Best Practice & Research Clinical Endocrinology & Metabolism 33 (2019) 101296

Contents lists available at ScienceDirect

Best Practice & Research Clinical Endocrinology & Metabolism

journal homepage: www.elsevier.com/locate/beem

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Volume–outcome relationship in adrenal surgery: A review of existing literature

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ARTICLE INFO

Article history:
Available online 12 July 2019

Keywords:
adrenal
surgery
adrenalectomy
volume
outcomes

The relationship between operative volume and perioperative outcomes after several oncologic operations is well documented. Recent studies on adrenalectomy reveal a robust association between higher surgeon volume and improved patient outcomes. Statistical analyses have demonstrated that outcomes are improved when surgeons perform at least six adrenalectomies annually; based on this threshold definition of a 'high-volume' surgeon, more than 80% of adrenalectomies in the United States are performed by 'low-volume' surgeons. When compared to low-volume surgeons, high-volume surgeons on average achieve lower rates of postoperative complications and mortality, as well as a shorter length of hospital stay, and lower cost of hospitalization. There does not appear to be a similar association between hospital adrenalectomy volume and improved patient outcomes; however, there is evidence of benefit for the subset of patients with adrenocortical carcinoma. Despite limitations of existing literature, evidence is sufficient to recommend the referral of patients with adrenal tumors to high-volume surgeons.

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https://doi.org/10.1016/j.beem.2019.101296
1521-690X/

Introduction

Adrenalectomies are being performed more frequently worldwide [1]. The rate of adrenalectomy in the United States has increased by more than 45% in the past 20 years; this increase is in part explained by more frequent use of computed tomography which has led to increased detection of incidental adrenal masses; in addition, the introduction of a laparoscopic approach appears to be associated with a lower tumor size threshold for operative intervention [2–4]. Current surgical indications for adrenalectomy include tumors that are large or enlarging, worrisome for a malignancy, and those that exhibit evidence of autonomous hormonal secretion [5,6].

First described in 1889, open adrenalectomy was initially the only surgical approach for removing adrenal tumors. In 1992, Gagner et al. reported results of the first three laparoscopic transabdominal adrenalectomies, ushering in an era of minimally invasive adrenalectomy. There are currently several surgical techniques that can be employed for adrenalectomy, including laparoscopic adrenalectomy, a robotic-assisted laparoscopic procedure, and a single-incision technique, all of which can be performed either transabdominally or via a retroperitoneal approach. Laparoscopic adrenalectomy is currently the preferred surgical technique, and has advantages including reduced postoperative pain, earlier resumption of oral intake, shorter hospital stay, earlier resumption of baseline activity, and superior cosmesis [5–9].

The relationship between surgical volume and patient mortality was first evaluated by Lee et al., in 1957, who reported higher case-fatality rates among patients undergoing procedures for appendicitis, perforated peptic ulcer disease, and prostatic hypertrophy [10]. In the past 25 years, there has been mounting evidence that patients undergoing diverse surgical procedures have better outcomes, on average, if care is provided by high volume providers. Operations for which high surgical volume has been shown to be associated with improved patient outcomes include thyroidectomy, gastrectomy, colectomy, lung procedures, pancreaticoduodenectomy, and a variety of vascular procedures [11–19]. For some procedures, a volume-outcomes threshold also has been computed using sophisticated analyses [17–19].

Surgeon volume–outcome association in adrenal surgery

Majority of adrenalectomies in the United States are performed by surgeons who do just one adrenalectomy per year [20,21]. Several studies have sought to determine the association between operative volume and patient outcomes in adrenal surgery. Given the overall rarity of adrenalectomy, most studies conducted in the United States are based on retrospective studies using state and national-level databases. Most of these studies examine a few outcomes of interest, often including occurrence of $\geq$1 complications, length of stay, and cost of hospitalization.

Initial studies of a volume–outcome relationship for adrenalectomy revealed conflicting results. Stavrakis et al.'s analysis of endocrine surgical procedures (thyroidectomy, parathyroidectomy, and adrenalectomy) based on data culled from New York and Florida state databases was among the first to examine the volume-outcome association in adrenal surgery [22]. The authors grouped surgeons into 1 of 6 groups based on their cumulative volume of endocrine specific procedures performed in year 2002; Group A, 1–3 operations annually; B, 4–8; C, 9–19; D, 20–50; E, 51–99; and F, $\geq$100 procedures. When outcomes of patients who underwent adrenalectomy were examined, the study found no association between surgeon volume and complication rates (observed to expected ratios: 1.04, 0.84, 1.00, 1.67, 0.00, 0.83 for Groups A to F, respectively, $p > 0.05$); however, each unit increase in surgeon volume was associated with a 0.28-day decrease in hospital length of stay ($p < 0.001$), and a U.S. $1472 decrease in costs ($p < 0.01$). Key limitations of the study were that surgeon volume was cumulative for all endocrine procedures and thus not restricted to adrenalectomy; data were derived from just two U.S. states, limiting generalizability; and the study did not examine surgical approach (open vs. laparoscopic). The study also did not adjust for hospital characteristics, such as teaching status and location (rural versus urban), which might influence patient outcomes.

Another study by Gallagher and colleagues, also published in 2007, retrospectively analyzed hospital discharges from a database maintained by the Florida Agency for Health Care Administration, for 1816 patients who underwent adrenalectomy from 1998 to 2005 [23]. In this study, surgeons were

assigned to one of 4 quartile groups based on their annual volume of adrenalectomies (1, 2, 3–6, ≥7 adrenalectomies/year). Again, no association was found between surgeon volume and postoperative complication rates (20%, 14%, 20%, 46%, for the successive surgeon volume groups, $p = 0.871$), but there was a shorter mean duration of hospital stay with increasing surgeon volume (7, 6, 7, and 5 days respectively, $p < 0.001$). Both of these inaugural studies likely lacked generalizability because data were derived from only 1 or 2 states.

In 2009, Park et al. examined a total of 3144 adrenalectomies captured in the Nationwide Inpatient Sample (NIS; 1999–2005) [20]. The authors first stratified surgeon volume based on quartiles; the top quartile was defined as high-volume based on the performance of ≥4 adrenalectomies per year, and the lower volume quartiles (<4 adrenalectomies per year) were defined as low-volume. The authors found that high-volume surgeons performed more bilateral adrenalectomies and used more laparoscopy; these surgeons operated more frequently at urban, and teaching hospitals. The study showed that adrenalectomies performed by low-volume surgeons vs high-volume surgeons were associated with a higher complication rate (18.3 vs 11.3%, $p < 0.001$) and longer length of stay (5.5 vs 3.9 days, $p < 0.001$). Differences in mean cost of hospitalization were not significant ($11,000 vs $12,600 for high-vs. low-volume surgeons, respectively, $p = 0.06$). This was the first study of the adrenalectomy volume–outcome relationship using national-level data; it was also the first to provide population-level evidence for a lower risk of complications when adrenalectomy is performed by high volume surgeons. The study also confirmed results of prior studies which showed a shorter duration of hospital stay for patients undergoing adrenalectomy by high volume surgeons. However, the study was limited in its ability to delineate surgical approach.

Hauch et al. provided updated results using data from the Nationwide Inpatient Sample (2003-9) [24]. A total of 7829 adrenalectomies were included in their study. Surgeon volume was analyzed based on a quartile distribution (low = 1, intermediate = 2–5, and high = >5 adrenalectomies per year). The authors found that complication rates for low- and intermediate-volume surgeons were 18.8% and 14.6%, respectively, and both groups had significantly higher complication rates than patients who underwent adrenalectomy by high-volume surgeons (11.6%, $p < 0.001$). Length of stay was also shorter when adrenalectomy was performed by a high-volume surgeon (2.7 ± 0.2 days [high] vs. 4.2 ± 0.1 days [low], $p < 0.001$). Similar to Park et al., this study found that surgeon volume was inversely associated with risk of complications in multivariate regression modeling [20]. In contrast to Park et al.'s results, this study reported significantly lower charges for high-volume surgeons compared to lower-volume groups ($p < 0.05$) when patients did not experience any complications ($27,324.00 ± 1882.05 vs. $33,499.00 ± 1062.81, $p = 0.001$), but the association was not significant with occurrence of ≥1 complications ($70,523 vs $78,299, $p > 0.05$). Of note, the use of hospital charges in the Nationwide Inpatient Sample is problematic because charges are unadjusted for pertinent cost-to-charge ratios and inflation rates.

Another study by Al-Qurayshi and colleagues utilized data from the Nationwide Inpatient Sample (2003–2009) to examine 7045 patients who underwent adrenalectomy with the aim of determining cost-differences related to surgical volume; the authors also estimated potential cost savings based on surgeon volume, extrapolating their findings to a national level [25]. Surgeon volume was classified on the basis of the annual number of adrenalectomies performed by each surgeon: low-volume (≤25th percentile, 1 adrenalectomy/year), intermediate-volume (>25th to ≤75th percentiles, 2–6 adrenalectomies/year), and high-volume surgeons (>75th percentile, ≥7 adrenalectomies/year). The study showed that adrenalectomies performed by low-volume surgeons were associated with a higher risk of postoperative complications (adjusted odds ratio: 1.66; 95% confidence interval: 1.23–2.24). After building a hypothetical statistical model, the authors calculated incremental cost savings of 7.7% and 8.1% if all adrenalectomies performed by low-volume surgeons were selectively referred to intermediate-volume and high-volume surgeons, respectively. The highest cost savings (32.4%) were calculated for patients with a Charlson score >2 who underwent adrenalectomy by a high-volume surgeon. Based on a conservative assumption that 5000 adrenalectomies per year are performed in the United States, the authors extrapolated hypothetical cost savings of $19.8 million if intermediate-volume surgeons performed cases done by low-volume surgeons, and cost savings of $24.8 million if these patients were treated by high-volume surgeons. This study demonstrated that improved clinical outcomes of high-volume adrenal surgeons may also have a potentially large economic implication.

A study by Lindemann et al. showed a significant association between surgeon volume and mortality following adrenalectomy [26]. The study analyzed adrenalectomies captured in the New York Statewide Planning and Research Cooperative System from 2000-14. High surgeon volume was defined using a threshold at ≥4 adrenalectomies per year; the volume threshold was chosen based on Park et al.'s data. The authors found that patients of high-volume surgeons experienced significantly lower mortality (0.56% vs 1.25%, $p = 0.004$) and a lower overall rate of complications (10.2% vs 16.4%, $p = < 0.001$) compared to those of low-volume surgeons. After risk adjustment, low-surgeon volume was an independent predictor of patients experiencing an inpatient complication (odds ratio = 0.96, $p = 0.002$).

International data also demonstrate a volume–outcome relationship for adrenalectomy. Palazzo et al. examined 795 adult adrenalectomies performed by 222 different surgeons in the United Kingdom (2013–14) [27]. Only thirty-six (16%) adrenal surgeons performed ≥6 adrenalectomies, which was the definition of a high volume surgeon used in the study. A total of 186 surgeons (84%) performed a median of one adrenalectomy per year. Length of stay and readmission rates within thirty days of surgery were compromised when adrenalectomy was performed by low-volume surgeons (60% longer and 47% higher, respectively). The authors concluded that in the United Kingdom, adrenal surgery is best performed by higher volume surgeons in centers with a dedicated adrenal multidisciplinary team expert in all aspects of care. These findings are consistent with those of a Spanish study in which high-volume surgeons (≥5 adrenalectomies per year) were found to have higher rates of performing a laparoscopic approach (91.9% vs. 74.5%, $p = 0.03$), lower rates of in-hospital complications (4.0% vs. 14.8%, $p = 0.02$), and shorter length of stay (3.9 vs. 5.3 days, $p < 0.001$) [28].

Volume thresholds for adrenalectomy are often selected arbitrarily or based on percentiles; this makes comparison across studies difficult. To address this lack of uniformity, Anderson et al. used sophisticated analyses with restricted cubic splines to determine the appropriate adrenalectomy volume threshold that can be used to define a surgeon as high-volume [29]. The authors examined the National Inpatient Sample (1998–2009), abstracting 6712 patients who underwent adrenalectomies at 687 hospitals by a total of 3496 surgeons; median annual surgeon volume was 1 case. Although the study did not adjust for surgical approach, it showed that the likelihood of experiencing a complication decreased with increasing annual surgeon volume up to 5.6 cases; thus, lower volume surgeons were deemed to be those who performed <6 adrenalectomies per year. When outcomes were re-analyzed based on this binary volume stratification, the authors found that after multivariate adjustment, patients undergoing adrenalectomy by low-volume surgeons (<6 cases/year) were more likely to experience complications (odds ratio 1.71, 95% confidence interval, 1.27–2.31, $p = 0.005$), have a longer hospital stay (relative risk 1.46, 95% confidence interval, 1.25–1.70, $p = 0.003$), and at increased cost (+26.2%, 95% confidence interval, 12.6–39.9, $p = 0.02$). This study established that high-volume adrenal surgeons achieve improved outcomes compared with surgeons who perform <6 adrenalectomies per year. Unfortunately, the majority of patients (83%) had surgery performed by a low-volume surgeon, with 82% of the surgeons performing an average of just one case per year. The study also confirmed results of an earlier study by Lindemann and colleagues, which previously showed an association between surgeon volume and postoperative mortality after adrenalectomy (0.6% vs. 2.4% for low vs high volume surgeons, respectively, $p < 0.001$) [26].

The impact of surgeon specialty on patient outcomes potentially complicates examination of a volume–outcome relationship in adrenalectomy. This is because, as compared to complex abdominal operations such as pancreatectomy and gastrectomy which are predominantly performed by specialized surgeons, adrenalectomy is performed by surgeons trained in general surgery, surgical oncology, endocrine surgery, and urology. There is wide variation in training experience; for instance, most general surgery residents in the United States graduate residency without performing an adrenalectomy, while those who complete an endocrine surgery fellowship report a median of 13 adrenalectomies in their year of fellowship [30,31]. Nonetheless, several studies have found no significant association between surgeon specialty and operative outcomes [20,26,32–34]. In Faiena et al.'s study of 8831 patients who underwent open, laparoscopic, or robotic adrenalectomy for benign or malignant disease in the Premier Hospital Database (2003–2013), the authors found no significant difference in complication rates or operative times based on surgical specialty. These results were consistent with an

earlier study which showed that urologists perform most adrenalectomies in the U.S., but surgeon specialty was not independently associated with outcomes [32].

Hospital volume-outcome association in adrenal surgery

Compared to studies focused on surgeon volume, those that have studied a hospital adrenalectomy volume-outcome association are comparatively fewer in number, more heterogeneous in patient and provider characteristics, and more often specific to surgical technique or disease process. Studies that have evaluated the association between hospital adrenalectomy volume and postoperative outcomes have yielded divergent results. Unlike the definition for high-surgeon adrenalectomy volume, there is currently no exact definition for a high volume adrenalectomy center.

In Bergamini et al.'s study of 833 adrenalectomies captured in the Italian Registry of Endoscopic Surgery-Adrenalectomy database (2000-9), surgical centers were arbitrarily divided into "referral centers" with >30 adrenalectomies and "non-referral centers" with <30 adrenalectomies performed [35]. Patients undergoing surgery at referral centers had lower rates of conversions to laparotomy (1.6% vs. 6.0%, $p = 0.003$) and postoperative complications (4.8% vs. 22.0%, $p < 0.001$). These results are similar to those of a study of more than 8000 patients who underwent adrenalectomy in New York, New Jersey, and Pennsylvania. Volume was stratified based on quintiles that were created using 1996 hospital volumes: Very Low Volume Hospital (VLVH): 0–1 cases, Low Volume Hospital (LVH): 2–3 cases, Moderate Volume Hospital (MVH): 4–6 cases, High-Volume Hospital (HVH): 7–14 cases, and Very High Volume Hospital (VHVH) ≥15 cases per year. The authors found that patients were less likely to die when treated at VHVHs than at VLVHs (OR 0.38, 95% CI 0.19–0.75, $p = 0.006$). A shorter hospital length of stay was associated with each increasing volume quintile. When controlling for year treated, a median difference of −1.75 days (95% CI: 1.80-1.69, $p < 0.001$) of hospital stay was noted in the VHVH cohort compared to the VLVH group. Limitations of the study include inadequate patient-specific data such as details on comorbid conditions and re-hospitalization. The study was based also on data from states with large urban areas and relatively extensive health care resources, thus compromising generalizability.

In contrast, Murphy et al.'s analysis of more than 40,000 adrenalectomies captured in the Nationwide Inpatient Sample (1998–2006) found no significant difference in risk of complications based on hospital volume; this finding was noted in both univariate and multivariate analyses [36]. To evaluate hospital volume, the authors categorized the hospitals as low- (<3 adrenalectomies/year), medium- (3–6/year) or high-volume (≥6 s/year). These procedure volume cut-points were selected to establish three volume groups of approximately equal sizes.

The relative influence of surgeon vs. hospital volume on patient outcomes remains unresolved, as few studies have included both surgeon and hospital volume together in their analyses. Al-Qurayshi and colleagues showed that when controlling for multiple factors, including surgeon volume, patients managed in low- (1–3 adrenalectomies/year) or intermediate-volume hospitals (4–64 adrenalectomies/year) did not have a statistically significant difference in risk of postoperative complications compared to those managed in high-volume hospitals (>75th percentile or ≥65 adrenalectomies/year) [low-volume hospital; odds ratio: 1.09, 95% CI: (0.73, 1.63), $p = 0.67$] [intermediate-volume hospital; odds ratio: 1.04, 95% CI: (0.78, 1.40), $p = 0.79$] [25]. This finding echoes Hauch et al.'s analysis of the Nationwide Inpatient Sample, in which hospital adrenalectomy volume impacted risk of postoperative complications in univariate analyses ($p = 0.004$) but lost significance in multivariate analyses after controlling for several factors, including surgeon volume [24].

Volume–outcome studies that have examined surgical technique tend to assess hospital rather than surgeon volume for that specific technique; thresholds for volume are commonly arbitrary. In Greco et al.'s study of 363 patients who underwent laparoscopic adrenalectomy at 23 centers in Germany, centers were stratified into three groups according to their laparoscopic adrenalectomy experience: group A (<10/year), group B (10–20/year) and group C (>20/year) [37]. Although complications were not analyzed in the study, when Groups A, B, and C were compared, mean operative time was significantly shorter at higher volume centers (105.4 vs. 116.5 vs. 159.9 mins $p = 0.013$) but there was no difference in hospital length of stay (6.9 vs 7.1 vs. 7.4 days, $p = 0.942$).

In Villar et al.'s study of 155 adrenalectomies performed in 2008 in surgical departments in Spain, high-volume centers were defined as those with an annual volume of ≥10 adrenalectomies while low-volume centers were those with an annual volume of <10 adrenalectomies that year [28]. The authors found that high-volume centers were more likely to use laparoscopy (92.2% vs 75.6% $p = 0.008$), treat malignant lesions (20.7% vs 8.9%, $p = 0.03$), and had a shorter length of hospital stay (3.7 vs. 5.5 days, $p < 0.001$). Although high volume centers had lower rates of conversion to laparotomy, fewer post-operative complications and reoperations, these differences were non-significant likely due to low statistical power. Adjusted analyses to adequately delineate the independent impact of surgeon vs hospital volume also were not performed.

Gratian et al.'s study is one of a few studies focusing on a specific disease process - adrenocortical carcinoma (ACC) [38]. In their study, 2765 patients with ACC were identified from 1046 facilities participating in the National Cancer Database (1998–2011). High-volume centers were defined by a volume of ≥4 cases of ACC annually, which corresponded to the 90th percentile of case volume in the study cohort. All other facilities were considered to be low-volume centers. From a surgical perspective, patients treated at high-volume centers underwent higher rates of adrenalectomy (78.8 vs. 73.4%), radical resection (17.3 vs. 13.9%), regional lymph node evaluation (23.2 vs. 18.8%), and chemotherapy, including mitotane (43.8 vs. 31.0%, all $p < 0.05$), compared to patients treated at low-volume centers. There were no significant differences in median length of stay (5 days), 30-day readmissions (4.0% for high-volume centers vs. 3.9% for low-volume centers), or 30-day postoperative mortality (1.9% for high-volume centers vs. 3.7% for low-volume centers). Despite more aggressive operations, fewer positive surgical margins, and more adjuvant treatment at high-volume centers, overall survival did not differ based on hospital volume.

In contrast, Kerkhofs and colleagues evaluated patients with Stages I-III ACC followed in the National Cancer Registry in the Netherlands [39]. Five-year overall survival was improved for patients undergoing surgery in a Dutch Adrenal Network (DAN) hospital compared to those having surgery in a non-DAN hospital (63 vs. 42%, $p = 0.044$ in unadjusted analyses; and hazard ratio: 1.96, $p = 0.047$ in adjusted analyses). Likewise, in an Italian series published by Lombardi et al., performance of aggressive surgery was more likely at high-volume centers (lymphadenectomy rate: 22% vs. 7.7% at low-volume centers, $p < 0.01$; multi-organ resection rate: 24% vs 8% at low-volume centers, $p < 0.01$) [40]; the proportion of patients who underwent laparoscopic resection for ACC was higher at low-volume compared to high-volume centers (19.7% vs. 8.7%, respectively; $p < 0.05$). Local and distant ACC recurrences occurred more frequently in patients who underwent their initial operation at low-volume centers, and the mean time to recurrence was shorter at low-volume centers (10.1 ± 7.5 months vs 25.2 ± 28.1 months; $p < 0.001$). Median disease-specific survival was 63 months at high-volume centers and 32 months at low-volume centers, and median overall survival was 24 and 15 months, respectively; however, these differences were not statistically significant, likely due to small sample size.

A meta-analysis by Langenhuijsen and colleagues which examined contemporary management of ACC included five studies that provided data on provider volume [41]. Overall, the authors found that high-volume centers performed more aggressive, open surgery for ACC, and their patients experienced lower rates of local and distant recurrence as well as a longer time to recurrence. However, the findings of the meta-analysis were limited by the fact that a threshold for high hospital volume was not defined; the meta-analysis also had significant data heterogeneity as well as an overall low level of evidence.

Methodologic limitations

1. Special patient populations

One study by Kazaure et al. reported that advanced age was independently associated with adverse short-term clinical and economic outcomes after adrenalectomy [42]. The authors found that elderly patients are more likely to receive care by low-volume surgeons (62.8% of patients aged 61–70 years and 65.2% > 70 years vs. 58.5% ≤ 60 years; $p = 0.007$); however, complications, length of stay, and costs were reduced if patients underwent surgery by high-vs. low-volume surgeons. There is a scarcity of

studies examining specific patient populations with adrenal tumors, including elderly and pediatric patients, as well as patients with familial syndromes or pheochromocytoma/paraganglioma. These subsets of patients often require more preoperative evaluation, multi-disciplinary, long-term, or focused care. With more data, a particularly compelling case could be made for centralization of care for these subsets of patients.

2. Quality of data

In part because adrenalectomy is a relatively uncommon operation, most published studies on adrenalectomy are based on population-level data derived from large databases such as the NIS or state databases linked to the NIS. The NIS provides data from a 20% sample of state databases from around the United States, bringing needed statistical power but without some important clinical and pathologic detail [43]. This is a major constraint, especially given the current diversity of adrenalectomy techniques. For example, the NIS uses *International Classification of Disease* (ICD) codes to identify procedures. At present, the ICD coding system does not precisely discriminate between surgical approaches, and there is no specific ICD for "retroperitoneal adrenalectomy". Limitations of procedure coding with the ICD system are appreciated when results of studies based on NIS data are compared to those derived from other large databases such as the American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP), which uses the more precise *Current Procedural Terminology* coding system to identify surgical procedures. In the NIS, only 20% of all adrenalectomy cases performed between 2003 and 2009 were coded as being done laparoscopically [25]. This rate is considerably lower than the one reported in ACS-NSQIP over a similar time period, during which time 79.2% of adrenalectomies were coded as being performed laparoscopically [44].

Given these methodologic limitations, future studies examining volume-outcome associations for adrenalectomy would be enhanced by the inclusion of detail regarding extent of disease, severity of symptoms, granular information on surgical technique, and delineation of long-term quality of life measures.

Summary

Different definitions of surgeon and hospital volume thresholds have been used, making it tricky to compare analyses of volume-outcomes associations in adrenal surgery. Still, there is considerable evidence in support of an operative volume-outcome association; evidence in favor of improved patient outcomes is stronger for high surgeon volume as compared to high hospital volume. High surgeon volume may be a proxy for advanced surgical skill and/or diligence in following established clinical guidelines, such that improved patient outcomes are not only a reflection of technical ability but also of evidence-based multi-disciplinary approach to patient care; this is difficult to ascertain with existing data. The rarity of adrenal tumors, significant data heterogeneity, and low event rates for some outcomes such as mortality limit our ability to extrapolate the implications of a volume-outcome association in adrenalectomy into health policy initiatives such as credentialing and reimbursement. While existing data are imperfect, there is evidence supporting the selective referral of patients with adrenal tumors to surgeons who do ≥ 6 adrenalectomies per year in order to enhance the likelihood of improved perioperative outcomes at a lower health care cost. This is an important goal in the current era of value-based care.

Research agenda

- More precise coding of surgical technique and approach
- Assessment of long term outcomes, including recurrence
- Evaluation of postoperative health-related quality of life
- Focus on special populations such as elderly and pediatric patients, as well as those with familial syndromes

Practice points

- The rate of adrenalectomy is increasing in the United States.
- Data on the association between adrenalectomy volume and postoperative outcomes are conclusive for surgeon volume, but inconclusive for hospital volume.
- Surgeons who perform at least 6 adrenalectomies per year achieve significantly better outcomes, as compared to those who do less than 6 cases annually.
- More studies are needed to examine adrenalectomy volume–outcome relationship by surgical technique, and in special patient populations.

Disclosures

JAS is a member of the Data Monitoring Committee of the Medullary Thyroid Cancer Consortium Registry supported by GlaxoSmithKline, Novo Nordisk, Astra Zeneca and Eli Lilly.

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