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The Effect of Age and Chronic Illness on Life Expectancy after a Diagnosis of Colorectal Cancer: Implications for Screening

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Background: Older adults with shorter life expectancies may receive less benefit from colorectal cancer screening than younger, healthier patients.

Objective: To determine the degree to which life expectancy after diagnosis of an early-stage cancer varies according to age or coexisting chronic illness.

Design: Retrospective cohort study.

Setting: Population-based cancer registry with linked administrative claims data.

Patients: Patients 67 years of age or older who received a diagnosis of colorectal cancer from 1993 through 1999.

Measurements: Chronic conditions were identified by searching Medicare claims. Using a life-table approach, the authors quantified the degree to which life expectancy associated with each cancer stage at diagnosis varied with patient age, sex, and burden of chronic conditions.

Results: The final study sample consisted of 35 755 patients. After accounting for cancer stage at diagnosis, the authors found that life expectancy was strongly related to both age and the burden of chronic illness. Among men who received a diagnosis of stage I cancer at 67 years of age, life expectancy decreased from 19.1 years (95% CI, 17.8 to 20.5 years) for patients with no chronic conditions to 12.4 years (CI, 11.4 to 13.5 years) for those with 1 or 2 conditions and 7.6 years (CI, 6.1 to 9.4 years) for those with 3 or more conditions. A similar trend was noted among female counterparts, with life expectancy decreasing from approximately 23 years to 16 years and 7 years for the 3 chronic condition groups, respectively. For men and women 81 years of age with no chronic illnesses, life expectancy after stage I cancer diagnosis was 10.3 years (CI, 9.2 to 11.9 years) and 13.8 years (CI, 12.3 to 15.3 years), respectively.

Limitations: Administrative claims may not identify all chronic conditions. Life expectancy estimates at the population level are averages and, therefore, may not accurately predict the life expectancy of individual patients.

Conclusions: Coexisting chronic illness is associated with a substantial reduction in life expectancy after diagnosis of early-stage colorectal cancer. Physicians should consider this when deciding whether to screen older persons.

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Screening for colorectal cancer has been strongly advocated in the medical literature, by professional societies, and in the lay media (1–7). However, evidence to guide screening decisions for older persons is lacking because most trials have excluded patients who are older than 75 years of age (8). One the one hand, screening older persons seems warranted because the incidence of colorectal cancer increases substantially with age (1). On the other hand, patients with shorter life expectancies—on the basis of increased age or a higher burden of chronic illness—will be at risk for a malignant condition or for progression of cancer after diagnosis for a shorter time (7, 9–12).

One approach to weighing the benefits of colorectal cancer screening is to examine life expectancy after a diagnosis of early-stage cancer. Randomized trials have suggested that a mortality difference between screened and unscreened patients does not become noticeable until 5 years after screening (5, 13, 14). As a result, screening patients with a life expectancy of less than 5 years after diagnosis is unlikely to extend their lives (11, 12). Conversely, patients with a longer life expectancy after stage I cancer at diagnosis could gain more years of life from screening. Further clarity about life expectancy after an early-stage cancer diagnosis could inform screening decisions.

The degree to which chronic conditions—considered either individually or in aggregate—affect life expectancy among older patients with cancer is uncertain. Further evidence is needed to understand how screening benefits vary according to chronic condition burden, which could help guide efforts to evaluate and improve cancer screening efforts at the population level. Some of these efforts have emphasized the need to focus screening initiatives on specific groups of patients that would benefit the most from early cancer detection (15). A better understanding of life expectancy after a cancer diagnosis could also help physicians and patients make informed decisions about screening (16). We therefore conducted a population-based cohort study of older persons with colorectal cancer to provide quantitative data for a framework to weigh chronic

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conditions and their association with life expectancy after an early diagnosis of cancer.

Context

When to stop screening for cancer should depend on a person's life expectancy and, thus, on age and health status.

Contribution

The authors used the Surveillance, Epidemiology, and End Results (SEER) data set and Medicare files to calculate life expectancy of patients with colorectal cancer at a given age and with specific chronic diseases. Patients between 76 and 81 years of age who had stage I colorectal cancer and 3 or more chronic diseases had life expectancies of 5 years or less.

Cautions

The authors probably underestimated chronic disease prevalence.

Implications

A heavy burden of chronic diseases is one reason to stop screening older persons for colorectal cancer.

—The Editors

METHODS

Study Sample

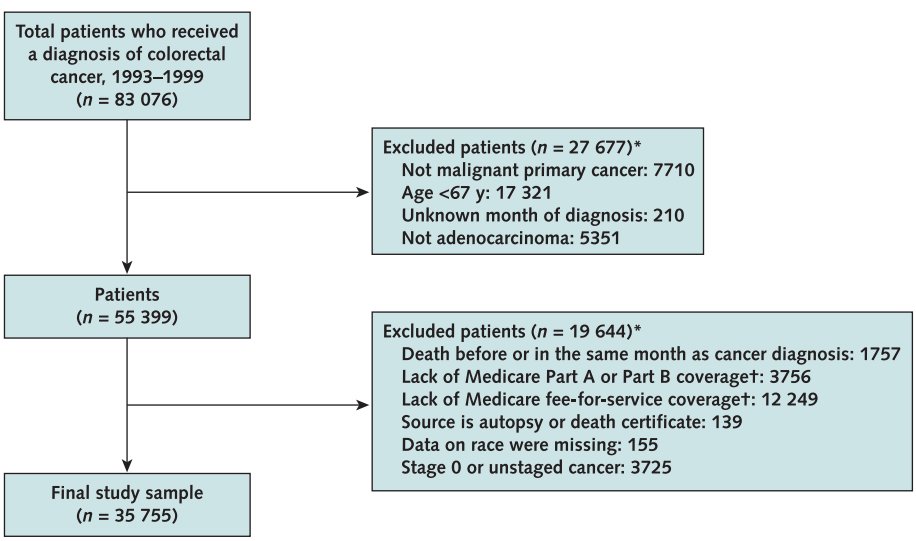
We identified a cohort of patients in the linked Surveillance, Epidemiology, and End Results (SEER) Program–Medicare database who had a primary diagnosis of colon cancer during 1993 through 1999. All cases of incident cancer that were reported to the SEER registries are cross-matched with a master file of Medicare enrollment. Previous work has demonstrated excellent agreement among data sources in case ascertainment (17).

We included patients who were 67 years of age or older at the time of cancer diagnosis to allow for a 2-year ascertainment period for chronic conditions before a cancer diagnosis. We excluded patients who did not have Medicare fee-for-service or Part B coverage for any time during the 2 years before diagnosis, because these patients' claims are not routinely included in the SEER–Medicare database (**Figure 1**). We also excluded patients who were missing data on race or cancer stage. We used available vital status information through 2002.

We selected the following chronic conditions on the basis of previous published indices, as well as preliminary analyses, that demonstrated a statistically significant relationship to death in the patient population: myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, chronic obstructive pulmonary disease (COPD), dementia, paralysis, diabetes, renal failure, liver disease, ulcers, rheumatologic disease, AIDS, hip fracture, and atrial fibrillation (18). We assigned patients to 1 of 3 categories according to the number of chronic conditions present at diagnosis (0 conditions, 1 or 2 conditions, or ≥3 conditions).

We identified the chronic conditions by searching inpatient, outpatient, and physician encounter claims for each patient between the 2 years before the cancer diagnosis to 60 days after diagnosis (18, 19). We included diagnoses during this broad interval to increase the sensitivity of our approach (18). As recommended by other authors to increase specificity, we included *International Classification*

Figure 1. **Study flow diagram.**



*Patients could have more than one reason for exclusion from the study sample. †During 2-year period before cancer diagnosis.

Table 1. **Sample Characteristics**

Characteristics	Total Patients, *n (%)*	Patients with Stage I Cancer at Diagnosis, %
Total	35 755 (100)	26.1
Age		
67–70 y	6184 (17.3)	27.9
71–75 y	9264 (25.9)	26.2
76–80 y	8860 (24.8)	26.4
81–85 y	6569 (18.4)	25.5
≥86 y	4878 (13.6)	23.5
Sex		
Male	16 150 (45.2)	27.2
Female	19 605 (54.8)	25.1
Cancer stage at diagnosis		
I	9322 (26.1)	
II	11 978 (33.5)	
III	8647 (24.2)	
IV	5808 (16.2)	
Site		
Proximal colon	17 060 (47.7)	19.1
Distal colon	9524 (26.6)	31.1
Colon, not otherwise specified	577 (1.6)	12.1
Rectum	8594 (24.0)	35.3
Race		
White	31 561 (88.3)	26.2
Black	2442 (6.8)	23.8
Other	1752 (4.9)	27.4
Hospitalizations		
0 hospitalizations	26 122 (73.1)	25.2
1–2 hospitalizations	8029 (22.5)	27.7
3 hospitalizations	808 (2.3)	29.7
≥4 hospitalizations	796 (2.2)	34.3
Chronic conditions		
0 conditions	14 436 (40.4)	25.5
1–2 conditions	15 844 (44.3)	25.9
≥3 conditions	5475 (15.3)	28.1
Individual conditions*		
Chronic obstructive pulmonary disease	7327 (20.5)	27.3
Heart failure	6404 (17.9)	26.4
Diabetes	6283 (17.6)	27.3
Atrial fibrillation	5570 (15.6)	26.8
Cerebrovascular disease	3475 (9.7)	27.6
Myocardial infarction	2637 (7.4)	28.2
Peripheral vascular disease	2296 (6.4)	25.0
Hip fracture	2070 (5.8)	26.3
Ulcer	1722 (4.8)	25.7
Dementia	1038 (2.9)	26.3
Rheumatism	818 (2.3)	28.4
Chronic renal failure	784 (2.2)	33.7
Paralysis	684 (1.9)	29.1
Liver	473 (1.3)	33.4
AIDS	1 (0.003)	0.0

* The total of the percentages of patients with each condition exceeds 100% because patients could have had more than 1 condition.

of Diseases, Ninth Revision (ICD-9), diagnosis codes that appeared at least twice on outpatient or physician claims or that had a corresponding hospital claim (18).

Statistical Analysis

We used a life-table approach to estimate life expectancy for subgroups of older patients with colorectal cancer who were classified according to cancer stage, sex, age, and chronic illness burden. A standard life table shows the probability of death for persons at each age before their next birthday. By using the life table as a point of departure, we can derive many useful statistics, such as age-specific survival rates and life expectancy. Patients can also be combined into age groups to produce estimates of life expectancy for cohorts in a given age range. Separate life tables are often developed to reflect the different risks faced by people of a different age, sex, and health status.

To construct life tables based on our population of older persons with colorectal cancer, we estimated the mortality rate for patients in each 5-year age group. We used these life tables to simulate survival for a hypothetical cohort of 100 000 patients who were 67 years of age. We used the mortality rate for the age group of 67 to 70 years to determine how many of these patients would die before age 71 years. The remaining individuals would enter the next age group (71 to 76 years of age). We created life tables for clinically relevant subgroups and used them to estimate how long, on average, an individual at a given age would be expected to live. For instance, we constructed 1 life table by using survival data derived from men with stage I cancer and no chronic conditions and another life table by using data derived from women with stage I cancer and no chronic conditions.

We generated life tables for each chronic condition group after stratifying by sex and cancer stage. Within each group, we calculated the total number of deaths and person-years of follow-up within the 5-year age groups and entered these results into the life table. For example, a person who received a cancer diagnosis at 67 years of age and had 6 years of follow-up would contribute 4 person-years to the 67- to 70-year age group and 2 person-years to the 71- to 75-year age group. We repeated the life-table analysis for each age. We generated 1 life table by using the 67- to 70-year age group (with subsequent age groups 71 to 75 years, 76 to 80 years, 81 to 85 years, and ≥86 years) and then generated similar life tables starting at age 68, 69, 70, and 71 years. We estimated the life expectancy for a hypothetical group of patients entering each new age group in accordance with standard life-table analysis. For all life-table analyses, we derived 95% CIs by bootstrapping, with 1000 iterations. Because more than 50% of patients died within 1 year after a stage IV cancer diagnosis for all age and chronic condition groups, we reported the median time from diagnosis to death rather than performing life-table analyses for these patients.

In addition to estimating life expectancy as a function of the total number of chronic conditions, we also investigated how life expectancy varied according to combinations of 4 specific conditions: diabetes, COPD, cerebrovascular disease, and heart or vascular disease. We defined

heart or vascular disease as the presence of ICD-9 codes for any of the following: myocardial infarction, heart failure, atrial fibrillation, or peripheral vascular disease. We stratified the study cohort first into groups according to each potential combination of these conditions (for example, diabetes alone, diabetes with cerebrovascular disease, and diabetes with COPD). Combinations of fewer than 100 patients were eliminated. For each patient group, we then constructed a life table and estimated life expectancy as described previously.

Patients with more chronic illnesses may be less likely to receive cancer treatment and, therefore, may have shorter life expectancies. To assess whether treatment mediates the relationship between chronic illness and survival, we used a Cox proportional hazards model to estimate the adjusted 5-year survival rate for patients with resected stage III colon cancer. Receipt of adjuvant therapy was the independent variable, and covariates were the total number of chronic conditions, age, sex, race (white, black, or other), marital status, histologic grade, tumor site (colon or rectum), and number of positive lymph nodes. We identified cancer treatment–related variables, such as cancer-specific surgery and adjuvant chemotherapy, by ICD-9 codes derived from published sources (20, 21).

We performed all analyses by using SAS, version 9.1 (SAS Institute, Cary, North Carolina). All statistical tests were 2-tailed, and we considered a P value less than 0.05 to indicate statistical significance.

Role of the Funding Sources

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RESULTS

Study Sample

The final study sample consisted of 35 755 patients. Approximately 45% were men, 88% were white, and 73% had had no hospitalizations in the 2 years before diagnosis (**Table 1**). About 40% of the patients (n = 14 436) had no chronic conditions, 44% (n = 15 844) had 1 or 2 conditions, and 15% (n = 5475) had 3 or more chronic conditions. Among patients with no chronic conditions at diagnosis, 25.5% had stage I cancer, while 28.1% of patients with 3 or more conditions at diagnosis had stage I cancer (**Table 1**). The median length of follow-up was 4 years (**Appendix Figure**, available at www.annals.org).

Life Expectancy after Cancer Diagnosis

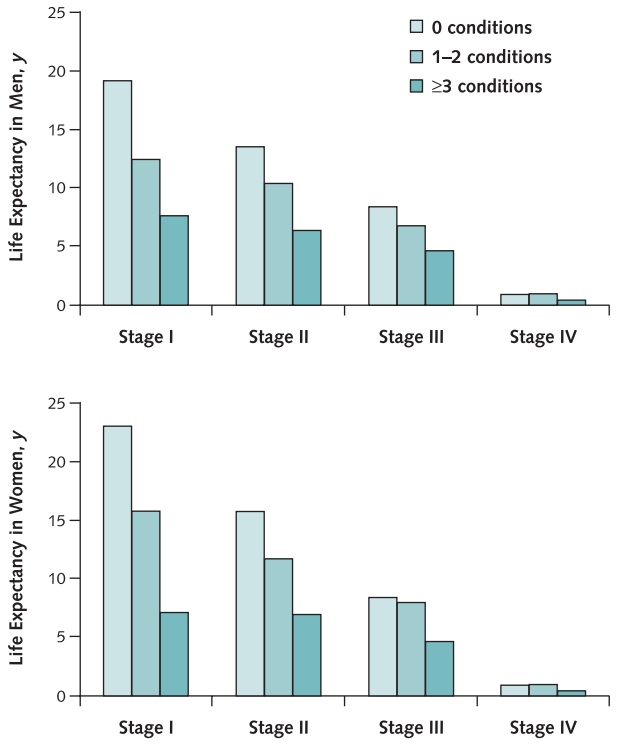
Life expectancy was strongly related to age, cancer stage at diagnosis, and the burden of chronic illness (**Table 2** and **Figure 2**). The relationship between chronic illness and life expectancy was particularly strong for patients with stage I cancer. For instance, among men who received a diagnosis of stage I cancer at 67 years of age, life expectancy after diagnosis decreased from 19.1 years (95% CI, 17.8 to 20.5 years) for patients with no chronic conditions to 12.4 years (CI, 11.4 to 13.5 years) for those with 1 or 2 conditions and 7.6 years (CI, 6.1 to 9.4 years) for those with 3 or more conditions. Female patients had a similar trend.

For patients who received a diagnosis of cancer, a stage I cancer diagnosis would represent the best-case scenario for enjoying the benefits of early detection. Among patients

Table 2. **Life Expectancy after Colorectal Cancer Diagnosis**

Variable	Life Expectancy in Men (95% CI), y			Life Expectancy in Women (95% CI), y		
	Stage I Cancer	Stage II Cancer	Stage III Cancer	Stage I Cancer	Stage II Cancer	Stage III Cancer
Age 67 years						
0 chronic conditions	19.1 (17.8–20.5)	13.5 (12.5–14.6)	8.4 (7.6–9.2)	22.9 (21.2–24.6)	15.6 (14.4–16.9)	8.5 (7.6–9.5)
1–2 chronic conditions	12.4 (11.4–13.5)	10.4 (9.5–11.4)	6.8 (6.1–7.6)	15.7 (14.4–16.9)	11.6 (10.4–12.7)	7.9 (7.0–8.9)
≥3 chronic conditions	7.6 (6.1–9.4)	6.4 (5.0–7.8)	4.6 (3.3–6.0)	6.9 (5.1–8.8)	6.8 (5.1–8.7)	4.7 (3.5–6.1)
Age 71 years						
0 chronic conditions	15.9 (14.9–17.2)	11.6 (10.9–12.2)	7.4 (7.0–7.9)	19.7 (18.4–21.1)	14.0 (13.4–14.7)	8.3 (7.8–8.8)
1–2 chronic conditions	10.3 (9.8–10.9)	8.6 (8.1–9.0)	6.1 (5.7–6.5)	13.2 (12.5–13.8)	10.0 (9.5–10.6)	6.6 (6.1–7.0)
≥3 chronic conditions	5.9 (5.3–6.5)	5.6 (5.0–6.2)	4.4 (3.9–5.0)	6.4 (5.6–7.2)	6.0 (5.2–6.7)	3.7 (3.1–4.3)
Age 76 years						
0 chronic conditions	12.8 (11.8–14.2)	10.0 (9.4–10.7)	6.3 (5.8–6.8)	16.4 (15.1–17.8)	11.7 (11.1–12.4)	7.4 (7.0–7.9)
1–2 chronic conditions	8.5 (8.0–9.0)	7.4 (7.0–7.8)	5.2 (4.8–5.6)	10.5 (10.0–11.1)	8.9 (8.5–9.4)	5.8 (5.5–6.2)
≥3 chronic conditions	5.2 (4.7–5.7)	5.1 (4.6–5.5)	3.6 (3.2–4.0)	5.4 (4.8–6.0)	5.3 (4.8–5.9)	3.8 (3.4–4.2)
Age 81 years						
0 chronic conditions	10.3 (9.2–11.9)	8.3 (7.6–9.0)	5.5 (5.0–6.1)	13.8 (12.3–15.3)	9.7 (9.1–10.5)	6.4 (5.9–6.9)
1–2 chronic conditions	6.7 (6.3–7.3)	6.1 (5.7–6.5)	4.9 (4.5–5.3)	8.2 (7.7–8.8)	7.3 (7.0–7.7)	4.8 (4.4–5.1)
≥3 chronic conditions	4.3 (3.9–4.8)	4.2 (3.8–4.6)	2.9 (2.6–3.3)	4.9 (4.5–5.4)	4.7 (4.3–5.1)	2.8 (2.5–3.2)

Figure 2. **Life expectancy after diagnosis of colorectal cancer at age 67 years according to cancer stage and number of chronic conditions.**



with stage I cancer and no documented chronic conditions, the life expectancy was greater than 10 years for men who were 67 to 80 years of age at diagnosis and for women who were 67 to 85 years of age at diagnosis (**Figure 3**). Conversely, men and women with 3 or more chronic conditions had a life expectancy of approximately 5 to 6 years if they were in their early 70s at diagnosis.

In contrast to patients with stage I cancer, patients with late-stage cancer had a weaker association between chronic condition burden and life expectancy (**Table 2**). For instance, a 71-year-old woman with stage I cancer had a life expectancy that ranged from 19.7 years (CI, 18.4 to 21.1 years) if she had no chronic conditions to 6.4 years (CI, 5.6 to 7.2 years) if she had 3 or more conditions. If the woman had stage III cancer, her life expectancy ranged from 8.3 years (CI, 7.8 to 8.8 years) with no conditions to 3.7 years (CI, 3.1 to 4.3 years) with 3 or more conditions. The median survival for patients with stage IV cancer was less than 1 year regardless of chronic conditions (**Figure 2**).

We found that using age as the sole determinant of life expectancy after early-stage cancer diagnosis can be misleading (**Table 2**). For example, life expectancy after stage I cancer diagnosis for an 81-year-old woman with no chronic conditions was 13.8 years (CI, 12.3 to 15.3 years), which is much longer than that for a 67-year-old woman with stage I cancer and 3 or more chronic conditions (life expectancy, 6.9 years [CI, 5.1 to 8.8 years]).

Life Expectancy and Specific Conditions

After considering life expectancy as a function of the total number of chronic conditions, we assessed the relationship between life expectancy and the 4 specific chronic conditions in patients with stage I cancer at diagnosis (**Table 3**). Life expectancy varied considerably across conditions: Patients 71 years of age with diabetes alone (and none of the other 3 conditions) had a life expectancy of 13.2 years, while those with a previous cerebrovascular accident alone had a life expectancy of 9.4 years. However, these chronic conditions often occur together. For instance, of the 1718 patients with diabetes, most patients (n = 977 [57%]) had at least 1 of the other 3 conditions.

Figure 3. **Life expectancy after stage I cancer diagnosis according to age, number of chronic conditions, and sex.**

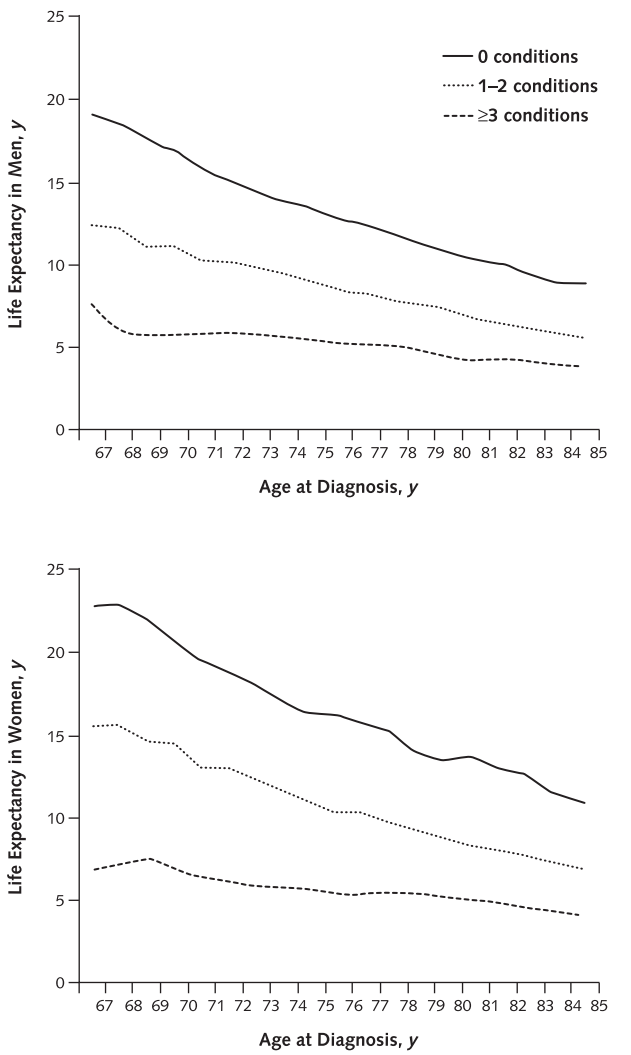


Table 3. **Life Expectancy after Stage I Colorectal Cancer Diagnosis according to Chronic Conditions and Age***

Chronic Condition	Patients, *n*	Life Expectancy (95% CI), *y*	
		Age 71 y at Diagnosis	Age 81 y at Diagnosis
Overall	4295	16.9 (16.2–17.6)	11.2 (10.5–12.0)
COPD	846	12.4 (11.3–13.6)	8.7 (7.5–10.2)
CVA	252	9.4 (7.8–10.9)	6.5 (5.2–8.1)
Heart or vascular disease	1208	10.9 (10.1–11.8)	6.9 (6.4–7.4)
Diabetes	741	13.2 (12.1–14.3)	8.3 (7.2–9.6)
Diabetes and heart or vascular disease	387	7.0 (5.9–8.1)	4.6 (4.0–5.4)
Diabetes and COPD	144	9.6 (7.8–11.7)	6.3 (5.1–7.9)
Diabetes, heart or vascular disease, and COPD	164	5.6 (4.4–6.8)	4.8 (3.5–6.5)
Diabetes, CVA, and heart or vascular disease	124	5.8 (4.3–7.7)	5.6 (4.1–7.4)
Heart or vascular disease and COPD	578	6.5 (5.6–7.5)	5.3 (4.8–6.0)
Heart or vascular disease and CVA	235	8.0 (6.2–10.0)	5.3 (4.5–6.2)
Heart or vascular disease, CVA, and COPD	109	5.4 (3.7–7.2)	4.0 (3.0–5.1)

* COPD = chronic obstructive pulmonary disease; CVA = cerebrovascular accident. Combinations that had fewer than 100 patients were eliminated due to small sample size (these included CVA and COPD; diabetes and CVA; diabetes, CVA, and COPD; and all 4 conditions). Heart or vascular disease was defined as the presence of *International Classification of Diseases, Ninth Revision* (ICD-9), codes for any of the following conditions: myocardial infarction, heart failure, atrial fibrillation, or peripheral vascular disease.

Among patients 71 years of age, the life expectancies for patients with diabetes alone, patients with diabetes in combination with heart or vascular disease, and patients with diabetes in combination with COPD were 13.2 years (CI, 12.1 to 14.3 years), 7.0 years (CI, 5.9 to 8.1 years), and 9.6 years (CI, 7.8 to 11.7 years), respectively. Patients who were 81 years of age at diagnosis had similar findings (**Table 3**).

Effect of Treatment

We hypothesized that patients with a higher burden of chronic illness have shorter survival because they are less likely to receive cancer therapy rather than solely because of their noncancer illnesses. To determine whether the association of chronic illness with survival was independent of treatment status, we estimated 5-year survival of patients with resected stage III cancer who did or did not receive adjuvant therapy. Among patients who had received adjuvant therapy, the adjusted 5-year survival ranged from 55.6% (CI, 53.7% to 57.6%) for patients with no conditions to 34.8% (CI, 31.7% to 38.2%) for those with 3 or more conditions (**Table 4**). Patients who did not receive adjuvant therapy had a similar trend but had worse survival, which decreased from about 46% (group with no conditions) to about 25% (group with ≥3 conditions).

DISCUSSION

We found a strong relationship between chronic illness and life expectancy after cancer diagnosis. The relationship was strongest among patients who received a diagnosis of early-stage cancer. We also found substantial variation in life expectancy after a diagnosis of stage I colorectal cancer among older persons. Patients with several chronic conditions had a substantially lower gain in life expectancy associated with early-stage cancer at diagnosis than did their counterparts without such conditions. For instance, a 75-year-old woman with no chronic conditions had a life expectancy of more than 15 years after a stage I cancer diagnosis. If she had 3 or more conditions, however, her life expectancy was approximately 5 years and her benefit from screening would be marginal. This is because she would be unlikely to survive to the point (approximately 4 years) where, in clinical trials of screening, patients randomly assigned to screening had a lower colorectal cancer mortality rate than unscreened participants. These findings suggest that physicians must consider the burden of chronic illness in conjunction with age to estimate the benefits associated with an early diagnosis of colorectal cancer.

These results add to previous work by demonstrating a clinically relevant approach to estimating potential changes in life expectancy associated with cancer screening by using population-based data derived from a large cohort of older persons with cancer. We assessed the validity of our approach by comparing our life expectancy estimates with life-table estimates from previous work, which divided the general population into quartiles of life expectancy but did not analyze it according to chronic illness burden (11, 12). For instance, we estimated life expectancy after stage I cancer diagnosis for a 70-year-old woman to be approximately 22, 15, and 7 years if she had 0, 1 or 2, and 3 or more conditions, respectively. Previously published life expectancy estimates for 70-year-old women in the general population that were based on 1997 life tables and were stratified by quartiles of health status were 21.3, 15.7, and 9.5 years, respectively (11, 12). To use this approach, one must assign a patient to a specific quartile of health status, which is a subjective judgment. Thus, our approach has several advantages. First, the life expectancies are those of patients with colorectal cancer and the specific chronic diseases. Second, we used readily available administrative data by

using a specific algorithm (assessing chronic illness burden) to estimate life expectancy.

Although interest in targeting colorectal cancer screening efforts to patients who would benefit the most from early diagnosis has increased, whether current practices are consistent with these recommendations is unclear (15). We found that patients with a higher burden of chronic illness were just as likely to receive a diagnosis of stage I cancer as those without such conditions. Further work should explore the effect of individualized data about screening risks and benefits on decision making. Targeting screening efforts to patients with a greater expected benefit is also important from a societal perspective. An estimated 40 million adults older than 50 years of age have not been screened for colorectal cancer. Endoscopic screening for all of them would take up to 10 years according to estimates of existing capacity (22). Given the limited colonoscopy resources, the distribution of resources to colorectal cancer screening, as well as screening guidelines and quality-of-care assessments, should take into account the expected benefits, which we have shown to depend on chronic disease burden.

Although the association with life expectancy can vary across chronic conditions, we found that incorporating specific conditions into life expectancy estimates can be challenging. Not only did the conditions we investigated frequently occur in combination, we also found that knowing a specific combination is clinically relevant. For instance, the life expectancy for an 81-year-old patient with diabetes and heart or vascular disease was about 5 years, which is in contrast to the 8-year life expectancy for a patient with diabetes alone and the 7-year life expectancy for a patient with heart or vascular disease alone. Therefore, a specific recommendation about screening patients with heart disease may not apply to all patients. While our approach to counting comorbid conditions corresponds well to population-based data, future work should explore how to integrate specific conditions and combinations of conditions into more precise estimates of life expectancy—a task that we have begun (**Table 3**).

We also found that the burden of chronic conditions was strongly related to survival, regardless of whether patients had received adjuvant therapy. This suggests that chronic conditions exert a substantive effect on survival that is independent of their effect on decisions to give adjuvant therapy or its effectiveness. While several comorbid conditions may certainly alter a person's willingness to undergo cancer-specific therapy, our findings suggest that the main mechanism by which comorbid conditions affect life expectancy is through the competing causes of death attributable to these conditions. Therefore, even among patients who are willing to undergo cancer treatment, chronic condition status should inform screening decisions.

Our analyses have several limitations. Administrative claims underestimate the prevalence of many chronic conditions, such as dementia, and the burden of chronic conditions for many patients was probably higher than that noted in their administrative claims. In addition, patients vary in the incidence of additional conditions after cancer diagnosis, which would add heterogeneity to life expectancy estimates within the chronic illness groups. Furthermore, our analysis focused on death as the sole outcome of interest. Future work should incorporate self-reported chronic illness and health status data to derive more comprehensive assessments of quality-adjusted life expectancy, as well as nonfatal outcomes of interest. We derived our life expectancy estimates from a life-table method, and survival probabilities for individuals within each age or chronic condition group could vary substantially. However, although a specific person's length of life is impossible to predict with certainty, patients would benefit from understanding the probabilities of reaching selected outcomes and how these probabilities vary with different screening strategies (16). Future work should explore the effect of screening across different patient age and chronic illness groups, as well as the effect of repeated screening and the variation in the relative contribution of colorectal cancer and non–colorectal cancer death to outcomes. Our analysis of specific conditions, and their interactions, demonstrated that conditions do vary in how they affect patient outcomes. Aggregating conditions into a single disease count can reduce the accuracy of prognostic estimates. An important limitation is that we included only patients with resected stage III cancer. Our findings may not be generalizable to patients with other stages of colorectal cancer or with other types of cancer.

Table 4. **Adjusted 5-Year Survival Rates according to Treatment Status and Chronic Illness Burden for Patients with Stage III Colorectal Cancer***

Variable	No Adjuvant Therapy		Adjuvant Therapy	
	Patients, *n*	5-Year Survival Rate (95% CI), %	Patients, *n*	5-Year Survival Rate (95% CI), %
0 chronic conditions	848	45.9 (43.4–48.5)	2059	55.6 (53.7–57.6)
1–2 chronic conditions	1227	37.0 (34.8–39.5)	1872	47.4 (45.4–49.4)
≥3 chronic conditions	530	24.6 (21.9–27.7)	362	34.8 (31.7–38.2)

* Adjusted for age, sex, race, marital status, number of nodes, cancer type, and grade.

Our results provide population-based data about the health outcomes of older patients with cancer. We suggest that clinicians use these data to guide screening decisions. Colorectal cancer screening is underutilized, with fewer than 50% of eligible patients receiving appropriate screening (23–26). Not only do normative quality-of-care assessments include screening guidelines, but colorectal cancer screening is specifically one measure of the quality of care offered by providers. However, because colorectal cancer screening has risks or costs, it is important to identify the patients who are most likely to benefit from screening. Our results suggest that physicians should use age and chronic illness burden to identify such patients and, given that patients with a low burden of comorbid conditions were no more likely to have stage I cancer at diagnosis than patients with a higher burden, such targeting may not currently be taking place. Future work should explore how best to align objective assessments of screening risks and benefits with the preferences of patients and with societal resources.

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Disclaimer: Although this study used the linked SEER–Medicare database, the interpretation and reporting of these data are solely the authors' responsibility.

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Appendix Figure. **Length of follow-up after cancer diagnosis.**