada	NR	1985–1999	2925	≥60, 79	Manitoba; patients and health services data from CancerCare Manitoba (cancer registry and treatment data)	Receipt of RT increased 32% to 40% between 1985 and 1999
	Dobie, 2008 (33)	United States	II–III	1992–1999	2886	≥66, 100	Multiple states; patients and health services data identified from SEER–Medicare	55% of all patients received RT; 48% of stage II and 62% of stage III patients received RT
	Morris, 2008 (34)	United States	II–III	1992–1999	2716	≥66, 100	Multiple states; patients and health services data identified from SEER–Medicare	57% of blacks and 65% of whites consulted with a radiation oncologist; among these, 74% of blacks and 83% of whites received RT after consultation
	Chang, 2007 (15)	United States	I–III	1991–2002	21 390	Median 68	Multiple states; patients and health services data identified through SEER	47% of patients received adjuvant RT; increasing age was associated with decreased receipt of RT
	Morris, 2006 (34)	United States	I–IV	1992–1999	10 940	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare	Among patients with stage II to IV disease, black patients were less likely to receive RT compared with white patients (25% vs 34%)
	Baxter, 2005 (35)	United States	Local regional	1976–2005	45 627	≥18, 100	Multiple states; patients and health services data identified from SEER	Overall, 32% of patients received RT; receipt increased 15% to 42% from 1976 to 2000; younger age, male sex, and regional spread was associated with RT use

(Table continues)

**Table 5 (Continued).**

Site	First author, year (ref.)	Country	Stage	Diagnosis year	Sample size	Age, y, %†	Health delivery setting and data sources	Findings
	Morris, 2004 (19)	United States	Any	1988–1999	52 864	≥35, 100	Multiple states; patients and health services data identified from SEER	47% of white patients and 44% of black patients received any RT; 7% of white patients and 7% of black patients received neoadjuvant RT
	Phang, 2003 (20)	Canada	0–IV	1996	481	Median 70	British Columbia; patients were identified through the British Columbia Cancer Agency; chart review and physician surveys were used to obtain health services data	60% of stage II and stage III patients received RT; of these, 89% received postoperative radiation and 11% received neoadjuvant radiation
	Neugut, 2002 (36)	United States	II–III	1991–2002	55 204	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare	Overall, 48% of patients received RT following surgery; 11% of patients received RT only for adjuvant therapy
	Schrag, 2001 (37)	United States	II–III	1992–1996	1411	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare	57% of patients received RT; increasing age was associated with decreased likelihood of RT receipt
	Shroen, 2001 (21)	United States	I–IV	1994–1996	637	Range 22–94	California; patients and health services data identified from the Cancer Surveillance Program (Sacramento)	14% of stage I, 53% of stage II, 63% of stage III, and 30% of stage IV patients received RT
Colorectal	Chan, 2010 (22)	Canada	IV	2000–2002	411	≥70, 40%	British Columbia; patients and health services data identified through the British Columbia Cancer Agency	63% of resected and 58% of nonresected rectal cancer patients received RT
	Ayanian, 2003 (38)	United States	II–III	1996–1997	1956	≥18, 100%	California; patients were identified from the registry; health services data obtained from physician surveys or hospital records	Based on registry data, 58% of patients received RT; this proportion increased to 64% with additional data obtained from physician surveys or hospital records; black and older patients were less likely to receive RT
	Wudell, 2002 (26)	United States	I–IV	1990–1999	668	Median 69, 74‡	Tennessee; data were collected through cancer registry databases at a university medical center and a city hospital in the Nashville area	There was no significant difference in RT receipt by race or hospital; at the university hospital, 7% of black patients and 10% of white patients received RT; at the city hospital, 7% of black patients and 6% of white patients received RT
	Roetzheim, 2000 (27)	United States	Any	1994	9551	Mean 72	Florida; patients identified through the Florida Cancer Data System; health services data were obtained from statewide hospital and ambulatory surgical centers, freestanding RT centers, and diagnostic imaging centers	Overall, 26% of patients received RT; a higher proportion of male, married, lower income, smoking, Medicaid, distant stage, and rectal cancer patients received surgery

\* NCCN = National Comprehensive Cancer Network; NR = not reported; RT = radiotherapy; SEER = Surveillance, Epidemiology, and End Results.

† For studies where age distributions were not explicitly stated, we include measures of mean, median, or range as reflected in the original study's presentation.

‡ Median shown at university medical center, city hospital, respectively.

**Table 6.** Patterns of care for the initial receipt of chemotherapy for colorectal cancer in the United States and Canada\*

Site	First author, year (ref.)	Country	Stage	Diagnosis year	Sample size	Age, y, %†	Health delivery setting and data sources	Findings
Colon	Kirkpatrick, 2010 (39)	United States	II	1995–2003	287	≥65, 69	Texas; patients identified through the Baylor University Medical Center tumor registry; health services data from chart review	Among patients receiving resection, 56% were referred to a medical oncologist, 28% received adjuvant chemotherapy; receipt of chemotherapy was associated with age at diagnosis, comorbidity score, tumor grade, and stage
	Winget, 2010 (40)	Canada	III	1999–2000	772	≥70, 56	Alberta; patients identified from the registry; health services data obtained from hospital discharge data and EMRs	Among patients who received surgery, 80% received an oncologist consultation within 6 mo of diagnosis; 63% of patients with an oncologist consultation received chemotherapy; 46% of patients received chemotherapy; 77% of patients who initiated chemotherapy completed at least 4 mo of therapy; an oxaliplatin-containing regimen was used for 67% of patients
	Earle, 2009 (41)	United States	II	2005–2008	258	≥65, 46	Multiple states; patients and health services data identified from the NCCN Colon/Rectum Cancer Outcomes Database	Patients aged ≥80 y received chemotherapy less often than younger patients; older patients who did receive chemotherapy were less likely to receive multiple agents
	Hardiman, 2009 (9)	United States	Any	1998–2004	10 433	≥80, 30	Oregon; patients and health services data identified through the Oregon State Cancer Registry	Study cohort was limited to patients who received chemotherapy; 17% received erythropoiesis-stimulating agents
	Hershman, 2009 (42)	United States	NR	1991–2002	13 422	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare	0% of stage I, 37% of stage II, and 92% of stage III colon cancer patients received chemotherapy
	Wirtzfeld, 2009 (43)	Canada	I–III	1999–2000	419	NR	Newfoundland and Labrador, Ontario; patient and health services data from the Newfoundland and Labrador Familial Colorectal Cancer Registry, the Ontario Familial Colorectal Cancer Registry, medical record review, and questionnaire	
	Romanus, 2009 (32)	United States	I–IV	2005–2008	2042	≥65, 50	Multiple states; patients and health services data obtained from the NCCN Outcomes Database Project	90% of stage III patients aged ≤80 y received chemotherapy within 4 mo of diagnosis
	Bradley, 2008 (44)	United States	I–IV	1997–2000	4675	≥66, 100	Michigan; patients identified from the registry; health services data identified from Medicare and Medicaid insurance claims	Oncologist consultations were received by 81% of Medicaid beneficiaries and 85% of Medicare-only beneficiaries; 23% of Medicaid beneficiaries and 34% of Medicare-only beneficiaries initiated chemotherapy; of these, 48% of Medicaid beneficiaries and 62% of Medicare-only beneficiaries completed chemotherapy regimens

(Table continues)

**Table 6 (Continued).**

Site	First author, year (ref.)	Country	Stage	Diagnosis year	Sample size	Age, y, %†	Health delivery setting and data sources	Findings
	Quah, 2007 (45)	United States	I–III	1990–2001	1327	Median 70	New York; patients and health services data identified from the MSKCC Colorectal Service Database and chart review	Younger patients (≤40 y) were more likely to receive chemotherapy compared with older patients: 39% vs 14% of stage II patients, 87% vs 80% of stage III patients Researchers classified receipt of chemotherapy using both liberal (1 claim-day in a month) and conservative (3 claim-days in a month) definitions; by the conservative definition, 16% initiated and 38% completed chemotherapy; by the liberal definition, 12% initiated and 42% completed chemotherapy 78% of patients saw an oncologist within 6 mo of diagnosis; 59% of patients received chemotherapy within 6 mo of diagnosis; consultation with a medical oncologist, younger age, white race, being married, and later year of diagnosis were associated with receipt of chemotherapy 48% of patients received chemotherapy
	Dobie, 2006 (46)	United States	III	1992–1996	5778	>66, 100	Multiple states; patients and health services data identified from SEER–Medicare	More than 30% of patients were treated with chemotherapy for 1 to 4 mo; chemotherapy treatment for 5–7 mo was associated with younger age, more recent year of diagnosis, being married, having a tumor of well/moderately differentiated grade, and having no comorbidities There was no difference in the proportions of white and black patients who received consultation with an oncologist (79% and 79%, respectively, $P = 0.922$ ); however, a significant difference in treatment receipt was observed where 70% of whites and 60% of blacks received chemotherapy ( $P < 0.001$ )
	Luo, 2006 (47)	United States	III	1992–1999	8978	>66, 100	Multiple states; patients and health services data identified from SEER–Medicare	
	McGory, 2006 (48)	United States	III	1994–2001	13 231	Mean 69	California; patients identified from the registry; health services data from California Patient Discharge Database	
	Neugut, 2006 (49)	United States	III	1995–1999	3733	>65, 100	Multiple states; patients and health services data identified from SEER–Medicare	
	Baldwin, 2005 (50)	United States	III	1992–1996	5294	>66, 100	Multiple states; patients and health services data identified from SEER–Medicare	

(Table continues)

**Table 6 (Continued).**

Site	First author, year (ref.)	Country	Stage	Diagnosis year	Sample size	Age, y, %†	Health delivery setting and data sources	Findings
	Jessup, 2005 (51)	United States	III	1990–2002	85 934	≥60, 79	Multiple states; patients and health services data from the National Cancer Data Base	Use of adjuvant chemotherapy increased from 39% in 1990 to 64% in 2002; these percentages include the use of both chemotherapy and biological response-modifiers (primarily 5-FU, levamisole, and BCG vaccine)
	Keating, 2005 (52)	United States	III	1993–1999	48 027	≥66, 100	Multiple states; patients and health services data identified from SEER–Medicare	Increases in market share of managed care by county was not associated with receipt of adjuvant chemotherapy ( $P = .94$ )
	Wu, 2004 (53)	United States	III	2001	303	≥65, 63	Louisiana; patients identified from the registry; health services data from medical records of patients treated in CoC and non-CoC hospitals	Receipt of chemotherapy based on race/sex was as follows: 65% white/male, 66% white/female, 72% black/male, 66% black/female; 75% of patients treated at CoC hospital and 54% at non-CoC hospital
	Sundararajan, 2002 (54)	United States	III–IV	1992–1996	4768	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare	4% of patients received chemotherapy that did not include 5-FU, whereas 52% received 5-FU-based therapy; younger age was strongly associated with receiving 5-FU treatment
	Schrag, 2001 (55)	United States	III	1991–1996	6262	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare	55% of all patients received chemotherapy; older age was associated with decreased likelihood of receipt of chemotherapy
	Sundararajan, 2001 (56)	United States	III	1992–1996	4998	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare	Approximately 50% of patients received 5-FU during the study period; use of 5-FU increased by 10% between 1992 and 1996
Rectal	Kuo, 2010 (30)	United States	II	1994–2003	329	Range 28–93	California; patients and health services data identified through the registry's Desert Sierra Cancer Surveillance Program	45% of patients received chemotherapy; among these, 11% of patients received chemotherapy only in addition to surgery
	Pisu, 2010 (10)	United States	I–III	1999–2003	675	≥65, 100	Alabama; patients identified through registry; health services data from Medicare claims	11% of patients received neoadjuvant chemotherapy; 37% received adjuvant chemotherapy
	Romanus, 2009 (32)	United States	I–IV	2005–2008	2042	≥65, 50	Multiple states; patients and health services data obtained from the NCCN Outcomes Database Project	81% of stage II/III patients aged ≤80 y received chemotherapy within 4 mo of diagnosis
	Demers, 2008 (13)	Canada	NR	1985–1999	2925	≥60, 79	Manitoba; patients and health services data from CancerCare Manitoba (cancer registry and treatment data)	Receipt of chemotherapy increased 13% to 37% between 1985 and 1999

(Table continues)

**Table 6 (Continued).**

Site	First author, year (ref.)	Country	Stage	Diagnosis year	Sample size	Age, y, %†	Health delivery setting and data sources	Findings
	Dobie, 2008 (33)	United States	II–III	1992–1999	2886	≥66, 100	Multiple states; patients and health services data identified from SEER–Medicare	52% of all patients received chemotherapy; 42% of stage II and 63% of stage III patients received chemotherapy
	Morris, 2008 (34)	United States	II–III	1992–1999	2716	≥66, 100	Multiple states; patients and health services data identified from SEER–Medicare	73% of blacks and 75% of whites consulted with a medical oncologist; following consultation, 54% of blacks and 70% of whites received chemotherapy
	Morris, 2006 (17)	United States	I–IV	1992–1999	10 940	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare	Among patients with stage II to IV disease, black patients were less likely to receive chemotherapy compared with white patients (27% vs 40%)
	Phang, 2003 (20)	Canada	0–IV	1996	481	Median 70	British Columbia; patients were identified through the British Columbia Cancer Agency; chart review and physician surveys were used to obtain health services data	60% of stage II and stage III patients received adjuvant chemotherapy
	Neugut, 2002 (36)	United States	II–III	1991–2002	55 204	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare	Overall, 51% of patients received adjuvant chemotherapy with 5-FU-containing regimens; 14% of patients received a 5-FU regimen only in addition to surgery
	Shroen, 2001 (21)	United States	I–IV	1994–1996	637	Range 22–94	Sacramento, California; patients and health services data identified from the Cancer Surveillance Program	11% of stage I patients, 54% of stage II patients, 70% of stage III patients, and 55% of stage IV patients received chemotherapy
Colorectal	Chan, 2010 (22)	Canada	IV	2000–2002	411	≥70, 40	British Columbia; patients and health services data identified through the British Columbia Cancer Agency	61% of resected patients and 58% nonresected patients received chemotherapy
	Hendren, 2010 (57)	United States	III	1998–2005	17 108	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare; patients receiving RT were excluded	66% of patients received adjuvant chemotherapy; surgical complications were associated with nonreceipt of chemotherapy
	Oliveria, 2004 (58)	United States	I–IV	1997–1999	217	Mean 72	Massachusetts; patient and health services data obtained from HMO administrative data and medical record review	48% of stage I patients, 60% of stage II patients, 87% of stage III patients, and 67% of stage IV patients received consultation with an oncologist; among those who received consultation with an oncologist, 14% of stage I patients, 44% of stage II patients, 67% of stage III patients, and 61% of stage IV patients received chemotherapy

(Table continues)

**Table 6 (Continued).**

Site	First author, year (ref.)	Country	Stage	Diagnosis year	Sample size	Age, y, %†	Health delivery setting and data sources	Findings
	Ayanian, 2003 (38)	United States	II–III	1996–1997	1956	≥18, 100	California; patients were identified from the registry; health services data obtained from physician surveys or hospital records	Based on registry data, 59% of patients received chemotherapy; this proportion increased to 67% with additional data obtained from physician surveys or hospital records; older and unmarried patients were less likely to receive chemotherapy
	Wudel, 2002 (26)	United States	I–IV	1990–1999	668	Median 69, 74‡	Tennessee; data were collected through cancer registry databases, a university medical center, and a city hospital in the Nashville area	There was no difference in chemotherapy receipt by race or hospital; at the university hospital, 16% of black patients and 21% of white patients received chemotherapy; at the city hospital, 16% of black patients and 25% of white patients received chemotherapy
	Roetzheim, 2000 (27)	United States	Any	1994	9551	Mean 72	Florida; patients identified through the Florida Cancer Data System; health services data were obtained from statewide hospital and ambulatory surgical centers, freestanding RT centers, and diagnostic imaging centers	Overall, 21% of patients received chemotherapy; a higher proportion of married, smoking, uninsured, distant stage, and rectal cancer patients received surgery

\* 5-FU = 5-Fluorouracil; CoC = Commission on Cancer; BCG = Bacillus Calmette–Guérin; EMR = electronic medical record; HMO = health maintenance organization; MSKCC = Memorial Sloan-Kettering Cancer Center; NCCN = National Comprehensive Cancer Network; NIP = not reported; RT = radiotherapy; SEER = Surveillance, Epidemiology, and End Results.

† For studies where age distributions were not explicitly stated, we include measures of mean, median, or range as reflected in the original study's presentation.

‡ Median shown at university medical center, city hospital, respectively.

**Table 7. Patterns of care for the initial receipt of multicomponent therapy for colorectal cancer in the United States and Canada\***

Site	First author, year (ref.)	Country	Stage	Diagnosis year	Sample size	Age, y, %†	Health delivery setting and data sources	Findings
Colon	Cree, 2009 (59)	Canada	III	2004	3280	≥65, 70	Alberta, Manitoba, and Saskatchewan; patients identified from registry; health services data from medical record review and/or through cancer registry	53% of stage III patients received standard care (surgery + chemotherapy and/or RT), as per the NIH Consensus Conference statement
	Cronin, 2006 (60)	United States	II–III	2000	475	≥20, 100	Multiple states; patients and health services data obtained from SEER registries and supplemental Patterns of Care physician surveys	61% of stage III patients received guideline therapy (surgery + 5-FU + leucovorin/levamisole); notably, due to a lack of consensus on guideline treatment for stage II disease, these patients were not included in survival or regression analyses
	VanEenwyk, 2002 (61)	United States	III	1996–1997	632	≥65, 71	Washington; patients identified from the registry linked to hospital discharge data	38% of patients did not receive adjuvant therapy (any chemotherapy or RT) in their treatment plan; older age, not having private health insurance, and living in a lower income area was associated with not having an adjuvant therapy treatment plan
Rectal	Pisu, 2010 (10)	United States	I–III	1999–2003	675	≥65, 100	Alabama; patients identified through registry; health services data from Medicare claims	17% of patients received chemoradiation
	Cree, 2009 (59)	Canada	II–III	2004	3280	≥65, 70	Alberta, Manitoba, and Saskatchewan; patients identified from registry; health services data from medical record review and/or through cancer registry	51% of stage II–III rectal cancer patients received standard care (surgery + chemotherapy and/or RT), as per the NIH Consensus Conference statement
	Latosinsky, 2009 (12)	Canada	I–III	1984–1997	333	Range 27–96	Manitoba; patients identified from the registry; health services data identified from medical records	Chemotherapy was administered concomitantly for more than 80% of patients who received RT
	Demers, 2008 (13)	Canada	NR	1985–1999	2925	≥60, 79	Manitoba; patients and health services data from CancerCare Manitoba (cancer registry and treatment data)	The combination of major surgery and perioperative chemoradiation increased from 1% to 25% between 1985 and 1999
	Dobie, 2008 (33)	United States	II–III	1992–1999	2886	≥66, 100	Multiple states; patients and health services data identified from SEER–Medicare	45% of patients received both chemotherapy and RT; 38% of stage II and 54% of stage III patients received both chemotherapy and RT
	Esnaola, 2008 (14)	United States	I–III	2003–2005	35 695	≥65, 51	Multiple states; patients identified from the NCDB; health services data obtained by medical record abstraction	Increasing age was associated with lower use of chemoradiation
	Morris, 2008 (34)	United States	II–III	1992–1999	2716	≥66, 100	Multiple states; patients and health services data identified from SEER–Medicare	Following consultation with an oncologist, 77% of whites and 61% of blacks received both chemotherapy and RT
	Cronin, 2006 (60)	United States	II–III	2000	352	≥20, 100	Multiple states; patients and health services data obtained from SEER registries and supplemental Patterns of Care physician surveys	55% of stage II and 53% of stage III rectal cancer patients received guideline therapy (surgery + 5-FU + RT)

(Table continues)



**Table 7 (Continued).**

Site	First author, year (ref.)	Country	Stage	Diagnosis year	Sample size	Age, y, %†	Health delivery setting and data sources	Findings
	McGory, 2006 (48)	United States	III	1994–2001	13 231	Mean 69	California; patients identified from the registry; health services data from California Patient Discharge Database	52% of stage I and 62% of stage II patients received chemoradiation
	Keating, 2005 (52)	United States	III	1993–1999	48 027	≥66, 100	Multiple states; patients and health services data identified from SEER–Medicare	Increases in market share of managed care by county were associated with receipt of adjuvant chemoradiation for patients with stage II or stage III cancer; rates peaked in areas with a market share of managed care between 1% and 10% ( $P = 0.001$ ).
	Dharma-Wardene, 2002 (62)	Canada	NR	1985–1999	2925	Median 69	Manitoba; patients identified from registry and health services data obtained from CancerCare Manitoba	The combination of major surgery and perioperative chemoradiation increased from 1% to 25% between 1985 and 1999
	Neugut, 2002 (36)	United States	II–III	1991–2002	55 204	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare	37% of patients received surgery with RT and 5-FU chemotherapy
	VanEenwyk, 2002 (61)	United States	III	1996–1997	632	≥65, 71	Washington; patients identified from the registry linked to hospital discharge data	27% of patients did not receive adjuvant therapy (any chemotherapy or RT); older age and later stage were associated with not having an adjuvant therapy treatment plan
	Schrag, 2001 (37)	United States	II–III	1992–1996	1411	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare	Overall, 42% of patients received chemoradiation; increasing age reduced likelihood of treatment receipt
	Shroen, 2001 (21)	United States	I–IV	1994–1996	637	Range 22–94	California (Sacramento); patients and health services data identified from the Cancer Surveillance Program	Evaluated by NIH Consensus Conference recommendations, 44% of stage II patients and 60% of stage III patients received recommended therapy (surgery + RT + chemotherapy)
Colorectal	White, 2008 (63)	United States	I–III	1991–2002	55 204	≥65, 100	Multiple states; patients and health services data identified from SEER–Medicare	77% of white patients and 74% of black patients received standard therapy according to NCI Physician Data Query guidelines
	Potosky, 2002 (64)	United States	II–III	1987–1995	4706	≥20, 100	Multiple states; patients and health services data obtained from SEER registries and supplemental Patterns of Care physician surveys	Standard therapy = 5-FU + levamisole/leucovorin for stage III colon patients, 5-FU with or without RT for stage II/III rectal patients; 78% of patients <55 y received standard therapy; 58% of whites, compared with 47% of blacks, received standard therapy

\* 5-FU = 5-Fluorouracil; NCDB = National Cancer Data Base; NCI = National Cancer Institute; NIH = National Institutes of Health; NR = not reported; RT = radiotherapy; SEER = Surveillance, Epidemiology, and End Results.

† For studies where age distributions were not explicitly stated, we include measures of mean, median, or range as reflected in the original study's presentation.

from registry linkages to medical claims, medical record review, or from a national research project designed to survey patterns of care and care outcomes for cancer patients (ie, Cancer Care Outcomes Consortium [CanCORS]). Physical examinations of the bowel or colon (eg, colonoscopy, sigmoidoscopy) accounted for a majority of surveillance methods reported, followed by carcinoembryonic antigen (CEA) testing, physician office visits, and scans of the abdomen, pelvis, or chest.

Because various established guidelines were used to evaluate adherence to postdiagnostic surveillance at varying time points following initial treatment, studies reported disparate proportions for receipt of care. In the United States, receipt of surveillance care ranged between 26% and 83% for bowel or colon examinations, and between 60% and 92% for physician office visits. In Canada, 59% to 71% of patients received CEA testing compared with 47% of patients in a US population (65,66). The use of scans for colorectal cancer surveillance has not been included in any published guidelines at the time of this publication; however, US studies reported 7% to 59% for the use of X-ray or positron emission tomographic scans. Receipt of surveillance care was independently associated with race, age, and treatment facility; blacks, older patients, and patients treated in community vs teaching hospitals were less likely to receive care (65,69,77).

### End-of-Life Care

Five studies reported the receipt of end-of-life care for colorectal cancer patients (71,73,75,76,80). These studies were all conducted in the United States and evaluated the use of palliative chemotherapy, hospice care, and hospital or emergency room services. Notably, four of the five studies acquired health services data from Medicare claims. The exception, McCarthy et al. (76), obtained data from a special study seeking to assess patient outcomes (ie, Study to Understand Patient Prognoses and Preferences for Outcomes and Risks of Treatments [SUPPORT]).

### Discussion

In this study, we evaluated contemporary patterns of colorectal cancer care in the United States and Canada, as identified through a systematic review of 73 studies. Although direct comparisons between and within the two countries were limited by differences in study populations and research methods, we generally observed similar patterns of cancer-directed initial care, including rates of surgical treatment, use of adjuvant chemotherapy, and use of radiation therapy in the United States and Canada. Few studies measured postdiagnostic surveillance or end-of-life care. Our findings highlighted research gaps related to treatment practices in the absence of consensus-based guidelines. In addition, the time required to link data sources used to measure patterns of care results in data lags that can affect promising research, as in the case of the SEER–Medicare linkage (83). Researchers, clinicians, and policy makers can use findings from this review in efforts to quantify future economic and health-care resources that will be needed to improve treatment, outcomes, and access to care for colorectal cancer patients treated in the United States and Canada.

Findings for cancer-directed surgery in both the United States and Canada showed that most patients were resected, although the specific types of surgery received varied. Since 2000, surgical resection as the sole treatment modality for any colorectal cancer has declined with the addition of neoadjuvant and adjuvant treatment. In recent years, permanent colostomies have occurred less frequently and sphincter-sparing procedures have become a viable option for more rectal cancer patients when radiotherapy is given preoperatively (84). Moreover, the role of radiotherapy among colorectal cancer patients is largely restricted to those with rectal cancer. For these patients, the use of radiotherapy increased over time, whereas rates for colon cancer patients remained stagnant at 20% or less (27,29). This observation is consistent with recommendations for the treatment of colorectal cancer (85), which endorse radiotherapy for patients with rectal cancer, specifically those with stage II or III disease. In contrast, receipt of radiotherapy is only indicated for stage IV colon cancer patients or those who have experienced recurrence. The receipt of neoadjuvant radiotherapy for rectal cancer patients also increased over time (31). Shrinking the tumor preoperatively through neoadjuvant therapy maximizes options for surgical resection and is likely to affect observed patterns of both surgical and adjuvant care.

Receipt of chemotherapy increased over time, but varied considerably across studies, ranging between 28% and 90% in the United States and between 0% and 92% in Canada. Chemotherapy receipt was associated with anatomical site of the tumor, stage of disease, and patient insurance status; such wide variation in treatment receipt was due to differences in study populations and research methods. For US and Canadian studies that had comparable patient populations, receipt of chemotherapy was generally similar. Among those receiving chemotherapy, 5-Fluorouracil (5-FU)-based regimens were commonly administered, particularly for patients with stage II–IV colon cancer where such treatment is recommended by guidelines (85). However, with the advent of effective but expensive drugs (86) and use of supportive agents (87), costs associated with chemotherapy are expected to increase over time, potentially introducing an additional barrier for patients to receive appropriate care. Few studies in our review addressed the use of newer chemotherapeutic or biological agents, due, in part, to lags in the availability of data on cancer drugs. Future research should evaluate the specific agents used in colorectal cancer care.

Consensus-based guidelines provided the context for many of the studies that assessed multicomponent care in our review; however, guideline adherence varied by study population setting and year of diagnosis, likely because practice guidelines vary in their treatment recommendations. One study assessing treatment in relation to NCCN guidelines among a network of NCCN institutions reported that although guideline adherence varied, the reported receipt of guideline care remained high (>80%), as may be expected among US comprehensive cancer centers (32). In contrast, a population-based study conducted by Shroen et al. demonstrated that only 44% of stage II and 60% of stage III rectal cancer patients obtained recommended therapy, as outlined by the National Institutes of Health Consensus Conference (21).

Comparisons of treatment receipt between and within the United States and Canada are limited for early- and late-stage colorectal cancer patients because of the lack of consensus-based guidelines for the two patient groups. Nearly 40% of colorectal cancer patients receive a diagnosis of localized disease, and approximately one-quarter of patients are diagnosed with distant disease. This results in a substantial number of patients whose treatment plans cannot be evaluated in relation to a standard of care (88). Controlled trials for these patient populations will play a large role in guideline development. However, it should be noted that treatment plans vary at the discretion of the treating physician along with patient preferences for care, despite the existence of guideline recommendations.

Few studies of postdiagnostic surveillance were identified for our review, and most were conducted in the context of achieving guideline recommendations. Because there was no general consensus on frequency and time to follow-up care across guidelines, proportions of care receipt varied widely. Coordinated development of evidence-based guidelines for postdiagnostic colorectal cancer surveillance is needed to improve patient care, and evaluation of their implementation will be important for future research.

Few studies in our literature review addressed end-of-life care for colorectal cancer patients. This may be expected because end-of-life studies tend to group all cancer patients together and do not report receipt of care separately by cancer site. However, because palliative care is not cancer-directed, this component of end-of-life care may be relatively consistent for all cancer patients. Of the five end-of-life care studies we identified, four were conducted among US patients with Medicare coverage, which promotes the use of hospice care. Future research describing end-of-life care will be important, particularly in Canada, where we did not identify any study and where the availability of hospice care varies by province.

A significant proportion of patients did not receive expected surgical or adjuvant care based on tumor site and disease stage, particularly patients who were nonwhite, older age, or who reported comorbidities. In the United States, blacks were least likely to receive any component of colorectal cancer care. However, we identified particularly worrisome findings in our review for chemotherapy use in the context of disparities by race. Although black and white colon cancer patients received consultation with an oncologist in similar proportions, blacks were significantly less likely to receive chemotherapy (34,50). The Canadian studies included in our review generally did not provide data on treatment receipt stratified by race. Studies assessing the association between race and treatment receipt in Canada's universal health-care system would add to the current body of knowledge regarding disparities in health-care access because barriers to care are assumed to be mitigated in this population. In the United States, more studies of Asian and Hispanic populations, which were underrepresented in our review, are needed to inform efforts that seek to improve care. Older patients and

individuals with comorbidities were also consistently less likely to obtain recommended care (36,45,47,61). However, these patient populations typically have contraindications to treatment; thus, data on performance status in future research will allow for improved assessments of patterns of care. Ongoing efforts to improve measurement of comorbidities and to evaluate potential barriers of access to care will inform future efforts to reduce treatment disparities.

Though trends in the receipt of care were generally similar between the two countries, we observed differences in the United States and Canada with respect to data resources used to identify colorectal cancer treatment. Health-care payers in each country are central to the availability of patient treatment data. Canada's universal health coverage provides centralized systems health services data, thereby creating a potential resource that would allow for the continuous observation of patients. However, few provinces or territories have linked registry data to insurance claims. In the United States, varying forms of health-care coverage yield multiple data sources that can be used to measure patterns of care. But the disparate resources pose a challenge in the accurate assessment of care patterns for the US population as a whole. Additionally, measuring patterns of care is limited by discontinuity between data sources and lags in data availability for both countries. In the United States, ongoing state-based efforts to link registry data with multiple health insurance datasets may lead to a more comprehensive view of cancer care patterns (89–91). In Canada, the Canadian Partnership Against Cancer (CPAC) heads several initiatives that seek to improve cancer surveillance, including efforts to reduce information gaps at the national, provincial, and territorial levels (92).

In conclusion, this review summarizes a substantial volume of literature on colorectal cancer treatment practices in the United States and Canada, providing a basis for researchers who seek to address research gaps within colorectal cancer populations. Future work in assessing patterns of care for colorectal cancer patients in the United States and Canada should seek to include more studies in the areas of postdiagnostic surveillance and end-of-life care, which were both underrepresented in our review. Although guidelines provide insight on specific aspects of care, ongoing evaluation of the receipt of all types of colorectal cancer care for all stages and tumor sites will be important in identifying over- and under-use of health services. Further, where guideline consensus does not exist, as in the case of postdiagnostic surveillance care, descriptions of metrics used to assess receipt of care will enable comparisons across studies. Future work should also address challenges to the interpretation of care patterns, including the use of various staging systems, alternating use of clinical or pathological staging, and contraindications to treatment that are not consistently captured or are absent from data sources. High-quality research on patterns of colorectal cancer care will aid policy makers in quantifying the resources needed to treat this population, while addressing disparities, projecting future costs, and ultimately improving care and cancer outcomes.

## Appendix 1

Search No.	Limits: English, Journal Article, Humans, Publication Date from 2000 to 2010
1	"Colorectal Neoplasms/drug therapy"[Mesh] OR "Colorectal Neoplasms/radiotherapy"[Mesh] OR "Colorectal Neoplasms/surgery"[Mesh] OR "Colorectal Neoplasms/therapy"[Mesh]
2	"Physician's Practice Patterns"[Mesh]
3	"Guideline Adherence"[Mesh]
4	"Health Services/statistics and numerical data"[Majr] OR "Health Services/trends"[Majr] OR "Health Services/utilization"[Majr]
5	"Quality of Health Care/statistics and numerical data"[Majr] OR "Quality of Health Care/trends"[Majr] OR "Quality of Health Care/utilization"[Majr]
6	"Chemotherapy, Adjuvant/statistics and numerical data"[Mesh] OR "Chemotherapy, Adjuvant/trends"[Mesh] OR "Chemotherapy, Adjuvant/utilization"[Mesh]
7	"Neoadjuvant Therapy/statistics and numerical data"[Mesh] OR "Neoadjuvant Therapy/trends"[Mesh] OR "Neoadjuvant Therapy/utilization"[Mesh]
8	"Radiotherapy, Adjuvant/statistics and numerical data"[Mesh] OR "Radiotherapy, Adjuvant/trends"[Mesh] OR "Radiotherapy, Adjuvant/utilization"[Mesh]
9	"Neoplasm Recurrence, Local/prevention and control"[Majr]
10	"Terminal Care"[Mesh]
11	"Patterns of Care"[Keyword String][Abstract or Title]
12	Search No. 1 AND (No. 2 OR No. 3 OR No. 4 OR No. 5 OR No. 6 OR No. 7 OR No. 8 OR No. 9 OR No. 10 OR No. 11)
13	Select studies conducted in the United States or Canada

## References

1. Ferlay J, Shin HR, Bray F, Forman D, Mathers C, Parkin DM. *GLOBOCAN 2008 v1.2, Cancer Incidence and Mortality Worldwide: LARC CancerBase No. 10*. Lyon, France: International Agency for Research on Cancer; 2010. <http://globocan.iarc.fr>. Accessed June 7, 2013.
2. Siegel R, Naishadham D, Jemal A. Cancer statistics, 2012 [published online ahead of print January 13, 2012]. *CA Cancer J Clin*. 2012;62(1):10–29. doi:10.3322/caac.20138.
3. Canadian Cancer Society's Steering Committee on Cancer Statistics. *Canadian Cancer Statistics 2011*. Toronto, ON: Canadian Cancer Society; 2011.
4. Edwards BK, Ward E, Kohler BA, et al. Annual report to the nation on the status of cancer, 1975–2006, featuring colorectal cancer trends and impact of interventions (risk factors, screening, and treatment) to reduce future rates [published online ahead of print December 10, 2009]. *Cancer*. 2010;116(3):544–573. doi:10.1002/cncr.24760.
5. Phillips KA, Liang SY, Ladabaum U, et al. Trends in colonoscopy for colorectal cancer screening [published online ahead of print January 17, 2007]. *Med Care*. 2007;45(2):160–167. doi:10.1002/cncr.24760.
6. Hurwitz H, Fehrenbacher L, Novotny W, et al. Bevacizumab plus irinotecan, fluorouracil, and leucovorin for metastatic colorectal cancer [published online ahead of print June 4, 2004]. *N Engl J Med*. 2004;350(23):2335–2342. doi:10.1056/NEJMoa032691.
7. Schrag D. The price tag on progress—chemotherapy for colorectal cancer [published online ahead of print July 23, 2004]. *N Engl J Med*. 2004;351(4):317–319. doi:10.1056/NEJMp048143.
8. Chawla N, Butler EN, Lund J, Warren JL, Harlan LC, Yabroff KR. Patterns of care in Europe, Australia, and New Zealand. *J Natl Cancer Inst Monogr*. 2013;46(1):36–61.
9. Hardiman KM, Cone M, Sheppard BC, Herzig DO. Disparities in the treatment of colon cancer in octogenarians [published online ahead of print April 28, 2009]. *Am J Surg*. 2009;197(5):624–628. doi:10.1016/j.amjsurg.2008.12.018.
10. Pisu M, Richardson LC, Kim YI, et al. Less-than-standard treatment in rectal cancer patients: which patients are at risk [published online ahead of print April 2, 2010]? *J Natl Med Assoc*. 2010;102(3):190–198.
11. Ricciardi R, Roberts PL, Read TE, Marcello PW, Schoetz DJ, Baxter NN. Variability in reconstructive procedures following rectal cancer surgery in the United States [published online ahead of print May 21, 2010]. *Dis Colon Rectum*. 2010;53(6):874–880. doi:10.1007/DCR.0b013e3181cf6f58.
12. Latosinsky S, Turner D. Local recurrence after rectal cancer treatment in Manitoba [published online ahead of print February 2, 2009]. *Can J Surg*. 2009;52(1):45–50.
13. Demers AA, Latosinsky S, Turner D. Survival and treatment trends of rectal cancer patients in a population with suboptimal local control [published online ahead of print November 6, 2007]. *Eur J Surg Oncol*. 2008;34(6):655–661. doi:10.1016/j.ejso.2007.09.002.
14. Esnaola NF, Stewart AK, Feig BW, Skibber JM, Rodriguez-Bigas MA. Age-, race-, and ethnicity-related differences in the treatment of nonmetastatic rectal cancer: a patterns of care study from the national cancer data base [published online ahead of print August 21, 2008]. *Ann Surg Oncol*. 2008;15(11):3036–3047. doi:10.1245/s10434-008-0106-9.
15. Chang GJ, Skibber JM, Feig BW, Rodriguez-Bigas M. Are we under-treating rectal cancer in the elderly? An epidemiologic study [published online ahead of print August 2, 2007]. *Ann Surg*. 2007;246(2):215–221. doi:10.1097/SLA.0b013e318070838f.
16. Ricciardi R, Virnig BA, Madoff RD, Rothenberger DA, Baxter NN. The status of radical proctectomy and sphincter-sparing surgery in the United States [published online ahead of print June 19, 2007]. *Dis Colon Rectum*. 2007;50(8):1119–1127; discussion 1126–1127. doi:10.1007/s10350-007-0250-5.
17. Morris AM, Wei Y, Birkmeyer NJ, Birkmeyer JD. Racial disparities in late survival after rectal cancer surgery [published online ahead of print November 25, 2006]. *J Am Coll Surg*. 2006;203(6):787–794. doi:10.1016/j.jamcollsurg.2006.08.005.
18. Purves H, Pietrobon R, Hervey S, Guller U, Miller W, Ludwig K. Relationship between surgeon caseload and sphincter preservation in patients with rectal cancer [published online ahead of print April 7, 2005]. *Dis Colon Rectum*. 2005;48(2):195–202; discussion 202–204. doi:10.1007/s10350-004-0793-7.
19. Morris AM, Billingsley KG, Baxter NN, Baldwin LM. Racial disparities in rectal cancer treatment: a population-based analysis [published online ahead of print February 11, 2004]. *Arch Surg*. 2004;139(2):151–155; discussion 6. doi:10.1001/archsurg.139.2.151.
20. Phang PT, MacFarlane JK, Taylor RH, et al. Practice patterns and appropriateness of rectal cancer management in British Columbia. *BC Med J*. 2003;45(7):324–329.
21. Schroen AT, Cress RD. Use of surgical procedures and adjuvant therapy in rectal cancer treatment: a population-based study [published online ahead of print October 31, 2001]. *Ann Surg*. 2001;234(5):641–651.
22. Chan TW, Brown C, Ho CC, Gill S. Primary tumor resection in patients presenting with metastatic colorectal cancer: analysis of a provincial population-based cohort [published online ahead of print August 26, 2009]. *Am J Clin Oncol*. 2010;33(1):52–55. doi:10.1097/COC.0b013e31819e902d.
23. Diggs JC, Xu F, Diaz M, Cooper GS, Koroukian SM. Failure to screen: predictors and burden of emergency colorectal cancer resection

- [published online ahead of print March 6, 2007]. *Am J Manag Care*. 2007;13(3):157-164.
24. Cook AD, Single R, McCahill LE. Surgical resection of primary tumors in patients who present with stage IV colorectal cancer: an analysis of surveillance, epidemiology, and end results data, 1988 to 2000 [published online ahead of print June 21, 2005]. *Ann Surg Oncol*. 2005;12(8):637-345. doi:10.1245/ASO.2005.06.012.
  25. Temple LK, Hsieh L, Wong WD, Saltz L, Schrag D. Use of surgery among elderly patients with stage IV colorectal cancer [published online ahead of print September 1, 2004]. *J Clin Oncol*. 2004;22(17):3475-3484. doi:10.1200/JCO.2004.10.218.
  26. Wudel LJ Jr, Chapman WC, Shyr Y, et al. Disparate outcomes in patients with colorectal cancer: effect of race on long-term survival [published online ahead of print May 2, 2002]. *Arch Surg*. 2002;137(5):550-554; discussion 554-556.
  27. Roetzheim RG, Pal N, Gonzalez EC, Ferrante JM, Van Durme DJ, Krischer JP. Effects of health insurance and race on colorectal cancer treatments and outcomes [published online ahead of print November 15, 2000]. *Am J Public Health*. 2000;90(11):1746-1754.
  28. Simunovic M, To T, Baxter N, et al. Hospital procedure volume and teaching status do not influence treatment and outcome measures of rectal cancer surgery in a large general population [published online ahead of print April 18, 2000]. *J Gastrointest Surg*. 2000;4(3):324-330.
  29. Dunn EF, Kozak KR, Moody JS. External beam radiotherapy for colon cancer: patterns of care [published online ahead of print July 22, 2009]. *Int J Radiat Oncol Biol Phys*. 2010;76(5):1420-1424. doi:10.1016/j.ijrobp.2009.03.014.
  30. Kuo I, Wong JH, Roy-Chowdhury S, Lum SS, Morgan JW, Kazanjian K. The use of pelvic radiation in stage II rectal cancer: a population-based analysis [published online ahead of print October 26, 2010]. *Am Surg*. 2010;76(10):1092-1095.
  31. Lin C, Charlton ME, Meza JL, Enke CA, Loberiza FR Jr. Temporal and regional variations in the use of preoperative radiation therapy for rectal cancer [published online ahead of print December 3, 2009]. *Am J Clin Oncol*. 2010;33(5):443-447. doi:10.1097/COC.0b013e3181b4b175.
  32. Romanus D, Weiser MR, Skibber JM, et al. Concordance with NCCN Colorectal Cancer Guidelines and ASCO/NCCN Quality Measures: an NCCN institutional analysis [published online ahead of print September 17, 2009]. *J Natl Compr Canc Netw*. 2009;7(8):895-904.
  33. Dobie SA, Warren JL, Matthews B, Schwartz D, Baldwin LM, Billingsley K. Survival benefits and trends in use of adjuvant therapy among elderly stage II and III rectal cancer patients in the general population [published online ahead of print January 15, 2008]. *Cancer*. 2008;112(4):789-799. doi:10.1002/cncr.23244.
  34. Morris AM, Billingsley KG, Hayanga AJ, Matthews B, Baldwin LM, Birkmeyer JD. Residual treatment disparities after oncology referral for rectal cancer [published online ahead of print May 15, 2008]. *J Natl Cancer Inst*. 2008;100(10):738-744. doi:10.1093/jnci/djn145.
  35. Baxter NN, Rothenberger DA, Morris AM, Bullard KM. Adjuvant radiation for rectal cancer: do we measure up to the standard of care? An epidemiologic analysis of trends over 25 years in the United States [published online ahead of print February 5, 2005]. *Dis Colon Rectum*. 2005;48(1):9-15. doi:10.1007/s10350-004-0792-8.
  36. Neugut AI, Fleischauer AT, Sundararajan V, et al. Use of adjuvant chemotherapy and radiation therapy for rectal cancer among the elderly: a population-based study [published online ahead of print June 1, 2002]. *J Clin Oncol*. 2002;20(11):2643-2650.
  37. Schrag D, Gelfand SE, Bach PB, Guillem J, Minsky BD, Begg CB. Who gets adjuvant treatment for stage II and III rectal cancer? Insight from surveillance, epidemiology, and end results—Medicare [published online ahead of print September 5, 2001]. *J Clin Oncol*. 2001;19(17):3712-3718.
  38. Ayanian JZ, Zaslavsky AM, Fuchs CS, et al. Use of adjuvant chemotherapy and radiation therapy for colorectal cancer in a population-based cohort [published online ahead of print March 29, 2003]. *J Clin Oncol*. 2003;21(7):1293-1300. doi:10.1200/JCO.2003.06.178.
  39. Kirkpatrick HM, Aitelli CL, Qin H, Becerra C, Lichliter WE, McCollum AD. Referral patterns and adjuvant chemotherapy use in patients with stage II colon cancer [published online ahead of print July 21, 2010]. *Clin Colorectal Cancer*. 2010;9(3):150-156. doi:10.3816/CCC.2010.n.020.
  40. Winget M, Hossain S, Yasui Y, Scarfe A. Characteristics of patients with stage III colon adenocarcinoma who fail to receive guideline-recommended treatment [published online ahead of print June 26, 2010]. *Cancer*. 2010;116(20):4849-4856. doi:10.1002/cncr.25250.
  41. Earle CC, Weiser MR, Ter Veer A, et al. Effect of lymph node retrieval rates on the utilization of adjuvant chemotherapy in stage II colon cancer [published online ahead of print August 22, 2009]. *J Surg Oncol*. 2009;100(7):525-528. doi:10.1002/jso.21373.
  42. Hershman DL, Buono DL, Malin J, McBride R, Tsai WY, Neugut AI. Patterns of use and risks associated with erythropoiesis-stimulating agents among Medicare patients with cancer [published online ahead of print November 12, 2009]. *J Natl Cancer Inst*. 2009;101(23):1633-41. doi:10.1093/jnci/djp387.
  43. Wirtzfeld DA, Mikula L, Gryfe R, et al. Concordance with clinical practice guidelines for adjuvant chemotherapy in patients with stage I-III colon cancer: experience in 2 Canadian provinces [published online ahead of print April 29, 2009]. *Can J Surg*. 2009;52(2):92-97.
  44. Bradley CJ, Given CW, Dahman B, Fitzgerald TL. Adjuvant chemotherapy after resection in elderly Medicare and Medicaid patients with colon cancer [published online ahead of print March 12, 2008]. *Arch Intern Med*. 2008;168(5):521-529. doi:10.1001/archinternmed.2007.82.
  45. Quah HM, Joseph R, Schrag D, et al. Young age influences treatment but not outcome of colon cancer [published online ahead of print June 27, 2007]. *Ann Surg Oncol*. 2007;14(10):2759-2765. doi:10.1245/s10434-007-9465-x.
  46. Dobie SA, Baldwin LM, Dominitz JA, Matthews B, Billingsley K, Barlow W. Completion of therapy by Medicare patients with stage III colon cancer [published online ahead of print May 4, 2006]. *J Natl Cancer Inst*. 2006;98(9):610-619. doi:10.1093/jnci/djj159.
  47. Luo R, Giordano SH, Freeman JL, Zhang D, Goodwin JS. Referral to medical oncology: a crucial step in the treatment of older patients with stage III colon cancer [published online ahead of print October 13, 2006]. *Oncologist*. 2006;11(9):1025-1033. doi:10.1634/theoncologist.11-9-1025.
  48. McGory ML, Zingmond DS, Sekeris E, Bastani R, Ko CY. A patient's race/ethnicity does not explain the underuse of appropriate adjuvant therapy in colorectal cancer [published online ahead of print February 14, 2006]. *Dis Colon Rectum*. 2006;49(3):319-329. doi:10.1007/s10350-005-0283-6.
  49. Neugut AI, Matasar M, Wang X, et al. Duration of adjuvant chemotherapy for colon cancer and survival among the elderly [published online ahead of print April 19, 2006]. *J Clin Oncol*. 2006; 24(15):2368-2375. doi:10.1200/JCO.2005.04.5005.
  50. Baldwin LM, Dobie SA, Billingsley K, et al. Explaining black-white differences in receipt of recommended colon cancer treatment [published online ahead of print August 18, 2005]. *J Natl Cancer Inst*. 2005;97(16):1211-1220. doi:10.1093/jnci/dji241.
  51. Jessup JM, Stewart A, Greene FL, Minsky BD. Adjuvant chemotherapy for stage III colon cancer: implications of race/ethnicity, age, and differentiation [published online ahead of print December 8, 2005]. *J Natl Med Assoc*. 2005;294(21):2703-2711. doi:10.1001/jama.294.21.2703.
  52. Keating NL, Landrum MB, Meara E, Ganz PA, Guadagnoli E. Do increases in the market share of managed care influence quality of cancer care in the fee-for-service sector? [published online ahead of print February 17, 2005]. *J Natl Cancer Inst*. 2005;97(4):257-264. doi:10.1093/jnci/dji044.
  53. Wu X, Chen VW, Andrews PA, Chen L, Hsieh M, Fontham ET. Treatment patterns for stage III colon cancer and factors related to receipt of post-operative chemotherapy in Louisiana [published online ahead of print November 24, 2004]. *J La State Med Soc*. 2004;156(5):255-261.
  54. Sundararajan V, Mitra N, Jacobson JS, Grann VR, Heitjan DF, Neugut AI. Survival associated with 5-fluorouracil-based adjuvant chemotherapy among elderly patients with node-positive colon cancer [published online ahead of print March 5, 2002]. *Ann Intern Med*. 2002;136(5):349-357.
  55. Schrag D, Cramer LD, Bach PB, Begg CB. Age and adjuvant chemotherapy use after surgery for stage III colon cancer [published online ahead of print June 8, 2001]. *J Natl Cancer Inst*. 2001;93(11):850-857.
  56. Sundararajan V, Grann VR, Jacobson JS, Ahsan H, Neugut AI. Variations in the use of adjuvant chemotherapy for node-positive colon cancer in the

- elderly: a population-based study [published online ahead of print June 23, 2001]. *Cancer*. 2001;7(3):213–218.
57. Hendren S, Birkmeyer JD, Yin H, Banerjee M, Sonnenday C, Morris AM. Surgical complications are associated with omission of chemotherapy for stage III colorectal cancer [published online ahead of print December 24, 2010]. *Dis Colon Rectum*. 2010;53(12):1587–1593. doi:10.1007/DCR.0b013e3181f2f202.
  58. Oliveria SA, Yood MU, Campbell UB, Yood SM, Stang P. Treatment and referral patterns for colorectal cancer [published online ahead of print August 21, 2004]. *Med Care*. 2004;42(9):901–906.
  59. Cree M, Tonita J, Turner D, et al. Comparison of treatment received versus long-standing guidelines for stage III colon and stage II/III rectal cancer patients diagnosed in Alberta, Saskatchewan, and Manitoba in 2004 [published online ahead of print July 28, 2009]. *Clin Colorectal Cancer*. 2009;8(3):141–145. doi:10.3816/CCC.2009.n.023.
  60. Cronin DP, Harlan LC, Potosky AL, Clegg LX, Stevens JL, Mooney MM. Patterns of care for adjuvant therapy in a random population-based sample of patients diagnosed with colorectal cancer [published online ahead of print October 13, 2006]. *Am J Gastroenterol*. 2006;101(10):2308–2318. doi:10.1111/j.1572-0241.2006.00775.x.
  61. VanEenwyk J, Campo JS, Ossiander EM. Socioeconomic and demographic disparities in treatment for carcinomas of the colon and rectum [published online ahead of print July 13, 2002]. *Cancer*. 2002;95(1):39–46. doi:10.1002/cncr.10645.
  62. Dharma-Wardene MW, de Gara C, Au HJ, Hanson J, Hatcher J. Ageism in rectal carcinoma? Treatment and outcome variations [published online ahead of print June 10, 2003]. *Int J Gastrointest Cancer*. 2002;32(2–3):129–138. doi:10.1385/IJGC:32:2–3:129.
  63. White A, Liu CC, Xia R, et al. Racial disparities and treatment trends in a large cohort of elderly African Americans and Caucasians with colorectal cancer, 1991 to 2002 [published online ahead of print October 22, 2008]. *Cancer*. 2008;113(12):3400–3409. doi:10.1002/cncr.23924.
  64. Potosky AL, Harlan LC, Kaplan RS, Johnson KA, Lynch CF. Age, sex, and racial differences in the use of standard adjuvant therapy for colorectal cancer [published online ahead of print March 1, 2002]. *J Clin Oncol*. 2002;20(5):1192–1202.
  65. Cheung WY, Pond GR, Rother M, et al. Adherence to surveillance guidelines after curative resection for stage II/III colorectal cancer [published online ahead of print July 16, 2008]. *Clin Colorectal Cancer*. 2008;7(3):191–196. doi:10.3816/CCC.2008.n.025.
  66. Cooper GS, Kou TD, Reynolds HL Jr. Receipt of guideline-recommended follow-up in older colorectal cancer survivors: a population-based analysis [published online ahead of print September 10, 2008]. *Cancer*. 2008;113(8):2029–2037. doi:10.1002/cncr.23823.
  67. Cooper GS, Payes JD. Temporal trends in colorectal procedure use after colorectal cancer resection [published online ahead of print December 5, 2006]. *Gastrointest Endosc*. 2006;64(6):933–940. doi:10.1016/j.gie.2006.08.024.
  68. Cooper GS, Yuan Z, Chak A, Rimm AA. Patterns of endoscopic follow-up after surgery for nonmetastatic colorectal cancer [published online ahead of print July 7, 2007]. *Gastrointest Endosc*. 2000;52(1):33–38. doi:10.1067/mge.2000.106685.
  69. Ellison GL, Warren JL, Knopf KB, Brown ML. Racial differences in the receipt of bowel surveillance following potentially curative colorectal cancer surgery [published online ahead of print January 1, 2004]. *Health Serv Res*. 2003;38(6 pt 2):1885–1903. doi:10.1111/j.1475-6773.2003.00207.x
  70. Elston Lafata J, Cole Johnson C, Ben-Menachem T, Morlock RJ. Sociodemographic differences in the receipt of colorectal cancer surveillance care following treatment with curative intent [published online ahead of print May 1, 2001]. *Med Care*. 2001;39(4):361–372.
  71. Emanuel EJ, Young-Xu Y, Levinsky NG, Gazelle G, Saynina O, Ash AS. Chemotherapy use among Medicare beneficiaries at the end of life [published online ahead of print April 16, 2003]. *Ann Intern Med*. 2003;138(8):639–643.
  72. Hilsden RJ, Bryant HE, Sutherland LR, Brasher PM, Fields AL. A retrospective study on the use of post-operative colonoscopy following potentially curative surgery for colorectal cancer in a Canadian province [published online ahead of print April 21, 2004]. *BMC Cancer*. 2004;4:14. doi:10.1186/1471-2407-4-14.
  73. Keating NL, Landrum MB, Lamont EB, Earle CC, Bozeman SR, McNeil BJ. End-of-life care for older cancer patients in the Veterans Health Administration versus the private sector [published online ahead of print June 22, 2009]. *Cancer*. 2010;116(15):3732–3739. doi:10.1002/cncr.25077.
  74. Knopf KB, Warren JL, Feuer EJ, Brown ML. Bowel surveillance patterns after a diagnosis of colorectal cancer in Medicare beneficiaries [published online ahead of print October 26, 2001]. *Gastrointest Endosc*. 2001;54(5):563–571.
  75. Lang K, Lines LM, Lee DW, Korn JR, Earle CC, Menzin J. Trends in healthcare utilization among older Americans with colorectal cancer: a retrospective database analysis [published online ahead of print December 17, 2009]. *BMC Health Serv Res*. 2009;9:227. doi:10.1186/1472-6963-9-227.
  76. McCarthy EP, Phillips RS, Zhong Z, Drews RE, Lynn J. Dying with cancer: patients' function, symptoms, and care preferences as death approaches [published online ahead of print May 16, 2000]. *J Am Geriatr Soc*. 2000;48(5 suppl):S110–S121.
  77. Rolnick S, Hensley Alford S, Kucera GP, et al. Racial and age differences in colon examination surveillance following a diagnosis of colorectal cancer [published online ahead of print November 17, 2005]. *J Natl Cancer Inst Monogr*. 2005;(35):96–101. doi:10.1093/jncimonographs/ligi045.
  78. Rulyak SJ, Mandelson MT, Brentmall TA, Rutter CM, Wagner EH. Clinical and sociodemographic factors associated with colon surveillance among patients with a history of colorectal cancer [published online ahead of print January 28, 2004]. *Gastrointest Endosc*. 2004;59(2):239–247.
  79. Salz T, Weinberger M, Ayanian JZ, et al. Variation in use of surveillance colonoscopy among colorectal cancer survivors in the United States [published online ahead of print September 3, 2010]. *BMC Health Serv Res*. 2010;10:256. doi:10.1186/1472-6963-10-256.
  80. Shugarman LR, Bird CE, Schuster CR, Lynn J. Age and gender differences in Medicare expenditures at the end of life for colorectal cancer decedents [published online ahead of print March 29, 2007]. *J Womens Health (Larchmt)*. 2007;16(2):214–227. doi:10.1089/jwh.2006.0012.
  81. Snyder CF, Earle CC, Herbert RJ, Neville BA, Blackford AL, Frick KD. Trends in follow-up and preventive care for colorectal cancer survivors [published online ahead of print January 17, 2008]. *J Gen Intern Med*. 2008;23(3):254–259. doi:10.1007/s11606-007-0497-5.
  82. Colorectal Cancer Collaborative Group. Adjuvant radiotherapy for rectal cancer: a systematic overview of 8,507 patients from 22 randomised trials [published online ahead of print October 31, 2001]. *Lancet*. 2001;358(9290):1291–1304. doi:10.1016/S0140-6736(01)06409-1.
  83. Warren JL, Klabunde CN, Schrag D, Bach PB, Riley GF. Overview of the SEER-Medicare data: content, research applications, and generalizability to the United States elderly population [published online ahead of print August 21, 2002]. *Med Care*. 2002;40(8 suppl):3–18, iv. doi:10.1097/01.MLR.0000020942.47004.03.
  84. Wagman R, Minsky BD, Cohen AM, Guillem JG, Paty PP. Sphincter preservation in rectal cancer with preoperative radiation therapy and colanal anastomosis: long term follow-up [published online ahead of print September 25, 1998]. *Int J Radiat Oncol Biol Phys*. 1998;42(1):51–57.
  85. National Institutes of Health. Adjuvant therapy for patients with colon and rectal cancer [published online ahead of print September 19, 1990]. *J Natl Med Assoc*. 1990;264(11):1444–1450.
  86. Elkin EB, Bach PB. Cancer's next frontier: addressing high and increasing costs [published online ahead of print March 18, 2010]. *J Natl Med Assoc*. 2010;303(11):1086–1087. doi:10.1001/jama.2010.283.
  87. Du XL, Lairson DR, Begley CE, Fang S. Temporal and geographic variation in the use of hematopoietic growth factors in older women receiving breast cancer chemotherapy: findings from a large population-based cohort [published online ahead of print November 30, 2005]. *J Clin Oncol*. 2005;23(34):8620–8628. doi:10.1200/JCO.2005.02.6252.
  88. Howlader NA, Krapcho M, Neyman N, et al., eds. *SEER Cancer Statistics Review, 1975–2008*. Bethesda, MD: National Cancer Institute; 2011. [http://seer.cancer.gov/csr/1975\\_2008](http://seer.cancer.gov/csr/1975_2008).
  89. Boscoe FP, Schrag D, Chen K, Roohan PJ, Schymura MJ. Building capacity to assess cancer care in the Medicaid population in New York

- State [published ahead of print December 17, 2010]. *Health Serv Res.* 2011;46(3):805–820. doi:10.1111/j.1475-6773.2010.01221.x.
90. Bradley CJ, Given CW, Luo Z, Roberts C, Copeland G, Virnig BA. Medicaid, Medicare, and the Michigan Tumor Registry: a linkage strategy [published online ahead of print July 21, 2007]. *Med Decis Making.* 2007;27(4):352–363. doi:10.1177/0272989X07302129.
91. Lipscomb J, Gillespie TW. State-level cancer quality assessment and research: building and sustaining the data infrastructure [published online ahead of print July 30, 2007]. *Cancer.* 2011;17(4):246–256. doi:10.1097/PPO.0b013e3182296422.
92. Canadian Partnership Against Cancer Web site. <http://www.partnership-againstcancer.ca/>. Accessed June 7, 2013.

**Affiliations of authors:** Health Services and Economics Branch (ENB, NC, LCH, JLW, KRY) and Outcomes Research Branch (NC), Applied Research Program, Division of Cancer Control and Population Sciences, National Cancer Institute, Bethesda, MD; Department of Epidemiology, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC (JL); Department of Clinical Epidemiology, Aarhus University, Aarhus, Denmark (JL).