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National Trends and Cost of Minimally Invasive Surgery in Urology

Bilal Chughtai,* Douglas Scherr, Joseph Del Pizzo, Michael Herman, Christopher Barbieri, Jialin Mao, Abby Isaacs, Richard Lee, Alexis E. Te, Steven A. Kaplan, Peter Schlegel and Art Sedrakyan

From the Department of Urology (BC, DS, JDP, MH, CB, RL, AET, SAK, PS) and Department of Public Health (JM, AI, AS), Weill Medical College of Cornell University, New York-Presbyterian Hospital, New York, New York

Abstract

Introduction: We determine national trends in costs of care as well as associated growth and adoption of minimally invasive surgery for major uro-oncology procedures.

Methods: Using a nationally representative sample we identified patients diagnosed with prostate, renal and bladder cancer who underwent prostatectomy, nephrectomy, partial nephrectomy and cystectomy from 2000 to 2011. Temporal trends in patient demographics, hospital and procedure related characteristics, surgical volume, minimally invasive surgery use and costs of hospitalization over the years were analyzed. Hierarchical linear regression was performed to evaluate the effects of hospital volume, time and surgery type on costs of hospitalization.

Results: Overall 836,563, 440,337 and 122,992 patients underwent prostatectomy, nephrectomy and cystectomy from 2000 to 2011, respectively. There was a 33.6%, 50.8% and 25.5% increase in annual surgical volume for these 3 surgeries during the 10 years, with the most prominent increase at high volume hospitals. The use of minimally invasive surgery increased 65.6% for prostatectomy, 22.0% for nephrectomy and 12.5% for cystectomy, and this increase was more prominent at high volume hospitals. For all 3 surgeries the hospital stay for minimally invasive surgery cases was more expensive than for open procedures, but decreased during the study period from $17,367 to $11,145 for prostatectomy and from $54,209 to $28,753 for cystectomy.

Conclusions: High volume hospitals experienced greater growth in surgery caseloads and minimally invasive surgeries but this did not lead to higher costs of care. While minimally invasive surgery has consistently been more expensive than open surgery, the costs of minimally invasive prostatectomy and cystectomy have decreased in the last decade.

Key Words: prostatectomy, cystectomy, nephrectomy, treatment outcome, medical oncology

Abbreviations and Acronyms

MIS = minimally invasive surgery

NIS = Nationwide Inpatient Sample

The most common major urologic oncologic surgeries include prostatectomy, partial and radical nephrectomy, and cystectomy. The frequency of these surgeries has increased in recent years.[1–4] As the volume of urologic oncology surgeries continues to increase on a national level, major urologic oncology procedures are being performed by fewer surgeons and at fewer centers.[5,6]

The introduction of MIS and subsequent development of robotic techniques have the potential to dramatically shift practice patterns of major uro-oncology care. Advantages of the MIS approach include reduced blood loss and patient morbidity, shorter hospital stay and lower analgesia requirements.[7] Furthermore, in the last decade there has been a major shift toward more frequent use of minimally invasive procedures.[5]

However, the complexity of the relationship among the adoption of MIS, the growth of surgical procedures and the costs of care has not been well researched. There may be policy

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* Correspondence: Department of Urology, Weill Cornell Medical College, New York Presbyterian Hospital, 425 East 61st St., 12th Floor, New York, New York 10065 (telephone: 646-962-4811; FAX: 646-962-0140; *e-mail address:* bic9008@med.cornell.edu).

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implications related to the uncontrolled adoption of MIS if this new technology leads to increased costs or caseloads. Therefore, we conducted a national assessment of the trends of major urologic oncology procedures in a standardized framework to determine trends in the adoption of minimally invasive surgery and associated in-hospital costs of care for urologic oncology surgeries.

Methods

Data Source

Nationwide Inpatient Sample data from 2000 to 2011 were used in the analyses. The NIS database, developed as part of the HCUP (Healthcare Cost and Utilization Project), is an approximately 20% stratified sample of community hospitals in the United States. It contains administrative data for approximately 8 million hospital discharges each year regardless of insurance payer.

Study Population and Procedures

ICD-9 procedure codes were used to identify patients who underwent prostatectomy (ICD-9-CM 60.4, 60.5, 60.62),[8,9] nephrectomy (ICD-9-CM 55.4, 55.5, 55.51, 55.52, 55.54)[2,10] and cystectomy (ICD-9-CM 57.6, 57.7x, 57.87, 57.59, 56.5x, 68.8).[11,12] Among these patients only those with a diagnosis of prostate cancer (ICD-9-CM 185), renal cancer (ICD-9-CM 189.x) or bladder cancer (ICD-9-CM 188.x, 233.7) were included in the study. Those who underwent multiple urologic oncology surgeries were excluded from analysis.

Variable Definitions

Year of surgery was coded as a continuous variable to demonstrate a graphical trend but was also categorized a priori into 4 intervals to account for difference in sampling of large hospitals among the years. Patient demographics included age (younger than 65, 65 to 75 and older than 75 years), race (white and nonwhite), gender and insurance payer (Medicare, Medicaid, commercial and other).

Hospital related characteristics included hospital location (urban vs rural) and academic status (teaching vs nonteaching). Hospital volume for each surgical procedure was defined according to average annual surgical volume, stratified by patient tertiles. The specific categorization of hospital volume into low, medium and high tertiles for prostatectomy was low volume—0 to 40, medium volume—41 to 110 and high volume—more than 110 cases per year. Nephrectomy was divided into low volume—0 to 15, medium volume—16 to 40 and high volume—more than 40 cases per year. Cystectomy was grouped as low volume—0 to 5, medium volume—6 to 20 and high volume—more than 20 cases per year.

Patients were further classified as having undergone MIS with concurrent codes for laparoscopy (ICD-9-CM 54.21, 54.51), robotic assisted procedures (ICD-9-CM 17.4x, 00.39) and other computer assisted surgery (ICD-9-CM 00.39).[8–10] Cost of hospitalization data were obtained using charge data and cost-to-charge ratios from 2001 to 2011, further adjusted by diagnosis related group factors. Adjusted costs were then converted to 2011 dollars using the medical care service Consumer Price Index of the specific year.[13]

Statistical Analysis

Statistical analysis for categorical and continuous data was performed to compare patient demographics, comorbidities, hospital and procedure related characteristics, and in-hospital outcomes over the years, based on 4-year intervals of 3 consecutive years. Annual surgical volume was summarized for each year from 2000 to 2011 for prostatectomy, nephrectomy, partial nephrectomy and cystectomy. To assess temporal trend by hospital volume tertiles, annual surgery cases, percentages of MIS performed and cost of hospitalization were summarized in each volume category and the trends were evaluated graphically.

To further assess the relationship among hospital volume, time, surgery type and cost of hospital stay, hierarchical linear regression was performed, adjusting for patient demographics, perioperative comorbidities, length of hospital stay and hospital characteristics. Comorbidities were determined with ICD-9 diagnostic codes using algorithms validated by Elixhauser et al.[14] Logarithmic transformation and reweighting was performed in accordance with HCUP instructions for the analysis of cost.[15] All analyses were performed using SAS® v9.3.

Results

Weighted national estimates of 836,563 prostatectomies, 440,337 nephrectomies and 122,992 cystectomies were performed during 2000 through 2011. Table 1 shows patient demographics as well as hospital and procedure related characteristics. Compared to 12 years ago, more surgeries were performed at urban (prostatectomy 89.8% to 95.6%, nephrectomy 90.8% to 94.9%, cystectomy 90.8% to 96.6%) and teaching hospitals (prostatectomy 53.6% to 67.2%, nephrectomy 55.3% to 64.1%, cystectomy 58.3% to 77.3%). Annual surgical volume increased from 60,197 to 80,439 (33.6%) for prostatectomy, from 28,648 to 43,212 (50.8%) for nephrectomy and from 9,307 to 11,681 (25.5%) for cystectomy (fig. 1). The increases in surgery cases from 2000 to 2011 were most prominent at high volume hospitals for all 3 procedures, at 2.6 times for prostatectomy, 2.7 times for nephrectomy and 3.8 times for cystectomy (fig. 2). The increase in caseload at medium volume centers was only 44.7% for prostatectomy, 50.1% for nephrectomy and 2.9% for cystectomy. However, there was a decrease of 32.7%, 21.5% and 43.4% in caseload for prostatectomy, nephrectomy and cystectomy, respectively, at low volume centers.

The proportion of MIS continued to increase throughout the 12-year study period from 0.8% to 66.4% for prostatectomy, from 4.5% to 26.5% for nephrectomy and from 0.2% to 12.7% for cystectomy (table 1). The highest volume hospitals consistently performed more minimally invasive surgery