

Patterns of care for renal surgery: Underutilization of nephron-sparing procedures

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Abstract

Background: Nephron-sparing procedures are well-described, provide similar oncologic outcomes to nephrectomy, and potentially decrease morbidity as compared to nephrectomy.

Methods: We analyzed academic and community health system data from Virginia and Kentucky to evaluate the utilization and cost of nephron-sparing procedures. Primary International Classification of Disease (ICD-9) diagnosis and procedure codes were employed to target subjects of interest.

Results: In total, we analyzed 3809 subjects from Virginia and 3163 subjects from Kentucky between 2004 and 2009 who underwent treatment of a malignant renal mass. There has been a 6.1% and 14.8% decrease in nephrectomy utilization in Virginia and Kentucky, respectively, since 2004. In 2009, 71.4% and 68.8% of all procedures for the treatment of renal masses were radical nephrectomies. The proportion of nephron-sparing procedures has increased in academic (20%) and community (15%) health systems since 2004. The difference in cost between nephrectomy, partial nephrectomy and ablative therapy in Virginia and Kentucky hospitals was negligible ($p > 0.05$).

Conclusions: Nephron-sparing procedures have been increasingly employed over the last 6 years, but are still underutilized. There does not appear to be a significant cost difference in the treatment of renal masses with nephrectomy, partial nephrectomy or ablative therapies.

Introduction

In the United States about 1 in 67 people will be diagnosed with kidney cancer during their lifetime, with most being identified as a serendipitous radiographic finding.¹ Nephrectomy has been the mainstay of treatment, even for T1 tumours. Concerns regarding the total removal of one kidney were generally allayed by studies derived from living renal transplant donors that consistently demonstrated

adequate renal compensation of the contralateral kidney status post-nephrectomy.² The advent of laparoscopy made radical nephrectomies less morbid and, therefore, soon became standard practice. However, in recent years it has become clear that renal cancer patients differ markedly from renal transplant donors in their predisposition to a decline in renal function. Studies have shown that 25% of patients who have undergone radical nephrectomy progress to chronic kidney disease.³ In comparison, 11% of the general population and 16% of patients over 60 are diagnosed with chronic kidney disease (CKD). Thus the potential for the development of CKD in patients undergoing nephrectomy for renal tumours is of particular concern given the observed stepwise association between reduced glomerular filtration rate (GFR) and increased risk of death, cardiovascular events and hospitalization.^{4,5} Fortunately, current management of renal masses emphasizes nephron-sparing procedures due to similar oncologic outcomes, while potentially decreasing renal and cardiovascular morbidity compared to radical nephrectomy.⁶ These same concerns over renal and cardiovascular morbidity have led to the development of ablative procedures that can be done percutaneously to further minimize operative risk.⁷

In this cost-conscious environment, cost-effectiveness analyses that incorporate evaluation of quality-adjusted life years are becoming more prevalent. Chang and colleagues performed such an analysis comparing immediate open or laparoscopic partial nephrectomy, percutaneous or laparoscopic ablation, active surveillance with delayed percutaneous ablative or observation only for suspicious renal masses smaller than 4 cm.⁸ Using Markov models, they found immediate laparoscopic partial nephrectomy is the preferred option of a healthy patient less than 74 years of age.⁸

Although nephron-sparing approaches in managing renal tumours are well-described, the application of the techniques may not be widely practiced. To evaluate the utilization and cost of nephron-sparing procedures, we analyzed epidemiologic data from Virginia and Kentucky.

Methods

Data between 2004 and 2009 from Virginia were gathered from the Department of Health Patient Level Database System via the Thomson Reuters Polaris Suite; for Kentucky during the same period, we queried the Kentucky Hospital Association database. These databases reflect inpatient hospital stays for all patients. The data are reported at the county and hospital levels and represent data from 49 and 41 hospitals in Virginia and Kentucky, respectively. No outpatient surgery data were collected. An academic centre was defined as a hospital program that has resident participation. In the state of Virginia, the University of Virginia Hospital, Virginia Commonwealth University-Medical College of Virginia Hospital, Sentara Norfolk General Hospital and Sentara Virginia Beach General Hospital were considered academic hospitals. In the state of Kentucky, the University of Louisville Hospital and University of Kentucky Chandler Medical Center were considered academic hospitals.

Subjects of interest were all patients hospitalized for primary International Classification of Disease (ICD-9) code referencing a renal mass (Table 1). We identified renal cell carcinoma (RCC) by limiting the data to cases referenced by the primary ICD-9 codes "malignant neoplasm of kidney except pelvis" (189.0), "secondary kidney cancer" (198.0), "benign kidney neoplasm" (223.0), "other GU neoplasm not otherwise specified" (239.5) and "neoplasm of uncertain behaviour of kidney and ureter" (236.91). Benign kidney neoplasms were included since most renal masses are not biopsied prior to treatment. Transitional cell carcinoma was excluded by removing the following codes: benign renal pelvic neoplasm (223.1), renal pelvic tumour (189.1), renal pelvic disorder (593.9), bladder cancer NOS (188.9) and ureteral cancer (189.2). Furthermore, ICD-9 procedure codes consistent with nephrectomy, partial nephrectomy and ablative

Table 1. ICD-9 procedure codes

Patient variable
<ul style="list-style-type: none">• Open ablation of a renal lesion or tissue 55.32• Percutaneous ablation of renal lesion or tissue 55.33• Laparoscopic ablation of renal lesion of tissue 55.34• Other and unspecified ablation of renal lesion or tissue 55.35• Other local destruction or excision of renal lesion or tissue 55.39• Partial nephrectomy 55.4• Nephroureterectomy 55.51• Nephrectomy of a remaining kidney 55.52
ICD: International Statistical Classification of Diseases and Related Health Problems.

therapy were specified for comparison (Table 1). Hospitals do not charge by Current Procedural Terminology (CPT) codes, but by the ICD-9 procedure codes so this information is not available. As this is statewide reporting data, no linkage to individual disease characteristics, such as grade or stage, is available. Although we attempted to differentiate robotic from open cases, the secondary procedure code 1741 was listed as "open robotic assisted." As we could not reliably categorize these cases as open or robot assisted, we did not parse the data based on this coding schema. Descriptive statistics were performed comparing the rates of procedure over time.

Results

Proportion of radical versus nephron sparing

We identified 4911 subjects from Virginia and 3573 from Kentucky between 2004 and 2009 who underwent treatment of a malignant renal mass (Table 2). We tallied the proportion of patients undergoing radical nephrectomy as compared to nephron-sparing procedures between 2004 and

Table 2. Subject demographics by state, procedure type and practice venue

	Nephrectomy				Nephron sparing			
	Community		Academic		Community		Academic	
	Virginia	Kentucky	Virginia	Kentucky	Virginia	Kentucky	Virginia	Kentucky
Age >64	1093	1346	260	186	442	492	158	84
Age <64	1510	1083	408	61	782	297	258	24
Insurance								
-Medicaid	90	122	35	30	18	45	14	15
-Medicare	1403	1147	197	83	449	298	169	32
-Private	1351	936	276	98	703	380	182	47
-Self pay	52	68	45	18	11	15	24	9
-Other	14	156	5	18	10	51	2	5
Race								
-White	1924	Unknown	461	Unknown	972	Unknown	280	Unknown
-Black	446	Unknown	191	Unknown	188	Unknown	121	Unknown
-Asian	31	Unknown	4	Unknown	13	Unknown	1	Unknown
-Other	201	Unknown	13	Unknown	44	Unknown	4	Unknown

009 by state (Fig. 1). The prevalence of radical nephrectomy has been steadily decreasing in both states. In 2004, 74.3% and 80.5% of procedures for a renal mass were nephrectomies, while in 2009 nephrectomies comprised 67.3% and 66% of renal mass procedures in Virginia and Kentucky, respectively. In the early years, nephron sparing was more often utilized in Virginia, but by 2009 the percentage of nephron-sparing surgery had equalized.

Adoption of ablative procedures

We looked at the trend in ablative procedures as compared to extirpative procedures by state (Fig. 2). The largest proportion of ablative procedures was in 2007 in Virginia with 7.7% of all renal masses treated with ablative therapy. However, subsequent years did not show consistent adoption. There has been scant utilization of this modality in Kentucky. In Virginia, 28.4%, 4.3%, and 67.3% underwent a partial nephrectomy, ablative procedure, or nephrectomy in 2009, respectively; 33.7%, 0.3%, and 66% of patients underwent the same procedures, respectively, in Kentucky. Almost half of the ablative procedures were coded as laparoscopic ablation (Fig. 3).

Academic versus community practice patterns

The prevalence of nephrectomy, partial nephrectomy and ablative procedures were compared in academic and community hospitals by state (Fig. 4). The proportion of nephron-sparing procedures was 33.7% in academic institutions compared to 20.4% in community hospitals in 2004. This increased to 42.7% and 31.4% in 2009, respectively. Over the 5-year time frame, nephron-sparing techniques became more common in community hospitals and academic centres. Almost every year, academic centres employed the use of nephron-sparing techniques at a higher percentage of total procedures when compared to community hospitals. When nephron-sparing techniques are categorized into partial nephrectomies and ablative therapies, there remains a rising trend in the usage of both of these nephron-sparing procedures (data not shown).

Procedure charge comparison

When comparing the cost of these therapies in Virginia, we found that both nephrectomies and nephron-sparing therapies are more expensive in the academic setting than in community hospitals (Table 3). The median charges (proce-

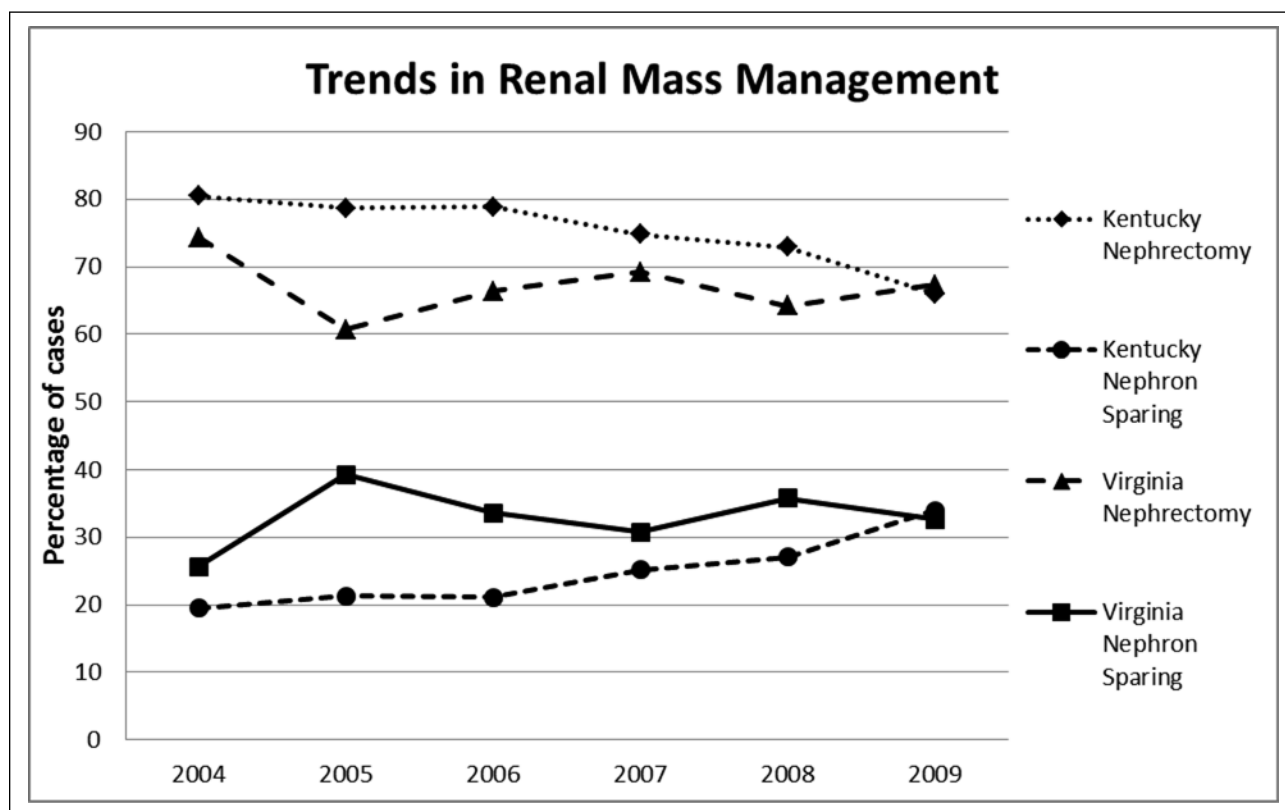


Fig. 1. The proportion of patients undergoing radical nephrectomy as compared to nephron sparing procedures from 2004-2009 by state.

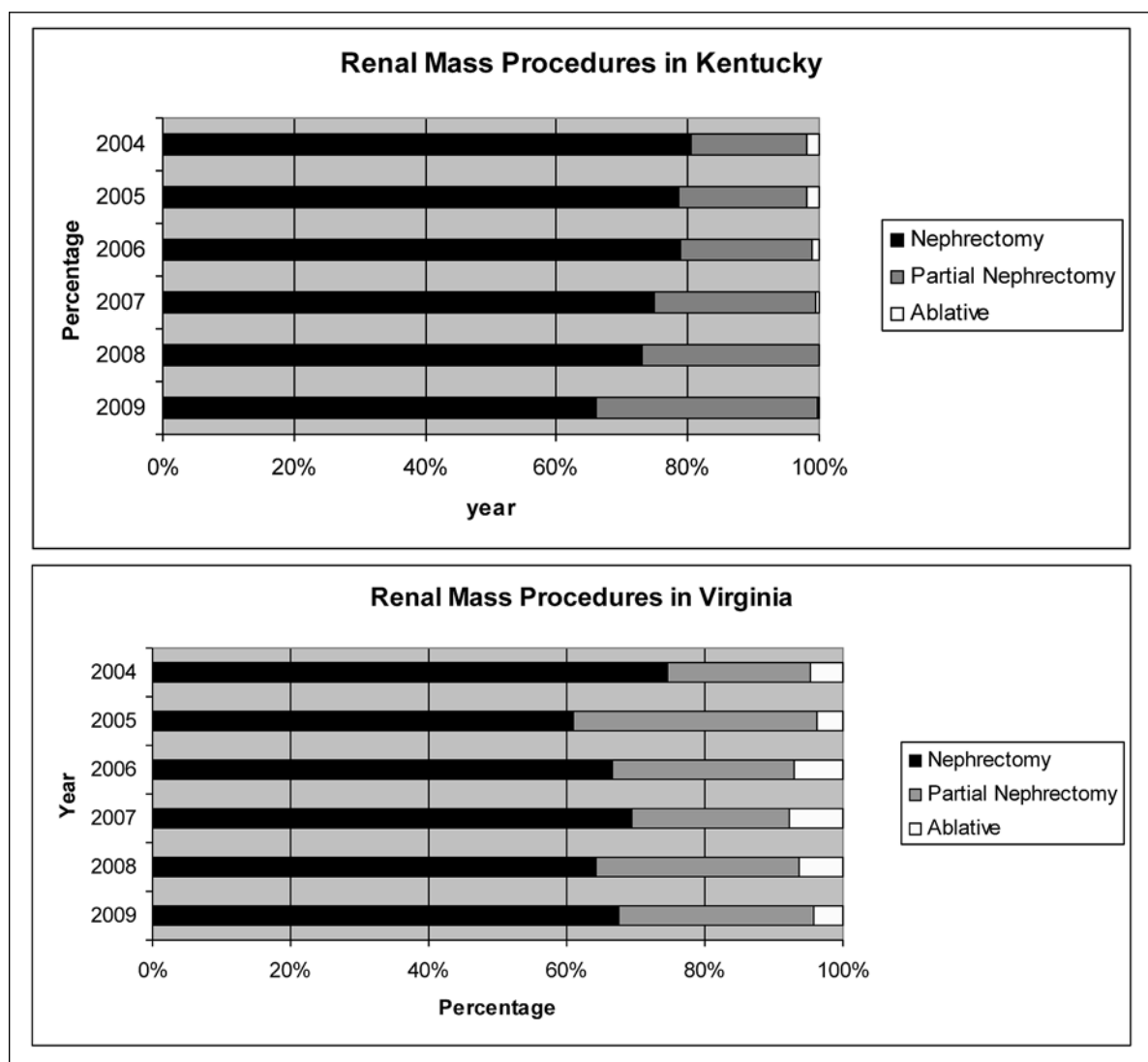


Fig. 2. Proportion of radical nephrectomy, partial nephrectomy and ablative procedures by state.

dures and hospitalization) for nephrectomy, partial nephrectomy and ablative therapy in all Virginia hospitals were \$41 650, \$43 091 and \$47 196, respectively (USD). The difference in cost between these three procedure types was negligible ($p > 0.05$). Similar trends were seen in Kentucky hospitals, with academic centres more expensive for both nephrectomies and partial nephrectomies. However, again, no significant differences were found in the overall cost.

Discussion

Our study has two important findings. First, nephron-sparing procedures have been increasingly utilized; by 2009, a third of all cases were treated with a nephron-sparing procedure. Second, the difference in cost between radical nephrectomy and nephron-sparing procedures is not as substantial as anticipated.

About 58 240 people in the United States will be diagnosed with kidney cancer this year; of these cancers, about 60% will be localized to the primary site with no evidence of metastasis.⁹ A recent randomized controlled trial addressing the long-term outcomes of partial nephrectomy as compared to radical nephrectomy found a better overall survival with radical nephrectomy.¹⁰ This study is criticized for having been done during an era in which many surgeons were not regularly performing partial nephrectomies; moreover, the study authors did not account for preoperative GFR. A more recent SEER Medicare analysis suggested better long-term survival with partial nephrectomy.¹¹ The issue remains controversial, but AUA guidelines recommend a partial nephrectomy for smaller masses. However, according to our data, in 2009, 28.6% and 31.2% of patients underwent a nephron-sparing procedure for renal mass in Virginia and Kentucky, respectively. While it is difficult to ascertain whether this

Table 3. Median charge by procedure type for academic and community hospitals, by state

	Academic						Community					
	Nephrectomy		Partial nephrectomy		Ablative		Nephrectomy		Partial nephrectomy		Ablative	
	Virginia	Kentucky	Virginia	Kentucky	Virginia	Kentucky	Virginia	Kentucky	Virginia	Kentucky	Virginia	Kentucky
2004	\$52,482	\$18,324	\$51,920	\$19,786	\$55,533	\$24,065	\$34,968	\$19,425	\$41,794	\$18,357	\$39,728	\$29,791
2005	\$50,754	\$20,480	\$40,436	\$19,845	\$60,754	\$19,335	\$35,353	\$18,950	\$35,596	\$19,627	\$24,973	\$18,316
2006	\$41,094	\$25,425	\$63,081	\$23,037	\$32,932	\$20,378	\$34,592	\$20,731	\$50,511	\$21,236	\$29,353	\$15,647
2007	\$42,340	\$24,037	\$44,699	\$24,119	\$39,627	\$15,768	\$35,524	\$22,365	\$31,737	\$23,277	\$40,587	\$15,768
2008	\$50,660	\$30,495	\$37,239	\$23,872	\$53,530	n/a	\$34,747	\$23,370	\$33,233	\$25,249	\$36,788	n/a
2009	\$49,472	\$34,686	\$32,854	\$32,363	\$79,024	n/a	\$42,167	\$26,382	\$33,474	\$27,171	\$44,711	\$24,652

*chi square for all >0.05.

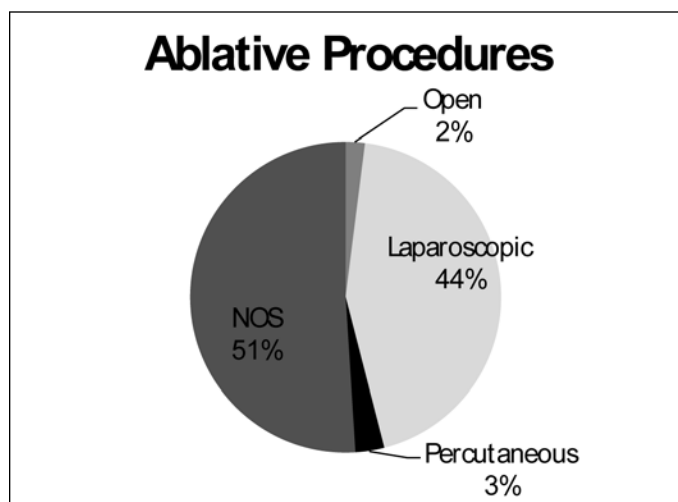
level of utilization is appropriate without the specific disease and patient characteristics, it is gratifying that the number has increased from 2004 when 22.5% and 16.4% of procedures were nephron-sparing in Virginia and Kentucky, respectively. Our statewide data are similar to regional SEER data. Using SEER data from Detroit and Chicago, Miller and colleagues analyzed 1136 patients and found that fewer than 20% of patients underwent a nephron-sparing surgery between 2002 and 2007. In 2005, 29% of patients underwent a nephron-sparing procedure, which is very similar to our finding of 30%.¹² Our study is limited because we do not know the size of the tumour; however, a separate SEER analysis of all regions did have access to tumour size. They were able to identify 14 647 patients with primary tumour size ≤ 7 cm. Only 4.6% and 17.6% of patients were treated with partial nephrectomy in 1988 and 2001, respectively.¹³ Given that most renal tumours are incidentally discovered, our study likely also includes tumours ≤ 7 cm.

Furthermore, academic hospitals showed an earlier and faster acceptance and utilization of new techniques and procedures compared to community hospitals. This difference was more pronounced in Virginia, where 40.3% of renal mass procedures were nephron sparing in academic hos-

pitals in contrast to 25.1% in community hospitals. This is expected; part of the mission of academic urology is to pilot new technologies in a controlled setting. Permpongkosol and colleagues found that over a 14-year period at a university academic institution, the use of laparoscopic partial nephrectomy was 41% and percutaneous ablation was increasing as a treatment option with 13.8% of procedures performed in 2005.¹⁴ While similar to these studies, our study has a larger population and wider geographical variation suggesting consistent change.

Breau and colleagues recently surveyed members of the American Urological Association to determine the factors that influenced the treatment of small renal masses. They found that fellowship-trained urologists and urologists at academic hospitals were less likely to choose radical nephrectomy.¹⁵ This supports our findings that more nephron-sparing procedures are performed at academic institutions than community hospitals.

Studies have shown that partial nephrectomies and radical nephrectomies have similar oncologic outcomes and perioperative morbidity in renal masses <4 cm, with partial nephrectomies allowing for greater preserved renal function. Long-term outcomes of ablative procedures are not as well-known, although a study on percutaneous radiofrequency ablation for RCC showed durable oncological control for RCCs <4 cm followed over a median of 61 months.¹⁶ Cryoablation was shown to have better oncologic control than radiofrequency ablation.¹⁷ While more studies are needed to determine the oncologic outcomes of cryoablation and radiofrequency ablation, they remain good alternatives in patients who are not surgical candidates. While the primary impetus for a minimally invasive percutaneous procedure is to minimize morbidity, we made the assumption that these procedures were also less costly. However, from the data comparing costs of each procedure type, there is no substantial difference in the costs of these therapies. However, the trend to perform these procedures percutaneously is likely not represented in these data; 44% were laparoscopic ablation and thus have an associated operative charge. Although our institution continues to require an overnight stay for percutaneous renal procedures, many cen-

**Fig. 3.** Type of ablative procedures.

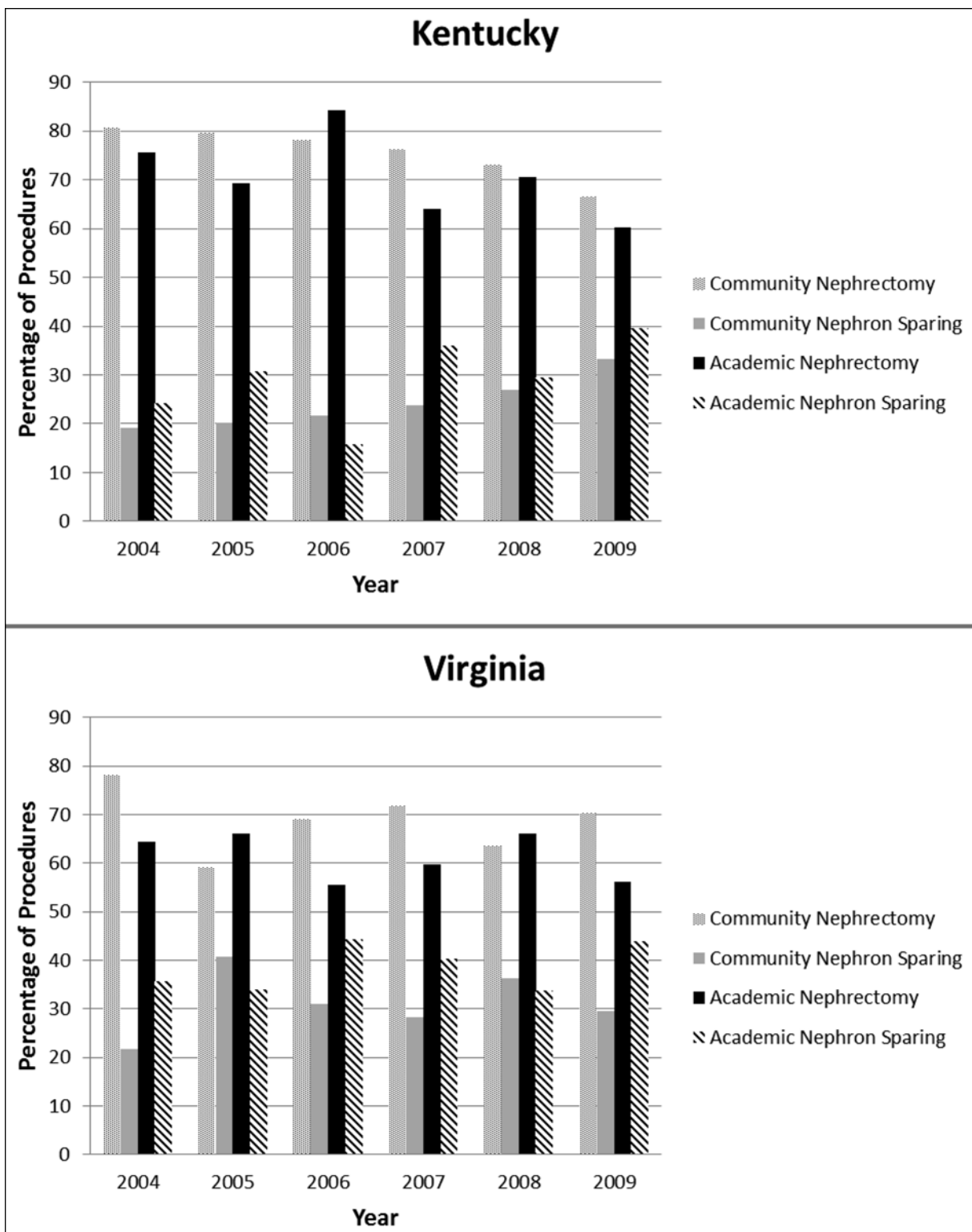


Fig. 4. Academic versus community practice patterns.

tres have moved to an outpatient practice pattern. Therefore, caution must be used in the interpretation of the cost of ablative procedures. Considering the presented data, which

show no difference in expenses, patients with renal cancer should be treated according to criteria that do not emphasize cost considerations.

From this study, renal cancer is more expensive when managed in an academic centre rather than a community hospital. This trend may be a result of the nature of the patients who are typically treated in academic centres. Patients treated for RCC in academic hospitals may have been more likely to have been referred due to the complexity of the cases. The data also demonstrate the tendency of academic centres to try new procedures more frequently and earlier than their community counterparts, which may lead to increased cost and complication rates. Being at the front-line of new procedures may have caused academic hospitals to receive the brunt of both expenses and complications.

Limitations to our study include the use of ICD-9 codes instead of CPT codes, which would have been more precise in our search for procedures and diagnosis. ICD-9 codes were selected due to hospital billing practices. While physicians use CPT codes, hospitals bill with ICD-9 codes; these codes are recorded and therefore can be analyzed. While we attempted to only identify patients with RCC, we may have inadvertently included other malignant renal masses, including transitional cell carcinoma. Similarly, excluding possible benign masses may also have decreased the number of nephron-sparing surgeries. Ideally, we would also prefer to know if a radiologist or a urologist was performing the percutaneous cryoablation and radiofrequency ablations. Furthermore, the study was performed in two southeastern states, which may limit its generalizability to the entire United States. Finally, we were limited in our ability to differentiate between large (>7 cm) and small (<4 cm) tumours; nephron-sparing procedures may have been higher in smaller tumours.

The cost differential is likely to be different if open and laparoscopic cases were not grouped together. We did ascertain the median cost of an open partial nephrectomy compared to a laparoscopic partial nephrectomy post hoc. The cost of open partial nephrectomy was \$43 000 and it was \$47 000 for laparoscopic partial nephrectomy hospitalization.

Conclusion

Virginia and Kentucky inpatient data indicate that practice patterns for management of renal masses has been changing with increased use of nephron-sparing therapies relative to radical nephrectomy. Academic hospitals have adopted nephron-sparing therapies earlier than community hospitals.

The trend over the past 6 years demonstrates increasing, albeit slow, adoption of nephron-sparing therapies in both academic and community hospitals.

Competing interests: None declared.

This paper has been peer-reviewed.

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