Assessment of healthcare quality metrics: Length-of-stay, 30-day readmission, and 30-day mortality for radical nephrectomy with inferior vena cava thrombectomy

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Abstract

Introduction: Length-of-stay (LOS), 30-day readmission, and 30-day mortality are metrics used to assess quality of care and provider reimbursement. Therefore, we investigated patient- and hospital-level characteristics associated with the three healthcare quality metrics for radical nephrectomy with inferior vena cava (IVC) thrombectomy.

Methods: Using the National Cancer Data Base, we established a cohort of patients who received radical nephrectomy following the diagnosis of renal cell carcinoma (RCC) stage cT3b between 1998 and 2011. We then assessed the associations between patient- or hospital-level characteristics and LOS using multivariable negative binomial regression. We used multivariable logistic regression to determine the associations between the characteristics and 30-day readmission or 30-day mortality.

Results: During the study period, 5768 patients were diagnosed with RCC stage cT3b and underwent radical nephrectomy. LOS ≤2 days and ≥9 days were associated with a higher likelihood of 30-day readmission (respective odds ratio [OR] 1.61 and 1.58) and 30-day mortality (respective OR 11.62 and 11.87). Older patients (60–79 years vs. <50 years) were less likely to experience 30-day readmission (OR 0.46–0.52). Older patients (≥80 years vs. <50 years, OR 3.67) and patients with a high index of comorbidity (Charlson comorbidity score ≥ 2 vs. 0, OR 1.95) were more likely to suffer 30-day mortality.

Conclusions: LOS is an important predictor of short-term readmission and mortality following radical nephrectomy with IVC thrombectomy. Older age and a high index of comorbidity also predict short-term mortality after the surgery.

Introduction

In 2012, the Canadian Institute for Health Information (CIHI) reported the rate of 30-day unplanned readmission for surgical inpatients is 6.5%, contributing to 23.9% of all readmissions.[1] In the United States, Centers for Medicare and Medicaid Services uses the rate of 30-day readmission as a metric for quality of care and penalizes hospitals that incur excess readmissions by reducing their reimbursement.[2] With growing attention to the burden of readmission on the healthcare system and providers, assessment of readmission and other healthcare quality metrics have grown in importance in surgical specialties, including urology. Previous studies of radical cystectomies and outpatient urological surgeries found certain patient-level characteristics, including sex and comorbidity, as predictors of readmission.[3-5]

In 2% to 7% of patients with renal cell carcinoma (RCC), a tumour thrombus may develop that extends into the renal vein and inferior vena cava (IVC).[6,7] In these patients, thrombectomy is routinely performed in conjunction with radical nephrectomy. Previous studies reported a short-term mortality rate of 3% to 7% following the aggressive procedure and identified several patient- and provider-level predictors of the postoperative mortality.[8,9] However, no previous studies have evaluated the predictors of length-of-stay (LOS) and readmission for radical nephrectomy with IVC thrombectomy. Therefore, we aimed to determine patient- and hospital-level characteristics that may predict healthcare quality metrics: LOS, 30-day readmission, and 30-day mortality for the procedure.

Methods

Design and setting

This study was approved by the institutional review board at the University Hospitals Case Medical Center (Cleveland, Ohio). We conducted this observational analysis of healthcare quality metrics using the National Cancer Data Base (NCDB; a joint project of the Commission on Cancer [CoC] of the American College of Surgeons and the American

Cancer Society). The NCDB contains information on 70% of all new cases of cancer in the United States and the utility of the database has been previously described.[10,11]

From the NCDB, we identified all adults who were diagnosed with primary kidney cancer between January 1998 and December 2011, based on the presence of International Classification of Diseases for Oncology, 3rd Edition code C64.9. From these patients, we restricted our analysis to a cohort of patients who were diagnosed with RCC stage cT3b (based on the American Joint Committee on Cancer [AJCC] Cancer Staging Manual) and received radical nephrectomy. Patients who received partial nephrectomy were not included. During the study period, three editions of AJCC Cancer Staging Manual were published for RCC.[12] The 5th and 6th Editions (published in 1997 and 2002, respectively) categorized tumours that extend into the renal vein or IVC below the diaphragm as RCC stage cT3b. The 7th Edition (published in 2010) categorized the tumours that extend into the IVC below the diaphragm as RCC stage cT3b.[12]

Outcomes

A description of variables considered in the analyses is presented in Appendix 1. The outcomes measured were (1) LOS, (2) 30-day readmission, and (3) 30-day mortality. We modelled LOS as a continuous variable when evaluating it as an outcome, but as a categorical variable when considering it as a predictor (Appendix 1). 30-day readmission was an unplanned readmission within 30 days of hospital discharge to the hospital in which the patient received the surgery. 30-day mortality was defined as death within 30 days following the surgery. 30-day mortality was computed in the NCDB by subtracting the "date of last contact or death" from the date of surgery and assessing the patient vital status (alive or dead) on the latter date. In the analysis of each outcome, patients with available outcome measure were included. Data on LOS and 30-day readmission were available for patients with a cancer diagnosis since 2003, whereas data on 30-day mortality were available throughout the study period.

Statistical analyses

We evaluated the associations between patient- or hospital-level characteristics and LOS using multivariable negative binomial regression. We used multivariable logistic regression to determine the associations between patient- or hospital-level characteristics and 30-day readmission or 30-day mortality. Missing values for the variables were treated as a separate category. We assessed the model fit of the negative binomial regression model using the deviance to degree of freedom (deviance/DF) ratio and of the logistic regression models using the C-statistic and Hosmer-Lemeshow goodness of fit test.

As an additional analysis, we compared the three outcomes between patients who were diagnosed with RCC stage cT3b in years up to 2009 and in those who were diagnosed with this stage of RCC starting in 2010. We did this to assess the potential influence of differing definitions of RCC stage cT3b. The Wilcoxon-Mann-Whitney test was used to compare LOS and chi-squared test was used to compare the rate of 30-day readmission and 30-day mortality between the two groups. All analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC).

Results

Between 1998 and 2011, 9678 patients were diagnosed with RCC stage cT3b. Of these patients, 5768 (59.6%) received radical nephrectomy and were included in the study cohort. With a mean age of 63.7 years, the study cohort was 32.8% (1892/5768) female and 89.4% (5158/5768) white. The patients lacked substantial comorbidities with 71.6% (3052/4260) having the Charlson comorbidity score of 0 (Table 1).

Within the study cohort, 4260 patients were diagnosed with RCC stage cT3b since 2003. A record on LOS was available for 3975 (93.3%) patients. The mean (standard deviation [SD]) and median (interquartile range [IQR]) LOS following the surgery were 6.5 (SD 7.6) days and 5 (IQR: 4–7) days, respectively. Results of the multivariable negative binomial regression analysis for LOS are presented in Table 2. Charlson comorbidity score ≥2 versus the score of 0 was associated with an increased LOS (incidence rate ratio [IRR] 1.19, 95% confidence interval [CI] 1.08–1.31). Kidney tumours >10 cm were also associated with a greater LOS compared to tumours ≤4 cm (IRR 1.13, 95% CI 1.06–1.20).

Of the 4168 (97.8%) patients with a record on 30-day readmission, 4.1% (n = 172) were readmitted. Results of the multivariable logistic regression analysis for 30-day readmission are presented in Table 3. Compared to patients under 50, those aged 60 to 69 years (odds ratio [OR] 0.52, 95% CI 0.30–0.92) and 70 to 79 years (OR 0.46, 95% CI 0.24–0.88) were less likely to undergo 30-day readmission. Compared to patients who had LOS of 3 to 5 days, those who had LOS ≤2 days (OR 1.61, 95% CI 1.01–2.58) or LOS ≥9 days (OR 1.58, 95% CI 1.03–2.42) were more likely to be readmitted within 30 days.

There were 5650 (98.0%) patients with a record of 30-day mortality between 1998 and 2011 and the mortality rate was 2.7% (155/5650). Results of the multivariable logistic regression analysis for 30-day mortality are presented in Table 4. A few patient-level characteristics were associated with higher 30-day mortality. Patients aged 80 years and older were nearly 4 times more likely to die within 30 days of the surgery compared to patients under 50 (OR 3.67, 95% CI 1.56–8.62). Patients with Charlson comorbid-

Table 1. Characteristics of patients who were diagnosed with RCC stage cT3b between 1998 and 2011 and received radical nephrectomy (n = 5768)

Variable	No. patients (%)
Age, mean (SD), years	63.7 (11.5)
Age categories (years)	
<50	643 (11.2)
50–59	1442 (25.0)
60–69	1803 (31.3)
70–79	1405 (24.4)
≥80	475 (8.2)
Female	1892 (32.8)
Male	3876 (67.2)
Race	
White	5158 (89.4)
Black	377 (6.5)
Other	233 (4.0)
Median annual household income, $[a]	
<30 000	753 (13.8)
30 000–35 000	1043 (19.1)
35 000–45 999	1558 (28.5)
≥46 000	2118 (38.7)
Year of diagnosis	
1998–1999	546 (9.5)
2000–2001	667 (11.6)
2002–2003	665 (11.5)
2004–2005	842 (14.6)
2006–2007	968 (16.8)
2008–2009	1587 (27.5)
2010–2011	493 (8.6)
Insurance status[b]	
Private	2594 (46.0)
Medicaid	250 (4.4)
Medicare	2549 (45.2)
Other government	65 (1.2)
Uninsured	182 (3.2)
Charlson comorbidity score[c]	
0	3052 (71.6)
1	915 (21.5)
≥2	293 (6.9)
Hospital type	
Academic/research cancer program	2652 (46.0)
Community cancer program	396 (6.9)
Comprehensive community cancer program	2565 (44.5)
Other unspecified cancer program	155 (2.7)
Hospital location	
Northeast	1162 (20.2)
Midwest	1562 (27.1)
West	1032 (17.9)
South	2012 (34.9)
Size of kidney tumour, cm[d]	
≤4	404 (7.1)
>4 but ≤7	1459 (25.7)
>7 but ≤10	1963 (34.6)
>10	1855 (32.7)
Site of kidney tumour[e]	
Right	3120 (54.3)
Left	2630 (45.7)

RCC: renal cell carcinoma; SD: standard deviation. [a]Data on median annual household income was available for 5472 (94.9%) patients. [b]Data on insurance status was available for 5640 (97.8%) patients. [c]Data on Charlson comorbidity score was available since 2003 and 4260 (75.4%) patients had a Charlson comorbidity score. [d]Data on size of kidney tumour was available for 5681 (98.5%) patients. eData on site of kidney tumour was available for 5750 (99.7%) patients.

ity score ≥2 were almost twice as likely to suffer 30-day mortality compared to those with the score of 0 (OR 1.95, 95% CI 1.04–3.65). Compared to LOS of 3 to 5 days, LOS ≤2 days (OR 11.62, 95% CI 5.38–25.10) and LOS ≥9 days (OR 11.87, 95% CI 5.73–24.59) were associated with increased odds of 30-day mortality.

Additional analysis is presented in Appendix 2. The median (IQR) LOS in patients who were diagnosed with RCC stage cT3b in years up to 2009 and in years starting in 2010 were 5 (IQR: 4–7) days and 6 (IQR: 4–8) days, respectively ($p < 0.001$). Although statistically significant, the between-group difference in LOS was not considered clinically meaningful. The rate of 30-day readmission and 30-day mortality did not differ between the patients who were diagnosed in years up to 2009 and those who were diagnosed in years starting in 2010 ($p = 0.135$ and 0.891, respectively).

Discussion

We conducted an observational analysis of healthcare quality metrics for radical nephrectomy with IVC thrombectomy. There were several patient-level characteristics that were associated with a greater LOS. It is difficult to conceive the association between non-black/white patients and longer LOS because the small group is comprised of heterogeneous racial groups. It is plausible that patients with a high index of comorbidity (Charlson comorbidity score ≥2) or very large tumour size (>10 cm) were likely to have a longer LOS because the severity of their conditions warranted additional hospital stay. The association between the Charlson comorbidity score and LOS might not have been robust because patients with a substantial index of comor-

Table 2. Associations between patient- or hospital-level characteristics and length-of-stay (in days) estimated by multivariable negative binomial regression analysis[ab]

Variable	Categories	Adjusted IRR (95% CI)	*p* value
Age (years)	<50	Referent	0.380
	50–59	1.06 (0.97–1.15)	
	60–69	1.04 (0.95–1.14)	
	70–79	1.08 (0.97–1.20)	
	≥80	1.12 (0.99–1.26)	
Sex	Male	Referent	0.109
	Female	0.96 (0.91–1.01)	
Race	White	Referent	<0.001
	Black	1.03 (0.94–1.14)	
	Other	1.40 (1.25–1.58)	
Median annual household income, $	<30 000	Referent	0.146
	30 000–35,000	1.07 (0.98–1.17)	
	35,000–45,999	1.02 (0.94–1.10)	
	≥46,000	0.98 (0.90–1.06)	
Year of diagnosis	2003	Referent	<0.001
	2004–2005	0.91 (0.82–1.00)	
	2006–2007	0.81 (0.73–0.89)	
	2008–2009	0.86 (0.78–0.94)	
	2010–2011	0.98 (0.89–1.10)	
Insurance status	Private	Referent	<0.001
	Medicaid	1.08 (0.96–1.21)	
	Medicare	1.14 (1.07–1.22)	
	Other government	1.19 (0.96–1.47)	
	No insurance	1.00 (0.87–1.15)	
Charlson comorbidity score	0	Referent	<0.001
	1	0.98 (0.93–1.04)	
	≥2	1.19 (1.08–1.31)	
Hospital type	Academic/research cancer program	Referent	0.009
	Community cancer program	1.01 (0.91–1.12)	
	Comprehensive community cancer program	0.92 (0.87–0.97)	
	Other unspecified cancer program	0.89 (0.75–1.06)	
Hospital location	Northeast	Referent	0.143
	Midwest	0.97 (0.90–1.05)	
	West	1.06 (0.98–1.15)	
	South	1.02 (0.95–1.09)	
Size of kidney tumour, cm	≤4	Referent	<0.001
	>4 but ≤7	0.95 (0.89–1.02)	
	>7 but ≤10	1.02 (0.95–1.08)	
	>10	1.13 (1.06–1.20)	
Site of kidney tumour	Right	Referent	0.424
	Left	1.02 (0.97–1.07)	

CI: confidence interval; IRR: incidence rate ratio. [a]Since 2003, 4260 patients received a diagnosis of RCC stage cT3b and radical nephrectomy. Data on length-of-stay was available for patients diagnosed from 2003 onwards and such a record was available for 3975 (93.3%) patients. [b]The deviance/DF ratio for the multivariable negative binomial regression model was 1.07.

bidity probably suffered mortality soon after the surgery, rendering a brief LOS. It is difficult to explain the association between Medicare and a longer LOS after adjusting for age and comorbidity. Additional studies are warranted to identify reasons for the associations of cancer diagnosis in years 2006 to 2009 and receipt of cancer care from comprehensive community cancer program with a shorter LOS.

LOS following radical nephrectomy with IVC thrombectomy appeared to be an important predictor of both 30-day readmission and 30-day mortality. The observed associations may be explained in several ways. Patients with short LOS (≤2 days) might have been discharged too early before

Table 3. Associations between patient- or hospital-level characteristics and 30-day readmission estimated by multivariable logistic regression analysis[ab]

Variable	Categories	Adjusted OR (95% CI)	*p* value
Age (years)	<50	Referent	0.176
	50–59	0.72 (0.43–1.21)	
	60–69	0.52 (0.30–0.92)	
	70–79	0.46 (0.24–0.88)	
	≥80	0.48 (0.22–1.05)	
Sex	Male	Referent	0.212
	Female	1.23 (0.89–1.70)	
Race	White	Referent	0.742
	Black	0.79 (0.41–1.51)	
	Other	0.88 (0.37–2.07)	
Median annual household income, $	<30 000	Referent	0.607
	30 000–35 000	0.66 (0.38–1.14)	
	35 000–45 999	0.80 (0.49–1.31)	
	≥46 000	0.71 (0.44–1.15)	
Year of diagnosis	2003	Referent	0.020
	2004–2005	1.91 (0.99–3.68)	
	2006–2007	1.43 (0.73–2.78)	
	2008–2009	1.06 (0.55–2.03)	
	2010–2011	0.90 (0.41–2.01)	
Insurance status	Private	Referent	0.713
	Medicaid	1.05 (0.49–2.25)	
	Medicare	1.44 (0.91–2.26)	
	Othedr government	0.59 (0.08–4.43)	
	No insurance	1.22 (0.54–2.77)	
Charlson comorbidity score	0	Referent	0.485
	1	1.23 (0.86–1.78)	
	≥2	0.93 (0.49–1.77)	
Hospital type	Academic/research cancer program	Referent	0.452
	Community cancer program	1.46 (0.80–2.66)	
	Comprehensive community cancer program	1.24 (0.88–1.73)	
	Other unspecified cancer program	0.80 (0.19–3.38)	
Hospital location	Northeast	Referent	0.193
	Midwest	0.87 (0.55–1.38)	
	West	0.58 (0.33–1.03)	
	South	1.00 (0.65–1.55)	
Size of kidney tumour, cm	≤4	Referent	0.129
	>4 but ≤7	0.60 (0.33–1.08)	
	>7 but ≤10	0.71 (0.41–1.23)	
	>10	0.61 (0.35–1.08)	
Site of kidney tumour	Right	Referent	0.152
	Left	0.90 (0.65–1.23)	
Length-of-stay (days)	0–2	1.61 (1.01–2.58)	0.153
	3–5	Referent	
	6–8	1.15 (0.77–1.72)	
	≥9	1.58 (1.03–2.42)	

OR: odds ratio; CI: confidence interval. [a]Since 2003, 4260 patients received a diagnosis of RCC stage cT3b and radical nephrectomy. Data on 30-day readmission was available for patients diagnosed from 2003 onwards and such a record was available for 4168 (97.8%) patients. [b]The C-statistic for the multivariable logistic regression model was 0.675 and *p* value for the Hosmer-Lemeshow goodness of fit test was 0.605.

Table 4. Associations between patient- or hospital-level characteristics and 30-day mortality estimated by multivariable logistic regression analysis[ab]

Variable	Categories	Adjusted OR (95% CI)	*p* value
Age (years)	<50	Referent	0.004
	50–59	1.32 (0.63–2.76)	
	60–69	1.36 (0.64–2.89)	
	70–79	1.89 (0.85–4.22)	
	≥80	3.67 (1.56–8.62)	
Sex	Male	Referent	0.567
	Female	0.90 (0.63–1.28)	
Race	White	Referent	0.239
	Black	0.69 (0.33–1.42)	
	Other	0.44 (0.13–1.42)	
Median annual household income, $	<30 000	Referent	0.313
	30 000–35 000	0.67 (0.39–1.18)	
	35 000–45 999	0.58 (0.34–0.99)	
	≥46 000	0.60 (0.36–1.00)	
Year of diagnosis	1998–1999	Referent	0.726
	2000–2001	0.90 (0.47–1.71)	
	2002–2003	1.20 (0.56–2.54)	
	2004–2005	0.96 (0.30–3.08)	
	2006–2007	1.33 (0.43–4.11)	
	2008–2009	1.56 (0.52–4.65)	
	2010–2011	1.64 (0.50–5.36)	
Insurance status	Private	Referent	0.511
	Medicaid	0.90 (0.31–2.59)	
	Medicare	1.46 (0.91–2.36)	
	Other government	0.81 (0.11–6.10)	
	No insurance	1.88 (0.77–4.62)	
Charlson comorbidity scored	0	Referent	0.093
	1	1.27 (0.77–2.08)	
	≥2	1.95 (1.04–3.65)	
Hospital type	Academic/research cancer program	Referent	0.293
	Community cancer program	0.44 (0.19–1.04)	
	Comprehensive community cancer program	0.86 (0.61–1.23)	
	Other unspecified cancer program	–∞ (no event)	
Hospital location	Northeast	Referent	0.519
	Midwest	1.03 (0.62–1.73)	
	West	1.42 (0.83–2.45)	
	South	1.21 (0.74–1.99)	
Size of kidney tumour, cm	≤4	Referent	0.008
	>4 but ≤7	0.64 (0.30–1.36)	
	>7 but ≤10	1.27 (0.63–2.55)	
	>10	1.48 (0.73–2.97)	
Site of kidney tumour	Right	Referent	0.005
	Left	1.30 (0.93–1.81)	
Length-of-stay (days)	0–2	11.62 (5.38–25.10)	<0.001
	3–5	Referent	
	6–8	2.23 (0.95–5.19)	
	≥9	11.87 (5.73–24.59)	

OR: odds ratio; CI: confidence interval. [a]Data on 30-day mortality was available for 5650 (98.0%) patients who were diagnosed with RCC stage cT3b and received radical nephrectomy.
[b]The C-statistic for the multivariable logistic regression model was 0.801 and P value for the Hosmer-Lemeshow goodness of fit test was 0.765.

sufficient recovery was made, leading to subsequent short-term readmission and mortality. Patients with longer LOS (≥9 days) might have been predisposed to readmission and mortality because the very impetus for longer LOS might have been circumstances that would lead such events, including slow recovery or post-surgical complications. Older age was associated with a reduced likelihood of 30-day readmission, but with increased likelihood of 30-day mortality. Readmission and mortality may be competing events especially in older patients, such that a greater proportion of the older patients died before there was a possibility for readmission to occur. A similar speculation may be valid for the observed relationship of Charlson comorbidity score with 30-day readmission and 30-day mortality.

A previous investigation of Ontario Cancer Registry found low-surgeon volume, left-sided tumour, and greater hospital volume were associated with short-term mortality following radical nephrectomy with renal vein or IVC thrombectomy.[8] Our results did not agree with the observed association between tumour laterality and short-term mortality. As in a prior study that used the CIHI Discharge Abstract Database, age and comorbidity predicted short-term mortality following radical nephrectomy with IVC thrombectomy in our analysis.[9]

To our knowledge, this is the first study that assessed LOS and readmission for radical nephrectomy with IVC thrombectomy. The use of the NCDB allowed us to capture a great proportion of newly diagnosed cases of kidney cancer in the United States, providing robust estimates of associations that are generalizable.[11] Through the NCDB, we were also able to acquire a comprehensive set of information on patient-level characteristics.

Several limitations must be considered. The AJCC Cancer Staging Manual 7th Edition for RCC was published in 2010 and, in the prior editions, tumours that only extended into the renal vein were classified as RCC stage cT3b in addition to tumours extending into the IVC below the diaphragm.[12] To address this limitation, we compared the three outcomes between the patients who were diagnosed with RCC stage cT3b in years up to 2009 and the patients who were diagnosed with such a stage of RCC starting in 2010. The analysis showed no notable between-group differences, leading us to believe that the inclusion of patients diagnosed who were diagnosed with RCC stage cT3b in the years up to 2009 did not appreciably affect our study outcomes. Since the outcome of 30-day readmission captured readmissions to the hospital where the patients received surgery, readmissions within 30 days to a different hospital could not be assessed. Moreover, we could not evaluate the proportion of 30-day mortality that occurred as in-hospital mortality, which might aid the interpretation of the association between the short LOS and 30-day mortality. Lastly, since the NCDB is not a database specific to urological cancer care, we could not ascertain urology-specific predictors and outcomes.

Conclusion

LOS is an important predictor of 30-day readmission and 30-day mortality among patients undergoing radical nephrectomy with IVC thrombectomy. Moreover, older age and a high index of comorbidity also appear to predict 30-day mortality following the complex procedure. Our results may provide foundation towards the development of risk-adjusted models for assessing healthcare quality. These patient-level predictors may also be considered when developing a risk-adjusted penalty system based on healthcare quality metrics.

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Appendix 1. Description of variables included in the multivariable regression analyses

Variable	Categories
Age	<50, 50–59, 60–69, 70–79, or ≥80
Sex	Male or female
Race	White, black, or other
Median annual household income, $[a]	<30 000, 30 000–35 000, 35 000–45 999, or ≥46 000
Year of diagnosis	
Insurance status	Private, Medicaid, Medicare, other government, uninsured
Charlson comorbidity score[b]	0, 1, or ≥2
Hospital type	Academic/research cancer program, community cancer program, comprehensive community cancer program, or other unspecified cancer program
Hospital location[c]	Northeast, Midwest, West, or South
Size of kidney tumour, cm	≤4, >4 but ≤7, >7 but ≤10, or >10
Site of kidney tumour	Right or left
Length-of-stay (days)[d]	0 to 2, 3 to 5, 6 to 8, or ≥9

[a]We used median household income based on patients' zip code at the time of diagnosis as a proxy variable for socioeconomic status. [b]Charlson comorbidity score was calculated from the International Classification of Diseases, 9th Revision Clinical Modification diagnosis codes. [c]We recorded hospital location as one of the four U.S. Census Regions. [d]We modelled length-of-stay (LOS) as a continuous variable when evaluating it as an outcome (dependent variable). However, when considering LOS as a predictor (independent variable), we modelled it as a categorical variable (0 to 2, 3 to 5, 6 to 8, ≥ 9 days) because we did not expect the LOS to be associated with 30-day readmission and 30-day mortality in a solely linear manner (e.g., higher LOS with increased odds of 30-day readmission).

Appendix 2. Comparison of outcomes between the patients who were diagnosed with RCC stage cT3b in years up to 2009 and of patients who were diagnosed with such a stage of RCC in years starting 2010

Outcome	Patients who were diagnosed in years up to 2009	Patients who were diagnosed in years starting 2010	*p* value
Length-of-stay (days), mean (SD)	6.4 (7.6)	7.3 (7.8)	0.02
Length-of-stay (days), median (IQR)	5 (4–7)	6 (4–8)	<0.001
30-day readmission rate, % (n/N)	4.3% (158/3,679)	2.9% (14/489)	0.135
30-day mortality rate, % (n/N)	2.7% (141/5,157)	2.8% (14/493)	0.891

RCC: renal cell carcinoma; SD: standard deviation; IQR: interquartile range.