Patient Function and the Value of Surgical Care for Kidney Cancer

Hung-Jui Tan,* Joseph D. Shirk, Karim Chamie, Mark S. Litwin and Jim C. Hu

From the Department of Urology, University of North Carolina (HJT), Chapel Hill, North Carolina, Department of Urology, David Geffen School of Medicine at UCLA (JDS, KC), Department of Health Policy and Management, UCLA Fielding School of Public Health and UCLA School of Nursing, Los Angeles (MSL), California, and Department of Urology, Weill Cornell School of Medicine (JCH), New York, New York

Abbreviations and Acronyms

ER = emergency room

FRI = function related indicator

ICU = intensive care unit

LOS = length of stay

SEER = Surveillance, Epidemiology and End Results

Accepted for publication December 6, 2016.

No direct or indirect commercial incentive associated with publishing this article.

The corresponding author certifies that, when applicable, a statement(s) has been included in the manuscript documenting institutional review board, ethics committee or ethical review board study approval; principles of Helsinki Declaration were followed in lieu of formal ethics committee approval; institutional animal care and use committee approval; all human subjects provided written informed consent with guarantees of confidentiality; IRB approved protocol number; animal approved project number.

Supported by American Cancer Society Grant 126217-PF-14-028-01-CPHPS (HJT) and a National Institutes of Health Loan Repayment Program grant (HJT, KC).

* Correspondence: Department of Urology, University of North Carolina at Chapel Hill, 170 Manning Dr., CB #7235, Chapel Hill, North Carolina 27599 (telephone: 919-966-2571; e-mail: hjtan@med.unc.edu).

Purpose: Frailty and functional status have emerged as significant predictors of morbidity and mortality for patients undergoing cancer surgery. To articulate the impact on value (ie quality per cost), we compared perioperative outcomes and expenditures according to patient function for older adults undergoing kidney cancer surgery.

Materials and Methods: Using linked SEER (Surveillance, Epidemiology and End Results)-Medicare data, we identified 19,129 elderly patients with kidney cancer treated with nonablative surgery from 2000 to 2009. We quantified patient function using function related indicators (claims indicative of dysfunction and disability) and measured 30-day morbidity, mortality, resource use and cost. Using multivariable, mixed effects models to adjust for patient and hospital characteristics, we estimated the relationship of patient functionality with both treatment outcomes and expenditures.

Results: Of 19,129 patients we identified 5,509 (28.8%) and 3,127 (16.4%) with a function related indicator count of 1 and 2 or greater, respectively. While surgical complications did not vary (OR 0.95, 95% CI 0.86−1.05), patients with 2 or more indicators more often experienced a medical event (OR 1.22, 95% CI 1.10−1.36) or a geriatric event (OR 1.55, 95% CI 1.33−1.81), or died within 30 days of surgery (OR 1.43, 95% CI 1.10−1.86) compared with patients with no baseline dysfunction. These patients utilized significantly more medical resources and amassed higher acute care expenditures ($p < 0.001$).

Conclusions: During kidney cancer surgery, patients in poor functional health can face a more eventful medical recovery at elevated cost, indicating lower value care. Greater consideration of frailty and functional status during treatment planning and transitions may represent areas for value enhancement in kidney cancer and urology care.

Key Words: kidney neoplasms, nephrectomy, perioperative period, health care costs, SEER Program

Kidney cancer is the seventh most common solid organ malignancy in the United States with 63,920 new cases per year.[1] With many patients undergoing surgery, nephrectomy has seen the second highest growth among nonorthopedic operations over the last decade.[2] Simultaneously, the operative approach has become more advanced with both nephron sparing and minimally invasive surgery.[3]

0022-5347/17/1975-1200/0
THE JOURNAL OF UROLOGY®

http://dx.doi.org/10.1016/j.juro.2016.12.012
Vol. 197, 1200-1207, May 2017
Printed in U.S.A.

Historically, surgery accounts for a disproportionate percentage of health care cost. Although 28% of hospital admissions are for elective operations, they represent nearly 50% of hospital based expenditures.[2] Previous investigations have also established substantial variation in the total episodic cost of surgery, suggesting that surgical care may be a ripe target for accountable care organizations or bundled payments.[4] In these risk sharing, alternative payment models, it becomes incumbent on health care providers to improve outcomes and save cost. In cancer and surgery, patient function and frailty have been identified as significant predictors of perioperative morbidity and mortality.[5–8] Although adverse events presumably add to cost, the total impact of functional disability on value (the quotient of surgical quality over cost) remains poorly defined.

Accordingly, it is crucial to understand the role of patient functionality in determining value in urological surgery. In this context, we concurrently examined the impact of patient function on outcomes and resource consumption during kidney cancer surgery. In understanding the influence of patient function on quality and cost, we aim to prepare for value based care.

MATERIALS AND METHODS

Data Source and Cohort Identification

For this study, we used data from SEER-Medicare. SEER is a population based United States cancer registry that maintains information regarding incidence, treatment and mortality. These data are linked to Medicare, which provides primary health insurance for 97% of the United States population 65 years old or older.[9,10]

We identified a total of 32,967 subjects 65 years old or older receiving fee for service care who were diagnosed while alive with primary, nonurothelial kidney cancer from 2000 to 2009. We excluded 2,496 subjects without continuous enrollment in the 12 months prior to diagnosis and 313 without continuous enrollment in the 6 months following diagnosis or until death, leaving 30,158 for analysis. We restricted our sample to 28,458 subjects with complete cancer staging information available and further excluded 46 with hospice care in the year preceding diagnosis and 86 with bilateral disease to create a preliminary sample of 28,326 subjects.

To identify patients treated with surgery, we applied a validated, claims based algorithm based on inpatient hospital and physician claims using ICD-9 and CPT codes.[11] We procured a total analytical cohort of 19,129 subjects who were treated with open radical nephrectomy, open partial nephrectomy, minimally invasive radical nephrectomy or minimally invasive partial nephrectomy.

Primary Measure of Patient Function

To measure patient function, we applied a set of 16 FRIs described by Chrischilles et al[12] to Medicare claims submitted in the 12 months preceding cancer diagnosis. FRIs use claims indicative of reduced functional status (eg mobility assistance device, falls, fractures, home oxygen or pressure ulcers) or overlying disability (eg dementia, depression, malnutrition, respiratory failure or sepsis). Previous assessments have demonstrated a strong correlation with performance status and short-term mortality.[12,13] For kidney cancer specifically, the FRI count predicts long-term mortality independent of age and comorbidity.[14] For this study, we created a 3-tier categorical variable based on indicator count (ie 0, 1 and 2 or greater).

Patient and Hospital Covariates

From SEER-Medicare, we extracted information on age, gender, marital status, race, year of treatment and tumor stage (ie AJCC stages I to IV). We utilized census tract level estimates of high school education and income to measure socioeconomic position and further identified rural/urban residential status. Comorbidity was assigned according to the Klabunde modification of the Charlson comorbidity index based on inpatient and outpatient claims submitted in the 12 months prior to cancer diagnosis.[15]

Using the SEER-Medicare hospital file, we classified the treating hospital in terms of ownership (ie nonprofit vs for profit vs governmental), academic affiliation and NCI (National Cancer Institute) cancer center status. We also ascertained the total number of patient beds and categorized nursing volume based on the number of nursing full-time equivalents per patient bed total. Finally, we calculated the number of kidney cancer surgeries performed at each hospital in each study year and created a 3-tier categorical variable for hospital volume.

Outcome Measures

For each subject, we assessed outcomes related to morbidity and mortality, resource use and cost. For the first category, we drew from CSP (Complication Screening Program) and from AHRQ (Agency for Healthcare Research and Quality) PSIs (Patient Safety Indicators) to identify specific ICD-9 codes indicative of potential complications during the index hospitalization or within 30 days after surgery, as described previously.[16–19] From these codes, we created binary measures for surgical complications (ie accidental puncture or laceration, gastrointestinal complications, genitourinary complications, postoperative hemorrhage, venous thromboembolism, wound complications and miscellaneous complications) and medical complications (ie acute renal failure, cardiac complications, neurological events, postoperative infection, pulmonary failure and sepsis). Geriatric events were also identified based on ICD-9 codes indicative of dehydration, delirium, falls/fractures, failure to thrive and pressure ulcers.[20] Next, we defined operative mortality as death during the above specified interval. From these measures, we examined failure to rescue, which is the case fatality rate among those with a complication.[19]

To assess resource use, we then examined ICU use, LOS, post-acute rehabilitation, ER visits and rehospitalizations. Based on Medicare billing codes, we defined ICU use as any admission to the intensive, intermediate or coronary care unit during the index hospitalization or at any time within 30 days of surgery.[21] We determined LOS by calculating the interval from hospital admission to discharge inclusive of transfers to acute care facilities. Because LOS varies with the surgical approach, we created an indicator variable for the top decile of hospitalizations according to procedure. We defined post-acute rehabilitation as any claim within 30 days of discharge to a skilled nursing facility or inpatient rehabilitation, for example DRG (Diagnosis-Related Group) 462 before 2008 and 945/946 thereafter. ER visits and rehospitalizations were captured by identifying subsequent Medicare claims for ER and inpatient care, respectively, within 30 days of discharge.[22]

Finally, we calculated cost by aggregating Medicare health care expenditures from inpatient, outpatient and physician claims submitted for the index hospitalization or within 30 days after surgery. We treated each subject as his or her own control by subtracting the monthly average of Medicare expenditures reported in the 12 months preceding diagnosis. All costs were adjusted to 2014 dollars using the Annual Report of the Boards of Trustees of the Federal Hospital Insurance Trust Fund and the Federal Supplemental Medical Insurance Trust Fund.

Statistical Analysis

First, we compared patient and hospital covariates according to FRI count using the chi-square test. Then, given the hierarchical nature of our data, we built multivariable, mixed effects models to evaluate the relationship between patient function and our outcomes. These models include patient covariates (ie age, comorbidity, race, gender, marital status, socioeconomic status, surgery type and cancer stage) and hospital covariates (ie bed size, nursing volume, hospital case volume, ownership control, cancer center status and academic affiliation) as fixed effects, along with a hospital level random intercept. For our binary outcome measures, we converted the likelihood estimates to risk adjusted predicted probabilities and obtained 95% CIs using bootstrapping with replacement for 1,000 replications. To evaluate cost, we log transformed our aggregated expenditures for the mixed effects models and retransformed our predicted log expenditures to obtain the total cost of care according to FRI count. We further determined the marginal cost between patient function categories and obtained 95% CIs for each estimate using bootstrapping with replacement for 1,000 replications.

To assess the robustness of our findings, we performed several sensitivity analyses. As comorbidity and function may be interrelated, we tested models inclusive of an interaction term between Charlson score and FRI count. We further repeated our primary analysis in comorbidity subgroups (ie Charlson score 0, 1 and 2 or greater). Finally, as outcomes and cost can vary by procedure, we refitted separate models for patients undergoing open, nephron sparing and minimally invasive surgery.

All statistical testing was 2-sided, completed using STATA®, version 14.1 and performed at the 5% significance level. This study was approved by the UCLA institutional review board.

RESULTS

Of 19,129 subjects we identified 5,509 (28.8%) and 3,127 patients (16.3%) with 1 and 2 or more FRIs, respectively. The most common FRIs were history of fall related injury, malnutrition, depression, pneumonia, syncope and mobility assistance device (supplementary table 1, http://jurology.com/). A higher FRI count was more common among patients who were older, female, unmarried, with lower socioeconomic standing or with a greater comorbidity burden ($p < 0.001$). Cancer stage and surgery type also varied with patient function ($p \leq 0.001$). We identified no statistically significant relationship between FRI count and our hospital covariates (tables 1 and 2).

Figure 1 shows the relationship between patient function and our morbidity and mortality outcomes. Based on our multivariable, mixed effects models, surgical complications did not differ according to FRI count. In contrast, patients with 1 FRI had a greater likelihood of medical events (OR 1.12, 95% CI 1.02−1.22) and geriatric events (OR 1.29, 95% CI 1.14−1.47) compared to those without any baseline dysfunction. Moreover, patients with at least 2 FRIs exhibited an increased likelihood of medical events (OR 1.22, 95% 1.10−1.36) and geriatric events (OR 1.55, 95% CI 1.33−1.81) as well as more failure to rescue (OR 1.41, 95% CI 1.06−1.86) and more operative mortality (OR 1.43, 95% CI 1.10−1.86) compared to those with a count of 0.

Figure 2 shows that patients with reduced function consumed more resources during the perioperative period. The relative increase varied with the health care service, ranging from a 10.4% increase in ICU care to a 76.8% increase in post-acute rehabilitation for patients with a FRI count of 2 or greater vs 0. No significant interactions were observed between our measures of comorbidity and patient function.

In terms of cost, the predicted expenditures varied significantly with patient function. For patients with no baseline deficit, 30-day expenditures stood at $23,285 (95% CI 22,679−23,957). Patients with 1 and 2 or more FRIs exceeded that amount by $1,335 (95% CI 734−2,100) and $2,120 (95% CI 1,226−3,179), representing an increase of 5.7% (95% CI 2.5−8.7) and 9.1% (95% CI 4.3−13.0), respectively.

Regardless of surgical approach or comorbidity burden, patients with 2 or more vs 0 FRIs experienced more geriatric events and generally consumed more resources than their healthier counterparts. Across these subgroups, health care expenditures were also consistently higher for patients with baseline dysfunction. Supplementary tables 2 to 4 (http://jurology.com/) show the results of these sensitivity analyses.

Table 1. *Patient characteristics according to function related indicator count*

	No. 0 FRI (%)	No. 1 FRI (%)	No. 2 or Greater FRIs (%)	p Value
Pts	10,493	5,509	3,127	—
Age:				
65—69	2,485 (23.7)	1,146 (20.8)	628 (20.1)	<0.001
70—74	3,340 (31.8)	1,628 (29.6)	804 (25.7)	
75—79	2,611 (24.9)	1,480 (26.9)	853 (27.3)	
80—84	1,501 (14.3)	890 (16.2)	561 (17.9)	
85+	556 (5.3)	365 (6.6)	281 (9.0)	
Female	4,012 (38.2)	2,401 (43.6)	1,585 (50.7)	<0.001
Race/ethnicity:				
White	8,618 (82.1)	4,554 (82.7)	2,528 (80.8)	0.091
Black	844 (8.0)	430 (7.8)	290 (9.3)	
Hispanic/Latino	632 (6.0)	319 (5.8)	209 (6.7)	
Asian	311 (3.0)	159 (2.9)	71 (2.3)	
Other	88 (0.8)	47 (0.9)	29 (0.9)	
Married	6,848 (65.3)	3,334 (60.5)	1,671 (53.4)	<0.001
Rural status	1,234 (11.8)	599 (10.9)	359 (11.5)	0.246
Income tercile:*				
Bottom	3,162 (30.2)	1,701 (30.9)	1,092 (35.0)	<0.001
Middle	3,516 (33.5)	1,791 (32.5)	1,003 (32.1)	
Top	3,805 (36.3)	2,013 (36.6)	1,029 (32.9)	
Education tercile:†				
Bottom	3,295 (31.4)	1,746 (31.7)	1,093 (35.0)	0.002
Middle	3,462 (33.0)	1,842 (33.5)	1,015 (32.5)	
Top	3,728 (35.6)	1,917 (34.8)	1,016 (32.5)	
Charlson comorbidity score:				
0	6,600 (62.9)	2,836 (51.5)	965 (30.9)	<0.001
1	2,594 (24.7)	1,510 (27.4)	863 (27.6)	
2 or Greater	1,299 (12.4)	1,163 (21.1)	1,299 (41.5)	
AJCC 10th edition tumor stage:				
I	6,412 (61.1)	3,478 (63.1)	2,047 (65.5)	<0.001
II	1,062 (10.1)	505 (9.2)	258 (8.3)	
III	2,208 (21.0)	1,090 (19.8)	637 (20.4)	
IV	811 (7.7)	436 (7.9)	185 (5.9)	
Nephrectomy type:				
Open radical	3,522 (33.6)	1,880 (34.1)	1,165 (37.3)	0.001
Laparoscopic radical	5,078 (48.4)	2,566 (46.6)	1,403 (44.9)	
Open partial	741 (7.1)	445 (8.1)	229 (7.3)	
Laparoscopic partial	1,152 (11.0)	618 (11.2)	330 (10.6)	
Treatment yr:				
2000	812 (7.7)	403 (7.8)	240 (7.7)	0.745
2001	955 (9.1)	476 (8.6)	247 (7.9)	
2002	963 (9.2)	488 (8.9)	307 (9.8)	
2003	1,063 (10.1)	535 (9.7)	318 (10.2)	
2004	1,070 (10.2)	623 (11.3)	329 (10.5)	
2005	1,141 (10.9)	588 (10.7)	346 (11.1)	
2006	1,106 (10.5)	591 (10.7)	333 (10.7)	
2007	1,129 (10.8)	596 (10.8)	320 (10.2)	
2008	1,108 (10.6)	579 (10.5)	322 (10.3)	
2009	1,146 (10.9)	603 (11.0)	365 (11.7)	

Column percents may not total 100% due to rounding.
* Income data missing on 17 patients.
† Education data missing on 15 patients.

Table 2. *Hospital characteristics according to function related indicator count*

	No. 0 FRI (%)	No. 1 FRI (%)	No. 2 or Greater FRIs (%)	p Value
Pts	10,493	5,509	3,127	—
Bed size:				
Small	4,715 (44.9)	2,505 (45.5)	1,371 (43.8)	0.167
Medium	3,274 (31.2)	1,642 (29.8)	959 (30.7)	
Large	2,504 (23.9)	1,362 (24.7)	797 (25.5)	
Nursing vol tertile:				
Lowest	3,525 (33.7)	1,811 (33.0)	1,000 (32.4)	0.446
Middle	3,440 (32.9)	1,823 (33.3)	1,067 (34.6)	
Highest	3,485 (33.4)	1,847 (33.7)	1,018 (33.0)	
Hospital vol (No. cases/yr):				
1—4	3,537 (33.8)	1,866 (34.0)	1,029 (33.4)	0.970
5—10	3,638 (34.8)	1,899 (34.6)	1,089 (35.3)	
Greater than 10	3,278 (31.4)	1,717 (31.3)	967 (31.4)	
Ca center	1,338 (12.8)	690 (12.6)	382 (12.4)	0.807
Academic institution	3,556 (34.0)	1,885 (34.4)	1,090 (35.3)	0.406
Hospital type:				
Nonprofit	7,997 (76.6)	4,228 (77.3)	2,332 (75.7)	0.233
For profit	937 (9.0)	510 (9.3)	305 (9.9)	
Government	1,504 (14.4)	734 (13.4)	442 (14.4)	

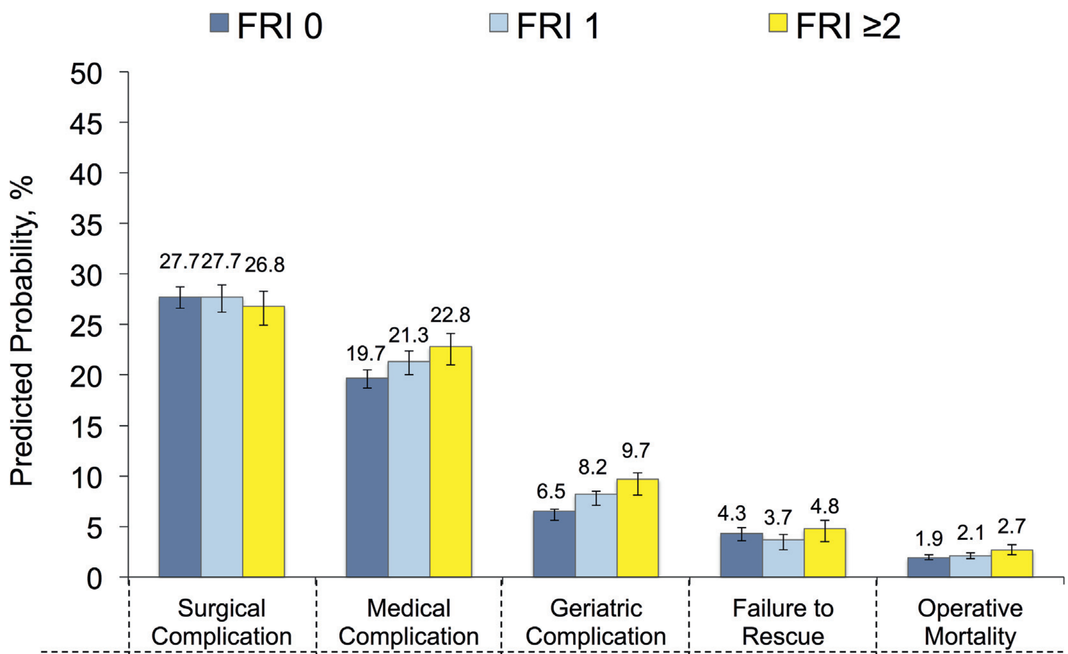
Hospital characteristics missing for 140 or fewer subjects (0.7% of analytical sample).

DISCUSSION

Recently, the emphasis in health care has shifted from simply improving outcomes to improving value, which is defined as treatment quality per cost. Accordingly, health care services that are either costly or that yield poor outcomes are lower in value and present opportunities for value enhancement. For older patients undergoing surgery for kidney cancer, we found that patients with decreased function, as evidenced by a higher FRI count, experienced a modest elevation in certain complications and a more demonstrable increase in resource use and cost.

Complications following kidney cancer surgery have been previously shown to develop as a function of age and comorbidity.[23] In this study, we found that patient function also contributes significantly to postoperative morbidity, consistent with institutional and registry studies surveying a variety of surgical procedures.[5–8] However, this relationship appears specific to medical and geriatric adverse events and not to surgical complications, which are often more technical in nature. Collectively, this suggests that while surgery is often feasible, recovery for patients with baseline dysfunction may be hampered once out of the operating room.

Likely as a reflection of both poorer baseline health and added postoperative morbidity, patients with reduced baseline function consumed significantly more resources than their healthier counterparts. The relationship between patient function and post-acute rehabilitation has been established previously.[8] However, our findings highlight the greater use of health care services in the hospital and following discharge, which carries significant meaning when considering the total cost of care. Intensive, intermediate and coronary care unit utilization appears to be high across the board but particularly for patients with decreased function. Similar relationships hold true for rehospitalization and post-acute care, which are 2 major cost centers in surgery that account for significant variability in total episodic cost.[4,24,25] When considering these



	Surgical Complication	Medical Complication	Geriatric Complication	Failure to Rescue	Operative Mortality
FRI 0	ref	ref	ref	ref	ref
FRI 1	1.00 (0.93–1.08)	1.12 (1.02–1.22)	1.29 (1.14–1.47)	1.06 (0.82–1.37)	1.08 (0.85–1.37)
FRI ≥2	0.95 (0.86–1.05)	1.22 (1.10–1.36)	1.55 (1.33–1.81)	1.41 (1.06–1.86)	1.43 (1.10–1.86)

Figure 1. Predicted probability of morbidity and mortality after kidney cancer surgery according to patient function as measured using FRIs. Estimates were derived from multivariable, mixed effects models adjusted for patient and hospital characteristics with 95% CIs obtained by bootstrapping with replacement for 1,000 replications. *ref*, referent.

implications on postoperative morbidity and resource use, kidney cancer surgery in patients with evidence of functional decline stands as an area in need of value enhancement in the current health care environment.

These results should be considered in the context of several limitations. 1) Our analysis depends on a claims based measure for patient function. As detailed above, the approach described by Chrischilles et al[12] has a strong relationship with 1-year mortality and it incorporates claims correlated with patient-reported performance status and long-term survival.[13] Furthermore, the inclusion of claims relating to mobility assistance devices, oxygen and dementia offers some face validity.

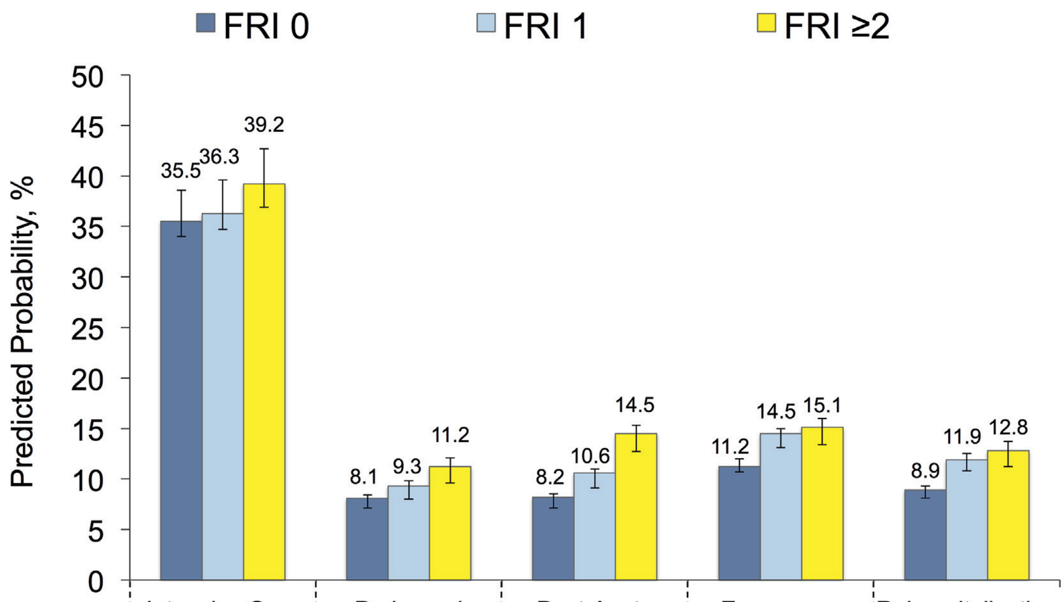
2) Given the observational nature of the study, our findings remain subject to potential bias. In particular, the relationship between patient function and outcomes could reflect residual confounding related to comorbidity. However, previous empirical work has shown comorbidity and functionality to be independent components of health,[14,26] and our findings remain largely consistent across comorbidity subgroups. Our findings may also be subject to bias related to omitted variables, such as surgeon volume and other surgeon characteristics.

3) The use of administrative claims to identify complications depends on coding accuracy. To the extent possible, we utilized either validated measures or diagnosis codes used previously in population based assessments.[16–18,20] Even so, misclassification can occur, particularly with preexisting conditions, although these conditions likely carry similar ramifications on resource use.

4) Because we performed a claims based analysis, we were unable to examine more granular, patient-reported assessments of function.

5) Our findings focused on Medicare beneficiaries and may not be generalizable to younger patients.

These limitations notwithstanding, our findings have important implications for urological surgery. In 2015 the Medicare Access and CHIP (Children's Health Insurance Program) Reauthorization Act was signed into law, accelerating the move toward value based reimbursement.[27] Soon, urologists will engage in either a next generation, pay for performance system that tracks quality and resource use or they will participate in alternative, risk bearing payment models. In the latter several care processes could generate value as they relate to patient function. Among them, "prehabilitation" interventions designed to improve patient health and fitness before treatment could be selectively



	Intensive Care Use	Prolonged Hospitalization	Post-Acute Rehabilitation	Emergency Room Visit	Rehospitalization
FRI 0	ref	ref	ref	ref	ref
FRI 1	1.04 (0.96–1.13)	1.18 (1.04–1.33)	1.37 (1.21–1.55)	1.28 (1.16–1.40)	1.39 (1.24–1.55)
FRI ≥2	1.20 (1.08–1.34)	1.46 (1.26–1.69)	2.07 (1.81–2.36)	1.35 (1.20–1.52)	1.51 (1.31–1.75)

Figure 2. Predicted probability of resource use after kidney cancer surgery according to patient function as measured using FRIs. Estimates were derived from multivariable, mixed effects models adjusted for patient and hospital characteristics with 95% CIs obtained by bootstrapping with replacement for 1,000 replications. *ref,* referent.

applied.[28] Emerging team based care models that deploy medicine physicians and rehabilitation therapists may offer benefit given the pattern of morbidity and resource use.[29] Finally, expectant management could be pursued more readily for patients in poor functional health.

Patients with early stage kidney cancer, including those with baseline disability, have often undergone surgical treatment despite data supporting an acceptable risk profile for active surveillance.[14,30] As urologists engage in the complexities of accountable care organization and bundled payments, the consideration and implementation of care processes geared toward patient function may represent an important opportunity to elevate the value of kidney cancer surgery and urology care more broadly.

CONCLUSIONS

With respect to patient function, surgery for kidney cancer can be performed safely, at least from a technical standpoint. However, patients with baseline dysfunction face a more onerous medical recovery at higher cost than those in better functional health. In the setting of risk sharing payment models, the early identification of patients at risk coupled with select interventions may represent a potential path to value creation in urology care.

REFERENCES

1. Siegel RL, Miller KD and Jemal A: Cancer statistics, 2016. CA Cancer J Clin 2016; **66:** 7.

2. Fingar KR, Stocks C, Weiss AJ et al: Most frequent operating room procedures performed in U.S. hospitals, 2003-2012. HCUP Statistical Brief #186. December 2014. Healthcare Cost and Utilization Project, Agency for Healthcare Research and Quality. Available at http://www.hcup-us.ahrq.gov/reports/statbriefs/sb186-Operating-Room-Procedures-United-States-2012.pdf. Accessed September 18, 2016.

3. Smaldone MC, Kutikov A, Egleston B et al: Assessing performance trends in laparoscopic nephrectomy and nephron-sparing surgery for localized renal tumors. Urology 2012; **80:** 286.

4. Miller DC, Gust C, Dimick JB et al: Large variations in Medicare payments for surgery highlight savings potential from bundled payment programs. Health Aff 2011; **30:** 2107.

5. Audisio RA, Pope D, Ramesh HS et al: Shall we operate? Preoperative assessment in elderly cancer patients (PACE) can help. A SIOG surgical task force prospective study. Crit Rev Oncol Hematol 2008; **65:** 156.

6. Makary MA, Segev DL, Pronovost PJ et al: Frailty as a predictor of surgical outcomes in older patients. J Am Coll Surg 2010; **210:** 901.

7. Suskind AM, Walter LC, Jin C et al: Impact of frailty on complications in patients undergoing common urological procedures: a study from the American College of Surgeons National Surgical Quality Improvement database. BJU Int 2016; **117:** 836.

8. Robinson TN, Eiseman B, Wallace JI et al: Redefining geriatric preoperative assessment using frailty, disability and co-morbidity. Ann Surg 2009; **250:** 449.

9. Warren JL, Klabunde CN, Schrag D et al: Overview of the SEER-Medicare data: content, research applications, and generalizability to the United States elderly population. Med Care 2002; **40**. IV-3.

10. Hankey BF, Ries LA and Edwards BK: The Surveillance, Epidemiology, and End Results program: a national resource. Cancer Epidemiol Biomarkers Prev 1999; **8:** 1117.

11. Miller DC, Saigal CS, Warren JL et al: External validation of a claims-based algorithm for classifying kidney-cancer surgeries. BMC Health Serv Res 2009; **9:** 92.

12. Chrischilles E, Schneider K, Wilwert J et al: Beyond comorbidity: expanding the definition and measurement of complexity among older adults using administrative claims data. Med Care, suppl., 2014; **52:** S75.

13. Davidoff AJ, Zuckerman IH, Pandya N et al: A novel approach to improve health status measurement in observational claims-based studies of cancer treatment and outcomes. J Geriatr Oncol 2013; **4:** 157.

14. Tan HJ, Chamie K, Daskivich TJ et al: Patient function, long-term survival, and use of surgery in patients with kidney cancer. Cancer 2016; **122:** 3776.

15. Deyo RA, Cherkin DC and Ciol MA: Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol 1992; **45:** 613.

16. Iezzoni LI, Daley J, Heeren T et al: Identifying complications of care using administrative data. Med Care 1994; **32:** 700.

17. AHRQ Quality Indicators™. Guide to the Patient Safety Indicators, Version 5.0, March 2015. Agency for Healthcare Research and Quality. Available at http://www.qualityindicators.ahrq.gov/Modules/PSI_TechSpec.aspx. Accessed June 10, 2016.

18. Lawthers AG, McCarthy EP, Davis RB et al: Identification of in-hospital complications from claims data. Is it valid? Med Care 2000; **38:** 785.

19. Tan HJ, Wolf JS Jr, Ye Z et al: Complications and failure to rescue after laparoscopic versus open radical nephrectomy. J Urol 2011; **186:** 1254.

20. Tan HJ, Saliba D, Kwan L et al: Burden of geriatric events among older adults undergoing major cancer surgery. J Clin Oncol 2016; **34:** 1231.

21. Yu W, Ash AS, Levinsky NG et al: Intensive care unit use and mortality in the elderly. J Gen Intern Med 2000; **15:** 97.

22. Jencks SF, Williams MV and Coleman EA: Rehospitalizations among patients in the Medicare fee-for-service program. N Engl J Med 2009; **360:** 1418.

23. Tomaszewski JJ, Uzzo RG, Kutikov A et al: Assessing the burden of complications after surgery for clinically localized kidney cancer by age and comorbidity status. Urology 2014; **83:** 843.

24. Sacks GD, Lawson EH, Dawes AJ et al: Variation in hospital use of postacute care after surgery and the association with care quality. Med Care 2016; **54:** 172.

25. Stitzenberg KB, Chang Y, Smith AB et al: Exploring the burden of inpatient readmissions after major cancer surgery. J Clin Oncol 2015; **33:** 455.

26. Reuben DB, Rubenstein LV, Hirsch SH et al: Value of functional status as a predictor of mortality: results of a prospective study. Am J Med 1992; **93:** 663.

27. Centers for Medicare and Medicaid Services: Medicare Program; Merit-Based Incentive Payment System (MIPS) and Alternative Payment Model (APM) incentive under the physician fee schedule, and criteria for physician-focused payment models. Proposed Rule. Federal Register 2016; **81:** 28161.

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.

29. Levit LA, Balogh EP, Nass SJ et al: Delivering High-Quality Cancer Care: Charting a New Course for a System in Crisis. Institute of Medicine of the National Academies. Washington, D.C.: National Academies Press 2013.

30. Smaldone MC, Kutikov A, Egleston BL et al: Small renal masses progressing to metastases under active surveillance: a systematic review and pooled analysis. Cancer 2012; **118:** 997.

EDITORIAL COMMENTS

In this article Tan et al provide a perspective on frailty as a determinant of value in treatment for renal cell cancer. Given the recent growth of advanced treatment modalities such focal therapy and robotic surgery, and more conservative approaches like active surveillance, there is a need to account for the value of renal cancer care. This will be especially important in coming years when alternative payment models such as bundled payments may make urologists accountable for outcomes and costs.[1] Tools to risk adjust and predict outcomes are key and traditional approaches like comorbidity score have limitations (reference 6 in article).

This study shows how frailty may provide a useful and accurate tool to predict how men and women with renal cancer may fare after surgery. Incorporating measures such as this in clinical decision making will be key to improving value in the care of urological cancer in the years to come.

Alexander P. Cole, Nicolas von Landenberg and Quoc-Dien Trinh
Division of Urological Surgery
Brigham and Women's Hospital
Harvard Medical School
Boston, Massachusetts
and
Department of Urology
Ruhr-University Bochum
Marien Hospital Herne
Herne, Germany

REFERENCE

1. Ellimoottil C and Miller DC: Anticipating the effect of the Patient Protection and Affordable Care Act for patients with urologic cancer. Urol Oncol 2014; **32:** 55.

Tan et al provide an interesting contribution to the urological health services literature on functional status and kidney cancer surgery. Using SEER-Medicare data, they found that poor functional status is independently associated with increased medical and geriatric complications but not with surgical complications after surgery. Resource utilization is higher in patients with worse functional status.

Although relative complication rates were higher in patients with poor functional health, more than 75% of these patients at high risk had no medical or surgical complication. The absolute increase in complications was only 3% in the most functionally limited patients compared to those with no limitations. While the prior work of these authors shows that patients with T1 disease and poor functional health are more likely to die of causes other than kidney cancer (reference 14 in article), the ability to select which patients should receive intervention vs observation remains imprecise. Hopefully the excellent work of these investigators will continue to evolve and provide further assistance in the selection of patients for surgical intervention.

Seth A. Strope
Department of Urologic Oncology
Baptist MD Anderson Cancer Center
Jacksonville, Florida