Surgeon Characteristics and Long-Term Trends in the Adoption of Laparoscopic Radical Nephrectomy

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Abbreviations and Acronyms

HMO = health maintenance organization

LRN = laparoscopic radical nephrectomy

NCI = National Cancer Institute

ORN = open radical nephrectomy

SEER = Surveillance, Epidemiology and End Results

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Purpose: We describe longitudinal trends in surgeon adoption of laparoscopic radical nephrectomy. We assessed whether this technique is associated with specific surgeon and/or practice setting characteristics.

Methods and Materials: We used Surveillance, Epidemiology and End Results-Medicare data to identify patients who underwent laparoscopic or open radical nephrectomy for early stage kidney cancer from 1995 through 2005. We assessed long-term trends in surgeon adoption of laparoscopic radical nephrectomy and fit multilevel logistic regression models to estimate the association between surgeon or practice setting characteristics and patient receipt of laparoscopic radical nephrectomy.

Results: The annual proportion of patients receiving laparoscopic radical nephrectomy increased from 1.4% in 1995 to 44.9% in 2005 ($p < 0.001$). In patients treated by recent medical school graduates (graduation year 1991 or thereafter) the likelihood of undergoing laparoscopic radical nephrectomy was more than 2-fold higher when urologists practiced at National Cancer Institute designated Cancer Centers (OR 2.37, 95% CI 1.11–5.06) or in urban settings (OR 2.92, 95% CI 1.10–7.75). Patients treated by urologists who graduated before 1991 and had a major academic affiliation (OR 1.78, 95% CI 1.34–2.38) or were in a group practice (OR 1.99, 95% CI 1.51–2.63) were significantly more likely to be treated with a minimally invasive surgical approach than those treated in nonacademic and solo practices, respectively.

Conclusions: Urologist adoption of laparoscopic radical nephrectomy increased progressively from 1995 through 2005 and was influenced by urologist proximity to training, academic affiliation and rural/urban status. These data clarify residual barriers to surgeon adoption of laparoscopic radical nephrectomy and potentially of other innovative surgical therapies.

Key Words: kidney; carcinoma, renal cell; laparoscopy; diffusion of innovation; physician's practice patterns

Based on easier convalescence with equivalent cancer control laparoscopy emerged as an alternative standard of care in patients undergoing radical nephrectomy for renal cell carcinoma.[1–4] However, despite potential advantages relative to open surgery urologists have slowly adopted LRN and, at least through the early 21st century, ORN has remained the predominant surgical therapy for localized kidney cancer.[5–7]

To explain the protracted dissemination of LRN we previously reported

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that in many patients with kidney cancer the surgery performed depends more on the treating urologist than on patient or tumor characteristics.[8] Accordingly further characterization of which urologists perform this technique may inform efforts to increase the use of laparoscopy for kidney cancer. To our knowledge it remains particularly unknown whether and to what extent laparoscopy use depends on surgeon characteristics, eg time since medical school graduation, and/or the practice environment, eg rural vs urban setting.

We hypothesized that LRN instead of ORN is more common in patients treated by more recently trained surgeons. At the same time we posited that the effect of surgeon characteristics, including training era, varies across practice environments. To test these hypotheses we used SEER-Medicare data to describe longitudinal trends in surgeon adoption of LRN and assess whether this technique is associated with specific surgeon and/or practice setting characteristics. After these data are available, they may clarify barriers and facilitators to surgeon adoption of LRN and potentially of other innovative surgical therapies.

METHODS

Data Source, Cohort and Surgical Procedures

We used linked data from the NCI SEER Program, and the Centers for Medicare and Medicaid Services (Medicare) to identify 15,744 patients diagnosed with incident nonurothelial, nonmetastatic kidney cancer from 1995 through 2005. In this patient group we searched inpatient and physician claims to identify kidney cancer specific diagnosis and procedure codes. We applied a validated claims based algorithm to assign patients to 1 of 4 procedures, including LRN, ORN, or open or laparoscopic partial nephrectomy.[9] We limited our analytical cohort to 10,917 patients who underwent unilateral LRN or ORN as primary treatment for early stage kidney cancer.

Covariates

Patient level. For each patient in the analytical cohort we used SEER data to determine demographic and cancer specific information. Based on patient level ZIP Codes we assigned patients to 1 of 3 socioeconomic strata.[10] We measured preexisting comorbidity using a modified Charlson Index based on claims submitted during the 12 months before surgery.[11,12]

Surgeon level. To identify the treating surgeon for each patient we used the Unique Physician Identifier Numbers available in the Medicare database. We linked the list of surgeon Unique Physician Identifier Numbers to the American Medical Association Physician Masterfile, which contains demographic, educational and certification information on more than 1 million physicians in the United States. We then determined surgeon age, gender, medical school graduation year and practice size. We assigned each surgeon a rural-urban designation based on an established classification scheme using the primary office address ZIP Code.[13] We determined academic affiliation (major, minor or none) based on the methods described by Shahinian et al.[14] Finally, we determined the association of each surgeon with an NCI Cancer Center based on whether the surgeon had performed at least 1 radical nephrectomy at a hospital with this designation.

Statistical Analysis

The primary study outcome was patient receipt of LRN. We used the chi-square test to evaluate the association between the surgery performed, and patient and surgeon level covariates. We used the Mantel-Haenszel chi-square test to evaluate longitudinal trends in the patient receipt of LRN. To characterize longitudinal trends in surgeon adoption of LRN we determined the proportion of surgeons who performed at least 1 LRN in each calendar year. We defined new adopters as surgeons who performed an initial LRN in a given calendar year.

We then fit multilevel logistic regression models to estimate the association between surgeon or practice setting characteristics and patient receipt of LRN. Analysis was stratified by medical school graduation year, ie before vs after 1991, since we thought that urologists graduating after 1991 would have completed residency during or after the introduction of formal laparoscopic training. Our model included a surgeon specific random effect, and surgeon and patient level covariates as fixed effects. Since our primary research question focused on urologist adoption of laparoscopy, we excluded from multilevel analysis 806 patients (7% of the cohort) treated by nonurologists. Surgeon level fixed effects included gender, nephrectomy case volume and practice setting, ie practice type, rural/urban status and Cancer Center affiliation. We collapsed practice type into 3 levels, including solo/2-individual, group (greater than 2 individuals) and HMO/hospital/medical school/other practices. We collapsed rural-urban designation into rural/micropolitan and urban settings. We selected patient level fixed effects, ie age, surgery year, comorbidity and tumor size, a priori based on clinical experience and prior empirical series.[8] Statistical testing was 2-sided and performed at the 5% significance level using SAS®, version 9.1. We obtained University of Michigan institutional review board approval for this study.

RESULTS

We identified 2,229 surgeons who performed a total of 10,917 radical nephrectomies (median 3, range 1 to 84) from 1995 to 2005. We noted significant differences in the receipt of LRN by race/ethnicity (Hispanic 12% vs white 20%), socioeconomic status (low 18% vs high 24%), tumor size (greater than 7 vs 4 cm or less 12% vs 24%) and tumor histology (chromophobe vs papillary vs clear cell 35% vs 31% vs 19%, each $p < 0.001$). The annual proportion of patients treated with LRN increased significantly from 1.4% in 1995 to 44.9% in 2005 ($p < 0.001$, fig. 1, *A*).

In our analytical cohort 749 surgeons performed a total of 2,188 LRNs (median 2, range 1 to 55) and 2,039 performed a total of 8,729 ORNs (median 3, range 1 to 31). Laparoscopy was more commonly done in

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