Original Article

Sharpening the Focus on Causes and Timing of Readmission After Radical Cystectomy for Bladder Cancer

Michael Hu[1]; Bruce L. Jacobs, MD, MPH[2]; Jeffrey S. Montgomery, MD, MHSA[3,4]; Chang He, MS[5]; Jun Ye, MS[5]; Yun Zhang, PhD[5]; Julien Brathwaite[1]; Todd M. Morgan, MD[3]; Khaled S. Hafez, MD[3]; Alon Z. Weizer, MD, MS[3]; Scott M. Gilbert, MD, MS[6]; Cheryl T. Lee, MD[3]; Mariel S. Lavieri, PhD[1]; Jonathan E. Helm, PhD[7]; Brent K. Hollenbeck, MD, MS[3,5]; and Ted A. Skolarus, MD, MPH[3,4,5,8]

BACKGROUND: Readmissions after radical cystectomy are common, burdensome, and poorly understood. For these reasons, the authors conducted a population-based study that focused on the causes of and time to readmission after radical cystectomy. **METHODS:** Using Surveillance, Epidemiology, and End Results-Medicare data, at total of 1782 patients who underwent radical cystectomy from 2003 through 2009 were identified. A piecewise exponential model was used to examine reasons for readmission as well as patient and clinical factors associated with the timing of readmission. **RESULTS:** One in 4 patients (25.5%) were readmitted within 30 days of discharge after radical cystectomy. Compared with patients without readmission, those readmitted were similar with regard to age, sex, and race. Readmitted patients had more complications (33.8% vs 13.9%; $P<.001$) and were more likely to have been discharged to skilled nursing facilities from their index admission ($P<.001$). The average time to readmission and subsequent length of stay were 11.5 days and 6.7 days, respectively. The majority of readmissions (67.4%) occurred within 2 weeks of discharge, 66.8% had emergency department charges, and 25.9% involved intensive care unit use. Although the spectrum of reasons for readmission varied over the 4 weeks after discharge, the most common included infection (51.4%), failure to thrive (36.3%), and urinary (33.2%) and gastrointestinal (23.1%) etiologies; 95.8% of patients had ≥ 1 of these diagnosis groups present at the time of readmission. **CONCLUSIONS:** Readmissions after radical cystectomy are common and time-dependent. Interventions to prevent and reduce the readmission burden after cystectomy likely need to focus on the first 2 weeks after discharge, take into consideration the spectrum of reasons for readmission, and target high-risk individuals. ***Cancer* 2014;120:1409–16.** *© 2014 American Cancer Society.*

KEYWORDS: bladder cancer, readmission, cystectomy, quality, operations engineering.

INTRODUCTION

Hospital readmissions are increasingly scrutinized as drivers of health care spending.[1,2] They comprise nearly one-half of all hospitalizations and many are believed to be preventable.[3-5] In fact, preventable readmissions are responsible for an estimated $25 billion in unnecessary health care costs,[6] not to mention a significant burden on patients and caregivers. As efforts to reduce unnecessary spending mount, policies such as the Patient Protection and Affordable Care Act (ACA) have redoubled efforts to improve the readmission landscape. After ACA implementation, the Centers for Medicare and Medicaid Services (CMS) will now penalize hospitals with higher-than-expected 30-day readmission rates.[7] This policy has encouraged health care organizations to more actively evaluate and implement solutions to minimize hospital readmissions.

Cystectomy, a complicated surgical procedure entailing bladder removal and urinary tract reconstruction, is associated with one of the highest readmission rates of any surgery at approximately 25%.[8-10] Unfortunately, rates have remained stable over the past decade and current research offers limited insight into how best to reduce this burden.[10] One way to inform solutions might be to study in more detail when and why readmissions occur. However, clinical data

Corresponding author: Ted A. Skolarus, MD, MPH, Department of Urology, University of Michigan, Veterans Affairs Health Services Research and Development Center for Clinical Management Research, Veterans Affairs Ann Arbor Healthcare System, 1500 E. Medical Center Dr. 3875 Taubman Center, SPC 5330 Ann Arbor, MI 48109; Fax: (734) 232-2400; tskolar@med.umich.edu

[1]Department of Industrial and Operations Engineering, University of Michigan, Ann Arbor, Michigan; [2]Department of Urology, University of Pittsburgh, Pittsburgh, Pennsylvania; [3]Division of Oncology, Department of Urology, University of Michigan, Ann Arbor, Michigan; [4]Veterans Affairs Ann Arbor Healthcare System, Ann Arbor, Michigan; [5]Dow Division of Urologic Health Services Research, University of Michigan Health System, Ann Arbor, Michigan; [6]Department of Urology, University of Florida, Gainesville, Florida; [7]Indiana University Kelley School of Business, Operations & Decision Technologies, Bloomington, Indiana; [8]Veterans Affairs Health Services Research and Development Center for Clinical Management Research, Ann Arbor, Michigan

Readmissions after radical cystectomy are common and time-dependent. Interventions to prevent and reduce the readmission burden after cystectomy likely need to focus on the first 2 weeks after discharge, take into consideration the spectrum of reasons for readmission, and target high-risk individuals.

DOI: 10.1002/cncr.28586, **Received:** October 15, 2013; **Revised:** November 25, 2013; **Accepted:** December 2, 2013, **Published online** January 29, 2014 in Wiley Online Library (wileyonlinelibrary.com)

are often constrained by small sample sizes and most claims-based research examines readmissions at blunt cut-off values (eg, 30 days) when in reality patients are at risk of readmission each day after discharge and for a variety of reasons. A better understanding of readmissions after cystectomy may help to direct the type and intensity of post-discharge care to reduce their burden.

For these reasons, we conducted a population-based study that focused on the time to and causes of readmission after radical cystectomy. We examined how patient and clinical factors, including complications, were related to the timing of readmissions and provide previously unexplored details regarding resource use during readmission. Overall, this study sought to inform tailored interventions to prevent unnecessary readmissions and reduce the intensity of readmission for those in need of hospital care after cystectomy.

MATERIALS AND METHODS

Study Population

We used Surveillance, Epidemiology, and End Results-Medicare data to identify patients undergoing cystectomy (*International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM] codes 57.7, 57.71, 57.79, and 68.8) to treat bladder cancer between 2003 and 2009.[11] We followed beneficiaries' hospital-based medical care over time using the Medicare Provider Analysis and Review (MedPAR) files. We included patients between the ages of 66 and 99 years who were continuously enrolled in both Medicare Parts A and B during the period 12 months before and 6 months after their cystectomy date and whose only malignancy was bladder cancer. Patients in the Medicare Advantage program (n = 324) were excluded to ensure all health care was ascertained, as were those who died within 6 months of diagnosis. To examine whether significant selection bias existed in our final cohort, we compared age, race, sex, and pathologic stage of disease among those with and without Medicare Advantage coverage. We found no differences in age, race, or sex across the groups; however, unknown pathologic disease stage was more common among patients included in the current study (data not shown). Applying these criteria resulted in a study population of 1782 patients.

Postoperative Complications

We posited that a significant predictor of readmission was whether a postoperative complication occurred during the index hospitalization for radical cystectomy.[8,12,13] For this reason, we measured specific postoperative complications based on prior work using ICD-9-CM codes[14] for the following: acute renal failure and cardiac, gastrointestinal, genitourinary, neurological, wound, and miscellaneous technical complications, as well as postoperative hemorrhage, infection, pulmonary failure, and sepsis. Postoperative complications were then classified into medical, surgical, major, and any categories for our analyses based on previously published work.[14] Major complications included pulmonary, cardiac, acute renal failure, venous thromboembolism, gastrointestinal, sepsis, wound, iatrogenic injury, and hemorrhage.

Outcomes

The primary outcomes for this study were 30-day readmissions and time to readmission, defined as the number of days between discharge from a patient's index cystectomy hospitalization and subsequent readmission. We defined readmission as rehospitalization to any acute care hospital within 30 days of the index discharge date. Thus, we did not consider postdischarge admission to skilled nursing facilities (SNFs) or other similar destinations as a readmission. However, any subsequent hospital admission among these patients was classified as a readmission. We used a combination of discharge destination codes and the MedPAR SNF indicator to guide our classification algorithm. In general, discharge destination codes of 03, 04, 05, 61, 62, 63, 65, and 70 corresponded to subsequent SNF admissions. We used time to readmission in days to classify readmissions into 4 groups based on week(s) after discharge (weeks 1-4). This framework provided us with information regarding how the characteristics of the readmission changed over time, including readmitting diagnoses as well as patient and clinical factors associated with each readmission.

As a secondary outcome, 2 investigators (T.A.S. and B.L.J.) classified readmission diagnoses from ICD-9-CM codes in the MedPAR claims into 13 categories based on clinical relevance to the postcystectomy population and opportunity for targeted intervention: infection, metabolic/endocrine, failure to thrive, urinary, hematologic, cardiac, pulmonary, gastrointestinal, neurologic/psychologic/musculoskeletal/ophthalmologic/otorhinolaryngologic, vascular, wound/hematoma, female genitourinary/gynecologic, and other (available on request). In particular, we conducted a sensitivity analysis to identify ICD-9-CM codes that were present at the time of readmission but were not present during the index cystectomy admission to optimize our detection of new diagnoses related to the readmission. Because neoadjuvant chemotherapy could also impact perioperative outcomes, we used ICD-

9-CM codes in the outpatient files to identify ≥ 2 neoadjuvant chemotherapy claims within 6 months of surgery.

Statistical Analysis

We used chi-square and Student *t* tests to identify relationships between 30-day readmission and patient and index hospitalization characteristics including age (66-69 years, 70-74 years, 75-80 years, and > 80 years), sex, race (white, African American, and other/unknown), socioeconomic status (SES) (low, medium, and high), marital status (yes/no), number of comorbidities (0, 1, and ≥ 2), intensive care unit (ICU) use, end-stage renal disease/hemodialysis, whether a computed tomography (CT) scan was performed (yes/no), neoadjuvant chemotherapy (yes/no), pathologic stage of disease, blood transfusion (yes/no), length of stay (LOS), and discharge to a SNF (yes/no). We determined each patient's comorbidity burden by evaluating diagnoses from their Medicare claims for the 12 months preceding their surgery.[15] We determined SES using each patient's ZIP code according to the approach of Diez-Roux et al.[16]

To assess significant predictors of readmission in particular weeks after the index hospitalization, we used a piecewise exponential model.[17] We selected this approach to account for discrete time data given the exact time of readmission within an interval was known. We first classified the readmission history for each patient regardless of readmission status into a set of discrete time units based on the number of weeks from discharge (1 week-4 weeks excluding days 29 and 30) to account for censoring. These readmission indicators were treated as a distinct observation for each patient, with the time reset to 0 at the beginning of the week. For example, patients who were not readmitted were represented with 4 zeroes (0, 0, 0, and 0) versus a patient readmitted in week 3 represented by 2 zeroes and 1 (0, 0, and 1). For each observation, if no readmission occurred in the week, a time variable was assigned to a full 7 days. If a readmission occurred, the time variable was coded as the number of days from the start of the week until the readmission. In cases of multiple readmissions, the initial readmission was used.

After pooling all observations, we conducted a backward model building procedure to determine which factors had significant effects on readmission, and examine whether each factor's effect differed depending on the week of readmission by including the interaction terms between readmission predictors and weeks. For example, we examined whether the effects of a SNF varied over time (SNF [yes/no] × readmission week [1-4]). Factors in our starting model included any complication present during the index admission (yes/no), new diagnoses present at the time of readmission (13 groups), age, sex, marital status, race, ICU and CT scan use, neoadjuvant chemotherapy, pathologic disease stage, blood transfusions, SNF, comorbidity, LOS, and SES. ICU use, CT scan use, blood transfusions, and LOS all refer to the index admission.

All analyses were performed using SAS statistical software (version 9.3; SAS Institute Inc, Cary, NC) and all testing was 2-sided. The probability of a type I error was set at 0.05. The University of Michigan Institutional Review Board approved the study protocol.

TABLE 1. Patient and Clinical Characteristics According to 30-Day Readmission Status

Characteristic	Readmission No n=1327	Readmission Yes n=455	P[a]
Age, %			.44
66-69 y	18.1	15.0	
70-74 y	26.8	27.0	
75-80 y	33.1	35.8	
>80 y	22.0	22.2	
Sex (male), %	73.8	76.5	.25
Married, %	69.9	69.3	.79
Race, %			.93
White	90.9	91.3	
African American	3.8	3.9	
Other/unknown	5.3	4.8	
SES, %			.15
Low	32.3	28.2	
Medium	34.0	33.6	
High	33.7	38.2	
Comorbidity, %			.13
0	51.9	47.4	
1	28.0	28.4	
≥2	20.1	24.2	
Pathologic stage, %			.37
≤T1	25.2	29.5	
T2-T4	63.0	62.1	
Unknown	11.8	8.4	
Discharge to SNF, %	7.8	22.6	<.001
Intensive care, %	65.8	68.8	.24
CT scan, %	19.8	24.4	.04
Blood transfusion, %	5.1	6.2	.37
Length of stay, d	11.1	11.5	.29
Neoadjuvant chemotherapy, %	7.9	6.5	.34

CT indicates computed tomography; SES, socioeconomic status; SNF, skilled nursing facility.
[a] Chi-square test and Student *t* test for length of stay.

RESULTS

During the study period, 1 in 4 patients (25.5%) undergoing cystectomy were readmitted within 30 days of discharge (Table 1). We found that characteristics such as age, sex, race, SES, comorbidity, neoadjuvant chemotherapy, pathologic stage, ICU use, end-stage renal disease/

TABLE 2. Complications During Initial Hospitalization for Cystectomy and Subsequent Readmission

Complication Type	Complication Present During Index Hospitalization		Total No. of Patients With Complication (%)
	No. (% Readmitted)	Yes (% Readmitted)	
Any complication	13.9	33.8	1042 (58.5)
Any medical complication	17.6	34.9	820 (46.0)
Any surgical complication	22.7	32.5	517 (29.0)
Any major complication[a]	17.3	36.0	786 (44.1)
Genitourinary	24.9	27.8	389 (21.8)
Gastrointestinal	24.6	29.9	318 (17.9)
Acute renal failure	23.1	38.5	286 (16.1)
Sepsis	23.2	42.0	219 (12.3)
Infection	22.9	44.3	219 (12.3)
Bleeding	25.8	21.7	120 (6.7)
Wound	23.3	59.6	109 (6.1)

[a] Major complications included pulmonary, cardiac, acute renal failure, venous thromboembolism, gastrointestinal, sepsis, wound, iatrogenic injury, and hemorrhage.[14] In accordance with Surveillance, Epidemiology, and End Results (SEER)-Medicare rules, the following complications involving <5% of total patients were suppressed: pulmonary (4.3%), other (3.2%), cardiac (2.7%), and neurologic (1.3%). The sepsis and infection categories were not mutually exclusive; the total percentage of patients with such complications combined was 20.4%.

TABLE 3. Readmission Characteristics After Radical Cystectomy

Readmission Characteristics	%
Emergency room charge	66.8
Intensive care	25.9
CT scan	53.4
Discharge to SNF (after readmission)	21.8
Mean initial length of stay (median), d	11.5 (9)
Mean readmission length of stay (median), d	6.7 (5)
Mean time to readmission (median), d	11.5 (10)
Readmitted in wk 1	40.4
Readmitted in wk 2	27.0
Readmitted in wk 3	16.0
Readmitted in wk 4	13.9
New diagnoses at time of readmission (ie, reasons for readmission)	
Infection	51.4
Failure to thrive	36.3
Urinary	33.2
Gastrointestinal	23.1
Hematologic	16.9
Metabolic	16.5
Wound related/hematoma	13.9
NPMO	13.9
Vascular	11.7
Cardiac	10.8
Pulmonary	9.2

Abbreviations: CT, computed tomography; NPMO, neurologic, psychologic, musculoskeletal, ophthalmologic, and/or otorhinolaryngologic; SNF, skilled nursing facility.

hemodialysis, blood transfusions, and LOS for the index hospitalization were not associated with 30-day readmission (all $P > .10$). However, readmitted patients were more likely to have been discharged to SNFs compared with patients who were not readmitted (22.6% vs 7.8%; $P < .001$) and more likely to have had a CT scan during their index admission (24.4% vs 19.8%; $P = .04$). The rates of any complication during the index hospitalization exceeded 50% as shown in Table 2.[14] The 5 most common postoperative complications were genitourinary (21.8%), gastrointestinal (17.9%), acute renal failure (16.1%), infection (12.3%), and sepsis (12.3%). Moreover, the majority of complications we examined were more likely to be present among readmitted patients. For example, compared with those who were not readmitted, readmitted patients demonstrated a nearly 2-fold increase in medical complications after surgery (17.6% vs 34.9%; $P < .01$) and a nearly 3-fold increase in wound complications (23.3% vs 59.6%; $P < .01$).

With respect to readmissions, we found that the majority (67.4%) occurred within 2 weeks of discharge, 66.8% of readmissions had emergency department charges, and 25.9% of readmissions involved ICU use (Table 3). The average LOS for readmission after cystectomy in the current study was 1 week and the median time to readmission was 10 days. As a sensitivity analysis, we classified LOS into quartiles (25% percentile indicates an LOS of < 8 days; 25%-75% percentile indicates a LOS of 8-11 days; and > 75% percentile indicates a LOS of > 11 days) and examined readmission across the categories. There were no differences noted among the groups with respect to readmission ($P = .18$). We also examined readmissions among optimal patients (ie, those without any complications and LOS within 1 day of the median [n = 274; 15.4%]). We found these patients were significantly less likely to be readmitted to the hospital compared with other patients (12.0% vs 28.0%; $P < .001$).

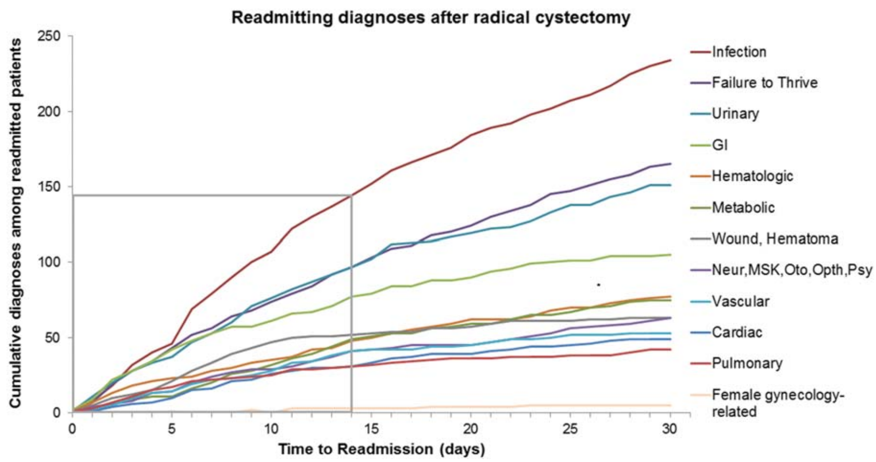

Figure 1. Trends in readmission diagnoses after radical cystectomy for bladder cancer are shown. The highlighted area represents the 2-week period during which 67.4% of readmissions occurred. The most common readmission diagnoses involved infection (51%), failure to thrive (36%), and urinary (33%) and gastrointestinal (23%) etiologies, with 96% of readmitted patients having $\geq$1 of these diagnosis groups. The diagnostic spectrum varied during the 4 weeks after discharge as shown. GI indicates gastrointestinal; Neur, neurologic; MSK, musculoskeletal, Oto, otorhinolaryngologic; Opth, ophthalmologic; Psy, psychologic.

As illustrated in Figure 1, the reason for readmission (ie, diagnosis category) depended on the time from discharge. For example, infectious diagnoses were ultimately most prevalent by 30 days. However, gastrointestinal and failure to thrive diagnoses appeared as common in the first 5 days after discharge. The 4 most common new diagnoses at the time of readmission involved infection, failure to thrive, and urinary and gastrointestinal etiologies. Moreover, we found that 95.8% of all 30-day readmissions had diagnoses belonging to at least 1 of those 4 categories (85.9% of patients had $\geq$ 1 of these groups as a new diagnosis at the time of readmission).

Based on our multivariable survival analysis, factors found to be significant for 30-day readmission include new diagnoses related to failure to thrive; urinary, gastrointestinal, NPMO, vascular, and wound diagnoses; index admission ICU care; and the presence of any complication during the index admission (Table 4). We also found that infectious, metabolic, and pulmonary diagnoses and SES were time-dependent factors based on their interaction terms. In particular, patients with new infectious diagnoses at the time of readmission were less likely to be readmitted in week 1 than in week 4, indicating that infections were not statistically significant contributors to readmission during the first week, relatively speaking (adjusted hazard ratio [aHR], 0.28; 95% confidence interval [95% CI], 0.15-0.51). Pulmonary diagnoses were mostly associated with readmission in the first week after discharge (aHR, 4.00; 95% CI, 1.28-12.52) when compared with week 4, whereas metabolic diagnoses were less common among patients readmitted in the first week (aHR, 0.42; 95% CI, 0.20-0.90). Finally, compared with high SES patients, patients with low SES were less likely to be readmitted within the first 3 weeks after discharge (Table 4).

DISCUSSION

This population-based study found that 1 in 4 patients undergoing cystectomy was readmitted to the hospital within 30 days regardless of their age, race, sex, and baseline comorbidity. Our analyses revealed that approximately two-thirds of the 30-day readmissions occurred within the first 2 weeks after hospital discharge. Not surprisingly, complications during the index admission were much more common among readmitted patients and associated with a 2-fold increase in the adjusted likelihood of readmission. As demonstrated in the current study, it was not uncommon for patients to incur emergency room charges, ICU use, and cross-sectional imaging during their readmission, which might last a week or more. The current study findings and time-dependent analyses highlight that reducing the burden of readmissions among patients who underwent cystectomy, caregivers, and health care systems is a complex target. Successful interventions to prevent and reduce the intensity of readmission after cystectomy will likely need to focus on the first 2 weeks after discharge, take into consideration the spectrum of diagnoses identified in the current study, and be tailored to high-risk individuals.

The current study provides an in-depth examination of 2 key elements contributing to readmission after

TABLE 4. Multivariable Analysis of Factors Associated With Readmission After Cystectomy

Factor (Referent)	Comparator	aHR (95% CI)
Readmission diagnoses		
Infection[a]		-
Metabolic[a]		-
Pulmonary		-
NPMO		1.41 (1.07-1.87)
Urinary		1.51 (1.21-1.88)
Failure to thrive		1.61 (1.29-2.01)
Vascular		1.67 (1.25-2.23)
Gastrointestinal		2.19 (1.73-2.77)
Wound		2.56 (1.92-3.42)
Index intensive care		1.23 (1.00-1.51)
Any complication during index hospitalization		1.92 (1.52-2.42)
SES[a]		-
Readmission wk[a]		-
Infection diagnoses by readmission wk	Wk 1	0.28 (0.15-0.51)
	Wk 2	0.51 (0.27-0.97)
	Wk 3	1.01 (0.49-2.06)
	Wk 4	1.00
Metabolic diagnoses by readmission wk	Wk 1	0.42 (0.20-0.90)
	Wk 2	0.99 (0.48-2.07)
	Wk 3	0.55 (0.22-1.35)
	Wk 4	1.00
Pulmonary diagnoses by readmission wk	Wk 1	4.00 (1.28-12.52)
	Wk 2	2.00 (0.57-2.94)
	Wk 3	1.30 (0.32-5.20)
	Wk 4	1.00
Readmission wk by SES	Wk 1[a]: Low	0.35 (0.17-0.73)
	Wk 1[a]: Medium	1.02 (0.46-2.24)
	Wk 1[a]: High	1.00
	Week 2[a]: Low	0.30 (0.14-0.65)
	Week 2[a]: Medium	0.93 (0.41-2.11)
	Week 2[a]: High	1.00
	Week 3[a]: Low	0.31 (0.13-0.73)
	Week 3[a]: Medium	1.04 (0.43- 2.52)
	Week 3[a]: High	1.00

95% CI, 95% confidence interval; aHR, adjusted hazard ratio; NPMO, neurologic, psychologic, musculoskeletal, ophthalmologic, and/or otorhinolaryngologic; SES, socioeconomic status.

[a] Refer to interaction terms for significant effects. Main effects were as follows for readmission week: readmission week 1: aHR, 1.91 (95% CI, 1.52-2.42); week 2: aHR, 4.55 (95% CI, 2.40-8.63); week 3: aHR, 2.84 (95% CI, 1.45-5.58); and week 4: referent.

surgery for bladder cancer: postoperative complications and common reasons for readmission (ie, infection, failure to thrive, and urinary and gastrointestinal etiologies). The former is consistent with research using both clinical and administrative data to examine the morbidity of cystectomy.[8,18-22] For example, our complication rate of 58% falls well within the ranges cited in the literature (38%-64%).[18,23,24]

With respect to the reasons for readmission, our population-based findings expand on those reported by clinical series with respect to the possible causes and timing of readmission in at least 2 ways. First, one descriptive study of readmitted patients (n = 200) after radical cystectomy found that common reasons for readmission within 30 days included ileus (10.8%), nausea/vomiting (7.0%), pyelonephritis (7.5%), urinary tract infection (7.0%), failure to thrive (5.4%), and dehydration (6.5%), findings that are consistent with the findings of the current study.[8] We expanded on these findings by providing a more precise look at the reasons for and the discrete timing of readmission (ie, weekly) at a population level to inform possible interventions. Second, by taking readmission timing into consideration, we were able to identify when the majority of 30-day readmissions occur (ie, within 2 weeks) to hone in on the most efficient way to prevent and reduce the burden of readmission. This is within the context of a multicenter, prospective cohort study that found the odds of avoidable readmissions decreased by 32% with each additional month after discharge (odds ratio, 0.68; 95% CI, 0.58-0.81), suggesting that earlier preventive efforts may be more productive.[25] We also highlight the extreme resource use associated with readmission after cystectomy (eg, ICU, emergency department, and imaging) as a call to sharpen the focus on not only reducing readmissions but also decreasing the intensity of readmission for those in need of hospital care.

Reducing readmissions after bladder cancer surgery will not only benefit patients and their caregivers but also health care systems.[2] In light of recent policy reforms, health care organizations are actively seeking to reduce excess readmissions to avoid payment reductions. By way of a modification to the Social Security Act, Section 3025 of the ACA established the Hospital Readmissions Reduction Program.[7] As part of this program, the CMS was mandated to reduce payments to Medicare inpatient prospective payment system hospitals with excess readmissions effective October 2012. Although the current focus is on excess readmissions compared with adjusted national averages for medical conditions of acute myocardial infarction, pneumonia, and heart failure, the CMS is finalizing plans to include acute exacerbations of chronic obstructive pulmonary disease as well as elective total hip and knee arthroplasty for fiscal year 2015. Although preventing readmissions after bladder cancer surgery may play a small part in solving the entire readmission dilemma, effective solutions may be generalizable to other surgical patients as the CMS program expands its clinical scope to include more surgical care.

Payers and health care organizations are already working to reduce readmissions through transitional care programs, improved discharge planning, postdischarge interventions, high-risk patient identification, and telemedicine.[2,26] Based on the findings of the current study, patients at high risk of readmission after cystectomy appear to be those with postoperative complications. In addition to more sophisticated time-dependent and systems engineering approaches to predict individuals at high readmission risk,[27] focusing efforts on the cystectomy population within the first 2 weeks after discharge appears to be a good starting point. Other interventions, such as physical rehabilitation before cystectomy (ie, prehabilitation), should be considered as possible components of a multifaceted approach to reduce the burden of readmission in this population.[28] The evidence base and best practices to reduce readmissions remain a work in progress.

There are several potential limitations to the current study. First, we used Medicare data and excluded patients aged < 66 years to ensure adequate comorbidity profiling. However, because the median age at bladder cancer diagnosis is 73 years and greater than one-half of the patients in the current study were aged > 75 years, the current study findings appear generalizable to the majority of patients undergoing major surgery for bladder cancer.[11] Second, there may be concerns with our classification of postoperative complications based on administrative claims. These should be allayed by the use of a well-vetted methodology to detect postoperative complications[14,29,30] and the finding that our complication rates were consistent with those reported in smaller clinical series. Third, we did not examine any intervening telephone or outpatient care that may have prevented readmission. Although this warrants further study, we did find a variety of factors associated with readmission that can potentially help to direct follow-up care and lines of inquiry for telemedicine and outpatient interventions. Finally, we did not characterize the type of urinary diversion performed among this study population. However, the majority of urinary diversions involve an ileal conduit with a bias toward patients with bladder cancer.[12] Furthermore, findings from a benign and cancer-related cystectomy cohort demonstrated no differences in readmission or 90-day mortality according to diversion type.[12]

High readmission rates after radical cystectomy continue to plague patients, caregivers, and health care systems. The findings of the current study and time-dependent analyses highlight that reducing the burden of readmissions after bladder cancer surgery is a complex target. We believe successful interventions to prevent and reduce the intensity of readmission after cystectomy likely need to focus on the first 2 weeks after discharge, take into consideration the spectrum of diagnoses in the current study, and be tailored to high-risk individuals.

FUNDING SUPPORT

Supported by the American Cancer Society Pennsylvania Division–Dr. William and Rita Conrady Mentored Research Scholar Grant (MSRG-07-006-01-CPHPS), the American Urological Association Foundation, Astellas Pharma US, and the University of Michigan Center for Healthcare Engineering and Patient Safety.

CONFLICT OF INTEREST DISCLOSURES

Dr. Jacobs is supported by National Institutes of Health grant KL2TR000146 for work performed outside of the current study. Cubist Pharmaceuticals supported Dr. Lee's participation in a clinical trial outside of the current study that examined the impact of alvimopan on gastrointestinal activity and on hospital length of stay (as a secondary endpoint). Dr. Hollenbeck was supported by grants from the Agency for Healthcare Research and Quality, National Cancer Institute, and American Cancer Society for work outside of the current study and is also an associate editor at Elsevier. Dr. Skolarus is supported by a VA Health Services Research and Development Career Development Award-2 (CDA 12-171) and is a paid consultant and grant contributor for ArborMetrix, Inc, a health care analytics and software firm specializing in hospital-based and specialty-based care.

REFERENCES

1. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. *N Engl J Med*. 2009;360:1418-1428.
2. Minott J. Reducing Hospital Readmissions: November 2008. academyhealth.org/files/publications/ReducingHospitalReadmissions.pdf. Accessed August 22, 2013.
3. Vest JR, Gamm LD, Oxford BA, Gonzalez MI, Slawson KM. Determinants of preventable readmissions in the United States: a systematic review. *Implement Sci*. 2010;5:88.
4. Feigenbaum P, Neuwirth E, Trowbridge L, et al. Factors contributing to all-cause 30-day readmissions: a structured case series across 18 hospitals. *Med Care*. 2012;50:599-605.
5. van Walraven C, Bennett C, Jennings A, Austin PC, Forster AJ. Proportion of hospital readmissions deemed avoidable: a systematic review. *CMAJ*. 2011;183:E391-E402.
6. PricewaterhouseCoopers' Health Research Institute The Price of Excess, Identifying Waste in Healthcare Spending. pwc.com/cz/en/verejna-sprava-zdravotnictvi/prices-of-excess-healthcare-spending.pdf. Accessed August 24, 2013.
7. Centers for Medicare & Medicaid Services. Readmissions Reduction Program. cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Readmissions-Reduction-Program.html. Accessed August 20, 2013.
8. Stimson CJ, Chang SS, Barocas DA, et al. Early and late perioperative outcomes following radical cystectomy: 90-day readmissions, morbidity and mortality in a contemporary series. *J Urol*. 2010;184:1296-1300.
9. Aghazadeh MA, Barocas DA, Salem S, et al. Determining factors for hospital discharge status after radical cystectomy in a large contemporary cohort. *J Urol*. 2011;185:85-89.
10. Jacobs BL, Zhang Y, Tan HJ, Ye Z, Skolarus TA, Hollenbeck BK. Hospitalization trends after prostate and bladder surgery: implications of potential payment reforms. *J Urol*. 2013;189:59-65.
11. National Cancer Institute. Surveillance, Epidemiology, and End Results (SEER) Program. seer.cancer.gov/. Accessed June 1, 2012.
12. Gore JL, Lai J, Gilbert SM. Readmissions in the postoperative period following urinary diversion. *World J Urol*. 2011;29:79-84.
13. Lawson EH, Hall BL, Louie R, et al. Association between occurrence of a postoperative complication and readmission: implications for quality improvement and cost savings. *Ann Surg*. 2013;258:10-18.

14. Tan HJ, Wolf JS Jr, Ye Z, Wei JT, Miller DC. Complications and failure to rescue after laparoscopic versus open radical nephrectomy. *J Urol*. 2011;186:1254-1260.
15. Klabunde CN, Potosky AL, Legler JM, Warren JL. Development of a comorbidity index using physician claims data. *J Clin Epidemiol*. 2000;53:1258-1267.
16. Diez Roux AV, Merkin SS, Arnett D, et al. Neighborhood of residence and incidence of coronary heart disease. *N Engl J Med*. 2001; 345:99-106.
17. Friedman M. Piecewise exponential models for survival-data with covariates. *Ann Stat*. 1982;10:101-113.
18. Chang SS, Cookson MS, Baumgartner RG, Wells N, Smith JA Jr. Analysis of early complications after radical cystectomy: results of a collaborative care pathway. *J Urol*. 2002;167:2012-2016.
19. Novara G, De Marco V, Aragona M, et al. Complications and mortality after radical cystectomy for bladder transitional cell cancer. *J Urol*. 2009;182:914-921.
20. Khan MS, Elhage O, Challacombe B, Rimington P, Murphy D, Dasgupta P. Analysis of early complications of robotic-assisted radical cystectomy using a standardized reporting system. *Urology*. 2011;77:357-362.
21. Kim SP, Shah ND, Karnes RJ, et al. The implications of hospital acquired adverse events on mortality, length of stay and costs for patients undergoing radical cystectomy for bladder cancer. *J Urol*. 2012;187:2011-2017.
22. Johar RS, Hayn MH, Stegemann AP, et al. Complications after robot-assisted radical cystectomy: results from the International Robotic Cystectomy Consortium. *Eur Urol*. 2013;64:52-57.
23. Lowrance WT, Rumohr JA, Chang SS, et al. Contemporary open radical cystectomy: analysis of perioperative outcomes. *J Urol*. 2008; 179:1313-1318.
24. Donat SM, Shabsigh A, Savage C, et al. Potential impact of postoperative early complications on the timing of adjuvant chemotherapy in patients undergoing radical cystectomy: a high-volume tertiary cancer center experience. *Eur Urol*. 2009;55:177-185.
25. van Walraven C, Jennings A, Taljaard M, et al. Incidence of potentially avoidable urgent readmissions and their relation to all-cause urgent readmissions. *CMAJ*. 2011;183:E1067-E1072.
26. Harrison PL, Hara PA, Pope JE, Young MC, Rula EY. The impact of postdischarge telephonic follow-up on hospital readmissions. *Popul Health Manag*. 2011;14:27-32.
27. Kopach-Konrad R, Lawley M, Criswell M, et al. Applying systems engineering principles in improving health care delivery. *J Gen Intern Med*. 2007;22(suppl 3):431-437.
28. Mayo NE, Feldman L, Scott S, et al. Impact of preoperative change in physical function on postoperative recovery: argument supporting prehabilitation for colorectal surgery. *Surgery*. 2011;150: 505-514.
29. Iezzoni LI, Daley J, Heeren T, et al. Identifying complications of care using administrative data. *Med Care*. 1994;32: 700-715.
30. Weingart SN, Iezzoni LI, Davis RB, et al. Use of administrative data to find substandard care: validation of the complications screening program. *Med Care*. 2000;38:796-806.