Hospital Volume is a Determinant of Postoperative Complications, Blood Transfusion and Length of Stay After Radical or Partial Nephrectomy

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Purpose: We examined the impact of hospital volume on short-term outcomes after nephrectomy for nonmetastatic renal cell carcinoma.

Materials and Methods: Using the Nationwide Inpatient Sample we identified 48,172 patients with nonmetastatic renal cell carcinoma treated with nephrectomy (1998 to 2007). Postoperative complications, blood transfusions, prolonged length of stay and in-hospital mortality were examined. Stratification was performed according to teaching status, nephrectomy type (partial vs radical nephrectomy) and surgical approach (open vs laparoscopic). Multivariable logistic regression models were fitted.

Results: Patients treated at high volume centers were younger and healthier at nephrectomy. High hospital volume predicted lower blood transfusion rates (8.5% vs 9.7% vs 11.8%), postoperative complications (14.4% vs 16.6% vs 17.2%) and shorter length of stay (43.1% vs 49.8% vs 54.0%, all $p < 0.001$). In multivariable analyses stratified according to teaching status, nephrectomy type and surgical approach, high hospital volume was an independent predictor of lower rates of postoperative complications (OR 0.73–0.88), blood transfusions (OR 0.71–0.78) and prolonged length of stay (OR 0.76–0.89, all $p < 0.001$). Exceptions were postoperative complications at nonteaching centers (OR 0.94, $p > 0.05$) and blood transfusions in nephrectomies performed laparoscopically (OR 0.68, $p > 0.05$).

Conclusions: On average, high hospital volume results in more favorable outcomes during hospitalization after nephrectomy.

Key Words: health facility size; nephrectomy; teaching, morbidity; carcinoma, renal cell

Abbreviations and Acronyms

CCI = Charlson comorbidity index

NIS = Nationwide Inpatient Sample

pLOS = prolonged length of stay

PN = partial nephrectomy

RCC = renal cell carcinoma

RN = radical nephrectomy

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Nothing to disclose.

Supplementary material for this article can be obtained at http://www.cs.mcgill.ca/~ztian3/Table1.pdf and http://www.cs.mcgill.ca/~ztian3/Table3.pdf.

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HOSPITAL volume represents an important outcome determinant after surgery for several malignancies.[1–9] Several studies report that patients treated at high volume hospitals are less likely to die of their surgery.[6] Recent reviews suggest that a proportion of surgical deaths in the United States could have been prevented if surgeries were relegated to high volume hospitals.[10,11] Indeed high volume hospitals provide a greater spectrum of advanced medical technologies and services that are imperative to the treatment of patients, and they are better equipped with adequate experience with the

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surgical procedures involved.[12] Thus, given the stronger structural and process components related to high hospital volume, it may be expected that these hospitals are associated with better outcomes postoperatively.

Nonetheless the relationship between hospital volume and outcome is disputable in the context of nephrectomy. While some authors have shown that increasing hospital volume is associated with more favorable outcomes,[6,13,14] others have demonstrated no difference.[15–17] As a result, it remains questionable whether previous studies on hospital volume and outcomes apply to patients treated surgically for RCC. Moreover, to the best of our knowledge no other study has simultaneously examined the rates of postoperative complications, blood transfusions, length of stay and in-hospital mortality in the context of nephrectomy.

Therefore, in this study we examined the impact of hospital volume on short-term outcomes during hospitalization in patients treated with nephrectomy for nonmetastatic RCC between 1998 and 2007. Since other variables such as teaching status, nephrectomy type and surgical approach may affect this relationship, we stratified all models according to these 3 variables. To accomplish the analyses we relied on a large population based cohort representative of the United States.

MATERIALS AND METHODS

Data Source

Data from the most contemporary years (1998 to 2007) of the NIS were abstracted. The NIS includes inpatient discharge data collected via federal-state partnerships as part of the Agency for Healthcare Research and Quality Healthcare Cost and Utilization Project. As of 2007 the NIS contained administrative data on 8,043,415 discharges from 1,044 hospitals in 40 states, approximating 20% of community hospitals in the United States including public hospitals and teaching medical centers. The NIS is the sole hospital database in the United States with charge information on all patients regardless of payer, including persons covered by Medicare, Medicaid and private insurance as well as the uninsured.

Sample Population and Surgical Procedures

Patients with a primary diagnosis of kidney cancer were identified using ICD-9-CM diagnostic code 189.0. Secondary diagnostic codes (ICD-9-CM 197.0, 197.7, 198.x) were used to identify cases of metastases and these were excluded from further analysis. Relying on the ICD-9 procedure codes, cases of PN (55.4) and RN (55.5) were abstracted. Laparoscopic technique was identified via concurrent procedure code (54.21).

Hospital Characteristics

Hospital volume was quantified using annual hospital caseload, which represents the number of nephrectomies performed annually, as was done previously.[18] Patients were divided according to the annual caseload of the institution where the nephrectomy was performed in 3 equal groups of low—1 to 5 nephrectomies yearly, intermediate—6 to 15 and high—16 or more. Participating institutions were also stratified according to teaching status. The criteria for teaching hospital status were residency program approved by the American Medical Association, member of the Council of Teaching Hospitals, or a ratio of 0.25 or greater full-time equivalent interns and residents to nonnursing home beds.[19] Hospital region was also included in the analyses, and was defined by the United States Census Bureau[20] as Northeast, Midwest, South and West.[19]

Patient Characteristics

Patient age (59 years or younger, 60 to 69, 70 to 79 and 80 or older), gender, race (white, black, Hispanic, other races including Asian, Pacific Islander, Native American or unspecified, and unknown) and year of surgery tertiles (1998 to 2002, 2003 to 2005, 2006 to 2007) were examined. Baseline Charlson comorbidity index (0, 1, 2, 3 or more) was adapted according to the Deyo et al classification.[21]

Postoperative Complications and Blood Transfusions During Hospitalization

The NIS records up to 15 diagnoses and procedures for each admission. The presence of any complication was defined using ICD-9 diagnoses 2 through 15 as previously described.[22] Blood transfusion recipients were identified using ICD-9 procedure codes 99.02 and 99.04. Finally, vital status was used to define in-hospital mortality, which was coded from patient disposition. Length of stay was dichotomized according to the median (5 days or more). Hospital admissions with a length of stay greater than the median value were defined as pLOS.

Statistical Analysis

Frequencies and proportions were generated for categorical variables. The chi-square test was used to assess the statistical significance of proportions. Separate logistic regression models targeted the 4 separate end points of postoperative complications, blood transfusion, pLOS and in-hospital mortality. Subsequently the impact of hospital volume was evaluated in 6 separate models with stratification implemented according to teaching vs nonteaching, PN vs RN and laparoscopic vs open. All multivariable models adjusted for patient age, gender, race, Charlson comorbidity index, hospital region and year of surgery. All tests were 2-sided with statistical significance set at $p < 0.05$. Analyses were conducted using the statistical package for R (R Foundation for Statistical Computing, version 2.12.2).

RESULTS

Overall data on 48,172 patients with nonmetastatic RCC were abstracted. The majority underwent RN (82%) and most nephrectomies were performed via the open technique (92%). Most patients were treated at teaching institutions (56%) and surgeries were predominantly performed in the South (40%). Of interest 75%, 17%, 7% and 1% of patients were treated