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Health Care Disparities in Transsphenoidal Surgery for Pituitary Tumors: An Experience from Neighboring Urban Public and Private Hospitals

Alex J. Gordon[1] Yosef Dastagirzada[2] Jamie Schlacter[1] Sonal Mehta[3] Nidhi Agrawal[3] John G. Golfinos[2] Richard Lebowitz[4] Donato Pacione[2] Seth Lieberman[4]

[1] NYU Grossman School of Medicine, NYU Langone Health, New York, New York, United States
[2] Department of Neurosurgery, NYU Langone Health, New York, New York, United States
[3] Division of Endocrinology, Department of Medicine, NYU Langone Health, New York, New York, United States
[4] Department of Otolaryngology-Head and Neck Surgery, NYU Langone Health, New York, New York, United States

Address for correspondence Alex J. Gordon, BS, 550 1st Avenue, New York, NY 10016, United States (e-mail: Alex.Gordon@nyulangone.org).

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Abstract

Objectives Few studies have assessed the role of socioeconomic health care disparities in skull base pathologies. We compared the clinical history and outcomes of pituitary tumors at private and public hospitals to delineate whether health care disparities exist in pituitary tumor surgery.

Methods We reviewed the records of patients who underwent transsphenoidal pituitary tumor resection at NYU Langone Health and Bellevue Hospital. Seventy-two consecutive patients were identified from each hospital. The primary outcome was time-to-surgery from initial recommendation. Secondary outcomes included postoperative diabetes insipidus, cerebrospinal fluid (CSF) leak, and gross total resection.

Results Of 144 patients, 23 (32%) public hospital patients and 24 (33%) private hospital patients had functional adenomas ($p = 0.29$). Mean ages for public and private hospital patients were 46.5 and 51.1 years, respectively ($p = 0.06$). Private hospital patients more often identified as white ($p < 0.001$), spoke English ($p < 0.001$), and had private insurance ($p < 0.001$). The average time-to-surgery for public and private hospital patients were 46.2 and 34.8 days, respectively ($p = 0.39$). No statistically significant differences were found in symptom duration, tumor size, reoperation, CSF leak, or postoperative length of stay; however, public hospital patients more frequently required emergency surgery ($p = 0.03$), developed transient diabetes insipidus ($p = 0.02$), and underwent subtotal resection ($p = 0.04$).

Conclusion Significant socioeconomic differences exist among patients undergoing pituitary surgery at our institution's hospitals. Public hospital patients more often required emergency surgery, developed diabetes insipidus, and underwent subtotal tumor resection. Identifying these differences is an imperative initial step in improving the care of our patients.

Keywords
- pituitary tumor
- transsphenoidal surgery
- health care disparity
- practice setting

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Introduction

The treatment of patients with pituitary tumors is complex and multidisciplinary, often involving surgical and medical treatments as well as the potential for radiotherapy. Protocols for the surgical management of these tumors by otolaryngologists and neurosurgeons have been well characterized in the literature.[1–3] At the same time, little is known about whether socioeconomic disparities exist in the context of pituitary surgery. Characterizing these disparities is essential to ensuring that all patients receive the highest possible standard of care. Efforts to identify and alleviate socioeconomic health care disparities have taken place over several decades, such as the creation of the World Health Organization Commission on Social Determinants of Health in 2005.[4] More recently, the importance of addressing socioeconomic health care disparities was highlighted by the current coronavirus disease 2019 (COVID-19) pandemic, which disproportionately affected minority groups such as African Americans and Native Americans.[5]

While the COVID-19 pandemic remains a salient example of socioeconomic disparities in health care, numerous examples of similar disparities have been described in the surgical literature. Several studies have identified racial and socioeconomic disparities in surgical specialties including general surgery,[6] surgical oncology,[7,8] cardiothoracic surgery,[9] and orthopaedic surgery.[10] In spite of this, relatively little work has attempted to uncover these disparities in otolaryngology and neurosurgery. Some studies have characterized disparities in conditions such as sinusitis[11–13] and squamous cell carcinoma of the head and neck.[14,15] Other studies in neurosurgery have demonstrated poorer outcomes after ischemic strokes among patients without private insurance[16] and greater complication rates among African American patients undergoing craniotomies for glioma resection.[17]

One scoping review of neurosurgical research found that the majority of socioeconomic disparities research in neurosurgery is concerned with the role of race and income in surgical outcomes.[18] Furthermore, spine surgery, vascular neurosurgery, and cranial oncology have been studied most extensively in the context of socioeconomic disparities. At the same time, there is limited evidence on the impact of health care disparities in the context of particular pathologic entities within these categories. At present, few studies have addressed racial and socioeconomic disparities in the context of pituitary surgery.[19–21] Most studies have employed large databases such as the National Inpatient Sample and the New York Statewide Planning and Research Cooperative System to determine the association between complication rates and socioeconomic variables such as race, income, and insurance status. They have demonstrated higher complication rates and greater postoperative length of stay among black or Hispanic patients.[19,20] Moreover, these studies have suggested that patients belonging to racial minority groups or who have Medicaid are more likely to be treated at low-volume centers.[19,21] However, studies utilizing large databases have significant limitations such as missing data and selection bias. Other studies describing single-center or multicenter cohorts have corroborated these findings, demonstrating that patients in racial minority groups are more likely to present with advanced disease and experience postoperative complications.[22,23]

The close relationship between NYU Langone Health and Bellevue Hospital presents a unique opportunity to further our understanding of disparities in pituitary surgery. NYU Langone Health is a leading academic medical center and is the home of the NYU Grossman School of Medicine. In contrast, Bellevue Hospital is the oldest public hospital in the United States, and it serves as the main tertiary care center for the public hospital system of New York City. Despite being located three blocks from one another, these institutions differ considerably in the socioeconomic composition of their patient populations; however, they share common faculty members and residents. Accordingly, comparing the management of pituitary tumors between these hospitals would allow us to assess whether socioeconomic and racial disparities exist in pituitary surgery while controlling for hospital faculty and house staff.

Methods

The Institutional Review Boards of the New York University Grossman School of Medicine and Bellevue Hospital approved this retrospective chart review. Inclusion criteria were patients aged 18 to 90 who underwent endoscopic endonasal pituitary adenoma resection at NYU Langone Health or Bellevue Hospital between October 2011 and July 2020. This timeframe was chosen due to the availability of information from the medical record systems of each hospital. Patients with nonadenoma pituitary tumors and those without pathology reports were excluded. There were 72 Bellevue patients that met inclusion criteria within the time frame. Because NYU Langone Health has significantly larger case volume, consecutive patients starting July 2020 (and working retrospectively) were screened for inclusion until 72 subjects were identified for that group. Baseline socioeconomic variables collected included patient-identified race and ethnicity, primary payer, ability to speak English, and domiciled status. Race was defined as American Indian, Asian, Hispanic, non-Hispanic black, and non-Hispanic white. Medical history of diabetes mellitus, hypertension, obesity, and smoking were recorded. When available, tumor diameter and preoperative endocrine abnormalities were also recorded. Lastly, we recorded whether a preoperative eye exam was documented and whether a visual field deficit (unilateral or bilateral hemianopia) was observed.

Patients were grouped by the hospital where they underwent surgery. Subgroup analyses were then performed on the entire cohort based on racial/ethnic minority status and insurance type (private vs. other). Intraoperative variables including procedural duration and development of intraoperative cerebrospinal fluid (CSF) leak were recorded. The primary outcome was time to surgery from the initial neurosurgical recommendation, excluding patients who presented for emergency surgery. Emergency surgery was defined as procedures performed during the first presentation and admission at either institution. Reasons for emergency surgery included pituitary apoplexy, cranial nerve deficits, or sudden visual impairment. Secondary outcomes included symptom duration, intraoperative CSF leak, length of stay, gross total resection rate, postoperative CSF leak, postoperative diabetes insipidus, and hormone supplementation.

Statistical Analysis

Categorical variables were assessed using chi-square or Fisher's exact tests as appropriate. Continuous variables were assessed for normality using the Shapiro–Wilk test. Subsequently, continuous variables were analyzed with two-sample *t*-tests and Mann–Whitney *U* tests as appropriate. All analyses were performed using SPSS 28.0 (IBM, Armonk, New York, United States). Significance testing was two-sided with a 5% α level.

Results

A total of 144 patients were included in this study, 72 from NYU Langone Health and 72 from Bellevue Hospital. The average age was 48.8 years (standard error: 1.2), 85 patients (56.7%) were female, and the most common racial/ethnic group reported was Hispanic (46, 31.9%). Most patients (97, 67.4%) presented with a nonfunctioning adenoma. Among patients with functional adenomas, growth hormone-secreting adenomas were the most common type (19, 40.4%).

On average, private hospital patients were 5.6 years older than public hospital patients ($p = 0.06$, ►**Table 1**). Compared

Table 1 Comparisons between patients treated at a private and public hospital

	Public ($n = 72$)	Private ($n = 72$)	*p*-Value
Age (y)	46.5 (1.6)	51.1 (1.9)	0.06
Sex (female)	43 (59.7%)	40 (55.6%)	0.61
Race/Ethnicity			
American Indian	1 (1.4%)	0 (0.0%)	< **0.001**[a]
Asian	13 (18.1%)	5 (6.9%)	
Hispanic	34 (47.2%)	12 (16.7%)	
NH-black	15 (20.8%)	27 (37.5%)	
NH-white	6 (8.3%)	24 (33.3%)	
Other/Unknown	3 (4.2%)	4 (5.6%)	
English-speaking	31 (43.1%)	64 (88.9%)	< **0.001**[a]
Undomiciled	2 (2.8%)	0 (0.0%)	0.24
Primary payer			
Medicaid	33 (45.8%)	4 (5.6%)	< **0.001**[a]
Medicare	9 (12.5%)	13 (18.1%)	
Private insurance	6 (8.3%)	55 (76.4%)	
Uninsured	14 (19.4%)	0 (0.0%)	
Unknown	10 (13.9%)	0 (0.0%)	
Diabetes mellitus	11 (15.3%)	13 (18.1%)	0.66
Hypertension	16 (22.2%)	27 (37.5%)	0.05
Obesity	9 (12.5%)	9 (12.5%)	0.99
Current smoker	6 (8.3%)	5 (6.9%)	0.77
Tumor type			
Nonfunctioning adenoma	49 (68.1%)	48 (66.7%)	0.29
ACTH adenoma	3 (4.2%)	8 (11.1%)	
FSH adenoma	1 (1.4%)	1 (1.4%)	
GH adenoma	13 (18.1%)	6 (8.3%)	
Prolactinoma	6 (8.3%)	8 (11.1%)	
TSH adenoma	0 (0.0%)	1 (1.4%)	
Symptom duration (mo)	15.2 (2.7)	13.2 (1.4)	0.28
Emergency surgery	9 (12.5%)	2 (2.8%)	**0.03**[a]

Table 1 (*Continued*)

	Public ($n = 72$)	Private ($n = 72$)	*p*-Value
Preoperative hormone abnormalities			
Deficiency	30 (41.7%)	26 (36.1%)	0.68
Excess	41 (56.9%)	41 (56.9%)	0.67
Any	54 (75.0%)	51 (70.8%)	0.99
Previous surgery	8 (11.1%)	13 (18.1%)	0.24
Time to surgery (d)	46.2 (7.8)	34.8 (3.7)	0.39
Preoperative eye exam	66 (91.7%)	61 (84.7%)	0.20
Visual field deficit	38 (52.8%)	22 (30.6%)	**0.01**[a]
Tumor size (mm)	28.9 (1.7)	28.1 (1.9)	0.65
Cavernous sinus invasion	21 (29.2%)	35 (48.6%)	**0.04**[a]
Procedure length (min)	254.3 (11.0)	268.9 (15.4)	0.96
Intraoperative CSF leak	36 (50.0%)	39 (54.2%)	0.62
Length of stay (days)	8.5 (1.9)	5.5 (0.4)	0.05
Postoperative CSF leak	7 (9.7%)	11 (14.7%)	0.31
Transient diabetes insipidus	26 (36.1%)	13 (18.1%)	**0.02**[a]
Postoperative DDAVP supplementation	5 (6.9%)	12 (16.7%)	0.08
Reoperation	7 (9.7%)	8 (11.1%)	0.76
Readmission	6 (8.3%)	12 (16.7%)	0.12
Gross total resection	38 (52.8%)	50 (69.4%)	**0.04**[a]
At least one follow-up	69 (95.8%)	70 (97.2%)	0.65

Abbreviations: ACTH, adrenocorticotropic hormone; CSF, cerebrospinal fluid; DDAVP, desmopressin; FSH, follicle-stimulating hormone; GH, growth hormone; NH, non-Hispanic; TSH, thyroid stimulating hormone.
Note: Continuous variables reported as mean with standard error.
[a]Statistical significance.

with private hospital patients, public hospital patients were more likely to identify as a racial/ethnic minority group (87.5% vs. 61.1%, $p < 0.001$) and were less likely to have private insurance (8.3% vs. 76.4%, $p < 0.001$) or speak English (43.1% vs. 88.9%, $p < 0.001$). No significant differences between patients of both hospitals were observed for medical comorbidities, smoking status, symptom duration, or preoperative endocrine abnormalities. Similarly, no differences were seen in history of previous transsphenoidal surgery, tumor diameter, or whether a preoperative eye exam was performed; however, patients at Bellevue Hospital were more likely to have a documented visual field deficit (52.8% vs. 30.6%, $p = 0.01$).and were more likely to require emergency surgery (12.5% vs. 2.8%, $p = 0.03$). By contrast, patients at NYU Langone Health were more likely to present with cavernous sinus invasion on preoperative imaging (48.6% vs. 29.2%, $p = 0.04$).

Though 11 patients (7.6%) who presented for emergency surgery were included in this study, they were excluded when comparing time-to-surgery between the two facilities. Among the remaining 133 patients (92.4%), the average time to surgery from initial neurosurgical recommendation was 11.4 days lower at NYU Langone Health than at Bellevue Hospital, though this finding was not statistically significant ($p = 0.39$). No significant differences were seen in procedure length or development of intraoperative CSF leaks. Bellevue Hospital patients were more likely to develop transient diabetes insipidus ($p = 0.02$). No differences were seen in rates of postoperative CSF leaks, length of stay, 30-day reoperation, 30-day readmission, presentation for follow-up, or use of desmopressin supplementation. Based on postoperative imaging, gross total resection was more commonly achieved in private hospital patients than public hospital patients (69.4% vs. 52.8%, $p = 0.04$).

When stratifying patients of both hospitals by racial/ethnic minority status, non-Hispanic white patients had surgery 15.9 days earlier than patients belonging to minority groups, though this was not statistically significant (►**Table 2**). Minority group patients were more likely to develop diabetes insipidus ($p = 0.04$). A smaller difference in time-to-surgery (7.7 days) was observed when comparing patients with private insurance and those with other insurance types ($p = 0.99$, ►**Table 3**). In addition, patients with private insurance were more likely to have gross total resection achieved ($p = 0.02$).

Discussion

In this study, we characterize the socioeconomic and clinicopathologic differences among the patient populations of a

Table 2 Comparisons of outcomes based on racial/ethnic minority status

	Nonminority ($n=30$)	Minority ($n=107$)	p-Value
Time to surgery (d)	28.5 (3.7)	44.4 (5.8)	0.19
Length of stay (d)	6.0 (0.9)	7.4 (1.3)	0.33
Intraoperative CSF leak	18 (60.0%)	54 (50.5%)	0.36
Postoperative CSF leak	6 (20.0%)	12 (11.2%)	0.21
Transient diabetes insipidus	4 (13.3%)	35 (32.7%)	**0.04**[a]
Postoperative DDAVP supplementation	3 (10.0%)	14 (13.1%)	0.76
Reoperation	4 (13.3%)	11 (10.3%)	0.74
Readmission	1 (3.3%)	17 (15.9%)	0.12
Gross total resection	21 (70.0%)	64 (59.8%)	0.31
At least one follow-up	30 (100.0%)	102 (95.3%)	0.59

Abbreviations: CSF, cerebrospinal fluid; DDAVP, desmopressin.
Note: Continuous variables reported as mean with standard error.
[a]Statistical significance.

Table 3 Comparisons of outcomes based on insurance status

	Private insurance ($n=61$)	Other insurance ($n=73$)	p-Value
Time to surgery (d)	36.9 (4.1)	44.6 (7.5)	0.99
Length of stay (d)	5.7 (0.5)	8.2 (1.9)	0.30
Intraoperative CSF leak	33 (54.1%)	36 (49.3%)	0.20
Postoperative CSF leak	10 (16.4%)	8 (11.0%)	0.36
Transient diabetes insipidus	12 (19.7%)	22 (30.1%)	0.17
Postoperative DDAVP supplementation	10 (16.4%)	7 (9.6%)	0.26
Reoperation	7 (11.5%)	8 (11.0%)	0.90
Readmission	9 (14.8%)	9 (12.3%)	0.65
Gross total resection	43 (84.3%)	37 (50.7%)	**0.02**[a]
At least one follow-up	59 (96.7%)	70 (95.9%)	0.99

Abbreviations: CSF, cerebrospinal fluid; DDAVP, desmopressin.
Note: Continuous variables reported as mean with standard error.
[a]Statistical significance.

private, academic medical center and a prominent public hospital affiliated with our institution. We identified several differences in the baseline characteristics of these patient populations as well as differences in management and postoperative outcomes. Our study is distinguished in its analysis of patients from a single institution, whereas other efforts to uncover disparities in transsphenoidal surgery have relied on large databases.[19–21] Furthermore, our study is unique in its inclusion of patients from two separate hospital systems that share the same resident and attending physicians, which partially mitigates differences in the operative experience of the two facilities. This is true of all specialties involved in the management of pituitary tumors including neurosurgery, otolaryngology, endocrinology, and ophthalmology. Previously, hospital-level surgical volume has been identified as a driver of poorer outcomes after transsphenoidal surgery, particularly for the development of diabetes insipidus and other electrolyte abnormalities.[21] Our results show that these disparities persist even when controlling for physicians' operative experience, suggesting that these disparities are not fully explained by volume alone.

We found that on average, the time-to-surgery from the initial neurosurgical recommendation was 11.4 days lower for patients at our private hospital, though this difference was not statistically significant. There are many factors that can contribute to wait times. These include issues on the provider end of the spectrum such as operating room availability and attending availability. They also include patient factors such as navigating issues with time off work and managing family responsibilities. There is also the complex interplay of patient and provider factors. For example, our institution's attendings and trainees are typically aware that patients at our public hospital are more likely to be lost to follow-up due to increased barriers to care, including lower socioeconomic status, differences in education level, and language barriers. Physicians may therefore feel more comfortable in recommending an observational approach with serial imaging for private hospital patients, which would have the counterintuitive effect of delaying surgery relative to patients at our public hospital. Interestingly, more patients treated at our community hospital required emergency surgery. This is consistent with previous findings that patients with decreased access to care are more likely to present with pituitary apoplexy, an indication for emergency surgery.[24] Taken together, our results suggest that patients with impaired access to care may present with more advanced disease; however, once care is established, there are minimal differences in time-to-surgery.

The surgical management of patients at both hospitals was mostly similar; however, an important procedural difference between our two facilities is the availability of intraoperative magnetic resonance imaging (iMRI) at our private hospital. At NYU Langone Health, iMRI is commonly performed to evaluate for residual tumor following an initial attempt at resection, and in our cohort, iMRI was used in 60% of cases at our private hospital. We observed no difference in operative time between our hospitals; however, this may be partially explained by the inclusion of iMRI at NYU Langone Health during surgery. Both the time used to obtain the image and any subsequent attempts to resect additional tumor are included in operative time and may have masked a true difference in operative time between the two hospitals. Furthermore, several previous studies have documented higher rates of gross total resection when implementing this technique[25–27]; therefore, iMRI could be partially responsible for the higher rate of gross total resection achieved at our private hospital. Accordingly, this observed difference in gross total resection may be the result of disparities in the technology and resources available at our two hospitals, rather than the direct effect of socioeconomic differences between their patient populations.

This study has several limitations, many of which are the result of its retrospective design. As the data analyzed in this study were derived from medical records, it is possible that some information was not documented. Given the shared faculty and house staff, this is likely to have been comparable for both facilities, though we cannot be certain whether this introduced bias into our data. Given the retrospective nature of the study, the identification of postsurgical outcomes such as diabetes insipidus was based on provider notes, which is likely to have introduced bias. Physicians at both hospitals are encouraged to follow diagnostic algorithms for diabetes insipidus, such as that described by Christ-Crain et al[28]; however, we cannot be certain as to whether these guidelines were strictly followed. While our study assessed whether gross total resection was achieved on postoperative imaging, other long-term outcomes such as recurrence were outside of the scope of this study. Given the high density of hospitals in New York City, patients may also have presented with delayed complications to other hospitals, which would not have been detected during our data collection. Lastly, while our study was successful in identifying socioeconomic differences between our hospitals' patient populations, our sample is underpowered for multivariable analysis. As previously stated, several studies using national databases have accomplished this.

There are myriad differences between our private and public hospitals that cannot be controlled. At the public hospital, house staff often play a greater role in managing patients both in and out of the operating room. Faculty have a higher volume of pituitary surgery at the private hospital system and dedicated operative time for these cases, whereas cases are scheduled on an as-needed basis at the public hospital. Private hospitals have higher quality equipment and greater variety of modern surgical instruments than public hospitals. Furthermore, the two hospital systems have different anesthesiologists and operating room staff. These are just a few of the most readily apparent differences between these institutions.

The aim of this study was not to determine whether presenting to a private hospital or public hospital results in drastically different surgical outcomes; rather, our goal was to characterize the patient populations and outcomes of those undergoing transsphenoidal pituitary surgery of two socioeconomically disparate hospitals affiliated with the same institution. The hospital to which a patient presents is likely a composite of many socioeconomic factors including income, insurance status, U.S. citizenship, and area of residence, all of which could contribute to health care disparities. Our findings may inform practitioners by improving their awareness of these disparities, allowing them to identify patients who are at the greatest risk for complications.

Conclusion

Socioeconomic disparities exist in the management and outcomes of pituitary tumors, even when attempting to control for hospital faculty and staff. Compared with our private hospital, patients treated at our public hospital were more likely to present with visual field deficits and experience transient diabetes insipidus after undergoing transsphenoidal surgery, and they were less likely to have gross total resection on postoperative imaging. Further studies are needed to identify disparities in the long-term outcomes of transsphenoidal surgery for pituitary tumors.

Note
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Conflict of Interest
None declared.

References

1 Esposito D, Olsson DS, Ragnarsson O, Buchfelder M, Skoglund T, Johannsson G. Non-functioning pituitary adenomas: indications for pituitary surgery and post-surgical management. Pituitary 2019;22(04):422–434
2 Penn DL, Burke WT, Laws ER. Management of non-functioning pituitary adenomas: surgery. Pituitary 2018;21(02):145–153
3 Araujo-Castro M, Pascual-Corrales E, Martínez San Millan J, et al. Multidisciplinary protocol of preoperative and surgical

management of patients with pituitary tumors candidates to pituitary surgery. Ann Endocrinol (Paris) 2021;82(01):20–29
4 Marmot M, Friel S, Bell R, Houweling TA, Taylor SCommission on Social Determinants of Health. Closing the gap in a generation: health equity through action on the social determinants of health. Lancet 2008;372(9650):1661–1669
5 Carethers JM. Insights into disparities observed with COVID-19. J Intern Med 2021;289(04):463–473
6 Haider AH, Scott VK, Rehman KA, et al. Racial disparities in surgical care and outcomes in the United States: a comprehensive review of patient, provider, and systemic factors. J Am Coll Surg 2013;216(03):482–92.e12
7 Breslin TM, Morris AM, Gu N, et al. Hospital factors and racial disparities in mortality after surgery for breast and colon cancer. J Clin Oncol 2009;27(24):3945–3950
8 Sloane D, Chen H, Howell C. Racial disparity in primary hepatocellular carcinoma: tumor stage at presentation, surgical treatment and survival. J Natl Med Assoc 2006;98(12):1934–1939
9 Khera R, Vaughan-Sarrazin M, Rosenthal GE, Girotra S. Racial disparities in outcomes after cardiac surgery: the role of hospital quality. Curr Cardiol Rep 2015;17(05):29
10 Barrack RL, Ruh EL, Chen J, et al. Impact of socioeconomic factors on outcome of total knee arthroplasty. Clin Orthop Relat Res 2014;472(01):86–97
11 Sedaghat AR, Cunningham MJ, Ishman SL. Regional and socioeconomic disparities in emergency department use of radiographic imaging for acute pediatric sinusitis. Am J Rhinol Allergy 2014;28 (01):23–28
12 Smith DF, Ishman SL, Tunkel DE, Boss EF. Chronic rhinosinusitis in children: race and socioeconomic status. Otolaryngol Head Neck Surg 2013;149(04):639–644
13 Woodard T, Sindwani R, Halderman AA, Holy CE, Gurrola J II. Variation in delivery of sinus surgery in the Medicaid population across ethnicities. Otolaryngol Head Neck Surg 2016;154(05):944–950
14 Gourin CG, Podolsky RH. Racial disparities in patients with head and neck squamous cell carcinoma. Laryngoscope 2006;116(07): 1093–1106
15 Jiron J, Sethi S, Ali-Fehmi R, et al. Racial disparities in human papillomavirus (HPV) associated head and neck cancer. Am J Otolaryngol 2014;35(02):147–153
16 Fargen KM, Neal D, Blackburn SL, Hoh BL, Rahman M. Health disparities and stroke: the influence of insurance status on the prevalence of patient safety indicators and hospital-acquired conditions. J Neurosurg 2015;122(04):870–875
17 Thomas G, Almeida ND, Mast G, et al. Racial disparities affecting postoperative outcomes after brain tumor resection. World Neurosurg 2021;155:e665–e673
18 Glauser G, O'Connor A, Brintzenhoff J, Roth SC, Malhotra NR, Cabey WV. A scoping review of the literature on the relationship between social and structural determinants of health and neurosurgical outcomes. World Neurosurg 2022;158:24–33
19 Goljo E, Parasher AK, Iloreta AM, Shrivastava R, Govindaraj S. Racial, ethnic, and socioeconomic disparities in pituitary surgery outcomes. Laryngoscope 2016;126(04):808–814
20 Parasher AK, Workman AD, Kidwai SM, et al. Costs in pituitary surgery: racial, socioeconomic, and hospital factors. J Neurol Surg B Skull Base 2018;79(06):522–527
21 McKee S, Yang A, Kidwai S, Govindaraj S, Shrivastava R, Iloreta A. The socioeconomic determinants for transsphenoidal pituitary surgery: a review of New York State from 1995 to 2015. Int Forum Allergy Rhinol 2018;8(10):1145–1156
22 Ioachimescu AG, Goswami N, Handa T, Pappy A, Veledar E, Oyesiku NM. Racial disparities in acromegaly and Cushing's disease: a referral center study in 241 patients. J Endocr Soc 2021;6(01):bvab176
23 Cyprich J, Pangal DJ, Rutkowski M, et al. Comparative preoperative characteristics and postoperative outcomes at a private versus a safety-net hospital following endoscopic endonasal transsphenoidal resection of pituitary adenomas. J Neurosurg 2020;134 (03):742–749
24 Jahangiri A, Clark AJ, Han SJ, Kunwar S, Blevins LS Jr, Aghi MK. Socioeconomic factors associated with pituitary apoplexy. J Neurosurg 2013;119(06):1432–1436
25 Berkmann S, Schlaffer S, Nimsky C, Fahlbusch R, Buchfelder M. Follow-up and long-term outcome of nonfunctioning pituitary adenoma operated by transsphenoidal surgery with intraoperative high-field magnetic resonance imaging. Acta Neurochir (Wien) 2014;156(12):2233–2243, discussion 2243
26 Patel KS, Yao Y, Wang R, Carter BS, Chen CC. Intraoperative magnetic resonance imaging assessment of non-functioning pituitary adenomas during transsphenoidal surgery. Pituitary 2016;19(02):222–231
27 Ramm-Pettersen J, Berg-Johnsen J, Hol PK, et al. Intra-operative MRI facilitates tumour resection during trans-sphenoidal surgery for pituitary adenomas. Acta Neurochir (Wien) 2011;153(07): 1367–1373
28 Christ-Crain M, Bichet DG, Fenske WK, et al. Diabetes insipidus. Nat Rev Dis Primers 2019;5(01):54

