VOLUME 33 · NUMBER 5 · FEBRUARY 10 2015

JOURNAL OF CLINICAL ONCOLOGY

ORIGINAL REPORT

Exploring the Burden of Inpatient Readmissions After Major Cancer Surgery

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Published online ahead of print at www.jco.org on December 29, 2014.

Supported by the Integrated Cancer Information and Surveillance System, University of North Carolina (UNC) Lineberger Comprehensive Cancer Center with funding provided by the University Cancer Research Fund via the state of North Carolina. K.B.S. is supported in part by the UNC IBM Junior Faculty Development Award. M.E.N. was supported in part by the American Cancer Society (Grant No. MRSG-13-154-01-CPPB) and the Urology Care Foundation/Astellas. A.B.S. was supported in part by the National Center for Research Resources and the National Center for Advancing Translational Sciences, National Institutes of Health, through Grant No. KL2TR000084.

Terms in blue are defined in the glossary, found at the end of this article and online at www.jco.org.

Authors' disclosures of potential conflicts of interest are found in the article online at www.jco.org. Author contributions are found at the end of this article.

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0732-183X/15/3305w-455w/$20.00

DOI: 10.1200/JCO.2014.55.5938

ABSTRACT

Purpose
Travel distances to care have increased substantially with centralization of complex cancer procedures at high-volume centers. We hypothesize that longer travel distances are associated with higher rates of postoperative readmission and poorer outcomes.

Methods
SEER-Medicare patients with bladder, lung, pancreas, or esophagus cancer who were diagnosed in 2001 to 2007 and underwent extirpative surgery were included. Readmission rates and survival were calculated using Kaplan-Meier functions. Multivariable negative binomial models were used to examine factors associated with readmission.

Results
Four thousand nine hundred forty cystectomies, 1,573 esophagectomies, 20,362 lung resections, and 2,844 pancreatectomies were included. Thirty- and 90-day readmission rates ranged from 13% to 29% and 23% to 43%, respectively, based on tumor type. Predictors of readmission were discharge to somewhere other than home, longer length of stay, comorbidities, higher stage at diagnosis, and longer travel distance ($P < .001$ for each). Patients who lived farther from the index hospital also had increased emergency room visits and were more likely to be readmitted to a hospital other than the index hospital ($P < .001$). Of readmitted patients, 31.9% were readmitted more than once. Long-term survival was worse and costs of care higher for patients who were readmitted ($P < .001$ for all).

Conclusion
The burden of readmissions after major cancer surgery is high, resulting in substantially poorer patient outcomes and higher costs. Risk of readmission was most strongly associated with length of stay and discharge destination. Travel distance also has an impact on patterns of readmission. Interventions targeted at higher risk individuals could potentially decrease the population burden of readmissions after major cancer surgery.

J Clin Oncol 33:455-464. © 2014 by American Society of Clinical Oncology

INTRODUCTION

Patient travel distances to complex surgical cancer care have increased substantially over the last two decades. In a 2009 study examining pancreatectomy and esophagectomy, we demonstrated a more than 70% increase in patient travel as surgery was centralized at high-volume centers, raising the question of whether travel burden is a barrier to care for some patients.[1] For many patients, travel for a single episode of care will be feasible, whereas repeated trips may become a problem. Surgery is often viewed as a single episode of care, but in reality, complex surgical procedures often require extended hospital stays and multiple perioperative clinic visits, amounting to substantial travel burden for patients and their caregivers. The impact of travel distance on the postoperative care experience has not been previously studied. It is possible that patients may miss or delay postoperative visits as a result of long travel distances. Delayed care could increase the risk of hospital readmission if potentially minor issues are permitted to escalate (ie, urinary tract infection escalating to urosepsis). It is also possible that patients who live far from the operative (index) hospital may disproportionately use local emergency rooms (ERs) for postoperative care. Physicians at a local facility may be unfamiliar not only with the patient's specific case, but also with the broader management issues after complex cancer surgery. As a result, they may be less comfortable managing these problems in the outpatient setting, increasing the likelihood of readmission.

Table 1. Patient Demographics and Descriptive Statistics for All Cancer Sites

Demographic or Characteristic*	Total (N = 29,719)		Cancer Site: Bladder (n = 4,940)		Lung (n = 20,362)		Pancreas (n = 2,844)		Esophagus (n = 1,573)	
	No. of Patients	%	No. of Patients	%	No. of Patients	%	No. of Patients	%	No. of Patients	%
Age, years										
Mean	73.9		74.5		73.8		74.1		72.9	
SD	5.4		5.6		5.3		5.5		5.1	
Range	66-100		66-100		66-96		66-95		66-90	
Median	73		74		73		74		72	
Q1	70		70		70		70		69	
Q3	78		79		77		78		76	
66-69	7,390	25	1,139	23	5,070	25	689	24	492	31
70-74	9,579	32	1,463	30	6,680	33	894	31	542	34
75-79	7,877	27	1,335	27	5,445	27	745	26	352	22
≥ 80	4,873	16	1,003	20	3,167	16	516	18	187	12
Sex										
Male	16,265	55	3,633	74	10,113	50	1,288	45	1,231	78
Female	13,454	45	1,307	26	10,249	50	1,556	55	342	22
Race										
White	26,583	89	4,485	91	18,186	89	2,482	87	1,430	91
African American	1,484	5	200	4	1,046	5	165	6	73	5
Other	1,652	6	255	5	1,130	6	197	7	70	4
Marital status										
Married with living partner	18,174	61	3,230	65	12,066	59	1,768	62	1,110	71
All other†	11,545	39	1,710	35	8,296	41	1,076	38	463	29
Residence										
Urban	3,673	12	667	14	2,518	12	289	10	199	13
Metro	25,575	86	4,192	85	17,524	86	2,521	89	1,338	85
Rural	469	2	81	2	320	2	33	1	35	2
Dual eligibility (Medicaid), yes	3,240	11	458	9	2,366	12	297	10	119	8
% of patient census tract below poverty level										
Median	7.1		7.1		7.2		6.6		7.1	
Q1	3.9		3.9		3.9		3.6		4.1	
Q3	13.5		13.5		13.7		12.7		12.8	
Stage										
Localized	20,384	69	3,862	78	14,465	71	1,195	42	862	55
Node positive	7,874	26	873	18	4,959	24	1,425	50	617	39
Distant	1,461	5	205	4	938	5	224	8	94	6
Charlson comorbidity index										
0	13,657	46	2,918	59	8,554	42	1,304	46	881	56
1	9,164	31	1,171	24	6,640	33	913	32	440	28
2+	6,898	23	851	17	5,168	25	627	22	252	16
Distance to index hospital, miles										
Mean	47.1		59.4		40.0		63.4		71.0	
SD	186.4		197.5		173.7		226.0		221.1	
Median	10.4		13.6		9.4		13.9		16.8	
Q1	4.4		5.2		4.0		5.6		6.4	
Q3	29.1		40.7		24.1		40.5		50.2	
Yearly procedure volume, No. of procedures‡										
Mean	12.3		7.7		15.2		4.9		3.1	
SD	14.4		9.7		15.8		4.0		2.8	
Median	8		4		10		3		2	
Q1	3		2		5		2		1	
Q3	16		10		19		7		4	
Patients with at least one complication during index admission	5,307	18	918	19	3,163	16	686	24	540	34

(continued on following page)

Table 1. Patient Demographics and Descriptive Statistics for All Cancer Sites (continued)

Demographic or Characteristic*	Total (N = 29,719)		Cancer Site: Bladder (n = 4,940)		Lung (n = 20,362)		Pancreas (n = 2,844)		Esophagus (n = 1,573)	
	No. of Patients	%	No. of Patients	%	No. of Patients	%	No. of Patients	%	No. of Patients	%
Length of stay for index admission, days										
Mean	12.5		13.9		10.7		17.4		22.0	
SD	12.8		12.2		11.0		14.9		22.2	
Median	9		10		8		13		14	
Q1	7		8		6		9		11	
Q3	13		15		11		20		24	
Deaths during index admission	1,394	5	173	4	859	4	192	7	170	11
Discharge destination										
Home	23,465	79	3,760	76	16,574	81	2,071	73	1,060	67
SNF	3,903	13	823	17	2,349	12	476	17	255	16
Other§	2,351	8	357	7	1,439	7	297	10	258	16
Readmission										
No readmission	21,815	73	2,910	59	15,898	78	1,921	68	1,086	69
30-day readmission	4,859	16	1,411	29	2,567	13	580	20	301	19
31- to 90-day readmission	3,045	10	619	13	1,897	9	343	12	186	12

Abbreviations: SD, standard deviation; SNF, skilled nursing facility; Q, quartile.
*All characteristics are significantly different across disease sites ($P < .001$ for all), except census tract poverty ($P = .018$).
†Separated, divorced, or widowed.
‡Statistics are calculated at the patient level. For example, 50% of cystectomy patients had surgery at a hospital that performed four or more cystectomies for Medicare patients with bladder cancer per year. Mean/median volume at the hospital level is much lower.
§The majority of these patients were transferred to another inpatient facility (eg, rehabilitation, psychiatric, long-term care) from the index admission.

Hospital readmissions are costly and lead to fragmentation of care, resulting in poorer clinical outcomes, including greater 1-year mortality rates and detriment in the timing of and eligibility for recommended adjuvant therapies.[2,3] Hospital readmission rates after major cancer surgery are high.[4-25] The impact of travel distance on hospital readmissions is unknown. This study examines patterns of postoperative readmission for four cancers that require complex surgical resections—bladder, esophagus, lung, and pancreas cancer. We hypothesize that longer travel distances are associated with higher rates of postoperative readmission and poorer patient outcomes.

METHODS

Data Source

Data for this study were derived from the Surveillance, Epidemiology, and End Results (SEER)–Medicare linked database, which is a population-based data source that provides detailed information about 1.6 million Medicare beneficiaries with cancer. SEER is a National Cancer Institute registry program that collects information about cancer site, stage, and histology for incident cancer cases occurring in the SEER geographic areas. Sixteen SEER registries participate in the SEER-Medicare linkage, covering approximately 28% of the US population. The data used in this study include incident cancer cases from January 2001 to December 2007 linked to Medicare claims through 2009.

Patient Cohort Selection

Patients were included in the study if they were diagnosed with bladder, lung, pancreas, or esophagus cancer from 2001 to 2007. Patients were excluded if they were diagnosed at autopsy or by death certificate, ≤ 65 years of age at diagnosis (to ensure claims data available for 12 months before diagnosis to calculate comorbidity), not continuously enrolled in both Medicare Parts A and B for 12 months before and after cancer diagnosis, or enrolled in a health maintenance organization or Medicare Managed Care anytime during 12 months before and after cancer diagnosis (because claims data may not capture all delivered care for these patients). Finally, the cohort was limited to patients who underwent major extirpative surgery (Appendix Table A1, online only) for invasive bladder, esophagus, lung, or pancreas cancer between January 1, 2001, and December 31, 2008. Patients were included if they had claims with relevant International Classification of Diseases, Ninth Revision, procedure codes in the Medicare Provider Analysis and Review file (26,588 of 29,719 patients) or if they had claims with relevant Healthcare Common Procedure Coding System codes in the National Claims History file as well as admission records in the Medicare Provider Analysis and Review file for corresponding dates (3,131 of 29,719 patients). A flowchart of cohort selection is presented in Appendix Figure 1 (online only).

Outcomes

The primary outcomes included readmissions to acute care hospitals within 30 and 90 days of discharge from extirpative surgery (the index discharge). Admissions to acute inpatient rehabilitation facilities were excluded. Transfer, defined as admission to an acute inpatient facility other than the index hospital on the same day or day after index discharge, was considered part of the index admission, and the two admission records were analyzed as one admission. Many patients were readmitted more than once, but only the first readmission within 90 days was used for the analysis of factors associated with readmission. On the basis of the timing of first readmission, patients were grouped into the following three mutually exclusive groups: no readmission, 30-day readmission, and 31- to 90-day readmission. For all readmitted patients, the time from index discharge to first readmission, the total number of readmissions, the total readmission length of stay including all readmissions within 90 days, and the total number of complications during the 90 days after index discharge were measured.

Other outcomes measured included short-term mortality (30- and 90-day), total number of ER visits not resulting in readmission, and total cost of care including both inpatient and outpatient visits. Overall survival was measured as the number of months from surgery to death or the study end (December 31, 2009), whichever came first.

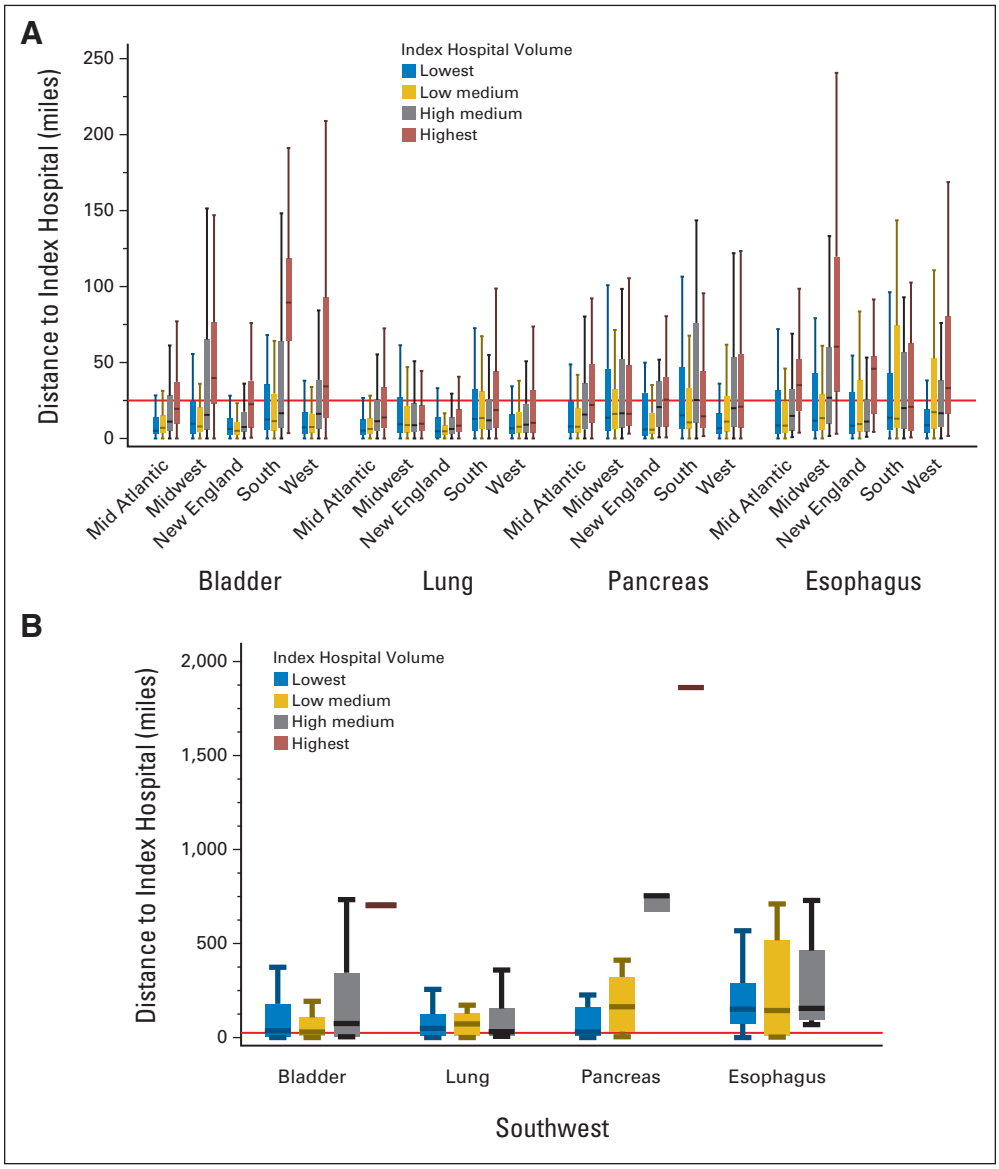

Fig 1. (A) Travel distances by SEER region, disease site, and index hospital volume. (B) Travel distances in the Southwest region are presented separately because of the large difference in range of values compared with other regions. Outlier values are not shown. Horizontal reference line designates 25 miles.

Covariates

Distance to care was defined as the straight-line distance between patient and provider, measured in miles.[26,27] Patients and providers were geocoded at the zip code level. Distance was examined in quartile groups. Because distance to care varies by cancer type, the quartiles were calculated for each cancer type separately.

Hospital volume, defined as the total number of SEER-Medicare patients who had extirpative surgery at the same hospital in the same year, was also calculated for each cancer type and analyzed in quartiles. Statistics for hospital volume were calculated at the patient level, such that the median value represents the hospital volume for the 50th percentile of patients, not the volume of the 50th percentile hospital.

Patient characteristics examined included demographic, socioeconomic, and clinical factors. The rate and number of postoperative complications, including surgical site infections, urinary tract infections, pneumonia, sepsis, venous thromboembolic events, and myocardial infarction, were also measured.[28]

Statistical Analysis

Descriptive statistics were reported for all variables and compared across disease sites. The distribution of travel distance to index hospital was plotted to illustrate variation in distance to care across SEER region, disease site, and index hospital volume. Thirty- and 90-day readmission rates were calculated for each cancer site using Kaplan-Meier estimates accounting for the number of patients at risk in each time period.

Multivariable negative binomial regression was performed to identify factors associated with readmissions and calculate incidence rate ratios counting the number of readmissions over days at risk. Patient demographics, clinical characteristics, and distance to index hospital and hospital volume were examined. Patients who died during the index admission were excluded from these analyses, because these patients could not have been readmitted. Similarly, for the 90-day readmission analysis, patients who did not survive 30 days or were readmitted during the first 30 days were excluded. The main analysis was performed by pooling all four cancer sites. However, the same analyses were repeated for each cancer site separately for sensitivity analysis.

The outcomes of patients who were readmitted within 90 days were compared by disease site with the outcomes of patients who were not readmitted. To investigate the association between patient travel and outcomes, the four cancer types were pooled and the outcomes were examined by distance quartiles. Survival since surgery was examined using Kaplan-Meier functions. Total costs of care were calculated as the total charges for all inpatient and outpatient care during the designated time period. SAS version 9.3 (SAS Institute, Cary, NC) was used for all statistical analyses. The study was reviewed and approved by the Institutional Review Board of the University of North Carolina (Chapel Hill, NC).

RESULTS

Index Hospitalization

Twenty-nine thousand seven hundred nineteen patients were included in the analysis (4,940 cystectomies, 1,573 esophagectomies, 20,362 lung resections, and 2,844 pancreatectomies; Table 1). Mean age ranged from 72.9 to 74.5 years for all disease sites. Median length of stay for the index admission ranged from 8 days for lung resections to 14 days for esophagectomy. One thousand three hundred ninety-four patients died during the index admission, representing 3.5% of cystectomies, 10.8% of esophagectomies, 4.2% of lung resections, and 6.8% of pancreatectomies.

Average travel distances for surgery were inversely proportional to known cancer incidence patterns, ranging from a median of 9.4 miles for lung to a median of 16.8 miles for esophagus (Fig 1). Patient travel distance increased as index hospital volume increased. Disease site and hospital volume patterns were the same in all regions; however, patients in certain regions had much longer average travel distances. In particular, in the Southwest region (which for these data include only New Mexico), patient travel was much greater. Presumably as a result, few patients in the Southwest had surgery at the highest volume hospitals.

Readmissions

Overall, 30- and 90-day readmission rates ranged from 13% and 23% for lung resection to 30% and 43% for cystectomy, respectively (Fig 2). Primary diagnoses for readmissions were similar at 30 and 90 days and were generally attributable to the prior surgery (Appendix Table 2, online only). Clinical and sociodemographic factors associated with readmission at 30 versus 90 days were also similar (Table 2). Older patients, male patients, and those with more advanced cancer and more comorbidity were consistently more likely to be readmitted ($P < .05$ for all). The strongest predictor of readmission, particularly at 30 days, was discharge from index admission to somewhere other than home (eg, skilled nursing facility, acute rehab; $P < .001$ for all). Similarly, longer length of stay was associated with increased risk of readmission at 30 and 90 days ($P < .001$). The occurrence of complications during the index admission was associated with increased risk of readmission at 90 days ($P < .001$) but not 30 days. Index hospital procedure volume was associated with readmission at 30 days ($P < .05$) but not 90 days, but the association was not linear. When all disease sites were analyzed together, distance to care was associated with 30-day ($P < .05$), but not 90-day, readmission rates. Patients who traveled the farthest were the most likely to be readmitted. However, when each disease site was analyzed separately, this association held true only for patients with lung cancer (data not shown).

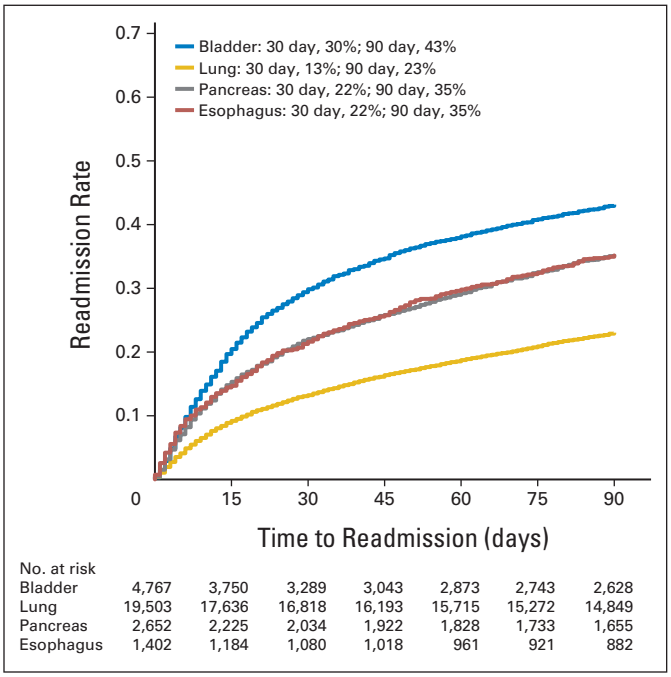

Fig 2. Readmission rates by disease site.

Outcomes

Patients who were readmitted had poorer outcomes than patients who were never readmitted. Of readmitted patients, 31.9% (2,542 of 7,904 patients) were readmitted more than once during the 90 days after the index hospitalization (Appendix Table A3, online only). On average, these 7,904 patients had 1.5 readmissions (range, one to 10 readmissions) during the 90 days after the index hospitalization and spent a total of 11.4 (lung), 13.4 (bladder), 13.8 (pancreas), and 15.8 (esophagus) readmission days in the hospital. For each tumor type, approximately one third of readmitted patients (30% to 34%) were readmitted to a hospital other than the index hospital. Median total 90-day costs of care for readmitted patients were substantially higher than the costs for those who were not readmitted (bladder, \$45,000 *v* \$26,000; esophagus, \$65,000 *v* \$40,000; lung, \$44,000 *v* \$26,000; and pancreas, \$63,000 *v* \$45,000, respectively; $P < .001$ for each). For patients with bladder and lung cancer, 90-day postdischarge mortality for readmitted patients was 15% and 14%, respectively, compared with 10% and 9%, respectively, for patients who were never readmitted ($P < .001$). In contrast, 90-day postdischarge mortality for patients with pancreas and esophagus cancer was not statistically significantly different for those who were readmitted compared with those who were not readmitted. However, 1-year mortality was statistically significantly worse for readmitted patients than for patients not readmitted for all disease sites (bladder, 40% *v* 24%; esophagus, 45% *v* 34%; lung, 33% *v* 15%; and pancreas, 55% *v* 37%, respectively; $P < .001$ for all; Fig 3).

Impact of Travel Distance

Time to readmission was similar regardless of travel distance (Table 3). Readmission to a hospital other than the index hospital was highly associated with travel distance, with 59% of patients in the longest distance quartile readmitted to different hospitals versus only 11% of patients in the shortest distance quartile ($P < .001$).

Table 2. Multivariable Analysis of Factors Associated With Readmission at 30 and 90 Days

Factor	30-Day Readmission				30- to 90-Day Readmission			
	No. of Patietns	Rate per Person-Day	IRR	95% CI	No. of Patients	Rate per Person-Day	IRR	95% CI
Age, years								
66-69	7,135	0.17	1		5,973	0.13	1	
70-74	9,178	0.18	1.06	0.94 to 1.18	7,601	0.14	1.03	0.94 to 1.14
75-79	7,473	0.21	1.23*	1.09 to 1.38	6,037	0.15	1.10	0.99 to 1.21
≥ 80	4,539	0.22	1.24†	1.08 to 1.41	3,608	0.15	1.11	0.98 to 1.24
Sex								
Male	15,363	0.22	1		12,246	0.15	1	
Female	12,962	0.16	0.64*	0.59 to 0.70	10,973	0.13	0.89†	0.82 to 0.96
Race								
White	25,368	0.20	1		20,744	0.14	1	
African American	1,385	0.18	0.93	0.7 to 1.14	1,148	0.16	1.07	0.91 to 1.26
Other	1,572	0.16	0.78‡	0.64 to 0.95	1,327	0.13	0.86	0.73 to 1.02
Marital status								
Married with living partner	17,352	0.19	1		14,247	0.14	1	
All other	10,973	0.19	1.01	0.92 to 1.10	8,972	0.14	0.91‡	0.84 to 0.98
Residence								
Urban	3,491	0.20	0.97	0.84 to 1.12	2,825	0.15	1.07	0.95 to 1.21
Metro	24,386	0.19	1		20,048	0.14	1	
Rural	447	0.26	1.43‡	1.04 to 1.98	345	0.14	0.93	0.69 to 1.28
Dual eligibility (Medicaid)								
No	25,279	0.19	1		20,787	0.14	1	
Yes	3,046	0.22	1.18‡	1.03 to 1.37	2,432	0.16	1.11	0.98 to 1.26
Stage								
Localized	19,565	0.18	1		16,198	0.12	1	
Node positive	7,409	0.21	1.12‡	1.02 to 1.23	5,991	0.19	1.59*	1.48 to 1.72
Distant	1,351	0.25	1.44*	1.20 to 1.74	1,030	0.24	1.95*	1.69 to 2.24
No. of complications (continuous)			1.03	0.98 to 1.09			1.08*	1.03 to 1.12
Length of stay, days (continuous)			1.03*	1.03 to 1.04			1.01*	1.01 to 1.01
Modified Charlson score								
0	13,217	0.17	1		11,114	0.12	1	
1	8,689	0.19	1.13‡	1.03 to 1.25	7,157	0.14	1.09	1.00 to 1.19
2+	6,419	0.25	1.46*	1.32 to 1.63	4,948	0.19	1.42*	1.30 to 1.55
Discharge destination								
Home	23,457	0.17	1		19,804	0.13	1	
SNF	3,898	0.31	1.61*	1.42 to 1.81	2,819	0.21	1.46*	1.32 to 1.62
Other	970	0.41	3.25*	2.54 to 4.16	596	0.27	1.62*	1.35 to 1.93
% census tract below poverty								
Highest (≥ 75%)	6,879	0.20	1		5,612	0.16	1	
Quartile 2	6,920	0.20	1.05	0.93 to 1.18	5,621	0.14	0.91	0.82 to 1.01
Quartile 3	6,982	0.19	1.00	0.88 to 1.14	5,761	0.14	0.90	0.81 to 1.01
Lowest (< 25%)	7,006	0.19	1.02	0.89 to 1.16	5,798	0.14	0.93	0.83 to 1.04
Hospital volume quartile								
Lowest	7,269	0.18	1		6,020	0.14	1	
Quartile 2	6,820	0.21	1.25*	1.11 to 1.41	5,504	0.13	0.98	0.89 to 1.09
Quartile 3	7,208	0.19	1.15‡	1.02 to 1.29	5,922	0.14	1.06	0.95 to 1.17
Highest	7,028	0.20	1.26*	1.12 to 1.43	5,773	0.15	1.09	0.99 to 1.21
Distance to hospital quartile								
Nearest	7,004	0.18	1		5,803	0.15	1	
Quartile 2	7,063	0.19	1.14‡	1.01 to 1.28	5,793	0.14	0.96	0.86 to 1.06
Quartile 3	7,091	0.19	1.12	1.00 to 1.27	5,822	0.14	0.96	0.86 to 1.06
Farthest	7,105	0.21	1.27*	1.12 to 1.45	5,748	0.14	0.94	0.84 to 1.05

Abbreviations: IRR, incidence rate ratio; SNF, skilled nursing facility.
*$P < .001$.
†$P < .01$.
‡$P < .05$.

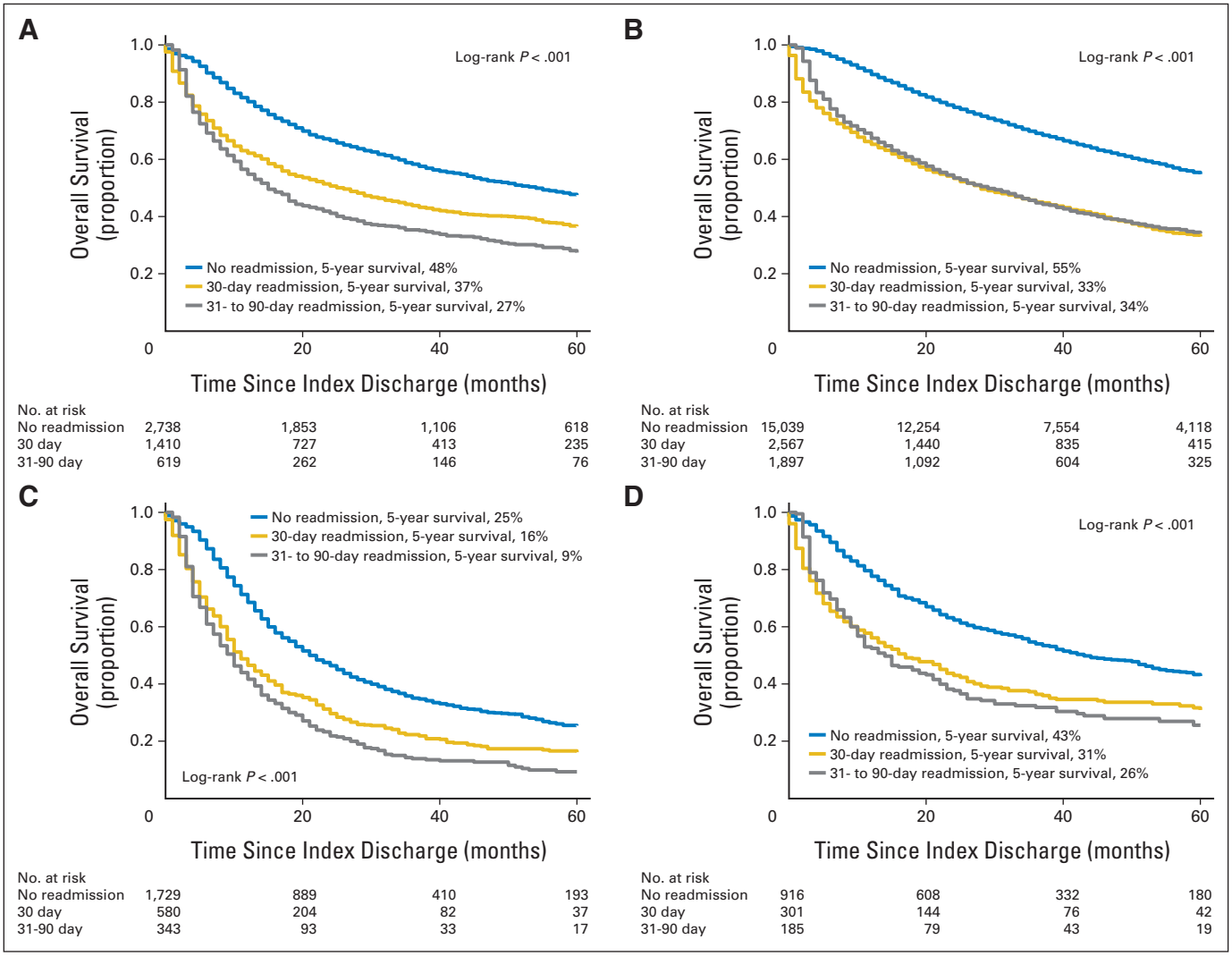

Fig 3. Kaplan-Meier estimates of survival by readmission group for (A) bladder cancer, (B) lung cancer, (C) pancreas cancer, and (D) esophagus cancer.

Patients who traveled longer distances generally had lower short-term mortality than patients who traveled shorter distances (Table 3). Accordingly, patients who lived farther from the index hospital had lower rates of complications during the index admission. However, recorded complications during the 90 days after discharge from the index admission did not vary based on travel distance to index hospital. Although no difference in postdischarge complication rates was noted, patients who lived farther from the index hospital had consistently higher rates of ER visits than those who had surgery closer to home. Eight percent of patients in the shortest travel quartiles had at least one ER visit by 30 days compared with 12% of patients in the longest travel quartile ($P < .001$); at 90 days, these differences persisted (14% *v* 20%, respectively; $P < .001$). Although patients in the longest travel groups had slightly higher readmission rates, among readmitted patients, the total number of readmission days spent in the hospital was greater for patients who lived closer to the index hospital ($P = .004$). Long-term overall survival was not different across distance groups.

DISCUSSION

Readmission rates after major cancer surgery are high. In this study, depending on cancer site, 20% to 50% of patients older than age 65 years were readmitted during the 90 days after discharge from the surgical admission. The precise burden of postoperative readmissions is difficult to measure because there is no standard methodology for defining readmission after cancer surgery. Varying time periods from 30 days to 1 year have been used to try to capture readmissions, and using secondary data, it is challenging to determine whether a hospital admission is a readmission (attributable to the index admission and potentially avoidable) or rather a separate index admission attributable to cancer progression or other comorbid medical conditions. This study suggests that the bulk of readmissions up to 90 days are attributable to the surgical intervention. The rate of readmission tapers at 20 days and further after 40 days, but a substantial portion of readmissions still occurs after this time period. Studies aimed at qualitatively studying readmissions may be able to focus on shorter time periods as representative of the larger picture. However,

Table 3. Outcomes by Distance Quartile

Characteristic	Total (N = 29,653)		Quartile of Distance to Index Hospital: Quartile 1: Nearest (n = 7,432)		Quartile 2 (n = 74,21)		Quartile 3 (n = 7,403)		Quartile 4: Farthest (n = 7,397)		*P*
	No. of Patients	%	No. of Patients	%	No. of Patients	%	No. of Patients	%	No. of Patients	%	
Time to readmission, days*											.299
Mean	29.15		29.97		28.76		29.37		28.55		
SD	25.67		25.67		25.33		25.83		25.85		
Median (Q1, Q3)	20		22		20		20		19		
Q1	7		8		7		8		7		
Q3	47		48		45		47		46		
Readmission to index hospital*											< .001
No	2,604	33	219	11	394	20	777	39	1,214	59	
Yes	5,285	67	1,696	89	1,561	80	1,196	61	832	41	
90-day mortality	2,969	10	860	12	748	10	672	9	689	9	< .001
1-year mortality	7,084	24	1,914	26	1,761	24	1,687	23	1,722	23	< .001
Complications during index admission, No.											
Mean	0.31		0.34		0.32		0.30		0.29		.001
SD	0.87		0.90		0.87		0.85		0.86		
0	24,358	82	5,985	81	6,029	81	6,141	83	6,203	84	< .001
≥ 1	5,295	18	1,447	19	1,392	19	1,262	17	1,194	16	
Complications in 90 day after index discharge, No.											
Mean	0.32		0.29		0.33		0.32		0.33		.085
SD	1.04		0.95		1.05		1.07		1.08		
0	25,625	86	6,450	87	6,389	86	6,433	87	6,353	86	.190
≥ 1	4,028	14	982	13	1,032	14	970	13	1,044	14	
No. of ER visits in 30 days											
Mean	0.11		0.10		0.08		0.12		0.14		< .001
SD	0.37		0.37		0.31		0.39		0.41		
Range	0-10		0-10		0-5		0-7		0-7		
0	26,919	91	6,824	92	6,901	93	6,678	90	6,516	88	< .001
≥ 1	2,734	9	608	8	520	7	725	10	881	12	
No. of ER visits in 90 days											
Mean	0.21		0.19		0.16		0.22		0.27		< .001
SD	0.62		0.70		0.47		0.59		0.69		
Range	0-38		0-38		0-6		0-13		0-18		
0	24,923	84	6,359	86	6,443	87	6,198	84	5,923	80	< .001
≥ 1	4,730	16	1,073	14	978	13	1,205	16	1,474	20	
Total No. of readmissions within 90 days											
Mean	0.39		0.37		0.38		0.39		0.41		.003
SD	0.77		0.74		0.75		0.77		0.80		
0	21,763	73	5,517	74	5,466	74	5,429	73	5,351	72	.034
1	5,352	18	1,339	18	1,325	18	1,334	18	1,354	18	
≥ 2	2,538	9	576	8	630	8	640	9	692	9	
Total readmission length of stay within 90 days, days*											.004
Mean	27.00		28.06		27.38		26.99		25.68		
SD	21.33		20.40		21.27		22.41		21.12		
Median	21		22		21		20		19		
Q1	14		15		14		14		14		
Q3	32		34		32		31		30		
Overall survival, months											.150
Mean	36.18		35.81		36.37		36.69		35.85		
SD	27.58		28.33		27.80		27.10		27.08		
Median	31		30		32		32		31		
Q1	13		11		13		14		13		
Q3	55		56		54		55		54		

Abbreviations: ER, emergency room; SD, standard deviation; Q, quartile.
*Calculated for readmission patients only.

studies aimed at quantifying the burden of readmissions attributable to cancer surgery should consider a longer postoperative time window, because a large portion of readmissions occurs after 30 days.

Hospital readmissions are costly and have been viewed as a marker of inferior quality of care in broader clinical contexts. In general, patients who are readmitted have poorer short- and long-term outcomes. As a result, investigators have sought to identify risk factors for readmission as a critical step toward the development of targeted interventions aimed at decreasing readmissions.[4,9-25] For cancer surgery, the most consistent risk factors for readmission are strikingly similar across tumor types and include patient comorbidity,[4,13,16,18-22,25] occurrence of postoperative complications during index admission,[9,11,12,16,17,21,22] and extended length of stay of index admission.[4,11,12,14-16,20-22] Extended length of stay and discharge to a destination other than home,[17,25] which were strong risk factors for readmission in this study, are both likely proxies for poor performance status. Consequently, efforts to minimize readmissions may best be directed toward patients with a complex index hospital stay and those with poor performance status preoperatively or at the time of discharge from the index hospitalization.

Because complex cancer surgery often requires longer hospitalizations and multiple perioperative visits, we hypothesized that travel burden could be a barrier to postoperative care for some patients. In this study, patients who traveled long distances had better immediate postoperative outcomes than patients who traveled short distances to the operative hospital. This is a result of the high correlation between longer travel distances and higher hospital volume. However, although postdischarge rates of complications were the same across travel distance groups, patients who traveled long distances to the operative hospital had higher rates of readmission and substantially higher rates of ER visits than patients who had surgery close to home. The latter finding suggests that patients who live far from the surgeon are more likely to use the ER for smaller postoperative issues that do not require readmission rather than travel long distances to the surgeon's office for evaluation.

Travel distance was also associated with the location of readmission, with patients who lived far from the index hospital being much more likely to seek postoperative care at a hospital closer to their home. The consequences of readmission to a hospital other than the index hospital are unknown. However, it can be presumed that this trend would lead to further increases in cost and fragmentation of care as additional providers who are unfamiliar with the patient, procedure, and plan of care are added to the treatment team. Additional studies are needed to determine the relationship between the location of readmission and the costs and outcomes of postoperative cancer care.

This study examined only patients with continuous Medicare coverage throughout their initial diagnosis and treatment for cancer. The findings from this older population may not completely reflect patterns of care and readmission for younger populations or for those with no or different health coverage. Older patients are more likely to have increased comorbidity and are also, in general, less willing to travel longer distances for care, both of which could influence patterns of readmission. In addition, although travel patterns are similar throughout the country, the burden of travel is certainly more substantial in some areas than others. In this study, this is most evident in the Southwest region of the United States, where travel distances for this small sample were five- to 10-fold greater than in other parts of the country. Consequently, there may be a differential impact of travel distance in the different regions of the country; however, further exploration of this was beyond the scope of the current study.

Travel distance impacts the patterns and burden of readmission after major cancer surgery. The negative impact of long patient travel distances does not seem to outweigh the benefits of having surgery at a high-volume center. However, travel distance needs to be acknowledged as a potential barrier to high-quality care. Future research into models of cancer care delivery should focus on interventions that can mitigate the negative consequences of patient travel. Multilevel interventions, targeted at higher risk patients, will be necessary to decrease the population burden of readmissions after cancer surgery on a large scale.

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Disclosures provided by the authors are available with this article at www.jco.org.

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Manuscript writing: All authors
Final approval of manuscript: All authors

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GLOSSARY TERMS

Surveillance, Epidemiology, and End Results (SEER): a national cancer registry that collects information from all incident malignancies in multiple geographic areas of the United States.

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Exploring the Burden of Inpatient Readmissions After Major Cancer Surgery

The following represents disclosure information provided by authors of this manuscript. All relationships are considered compensated. Relationships are self-held unless noted. I = Immediate Family Member, Inst = My Institution. Relationships may not relate to the subject matter of this manuscript. For more information about ASCO's conflict of interest policy, please refer to www.asco.org/rwc or jco.ascopubs.org/site/ifc.

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Appendix

Table A1. Codes Used to Identify Extirpative Procedures

Cancer Type	ICD-9 Procedure Code	HCPCS code
Bladder	57.7 Total cystectomy 57.71 Radical cystectomy 57.79 Other total cystectomy	51570 Removal of bladder 51575 Removal of bladder and nodes 51580 Removal of bladder/revise tract 51585 Removal of bladder and nodes 51590 Removal of bladder/revise tract 51595 Removal of bladder/revise tract 51596 Removal of bladder/create pouch 51597 Removal of pelvic structures
Lung	32.4 Lobectomy of lung 32.41 Thoracoscopic lobectomy of lung 32.49 Other lobectomy of lung 32.5 Pneumonectomy 32.50 Thoracoscopic pneumonectomy 32.59 Other and unspecified pneumonectomy	32440 Removal of lung 32442 Sleeve pneumonectomy 32445 Removal of lung 32480 Partial removal of lung 32482 Bilobectomy 32486 Sleeve lobectomy 32488 Completion pneumonectomy 32503 Resect apical lung tumor 32504 Resect apical lung tumor/chest 32663 Thoracoscopy surgical
Pancreas	52.5 Partial pancreatectomy 52.51 Proximal pancreatectomy 52.52 Distal pancreatectomy 52.53 Radical subtotal pancreatectomy 52.59 Other partial pancreatectomy 52.6 Total pancreatectomy 52.7 Radical pancreaticoduodenectomy	48140 Partial removal of pancreas 48145 Partial removal of pancreas 48146 Pancreatectomy 48148 Removal of pancreatic duct 48150 Partial removal of pancreas 48152 Pancreatectomy 48153 Pancreatectomy 48154 Pancreatectomy 48155 Removal of pancreas 48160 Pancreas removal/transplantation
Esophagus	42.4 Excision of esophagus 42.40 Esophagectomy, not otherwise specified 42.41 Partial esophagectomy 42.42 Total esophagectomy 43.5 Partial gastrectomy with anastomosis to esophagus 43.99 Other total gastrectomy	43107 Removal of esophagus 43108 Removal of esophagus 43112 Removal of esophagus 43113 Removal of esophagus 43116 Partial removal of esophagus 43117 Partial removal of esophagus 43118 Partial removal of esophagus 43121 Partial removal of esophagus 43122 Partial removal of esophagus 43123 Partial removal of esophagus 43124 Removal of esophagus

Abbreviations: ICD-9, International Classification of Diseases, Ninth Revision; HCPCS, Healthcare Common Procedure Coding System.

Table A2. Primary Admitting Diagnosis for Readmission

	% of Patients							
	Bladder		Lung		Pancreas		Esophagus	
Admitting Diagnosis	30-Day Readmission	90-Day Readmission	30-Day Readmission	90-Day Readmission	30-Day Readmission	90-Day Readmission	30-Day Readmission	90-Day Readmission
Volume depletion	8.8	5.7		3.1	9.0	7.9	6.0	8.1
Dyspnea			11.2	6.9			7.7	4.3
Abdominal pain	5.3	4.7			9.3	8.2		
Pneumonia			8.4	6.4		3.5	9.3	7.0
Urinary tract infection	7.7	7.1						
Nausea and vomiting					9.2	2.9	5.0	5.4
Fever	6.8	5.8			4.8	3.5		
Chest pain			5.2	4.8				4.3
Atrial fibrillation/flutter			2.9					
Postoperative infection					8.1		4.7	
Intestinal obstruction	5.3							
Congestive heart failure			2.7	2.5				
Septicemia		5.2						

Table A3. Outcomes of Readmitted Patients by Cancer Site

Characteristic	Total (N = 7,904)		Cancer Site: Bladder (n = 2,030)		Lung (n = 4,464)		Pancreas (n = 923)		Esophagus (n = 487)	
	No. of Patients	%	No. of Patients	%	No. of Patients	%	No. of Patients	%	No. of Patients	%
Total No. of readmissions within 90 days										
Mean	1.5		1.5		1.4		1.5		1.5	
SD	0.8		0.8		0.8		0.9		0.8	
Median	1		1		1		1		1	
Q1	1		1		1		1		1	
Q3	2		2		2		2		2	
1	5,362	68	1,284	63	3,170	71	595	64	313	64
≥ 2	2,542	32	746	37	1,294	29	328	36	174	36
Time to readmission, days										
Mean	29.1		25.0		31.2		29.0		28.2	
SD	25.7		23.2		26.5		26.0		25.5	
Median	20		16		23		20		20	
Q1	7		7		8		7		6	
Q3	47		37		51		48		46	
Readmission to index hospital										
No	2,606	33	615	30	1,510	34	314	34	167	34
Yes	5,298	67	1,415	70	2,954	66	609	66	320	66
Length of stay, days										
Mean	14.5		14.4		12.5		18.9		25.1	
SD	13.3		10.9		11.5		14.4		23.7	
Median	10		11		9		15		17	
Q1	8		9		7		10		12	
Q3	16		16		14		22		29	
Length of stay during first readmission, days										
Mean	8.7		8.7		8.3		9.4		10.9	
SD	9.8		10.2		9.3		10.1		12.2	
Median	6		6		6		6		7	
Q1	4		4		4		4		4	
Q3	10		10		9		11		13	
Total length of stay within 90 days, including index admission, days										
Mean	27.0		27.8		23.9		32.6		40.9	
SD	21.3		19.9		19.3		21.7		32.5	
Median	21		22		18		27		30	
Q1	14		16		12		18		20	
Q3	32		32		28		39		52	
Total readmission length of stay after index discharge, days										
Mean	12.5		13.4		11.4		13.8		15.8	
SD	14.1		15.1		13.2		14.2		16.9	
Median	8		9		7		9		10	
Q1	4		5		4		5		5	
Q3	15		16		14		18		20	
No. of ER visits not resulting in readmission within 30 days										
0	6,776	86	1,755	86	3,866	87	767	83	388	80
1	1,128	14	275	14	598	13	156	17	99	20
No. of ER visits not resulting in readmission within 90 days										
Mean	0.4		0.3		0.3		0.5		0.6	
SD	0.9		1.1		0.7		1.0		1.0	
Median	0		0		0		0		0	
Q1	0		0		0		0		0	
Q3	1		0		1		1		1	
0	5,856	74	1,555	77	3,347	75	635	69	319	66
1	2,048	26	475	23	1,117	25	288	31	168	34

(continued on following page)

Table A3. Outcomes of Readmitted Patients by Cancer Site (continued)

Characteristic	Total (N = 7,904)		Cancer Site: Bladder (n = 2,030)		Lung (n = 4,464)		Pancreas (n = 923)		Esophagus (n = 487)	
	No. of Patients	%	No. of Patients	%	No. of Patients	%	No. of Patients	%	No. of Patients	%
Distance to index hospital, miles										
Mean	48.2		53.1		44.4		53.2		53.2	
SD	177.0		163.3		187.0		178.6		127.3	
Median	11.3		13.8		10.1		12.8		17.2	
Q1	4.8		5.4		4.2		5.5		5.9	
Q3	32.4		39.8		26.8		37.3		46.5	
< 15	4,531	57	1,055	52	2,752	62	495	54	229	47
≥ 15	3,358	42	971	48	1,701	38	428	46	258	53
Distance to first readmission hospital, miles										
Mean	35.8		38.2		33.9		35.3		43.4	
SD	166.8		156.1		177.7		148.0		138.8	
Median	7.2		8.1		6.7		7.8		8.8	
Q1	3.2		3.6		2.9		3.5		3.8	
Q3	16.3		19.8		14.4		16.9		24.7	
< 15	5,728	72	1,379	68	3,372	76	661	72	316	65
≥ 15	2,144	27	645	32	1,069	24	260	28	170	35
Total costs within 90 days, US$										
Mean	58,704.4		54,278.4		54,001.0		73,419.1		92,377.9	
SD	47,760.7		39,380.7		40,953.6		47,267.1		95,634.3	
Median	46,869.2		44,740.9		43,466.5		62,123.8		64,459.5	
Q1	34,928.3		33,656.6		33,167.9		47,042.2		46,495.4	
Q3	65,841.7		62,663.7		59,931.4		83,793.0		101,988.8	
Discharge destination from index admission										
Home	5,944	75	1,531	75	3,431	77	662	72	320	66
SNF	1,532	19	412	20	791	18	212	23	117	24
Other	428	5	87	4	242	5	49	5	50	10
Discharge destination from readmission										
Home	5,696	72	1,447	71	3,291	74	655	71	303	62
SNF	1,253	16	341	17	654	15	155	17	103	21
Other	940	12	240	12	509	11	111	12	80	16
Time from surgery discharge to study end or death, months										
Mean	28.3		27.9		31.0		18.0		25.3	
SD	26.3		26.9		26.8		19.6		26.2	
Median	21		19		25		10		15	
Q1	6		5		7		4		4	
Q3	44		43		48		25		39	

Abbreviations: ER, emergency room; SD, standard deviation; SNF, skilled nursing facility; Q, quartile.

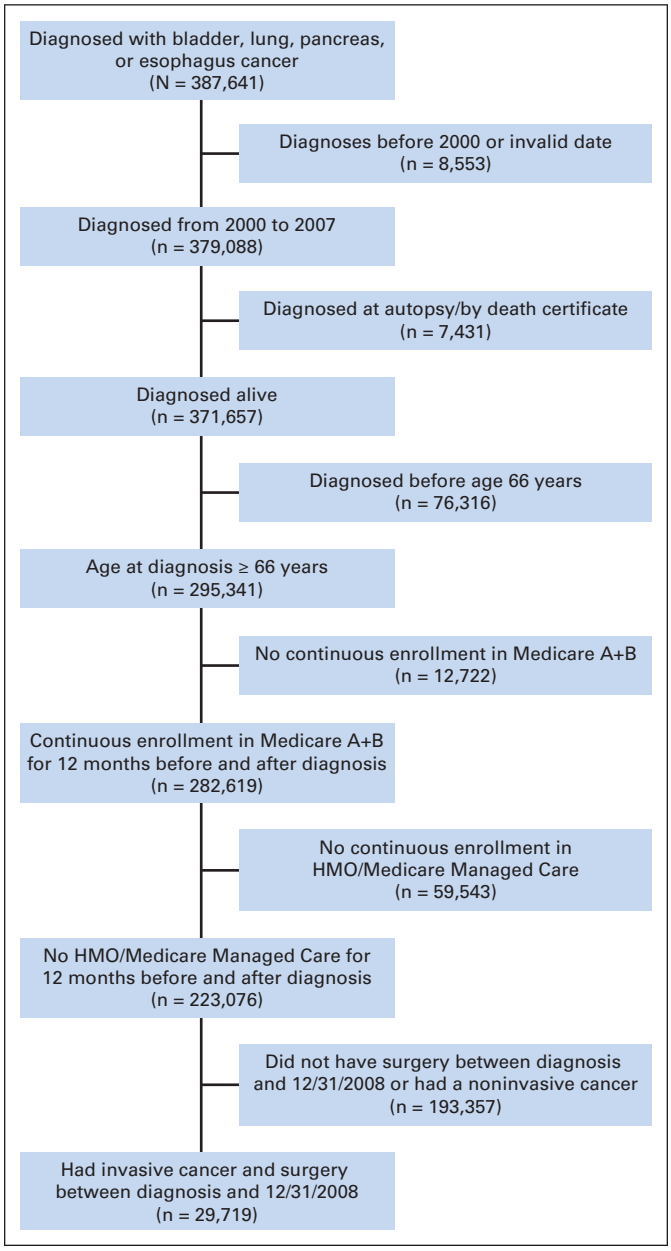

Fig A1. Patient cohort selection. HMO, health maintenance organization.