

Value-Based Care in Neurosurgery: Results from Maryland's Global Budget Revenue Program

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Abstract

Background

Maryland's Global Budget Revenue (GBR) model, enacted in January 2014, sets a fixed annual revenue ceiling for every hospital in the state and equalizes reimbursement across payers. Its effect on cranial surgery is unknown.

Objective

To evaluate whether a revenue ceiling can improve health equity without compromising clinical outcomes in a complex surgical indication.

Methods

The Maryland Health Services Cost Review Commission database was queried for International Classification of Diseases, Ninth and Tenth Revision, procedure codes for pituitary surgery performed between January 2012 and January 2018. Procedures before January 2014 were classified as pre-GBR and later procedures as post-GBR.

Results

1,197 procedures were included, 303 (25.3%) pre-GBR and 894 (74.7%) post-GBR. After adjustment for inflation and common comorbidities, average hospital charges per patient decreased significantly (\$37,615 to \$34,059, $p = 0.04$), and length of hospitalization decreased by 0.14 days per year ($p = 0.03$). Home health care discharges increased (2.9% to 6.5%, $p = 0.017$), with no significant change in in-hospital mortality or 30-day readmission. The proportions of patients aged 65 years or older (20.8% to 27.0%, $p = 0.033$) and insured by Medicaid (4.6% to 10.5%, $p = 0.0029$) increased, while private insurance (68.0% to 60.3%, $p = 0.02$) and self-pay (4.3% to 0.7%, $p < 0.001$) decreased.

Conclusion

Cost reduction and improved access for patients of lower socioeconomic status were achieved without adverse effects on clinical outcomes. Even in a complex indication such as pituitary surgery, a revenue ceiling may let hospitals broaden access while containing cost.

Trial Registration

Not applicable. This is a retrospective analysis of an existing administrative database and is not a clinical trial.

Introduction

Health care reimbursement models play a key role in shaping surgical practice patterns, hospital resource utilization, and patient outcomes [3]. Traditional fee-for-service models, which reimburse hospitals based on procedural volume rather than value, have long been associated with increased health care spending and hospitalizations [28, 35]. Furthermore, these fee-for-service models may lead to inequalities in the quality and cost of care across geographies and care settings [14]. This has led to the rise of value-based care, which incentivizes higher quality and lower cost by more directly holding providers financially accountable [14, 20].

In an effort to curb rising costs while maintaining quality of care, Maryland implemented one such value-based care model, known as the Global Budget Revenue (GBR) model, in 2014 [6]. GBR establishes equal reimbursement rates across patient insurance types and determines a specific annual revenue cap for each hospital in the state, encompassing emergency room, inpatient, and outpatient hospital services [22]. The goal of this program is to incentivize cost control through reductions in unnecessary admissions, efficient resource allocation, and shifts toward lower-cost outpatient and post-acute care [29]. On the whole, GBR has been found to have decreased hospital admissions by 7.2% in the five years after implementation, leading to an estimated \$796 million in savings [23]. However, while GBR has been studied extensively in medical admissions and emergency department utilization, one key goal of GBR, which was to increase equitable access to health care for vulnerable populations, remains understudied [5, 9, 10, 15, 21, 24, 25, 29, 30, 33, 34]. Furthermore, GBR's impact on surgical care is understudied despite the fact that surgical care is associated with higher rates of unequal reimbursement depending on patient insurance status [34].

Within surgical care, variations in treatment timelines, costs, and complication rates across different procedures warrant procedure-specific analyses of GBR's impact. Neurosurgical care in particular remains understudied, with only one study examining the impact of GBR in spinal fusions and none examining cranial surgeries [30]. Additionally, neurosurgery's complexity has raised questions of the potential for cost-control measures to affect clinician judgment and compromise patient outcomes [7]. Within neurosurgery, pituitary pathology requires precise surgical management due to the gland's proximity to critical neurovascular structures and the potential for significant endocrine dysfunction [1, 18, 31]. Given the complexity of pituitary procedures, postoperative care decisions including hospital length of stay, discharge disposition, and readmission rates are particularly sensitive to shifts in hospital financial incentives [16]. Additionally, GBR's emphasis on cost containment raises important questions about whether hospitals have altered perioperative management strategies [8, 21]. Furthermore, GBR's equal reimbursement across insurance types raises questions about whether it has allowed for increased access to a complex procedure such as pituitary tumor resection.

To that end, we analyze the effects of GBR on hospital charges, patient access, postoperative outcomes, and discharge disposition in patients undergoing pituitary surgery in Maryland. By evaluating whether GBR has reduced expenditures and increased access for vulnerable populations without compromising surgical outcomes, this study provides a greater understanding of the potential for value-based care to change health care delivery across neurosurgery.

Theoretical framework

Agency theory and the framework of strategic adaptation posit that organizational behavior is fundamentally shaped by the incentive structures established between payers (principals) and providers (agents) [4]. In traditional fee-for-service models, the misalignment of incentives often encourages health care organizations to maximize revenue through increased volume and resource utilization [27]. However, the implementation of Maryland's GBR model fundamentally alters this agency contract by imposing a hard revenue ceiling, thereby shifting the organizational objective from revenue generation to cost containment and efficiency. According to resource dependence theory, organizations must adapt their internal operations to align with these shifting external resource constraints to ensure survival [32].

Consequently, this study hypothesizes that hospital administrators and clinical leaders, when faced with GBR's fixed revenue cap, will strategically aim to optimize specific manageable variables, such as length of stay and discharge disposition, in order to optimize value. We theorize that the administrative pressure to operate within a global budget will cascade down to clinical management, necessitating a reduction in avoidable hospital days and a strategic shift toward lower-cost post-acute care settings. By examining pituitary surgery, a complex procedure with high variability in resource use, we test the theoretical proposition that value-based administrative constraints can successfully drive efficiency and equitable access without compromising clinical quality or patient safety.

Materials and methods

Data source and cohort

Deidentified, publicly available data from the Maryland Health Services Cost Review Commission (HSCRC) database were used to perform a retrospective analysis comparing demographics, costs, and outcomes of patients who underwent pituitary tumor resection surgery between January 2012 and January 2018. The HSCRC is an independent agency that establishes reimbursement rates and reports reimbursement and performance data from all 51 acute care and licensed specialty hospitals in Maryland. Patients were identified as undergoing pituitary surgery using International Classification of Diseases, Ninth Revision (ICD-9), and International Classification of Diseases, Tenth Revision (ICD-10), procedure codes (Table 1). Procedure codes consisting of excision, extirpation, resection, and biopsy of the pituitary gland from any approach were included. The procedure codes allowed for differentiation

between the open, percutaneous, and endoscopic approaches. Additional procedure data extracted included the procedure date and the hospital charges for the procedure.

Table 1

Included ICD-9 and ICD-10 procedure codes for pituitary surgery with an incidence greater than zero during the period of study (January 2012 to January 2018)

Procedure Code	Description	Incidence	Percentage
0714	Biopsy of pituitary gland, transsphenoidal approach	4	0.33
0761	Partial excision of pituitary gland, transfrontal approach	25	2.09
0762	Partial excision of pituitary gland, transsphenoidal approach	503	42.02
0763	Other partial excision of pituitary gland (approach not specified)	4	0.33
0764	Total excision of pituitary gland, transfrontal approach	3	0.25
0765	Total excision of pituitary gland, transsphenoidal approach	108	9.02
0768	Other total excision of pituitary gland (approach not specified)	1	0.08
0771	Hypophysectomy by cryogenic or stereotactic method	2	0.17
0779	Other destruction of pituitary gland	1	0.08
0GB00ZZ	Excision of pituitary gland, open approach	129	10.78
0GB03ZZ	Excision of pituitary gland, percutaneous approach	6	0.5
0GB04ZZ	Excision of pituitary gland, percutaneous endoscopic approach	344	28.74
0GT00ZZ	Resection of pituitary gland, open approach	25	2.09
0GT04ZZ	Resection of pituitary gland, percutaneous endoscopic approach	42	3.51

Patient data extracted included age (represented as a binary variable of 65 years or older versus younger than 65 years), sex, race, payer status, comorbidities, discharge disposition, in-hospital mortality, 30-day readmission, and length of hospital stay. Payer status was categorized as private, Medicare, Medicaid, other, or self-pay. Comorbidities included dyslipidemia, diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), smoking, chronic kidney disease (CKD), coronary artery disease (CAD), and chronic heart failure. Discharge disposition was categorized as routine discharge home, home health care with the care of a health service organization, short hospital stay, skilled nursing facility, in-hospital mortality, or other.

With the implementation of the GBR program on January 1, 2014, patients were classified as pre-GBR if their procedure took place from January 2012 through December 2013, and post-GBR if their procedure took place from January 2014 through December 2018.

Statistical analysis

The Pearson chi-squared test was used to analyze pre- and post-GBR differences in patient demographics, insurance status, readmission, and discharge disposition. The Wilcoxon rank-sum test was used to analyze pre- and post-GBR differences in inflation-adjusted hospital charges. Multivariable linear regression was used to assess the relationship between GBR implementation and length of hospitalization, and the Mann-Whitney U test was used to compare differences in the distribution of length of hospitalization pre- and post-GBR. Potential confounders of patient comorbidities (DM, CAD, CKD, and COPD) and age were adjusted for. Analysis was performed using Stata/IC 16 (StataCorp LLC, College Station, TX, USA) and Python 3.12.14, with a threshold for significance of $p \leq 0.05$ for all tests.

Statement of human and animal rights

This study was performed in line with the principles of the Declaration of Helsinki. The analysis used deidentified, publicly available administrative data and did not meet the definition of human subjects research; approval by an institutional research ethics committee and informed consent were therefore not required. No animals were used in this study.

Results

1,197 patients underwent pituitary surgery in Maryland between 2012 and 2018. Demographic information pre- and post-GBR is displayed in Table 2. 303 surgeries were pre-GBR (25.3%) and 894 were post-GBR (74.7%). 49% of patients were male and 25% were aged 65 years or more. Caucasian patients made up the majority of patients (52.6%), with African American patients the second most common (33.7%). The majority of patients had private insurance (62.2%), followed by 23.9% with Medicare, 9.0% with Medicaid, and 19 patients (1.6%) who were self-pay. 1,001 procedures (83.6%) were performed via a transsphenoidal or percutaneous endoscopic approach.

Table 2

Demographic characteristics and economic and clinical outcomes of pituitary gland surgery patients in Maryland pre- and post-Global Budget Revenue (GBR) implementation

Demographic	Pre-GBR (n = 303)	Post-GBR (n = 894)	P value
Age ≥ 65	63 (20.8%)	241 (27.0%)	0.033
Sex, Female	156 (51.5%)	456 (51.0%)	0.886
Race			
Caucasian	158 (52.2%)	472 (52.8%)	0.844
African American	93 (30.7%)	310 (34.7%)	0.205
Asian American	11 (3.6%)	36 (4.0%)	0.759
Other	41 (31.5%)	76 (8.5%)	0.011
Payer Status			
Medicare	66 (23.4%)	220 (24.6%)	0.36
Medicaid	14 (4.6%)	94 (10.5%)	0.0029
Private	206 (68.0%)	539 (60.3%)	0.02
Self-pay	13 (4.3%)	6 (0.7%)	0.000083
Other	4 (1.3%)	35 (3.9%)	0.025
Mean inflation and comorbidity-adjusted* hospital charges	\$37,615	\$34,059	0.04
Disposition			
Routine to home	281 (90.6%)	795 (87.5%)	0.13
Home healthcare	9 (2.9%)	59 (6.5%)	0.017
Short-term acute rehab	1 (0.3%)	1 (0.1%)	0.44
Inpatient rehab	7 (2.3%)	19 (2.1%)	0.86
Short-term hospital	8 (2.6%)	20 (2.2%)	0.7
Skilled nursing facility	3 (1.0%)	14 (1.5%)	0.58
Mortality in-hospital	1 (0.33%)	2 (0.22%)	1
Percentages for discharge disposition are calculated on the number of recorded disposition events, which may exceed the number of patients where more than one disposition event was recorded.			
*Adjusted for age, chronic kidney disease, chronic obstructive pulmonary disease, coronary artery disease, and diabetes mellitus			

Demographic	Pre-GBR (n = 303)	Post-GBR (n = 894)	P value
30-day readmission	31 (10.2%)	86 (9.6%)	0.84
Percentages for discharge disposition are calculated on the number of recorded disposition events, which may exceed the number of patients where more than one disposition event was recorded.			
*Adjusted for age, chronic kidney disease, chronic obstructive pulmonary disease, coronary artery disease, and diabetes mellitus			

There was a significant increase from 20.8% to 27.0% ($p = 0.033$) in the proportion of patients aged 65 years or older after GBR implementation. There was no significant change in the sex distribution of patients or in the proportion of patients who were Caucasian, African American, or Asian American. There was a significant increase in the proportion of patients receiving Medicaid from 4.6% to 10.5% ($p = 0.0029$), as well as significant decreases in the proportion of patients who had private insurance (68.0% to 60.3%, $p = 0.02$) or were self-pay (4.3% to 0.7%, $p < 0.001$). There was an increase in the proportion of patients receiving Medicare from 21.8% to 24.6% that was not significant ($p = 0.36$). The post-GBR increases in patients undergoing pituitary surgery were spread across counties with comparatively higher median household income, such as Anne Arundel County, and counties with comparatively lower median household income, such as Prince George's County (Fig. 1).

After adjusting for inflation, age, CKD, COPD, CAD, and DM, the average hospital charges per procedure decreased significantly from \$37,615 pre-GBR to \$34,059 post-GBR ($p = 0.04$) (Table 2). The average length of hospitalization for these procedures exhibited a significant year-over-year decrease of 0.14 days per year ($p = 0.03$) (Fig. 2). Contributing to this decrease was a reduction in the number of longer hospitalizations post-GBR ($p = 0.037$) (Fig. 3).

There was no significant change in the in-hospital mortality rate pre-GBR (0.33%) compared with post-GBR (0.22%). 30-day readmission rates were also statistically similar (10.2% pre-GBR versus 9.6% post-GBR, $p = 0.84$). The proportion of patients discharged to home health care increased significantly from 2.9% to 6.5% ($p = 0.017$). There was no significant change in the proportion of patients discharged routinely to home, to short-term rehabilitation, to inpatient rehabilitation, to a short-term hospital stay, or to a skilled nursing facility (Table 2).

Discussion

This study investigates the impact of a statewide all-payer hospital revenue ceiling on costs, outcomes, and access to pituitary surgery in Maryland from 2012 to 2018. Maryland's GBR program is the first of its kind, and research into its outcomes is essential for assessing whether this payment model can be effective nationwide [2]. While prior research has focused on clinical outcomes of this model in a variety of conditions, GBR's goal of increasing equitable health care access via its policy of equal reimbursement for all remains understudied. This is particularly true in neurosurgery, where complex procedures may not be easily standardized into a uniform reimbursement framework [7, 12].

We found significant increases in the proportion of patients undergoing pituitary surgery who were aged 65 years or older and who were insured by Medicaid. Correspondingly, we found significant decreases in patients with private insurance and self-pay patients. These changes came with a 9.5% reduction in the average inflation- and comorbidity-adjusted hospital charges for each pituitary procedure, as well as a significant 0.14-day year-over-year decrease in average length of hospitalization. Mortality rates and 30-day readmission rates were statistically similar pre- and post-GBR. These findings suggest that the GBR program was successful in reducing costs and improving access to pituitary surgery for socioeconomically disadvantaged patient populations while not sacrificing clinical outcomes. Prior research has shown lower socioeconomic status to be a significant barrier to accessing pituitary surgery, which results in delayed presentation and worse outcomes for these patients [26]. Furthermore, these patients may be more likely to be offered surveillance rather than definitive surgical treatment, and less likely to receive care at high-volume hospitals, which are associated with improved outcomes [11, 19]. The all-payer revenue model exemplified by GBR offers a potential mechanism to decrease these disparities by removing financial incentives for hospitals to treat patients with certain insurance types over others.

These findings with pituitary surgery are consistent with studies of Maryland's GBR program in other surgical indications. Shammassian et al. conducted the only other analysis of GBR's impact on a neurosurgical procedure, investigating changes in readmission and discharge to ancillary services or rehabilitation in spinal fusion patients [30]. Similar to this study, they found increases in discharges to home health care and rehabilitation, and no change in readmission rates. Shammass et al. conducted a systematic review and meta-analysis of GBR's impact on more than 170,000 non-neurosurgical procedures and found statistically significant reductions in hospital charges, complications, 30-day readmission, mortality, and length of hospitalization following GBR implementation [29]. Yang et al. found that increased proportions of African American and Medicaid patients received surgical treatment for esophageal cancer following GBR implementation [34]. While further study of the impact of the GBR model on neurosurgical procedures is warranted given the heterogeneity and complexity of neurosurgical care, the existing literature suggests that the GBR model can be a successful payment system in surgical care.

Alternative value-based payment systems exist, such as bundled payments, in which providers are given a single payment for all services given during a period of care [17]. Unlike bundled payments, the GBR system does not offer additional reimbursement for seeing additional patients. Additionally, bundled payment systems are typically implemented using an opt-in system, and hospitals in communities of lower socioeconomic status have been found to be less likely to participate, which can create barriers for patients from these communities to access care [13]. GBR offers a potential solution to this issue by replacing the opt-in system with a universal policy, leveling the reimbursement playing field across all hospitals in a region, for all types of insurance.

Practice implications

For health care administrators and organizational leaders transitioning to value-based payment models, this study offers evidence that global budget constraints can drive efficiency even in high-complexity, high-acuity service lines such as neurosurgery. Contrary to concerns that fixed revenue caps might stifle access to specialized care, our findings suggest that administrators can leverage global budgets to both contain costs and improve health equity. By decoupling revenue from volume, hospital leaders may be able to remove the financial disincentives often associated with treating patients of lower socioeconomic status. These capitated models may present an opportunity to expand access for vulnerable populations, such as Medicaid beneficiaries and older adults, without incurring the financial penalties inherent in traditional fee-for-service environments.

From an operational perspective, these results underscore the necessity of robust discharge planning and post-acute care integration. Leaders should prioritize care coordination protocols that facilitate earlier, safe discharges to lower-cost and lower-acuity settings, as this study suggests that reducing length of stay and shifting care outside the hospital can reduce overall hospital charges without negatively affecting readmission or mortality rates. Taken together, these findings suggest that the administrative management of length of stay and discharge disposition are effective levers for maintaining margins under a revenue ceiling.

Limitations

Our study has limitations. The heterogeneity of neurosurgical care makes it difficult to group a set of procedures together, and procedures involving the pituitary gland are no exception. Our analysis includes a wide array of conditions that warranted pituitary surgery. However, the importance of understanding the impact of this revenue model on neurosurgery necessitates the pooling of cases into certain procedure groups. Additionally, the HSCRC database did not contain data on total costs incurred by the hospital for each procedure; rather, it contained data on hospital charges to the patient, and this was used as a proxy. As a result, a direct comparison between GBR implementation and hospital costs was not possible. Finally, a major concern with value-based care models such as the GBR program is that they may disincentivize care for higher-risk patients [17]. Our study, by only examining patients at the point in time when they underwent pituitary surgery, is not able to capture information from diagnosis to surgery or details surrounding prior therapies. Further longitudinal study across a longer period of GBR implementation, with comparison to areas without such a revenue model, is needed to address these limitations.

Conclusion

Following implementation of Maryland's GBR model, patients undergoing pituitary surgery incurred lower inflation- and comorbidity-adjusted hospital charges and shorter hospitalizations, while the proportions of Medicaid beneficiaries and older adults receiving surgery increased, without detectable change in in-hospital mortality or 30-day readmission. This is the first study to investigate the impact of GBR on a

cranial surgery indication and adds an analysis of real-world data to the ongoing dialogue surrounding the use of value-based care in neurosurgery.

Declarations

Funding: The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Conflicts of Interest: The authors have no relevant financial or non-financial interests to disclose.

IRB Approval Status: Not applicable. This study analyzed deidentified, publicly available administrative data from the Maryland Health Services Cost Review Commission and did not meet the definition of human subjects research; institutional review board approval was therefore not required.

Patient Consent: Not applicable. This study used deidentified administrative data and contains no identifiable patient information, images, or other recognizable material.

Prior Presentation: None. No data from this study have been previously published or presented.

Data Availability: The data analyzed in this study are derived from the Maryland Health Services Cost Review Commission database, which is publicly available at <https://hsrc.maryland.gov>. Derived analytic files are available from the corresponding author on reasonable request.

Clinical Trial Number: Not applicable

Acknowledgments: Not applicable.

Author Contribution

A.B.Y., V.B.Y., and S.C.P. conceived and designed the study. A.B.Y., K.A.-A., and P.N. acquired the data from the Maryland Health Services Cost Review Commission database and performed the statistical analysis. A.B.Y., K.A.-A., P.N., V.B.Y., and S.C.P. interpreted the results. K.A.-A. and P.N. prepared figures 1–3 and tables 1–2. A.B.Y. and K.A.-A. wrote the main manuscript text. S.C.P. critically revised the manuscript and supervised the study. All authors commented on previous versions of the manuscript, and all authors reviewed and approved the final version.

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Figures

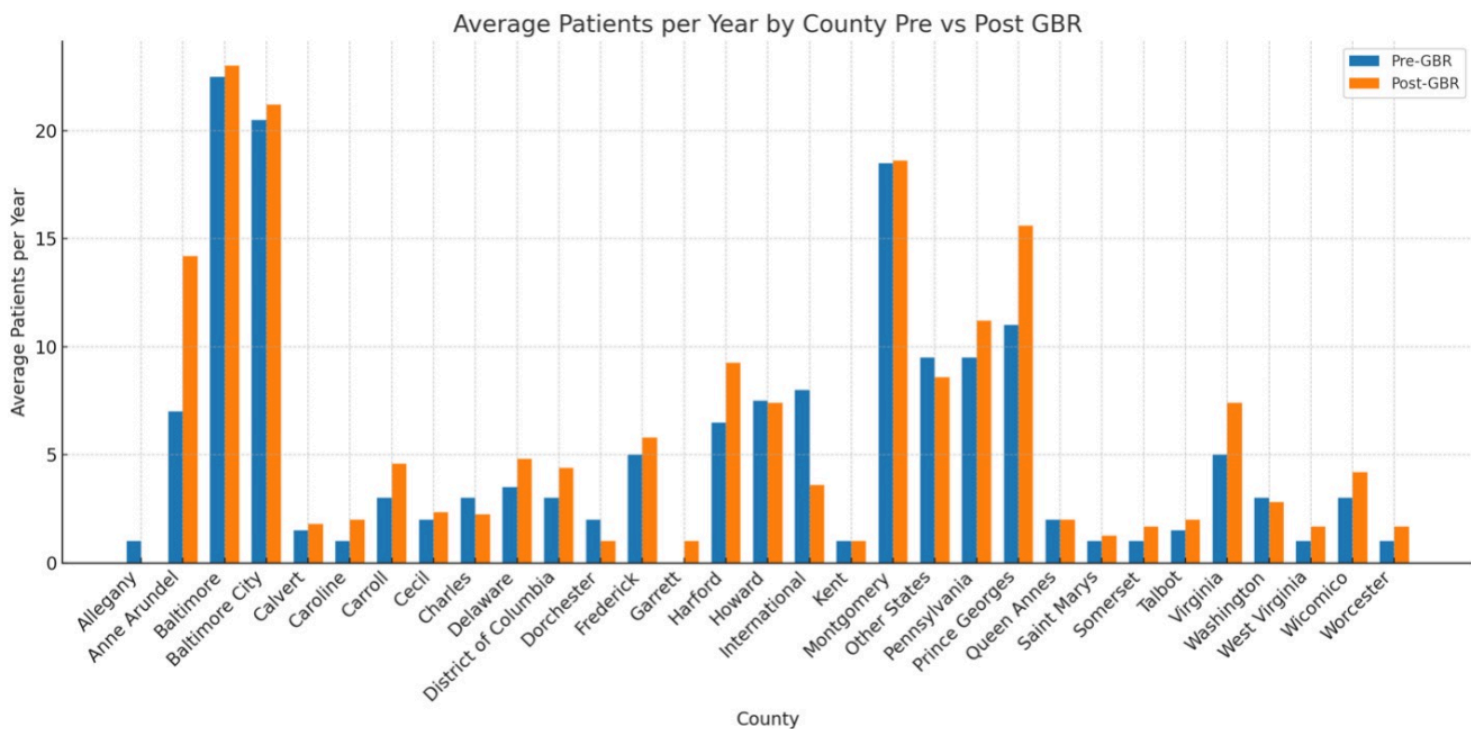


Figure 1

Average number of pituitary gland surgery patients per year in Maryland pre- and post-Global Budget Revenue (GBR) implementation, by county of patient residence. Blue bars denote the pre-GBR period (2012 to 2013) and orange bars the post-GBR period (2014 to 2018)

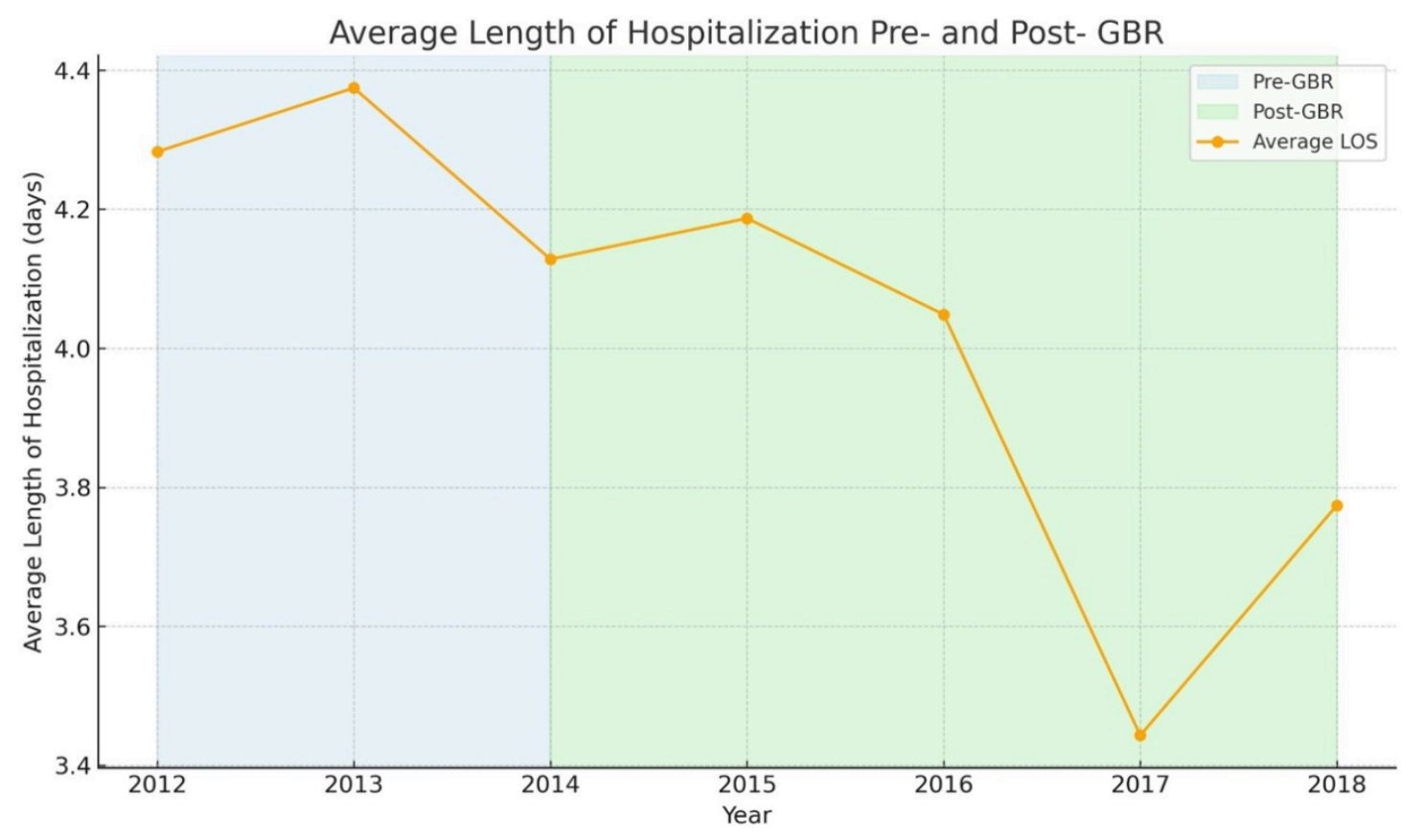


Figure 2

Average hospital length of stay of pituitary gland surgery patients in Maryland pre- and post-Global Budget Revenue (GBR) implementation, showing an annual change of 0.14 days per year ($p = 0.03$). The blue shaded region denotes the pre-GBR period and the green shaded region the post-GBR period

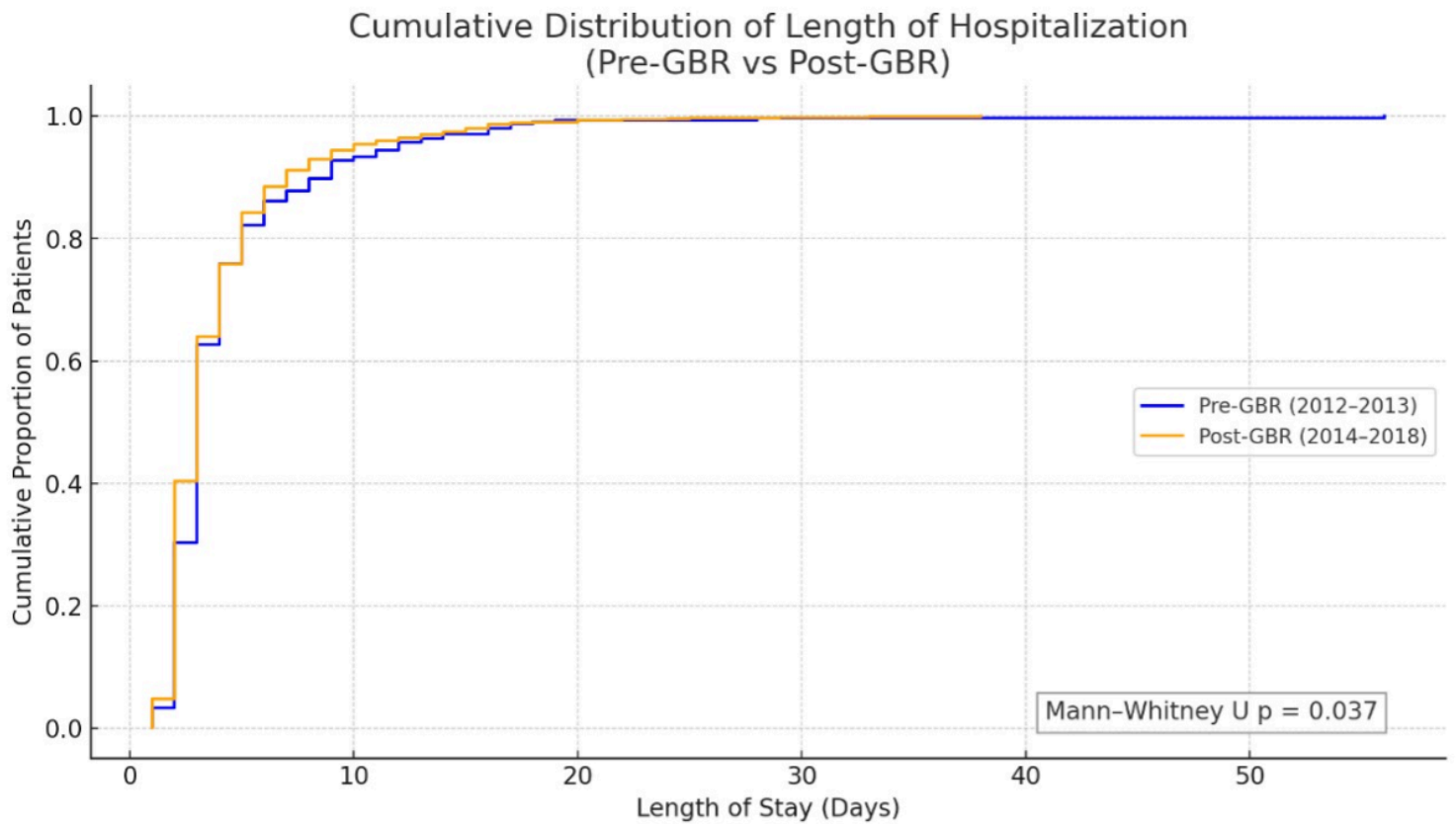


Figure 3

Cumulative distribution of length of hospitalization pre- versus post-Global Budget Revenue (GBR) implementation, showing fewer prolonged hospitalizations post-GBR (Mann-Whitney U $p = 0.037$). The blue line denotes the pre-GBR period (2012 to 2013) and the orange line the post-GBR period (2014 to 2018)