

Racial Disparities of Adrenalectomy

Simon A. Holoubek,¹ Jessica Maxwell,² and Abbey L. Fingeret²

¹NorthShore University HealthSystem, Department of Surgery, Evanston, Illinois 60201; and ²University of Nebraska Medical Center, Department of Surgery, Omaha, Nebraska 68198-6880

ORCID numbers: 0000-0003-4913-6518 (J. Maxwell); 0000-0002-0526-6364 (A. L. Fingeret).

Purpose: Racial disparities of surgical outcomes have been demonstrated for a variety of operations. We sought to determine whether minority status is associated with disparate care for adrenalectomy.

Methods: This study is a retrospective database review of the Collaborative Endocrine Surgery Quality Improvement Program (CESQIP) from January 1, 2014 through April 30, 2018. Primary outcome was complication rate. Secondary outcomes were length of stay and surgeon experience. Minority status was defined as Black or Hispanic and outcomes were compared with White patients.

Results: For the study period, 1141 patients who underwent adrenalectomies were included, of whom 69.9% were White and 22.6% minority. The minority patients were significantly younger with higher rates of diabetes mellitus. Minority patients had higher rates of complication and longer length of stay. Minority patients were more likely to have an adrenalectomy by a low-volume surgeon. In multivariate logistic regression, minority status remained associated with complication rate.

Conclusions: Minority patients undergoing adrenalectomy have higher rates of complication and longer lengths of stay when controlling for common comorbidities. Minority patients have decreased access to high-volume surgeons.

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Key Words: adrenalectomy, disparity, inequality, inequity, outcomes, access to care

Adrenalectomy has increased by nearly 50% over the past 2 decades [1]. This increase is likely due to frequent use of computed tomography (CT) imaging as well as to the rise of the laparoscopic transabdominal and retroperitoneal approaches [2]. Adrenalectomy has been shown to be a safe procedure with a less than 1% mortality rate [3]. However, complication rates range from 3.6% to 20%, which has prompted investigation of factors associated with adverse outcomes after adrenalectomy [3, 4]. These include wound infection or dehiscence (1%), cardiac events (2%), bleeding (3%), and urologic complications (5%) [3].

Health disparities have been implicated as an important factor with regard to poor health care access and worse surgical outcomes for several conditions in the United States [4-7]. Race has been suggested as an important variable when studying treatment disparities in a range of conditions, including colorectal cancer, breast cancer, cardiac surgery, and orthopedic surgery [8-14].

Disparity studies are relevant to surgeons who treat endocrine pathology. A national database study with 16 878 patients found that Black patients had a greater overall complication rate, at 4.9% compared with 3.8% in White patients, after thyroidectomy. This same

Abbreviations: BMI, body mass index; CESQIP, Collaborative Endocrine Surgery Quality Improvement Program; CT, computed tomography.

Received 17 May 2020

Accepted 27 July 2020

First Published Online 7 August 2020

Corrected and Typeset 28 August 2020

September 2020 | Vol. 4, Iss. 9

doi: 10.1210/jendso/bvaa110 | Journal of the Endocrine Society | 1-8

study also found that Whites were more likely to receive an operation from the highest-volume surgeons [15]. A study that included 3144 adrenalectomies found that patients who were treated by high-volume surgeons had a 1.6 day shorter length of hospital stay and that Black race was associated with seeing a low-volume surgeon [3, 16].

For all patients undergoing adrenalectomy, surgeon volume has been associated with improved outcomes. A large study of 6712 patients using a national database established that a volume threshold of 6 or more adrenalectomies per year, irrespective of training route, is associated with better outcomes. This study also found that high-volume surgeons perform surgery at \$1659 lower cost, have a 3-day shorter median hospital stay, fewer urologic complications (2% versus 5%) and decreased in-hospital mortality (0.6% versus 2.4%) [3]. These studies have raised questions in the discipline of endocrine surgery about patient access to high-volume surgeons, procedure cost, and the role of the American Association of Endocrine Surgeons in decreasing health inequities in the United States.

1. Methods and Materials

The Collaborative Endocrine Surgery Quality Improvement Project (CESQIP) was created to evaluate surgical outcomes for endocrine procedures. Designed by the American Association of Endocrine Surgeons, CESQIP is a Centers for Medicare and Medicaid Services Qualified Clinical Data Registry. Beginning in 2012, CESQIP includes aggregate self-reported data from 53 centers in the United States who have opted in for data aggregation. Because this database is unique to endocrine surgical conditions and operations, reported variables are relevant to the care of adrenalectomy patients. This robust data set includes patient demographic information, including age, sex, and race, as well as important clinical variables, including tumor size, hormone functionality, medical center, region, and surgeon volume.

This study is a retrospective database review using the CESQIP database. Patient demographic and clinical variables were queried, including age, gender, race, surgeon volume, body mass index (BMI), comorbidities of hypertension or diabetes mellitus, pre-operative diagnosis, presence of adrenal nodule, indication for surgery other than adrenal nodule (for example refractory Cushing disease or dominant aldosterone secretion without discrete nodule), adrenal nodule size, hormonal functionality, primary versus remedial surgery, open versus laparoscopic, transabdominal versus retroperitoneal approach, multi-organ resection, laterality, duration of surgery, capsular disruption, visceral injury, hemorrhage requiring transfusion, pathology, length of stay, emergency department visit, readmission, mortality, unplanned reoperation, complications, length of follow-up, and recurrence of disease. Patients are classified as sporadic or hereditary disease based on known mutation for Von Hippel–Lindau, multiple endocrine neoplasia type 1 or 2, Carney syndrome, neurofibromatosis, or succinate dehydrogenase. The data set has a unique identifier for primary surgeon. This was used to calculate surgeon experience, which was defined as high-volume if an average of 6 or more adrenalectomies per year were reported by a surgeon during the study years. This study was approved by the University of Nebraska, institutional review board.

Variables were analyzed with chi-square, Fisher's exact, Kruskal-Wallis, and Student *t* test for univariate analysis. Logistic regression was performed for multivariable analysis. Primary outcome studied was complication following adrenalectomy. Secondary outcomes included length of stay and surgeon experience. We dichotomized length of stay as less than 2 days versus greater than or equal to 2 days. Surgeon experience was also dichotomized; those reporting a mean of 6 or more adrenalectomies per study year were defined as high-volume surgeons compared with those who performed a mean of fewer than 6 adrenalectomies per study year. Racial minority was reported as Black, Hispanic, Asian, and other, with White race as the reference variable. STATA version 15 (Statacorp, Texas) was used for all statistical analyses.

2. Results

During the study years, 1141 adrenalectomy cases were available for analysis from 53 participating CESQIP sites (Table 1). Within this data set, 258 (23%) were identified as minorities, which included Black, Hispanic, Asian, and other. Asian and other races were not included in the univariate or multivariate disparity analysis due to a small sample size of only 86 patients in these categories, with 59 unknown race and 27 Asian. Women made up 60% of the patient population and were equally represented in White and minority groups. Minority patients were significantly younger than Whites, with a mean age of 47.8 years versus 54.0 years ($P < 0.001$). Minority status was associated with a greater rate of diabetes, with 31.4% versus 23.3% in Whites ($P < 0.01$). White and minority patients were not significantly different with respect to BMI, hypertension, presence of adrenal nodule, or adrenal nodule size. Follow-up was not different for the minority group compared with the White group.

The indications for adrenal surgery were studied. Minority patients were less likely to have a nonfunctioning nodule (11.2% compared with 17.2% in Whites, $P = 0.023$). Hyperaldosteronism was a more frequent indication for adrenalectomy in minority patients, with 27.5% compared with 17.2% in White patients ($P < 0.001$). There was no difference in other indications between the groups (Table 2).

Minority patients were significantly more likely to have an intraoperative hypertensive crisis ($P = 0.007$). White patients were more likely to be treated by a high-volume surgeon at 79.9%, compared with only 57.8% of minority patients ($P < 0.001$). These findings are included in Table 3. The groups did not differ on final pathology type for malignant diseases of the adrenal gland (Table 4). Findings included 39 patients diagnosed with adrenocortical carcinoma. There were no differences between the groups in American Joint Committee on Cancer stage at the time of surgery.

Minority patients experienced longer lengths of stay and a slightly greater rate of complications compared with Whites. Minority patients were more likely to have any complication with univariate analysis (Table 5). White patients were more likely to be discharged from the hospital in less than 2 days compared with minority patients ($P < 0.001$). No differences were found between groups with respect to open conversion of laparoscopic procedures, readmission rates, or mortality. Multivariable logistic regression showed that minority patients were more likely to experience any complication after adrenalectomy when controlling for common comorbidities, age, BMI, and surgeon volume ($P < 0.0001$).

3. Discussion

Health inequalities continue to be a significant issue for surgical patients in the United States. Poorer overall health and decreased life span for those of minority race has been

Table 1. Clinical and Demographic Factors of Adrenalectomy Patients

Variable	All	White	Minority	<i>P</i> value
Patients, n	n = 1141	n = 797	n = 258	
Female, n (%)	689 (60.4)	484 (60.7)	157 (60.9)	0.971
Age, years, mean (SD)	52.4 (14.4)	54.0 (13.9)	47.8 (14.5)	<0.001
BMI >40 (n)	173 (15.2)	127 (15.9)	35 (13.6)	0.351
Hypertension, n	811 (71.1)	560 (70.3)	192 (74.4)	0.2
Diabetes mellitus, n	283 (24.8)	186 (23.3)	81 (31.4)	0.01
Adrenal nodule, n	1035 (90.7)	725 (91.0)	232 (89.9)	0.616
Nodule size, cm (SD)	4.01 (2.82)	4.05 (2.80)	3.92 (2.98)	0.5412
Sporadic disease, n (%)	1072 (94.0)	745 (93.5)	239 (92.6)	0.64
Length of follow-up, months (SD)	2.5 (3.5)	2.6 (3.6)	2.1 (3.3)	0.1841

Abbreviations: BMI, body mass index; SD, standard deviation.

Table 2. Indication for Adrenalectomy

Variable	All	White	Minority	P value
	n = 1141	n = 797	n = 258	
Nonfunctioning adrenal mass, n (%)	185 (16.2)	137 (17.2)	29 (11.2)	0.023
Hyperaldosteronism, n (%)	237 (20.8)	140 (17.6)	71 (27.5)	0.001
Cushing syndrome, n (%)	182 (16.0)	131 (16.4)	43 (16.7)	0.931
Pheochromocytoma, n (%)	282 (24.7)	212 (26.6)	57 (22.1)	0.149
Paranglioma, n (%)	30 (2.6)	16 (2.0)	10 (3.9)	0.092
Adrenocortical carcinoma, n (%)	40 (3.5)	35 (4.4)	4 (1.6)	0.099
Metastatic disease, n (%)	65 (5.7)	45 (5.6)	13 (5.0)	0.710
Myelolipoma, n (%)	21 (1.8)	11 (1.4)	7 (2.7)	0.151
Cushing disease, n (%)	33 (2.9)	25 (3.1)	8 (3.1)	0.977
Other, n (%)	66 (5.8)	45 (5.5)	16 (6.2)	0.681

Table 3. Operative Factors

Variable	All	White	Minority	P Value
Primary adrenalectomy, n (%)	1089 (95.4)	751 (94.2)	249 (96.5)	0.175
Hemorrhage requiring transfusion, n (%)	29 (2.5)	20 (2.5)	8 (3.1)	0.609
Conversion to open, n (%)	28 (2.5)	15 (1.9)	10 (3.9)	0.089
Visceral injury, n (%)	19 (1.7)	14 (1.8)	3 (1.2)	0.776
Hypertensive crisis, n (%)	10 (0.9)	4 (0.5)	6 (2.3)	0.007
Operative time >2 hours, n (%)	622 (54.5)	444 (55.7)	130 (50.4)	0.136
Laparoscopic, n (%)	998 (87.5)	684 (85.8)	233 (90.3)	0.063
High-volume surgeon, n (%)	838 (73.4)	637 (79.9)	149 (57.8)	<0.001

Note: High-volume surgeon defined as performing ≥ 6 adrenalectomies annually in this data set averaged over all years reporting.

Table 4. Malignant Pathology Following Adrenalectomy

Variable	All	White	Minority	P Value
Adrenocortical carcinoma, n (%)	39 (3.4)	33 (4.1)	5 (1.9)	0.313
Malignant pheochromocytoma, n (%)	13 (1.1)	10 (1.3)	3 (1.2)	0.313
Metastatic disease, n (%)	25 (2.2)	18 (2.3)	6 (2.3)	0.313
Lymphoma, n (%)	2 (0.2)	1 (0.1)	1 (0.4)	0.313
Other, n (%)	6 (0.5)	6 (0.8)	0 (0)	0.313

attributed to housing, nutrition, socioeconomic status, and environment [17, 18]. Minority race or may predispose to lower quality of health care, largely driven by reduced access to care [19, 20]. Studying factors associated with health disparities may allow for a better understanding of health care delivery and over time allow for system improvements. Our data suggest that minority patients have less access to high-volume surgeons and experience higher rates of complication for adrenalectomy.

Disparities emanate from a complex network of health care factors, including demographics, socioeconomic status, insurance status, access to care, and sociologic factors including education, language, and culture. Culturally inappropriate care or implicit racial bias may be responsible for these disparities. Implicit racial bias has been shown to impact care with decreased referral of Black patients compared with Whites for cardiac catheterization in the setting of acute chest pain [8, 21]. This finding was replicated in our study, suggesting minority patients have disparate access to high-volume adrenal surgeons. A difference in access to high-volume surgeons implies that White patients with an indication

Table 5. Complications

Variable	All	White	Minority	P Value
Any complication, n (%)	52 (4.6)	30 (3.8)	19 (7.4)	0.025
Unplanned reoperation, n (%)	5 (0.4)	3 (0.4)	0 (0)	0.573
Emergency department visit, n (%)	70 (6.1)	44 (5.5)	20 (7.8)	0.229
Readmission, n (%)	39 (3.4)	27 (3.4)	9 (3.5)	1
Mortality, n (%)	7 (0.6)	4 (0.5)	3 (1.2)	0.371
Heart attack, n (%)	2 (0.2)	1 (0.11)	1 (0.41)	1
Surgical site infection, n (%)	4 (0.4)	2 (0.32)	2 (0.82)	1
Pulmonary embolism, n (%)	3 (0.3)	2 (0.32)	1 (0.41)	1
Deep venous thrombosis, n (%)	2 (0.2)	1 (0.1)	0 (0)	1
Sepsis, n (%)	2 (0.2)	0 (0)	2 (0.82)	0.152
Cardiac arrest, n (%)	4 (0.4)	2 (0.32)	2 (0.82)	1
Renal failure, n (%)	2 (0.2)	1 (0.1)	1 (0.41)	1
Pneumonia, n (%)	2 (0.2)	0 (0)	2 (0.82)	0.152
Ventilator, n (%)	4 (0.4)	3 (0.43)	1 (0.41)	1
Coma, n (%)	2 (0.2)	1 (0.1)	1 (0.41)	1
Transfusion, n (%)	6 (0.5)	5 (0.64)	1 (0.41)	0.381
Other complication, n (%)	30 (26.3)	17 (21.3)	11 (4.3)	1
Hernia, n (%)	2 (0.2)	2 (0.32)	0(0)	1

for an adrenalectomy are more often under the care of surgeons who may be more accurate in diagnosis, more facile in operative technique, and provide higher quality aftercare [22]. While this is a proxy for quality care, prior studies have suggested that patients do benefit from care under high-volume surgeons [11, 12]. Additionally, White patients were more likely to have a nonfunctional mass as an indication for adrenalectomy, while minority patients were more likely to have a functional aldosterone-producing adenoma. The disparity in indication for surgery with functional aldosterone-producing adenoma may be attributable to the lower proportion of adrenalectomy for nonfunctional masses driving the difference. Alternatively, minority patients may have more frequent evaluation for secondary hypertension due to higher prevalence of hypertension in these populations. The disparity in surgery for nonfunctional masses may be attributed to overall access or follow-up for cross-sectional imaging, as nonfunctional masses are more likely to be discovered incidentally on imaging for other indications. Alternatively, these findings may suggest that White patients have nonfunctional masses removed more frequently than may be necessary, as most of these were benign. Decreased access to high-volume surgeons may be related to decreased health literacy, geographic factors, or referral patterns. Without directly studying these factors, it is difficult to surmise exactly why minority patients are more likely to be under the care of low-volume adrenal surgeons.

Volume-outcome relationships may underlie the differences in complication rates for minority patients [23]. In our study, minority patients were also found to have more overall complications, consistent with findings from previous studies. Our study found a difference with respect to surgeon volume, which may drive the differences in overall complications. However, differences in overall complication rates were significant, even after controlling for surgeon volume and common comorbidities, including diabetes, which was higher in the minority group. There were, however, no significant differences with regard to mortality or hospital readmission rates. While not directly studied in this analysis, it is reasonable to assume that the overall cost of care may have been higher in the minority group, given the increased length of hospital stay as shown in prior studies [24].

Minority patients were more likely to experience a hospitalization of greater than 2 days according to our analysis. The similar rates of readmission in this study suggests that White patients were not discharged from the hospital prematurely. Multivariate analysis confirmed that this difference persisted when controlling for complications. Cultural differences, education, and caregiver support may play a role in this difference. Additionally,

while not a significant difference, minority patients did have higher rates of conversion to open adrenalectomy, which does increase length of stay and complication rates and may be contributing to the significant differences identified in these areas.

Despite a younger mean age, the minority group had an increased rate of diabetes, which is widely known to contribute to complications in postoperative patients [13]. Logistic regression analysis did, however, control for diabetes and other common comorbidities and showed that minority patients still experienced more complications following adrenalectomy. This suggests that an increased rate of diabetes would not account for more complications in this population.

The significance of our overall findings suggests that Black and Hispanic patients had less access to higher-volume surgeons and more overall complications, suggesting a significant disparity when faced with the need for adrenalectomy. While our larger data aggregate in Table 1 included all minority patients, our disparity analysis did not include Asian and other minority patients and therefore findings should not be generalized to these groups. We did not include these groups due to insufficient representation.

There are notable limitations in this study. Some potentially important variables were not studied, including geographic region, household income, or insurance status. In addition to lack of insurance status or payer as a variable, type of practice or hospital location (such as academic medical center versus community hospital) is also not available. Other limitations include this study's retrospective design, the degree of which the CESQIP database represents the true United States population of both patients and surgeons, and the inherent biases present in any database. Although CESQIP contains a limited proportion of adrenalectomies performed in the United States, the data set provides disease- and procedure-specific data that would not be available from an alternate registry that may encompass a higher proportion of patients. This study also has a short duration of follow-up, which may miss delayed complications such as hernias and inaccurately measure survival. Use of registry data also limits our ability to assess the degree of multidisciplinary care provided by endocrinology, medical or radiation oncology, anesthesia, or critical care providers, which may impact patient outcomes particularly related to perioperative events such as hypertensive crisis.

Further research should focus on determining whether race is a proxy for geographic region, household income, or insurance status. Due to an overall low sample size, we were unable to include Asian and other minority patients in our disparity analysis. The inability to generalize data to these groups suggests that more time is needed to include these minority groups in subset analyses for adrenalectomy.

4. Conclusion

Minority patients undergoing an adrenalectomy have higher rates of complications and increased lengths of stay than their White counterparts, even when controlling for common medical comorbidities. This study mirrors others showing a common trend that suggests disparities in care.

Minority patients were also found to have less access to high-volume adrenal surgeons. Access is multifactorial, as is any proposed solution. The complex employer-based health care system in the United States as well as regional demographics represent just two of the many reasons that we may see these trends in care.

Further study is warranted to assess and address the etiology of these disparities. Only after fully understanding the etiology of remaining disparities can we focus on solutions to improve equitable distribution of care and diminish disparities in clinical outcomes.

Acknowledgments

Financial Support: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author Contributions: S.H. prepared the manuscript; J.S. performed study design and manuscript critical review; A.F. performed study design, statistical analysis, and manuscript critical review.

Additional Information

Correspondence: Abbey L. Fingeret, MD, MHPTT, FACS, University of Nebraska Medical Center, Department of Surgery. 986880 Nebraska Medical Center, Omaha, NE 68198-6880. E-mail: abbey.fingeret@unmc.edu

Disclosure Summary: The authors declare that they have no conflict of interest.

Compliance With Ethical Standards: This database review was approved by the Institutional Review Board. This article does not contain any studies with human participants performed by any of the authors. Informed consent was not needed for this study.

Data Availability: Restrictions apply to the availability of data generated or analyzed during this study to preserve patient confidentiality or because they were used under license. The corresponding author will on request detail the restrictions and any conditions under which access to some data may be provided.

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