



Original research

Maryland's Global Budget Revenue model associated with lower inpatient costs and 30-day readmissions in patients undergoing total hip arthroplasty

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ABSTRACT

Background: Maryland implemented the Global Budget Revenue (GBR) to reduce hospital costs, improve quality, and decrease readmissions. Studies assessing its impact on inpatient total hip arthroplasty (THA) procedures are lacking. This study compared before and after GBR changes in 1) patient characteristics; 2) discharge dispositions and lengths of stay (LOS); 3) costs and charges of inpatient stays; and 4) 30-day readmission rates (RR) for THA recipients.

Methods: The Maryland State Inpatient Database was queried for patients who underwent THA between 2010 and 2016 utilizing the ICD-9 and ICD-10 procedure codes (n = 43,251). Pre- and post-GBR periods were grouped as 2010 to 2013 and 2014 to 2016, respectively. Chi-square analyses were used to analyze patient characteristics. Student's t-tests were utilized to compare ages, LOS, costs, charges, and RR.

Results: There were no differences in the proportion of minorities undergoing THA between the pre- and post-GBR periods (18.3% vs 19.4% African American, 1.2% vs 1.3% Hispanic; $P = .056$). The number of THA patients with Medicaid insurances increased during post-GBR (4.0% vs 6.7%; $P < .001$). There was an increased rate of home discharges during post-GBR (33.1% vs 40.9%; $P < .001$). We found lower LOS (-0.50 days; 95% CI: -0.458 to -0.533 ; $P < .001$), mean inpatient costs ($-\$1417.44$; 95% CI $-\$1143.76$ to $-\$1150.32$; $P < .001$), and mean inpatient charges ($-\$2196.50$; 95% CI: $-\$1980.10$ to $-\$2412.90$; $P < .001$) during the post-GBR period. There were lower 30-day RR during the post-GBR period ($-0.9%$; $P < .001$).

Conclusions: Our findings suggest favorable preliminary results for patients undergoing THA under the GBR model.

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Introduction

The nation's current health care system faces ongoing financial challenges as costs of care continue to rise. In response to increased federal expenditures, the Affordable Care Act authorized the Centers for Medicare and Medicaid Services (CMS) to specialize in the development and testing of innovative health care payment models [1]. These new models are designed to effectively drive costs down without compromising care delivery. In January 2014, CMS partnered with the state of Maryland and implemented a unique population-based payment model called Global Budget Revenue

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(GBR) as an alternative approach to the Medicare Inpatient Prospective Payment System, a fee-for-service payment system that exists in other states.

Maryland's GBR model aims to reduce hospital costs, improve quality, and decrease readmissions [2]. This hospital payment system moves away from a "fee-for-service" payment system to the one focused on controlling total hospital revenue per capita, with each hospital's annual revenue defined at the beginning of each fiscal year based on volume and quality indicators measured in prior years [3–6]. Specifically, the annual revenue assigned to an institution is generated by utilizing a preceding base period and subsequently adjusting for inflation, infrastructure requirements, changes in population volume, performance measures, market-shifts, and changes in payer mix [3]. As a function of preexisting state law and regulation, the GBR model applies equally to all payers including commercial entities [2,5,7]. This framework, which proponents argue, will lead to greater efficiencies and improvements in quality while maintaining access to care.

Under the predetermined global budget, GBR rewards institutions who spend under the budget and requires those who exceed the budget to assume financial responsibility, thereby extending financial risk to hospitals [8]. Other innovative payment models currently being tested by CMS across health care institutions outside the state of Maryland substantially differ from GBR. Unlike the GBR method, payments under most bundled payment systems are retrospectively bundled to reimburse providers (ie, hospitals, post-acute care providers, physicians, and practitioners) for medical services provided during an episode of care [9,10]. By establishing a 30- to 90-day care episode, or risk period, these models reward quality, as hospitals financially benefit from decreasing unnecessary utilization because of readmissions and complications. However, increases in case volume under bundled payment systems lead to increases in payments for that fiscal year. Therefore, hospitals under these models assume only a quality risk while GBR assumes a quality- and a population-based risk during any given year.

Maryland has agreed with CMS to implement GBR on the following terms over a 5-year period: (1) generation of \$330 million of Medicare savings annually within 5 years; (2) limit all-payer per capita hospital growth to 3.58% annually; (3) reduce all-cause, all-site hospital readmission rates to match national rates; and (4) reduce potentially preventable complications, such as urinary tract infections and acute myocardial infarction, by 30% [2]. Despite data demonstrating statewide success in achieving overall Medicare savings [4,11], published studies have yet to report on its statewide impact on inpatient total hip arthroplasty (THA) procedures. This study aimed to explore statewide changes of inpatient THA under the GBR model. Specifically, we compared before and after GBR in the state of Maryland changes in 1) patient characteristics; 2) discharge dispositions and lengths of stay (LOS); 3) costs and charges of inpatient hospital stays; and 4) 30-day readmission rates for patients who underwent primary THA.

Material and methods

Database

The Maryland State Inpatient Database (SID) was utilized for this study. The SID is a large, publicly available database, distributed by the Healthcare Cost and Utilization Project (HCUP). HCUP databases such as SID are sponsored by the Agency for Healthcare Research and Quality and developed to provide the largest collection of encounter-level health care data in the United States. This database represents 100% of all inpatient stays across the state and contains patient- and inpatient-related information. Patient demographics

such as ages, sex statuses, races, comorbidities, insurances, socioeconomic statuses, and insurance payers, as well as LOS, discharge dispositions, and hospital charges are included.

Patient selection

The Maryland SID was queried for all patients who underwent a primary THA between January 2010 and December 31, 2016. Episodes of care were identified using the appropriate ICD-9 (81.51) and ICD-10-PCS codes (OSR9029, OSR902A, OSR902Z, OSR9019, OSR901A, OSR901Z, OSR9039, OSR9039, OSR903Z, OSR9049, OSR904A, OSR904Z, OSR9069, OSR906A, OSR906Z, OSR90J9, OSR90JA, OSR90JZ). Subsequently, cases were excluded if they possessed ICD-9 or -10 codes reflecting a revision or conversion. Pre- and post-GBR periods were grouped as January 1, 2010, to December 31, 2013, and January 1, 2014, to December 31, 2016, respectively. This yielded a total of 43,251 THAs performed during both the pre-GBR (20,838 THAs) and post-GBR (22,413 THAs) periods.

Study variables

Patient characteristics included patient demographics, health status, and primary payer. Patient demographics included age, sex, and race. Health status was assessed by utilizing the age-adjusted Charlson Comorbidity Index (CCI), which is an objective measure for assessing all-cause 10-year mortality risk and often used in research [12,13]. The age-adjusted CCI is an updated version of CCI that accounts for age and has been validated as a more accurate predictor of mortality [14]. Patients were classified as obese and morbidly obese if they had a body mass index (BMI) greater than 30 kg/m² and greater than 40 kg/m², respectively. Discharge disposition was defined according to the categories described in the HCUP website [15]. Routine discharge is defined as discharge to home or self-care, whereas home health care is represented as discharge to home under care of an organized home health service organization. Charges were defined as the total cost of care billed to the primary payer. Costs were defined as the estimated costs to the hospital facility for the inpatient stay. The charge and cost data available in the Maryland SID database is recorded by the state's Health Services Cost Review Commission and relayed to HCUP. Cost estimations were made with the "Cost-to-Charge Ratio" supplemental file provided by HCUP. All costs and charges were adjusted for using the January 1, 2018, consumer price index [16]. Readmissions were assessed using the "readmit" variable specific the Maryland SID. This variable is defined as any hospital readmission within a 30-day period after discharge.

Statistical analyses

Chi-square analyses were used to analyze race, primary payer, CCI, obesity, and discharge destination. Student's t-tests were performed to compare ages, LOS, costs, charges, and readmission rates between the pre- and post-GBR groups. A *P*-value of .05 was set as the threshold for significance. All analyses were conducted using SPSS (IBM Corporation; Armonk, New York) version 25.

Results

Patient characteristics

There was no difference in the proportion of minority patients undergoing THA between the pre- and post-GBR periods (18.3% vs 19.4% African American, 1.2% vs 1.3% Hispanic; *P* = .056). There were minimal differences in age-adjusted CCI between the pre- and post-

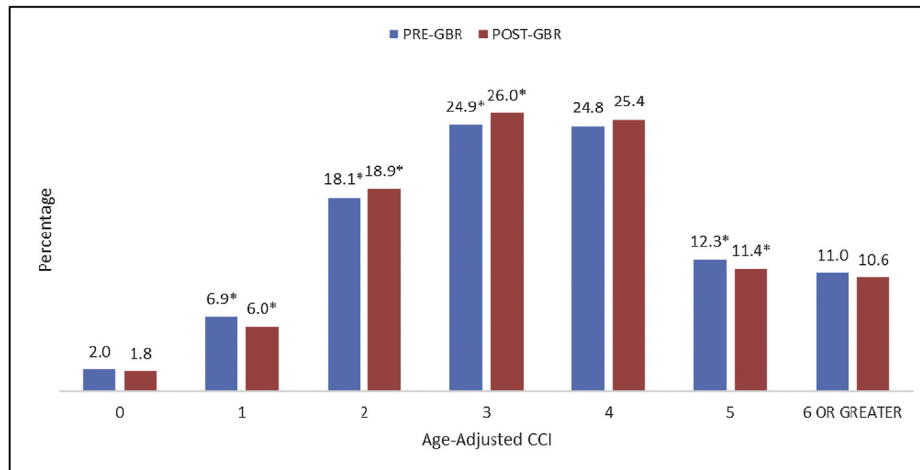


Figure 1. Chart detailing difference in the health status (as measured by age-adjusted Charlson Comorbidity Index) of total hip arthroplasty recipients during the pre- and post-Global Budget Revenue period * $P < .05$.

GBR periods (Fig. 1). There was an increased number of obese and morbidly obese patients undergoing THA during the post-GBR period (17.2% vs 20.3% obese; $P < .001$, 6.5% vs 7.1% morbidly obese; $P = .018$) (Table 1). The number of THA patients with Medicaid insurance increased significantly during the post-GBR period (4.0% vs 6.7%; $P < .001$).

Discharge dispositions and length of stay

During the post-GBR period, there was an increased rate of routine discharge (33.1% vs 40.9%; $P < .001$) and lower LOS (−0.50 days; 95% CI: −0.458 to −0.533; $P < .001$) (Table 2).

Costs and charges

During the post-GBR period, there was a decrease in the mean inpatient hospital costs (−\$1417.44; 95% CI −\$1143.76

to −\$1150.32; $P < .001$) and in the mean inpatient hospital charges (−\$2196.50; 95% CI: −\$1980.10 to −\$2412.90; $P < .001$) (Fig. 2).

Readmissions

When compared with pre-GBR, there were lower 30-day readmissions in the post-GBR period (−0.9%; $P < .001$).

Discussion

The State of Maryland implemented a unique payment model to promote patient health and quality of care while reducing health care expenditure. In 2014, Maryland’s new GBR model hoped to achieve cost containment by regulating total hospital costs per capita, a measure which may influence high demand procedures such as THA. Thus, this study evaluated the changes in inpatient THA procedures before and after the application of GBR’s payment incentives. Our results demonstrated an increased number of obese, morbidly obese, and Medicaid THA recipients after the GBR initiative took effect. In addition, we found an increase in the rate of home discharges during the post-GBR period. Furthermore, our analysis demonstrated lower LOS, lower inpatient costs, and lower 30-day readmission rates after the implementation of GBR.

This study had several limitations. The Maryland SID database provides information about total charges related to the inpatient stay, but the database lacks stratification of the distribution of costs. Although we cannot specify what areas of care demonstrated cost savings such as reductions in implant or medication expenditures, our analysis can determine the presence of reduced inpatient costs between the pre- and post-GBR periods. In addition, Malmlose et al. [5] reported early cost shifting from regulated hospital to unregulated outpatient spaces as more procedures were performed in the outpatient setting in 2014, a trend the SID cannot account for because the database contains only inpatient admissions. However, the patients who move to an outpatient setting are usually healthier, thus making any inpatient improvements in cost and outcomes more impressive. Furthermore, the SID database is unable to account for patients once discharged, and is unable to assess reoperations, emergency department visits, and outpatient complications beyond a 30-day window. This is a concern, as some marginalized groups, such as those on Medicaid, require more resources and a capitated budget may dissuade hospitals from

Table 1
Patient demographics and discharge destination among total hip arthroplasty recipients during the pre- and post-Global Budget Revenue period.

N (%)	Pre-GBR	Post-GBR	P-value
Number of procedures	20,838	22,413	<.001
Mean age (y) ^a	64.23 (12.26)	64.47 (11.74)	<.001
Female sex	9561 (56.4)	10,599 (55.9)	.409
Race			
White	12,875 (78.3)	13,889 (77.2)	.056
African American	3010 (18.3)	3485 (19.4)	
Hispanic	203 (1.2)	233 (1.3)	
Asian	113 (0.7)	142 (0.8)	
Native	20 (0.1)	19 (0.1)	
Other	230 (1.4)	216 (1.2)	
Body mass index			
Morbid obesity (>40 kg/m ²)	1105 (6.5)	1354 (7.1)	.018
Obesity (>30 kg/m ²)	2923 (17.2)	3839 (20.3)	<.001
Primary payer			
Medicare	8262 (48.7)	9357 (49.4)	<.001
Medicaid	677 (4.0)	1267 (6.7)	
Private	7572 (44.7)	7846 (41.4)	
Self-pay	94 (0.6)	36 (0.2)	
No charge	35 (0.2)	6 (<0.01)	
Other	318 (1.9)	437 (2.3)	

^a Values are given as the mean and standard deviation in parentheses.

Table 2

Comparisons of discharge disposition, mean lengths of stay, hospital costs, and 30-d readmission rates during the pre- and post-Global Budget Revenue period.

N (%)	Pre-GBR	Post-GBR	95% CI for mean difference	P-value
Discharge disposition				
Routine	5605 (33.1)	7737 (40.9)	N/A	<.001
Short-term hospital	39 (0.2)	50 (0.3)		
Skilled nursing facility	4865 (28.7)	4589 (24.2)		
Home health care	6409 (37.8)	6529 (34.5)		
Against medical advice	6 (<0.01)	8 (<0.01)		
Died	20 (0.1)	11 (0.1)		
Mean length of stay (d) ^a	2.96 (1.74)	2.46 (1.91)	0.458 to 0.533	<.001
Adjusted mean hospital costs ^a	\$20,129.04 (\$7656.16)	\$18,711.60 (\$8171.75)	\$1143.76 to \$1150.32	<.001
Adjusted mean total charges ^a	\$26,225.39 (\$10,284.34)	\$24,028.89 (\$10,622.47)	\$1980.10 to \$2412.90	<.001
30-d readmissions	471 (2.8)	357 (1.9)	N/A	<.001

SD, standard deviation; CI, confidence interval.

^a Values are given as the mean and standard deviation in parentheses.

providing those resources [17]. Despite these limitations, this study has value as it allows for assessment of GBR’s impact on high-volume procedures such as THA, Medicare’s largest inpatient surgical cost [10]. The Maryland inpatient database utilized for our analysis provides the largest patient sample available, allowing us to attempt to characterize GBR’s statewide impact as accurately as possible.

We found differences in CCI with a slight reduction of THA in patients with one and 5 comorbidities while patients with 2 and 3 comorbidities increased. Furthermore, we found a significant increase in the proportion of patients with Medicaid. The rise in patients with 2 or 3 comorbidities can be explained by a retrospective study from Torres et al. [18] suggesting the Affordable Care Act helped improve access to insurance for Americans with one or more comorbidities. Their group reported an increase in insurance coverage, regardless of insurance type, of patients with CCI of one or greater of 4.3% in states not expanding Medicaid and 5.6% in states expanding Medicaid. Our results follow this trend, as more patients shifted into either the 2 or 3 CCI category. In addition, Medicaid expansion increased access to lower total joint arthroplasty, as Delanois et al. reported in a large database study of 4,282,387 total knee arthroplasty recipients between 2009 and 2015. They demonstrated a 1.9% proportional increase in Medicaid patients receiving total knee arthroplasty after Medicaid

expansion, slightly lower than our 2.7% proportional increase in Medicaid patients receiving THA after GBR implementation. As Medicaid expansion and GBR implementations overlapped, they should not be viewed as mutually exclusive programs. Our results represent a possible synergistic relationship between Medicaid expansion and GBR, as the former expands insurance coverage to those who were previously uninsured while the latter incentivizes hospitals to perform more surgeries on Medicaid patients by equalizing payments through all-payor rate setting. However, Medicaid patients may require more resources, possibly dissuading hospitals from performing THA on this already marginalized population in the future [17]. This concern requires continued monitoring of trends to ensure GBR does not abandon those in greatest need.

We found a significantly greater number of obese and morbidly obese patients undergoing THA during the post-GBR period. These results may be a reflection of the changing population in the United States, as multiple reports demonstrate a greater proportion of patients undergoing THA with higher BMIs [19]. Although these trends may seem contrary to the GBR goal of decreasing cost, these results are supported by studies of total joint arthroplasties such as the one performed by Roche et al. [20]. Their team demonstrated a decrease in cost for TKA between 2010 and 2014, irrespective of the patient’s BMI. Furthermore, because GBR takes

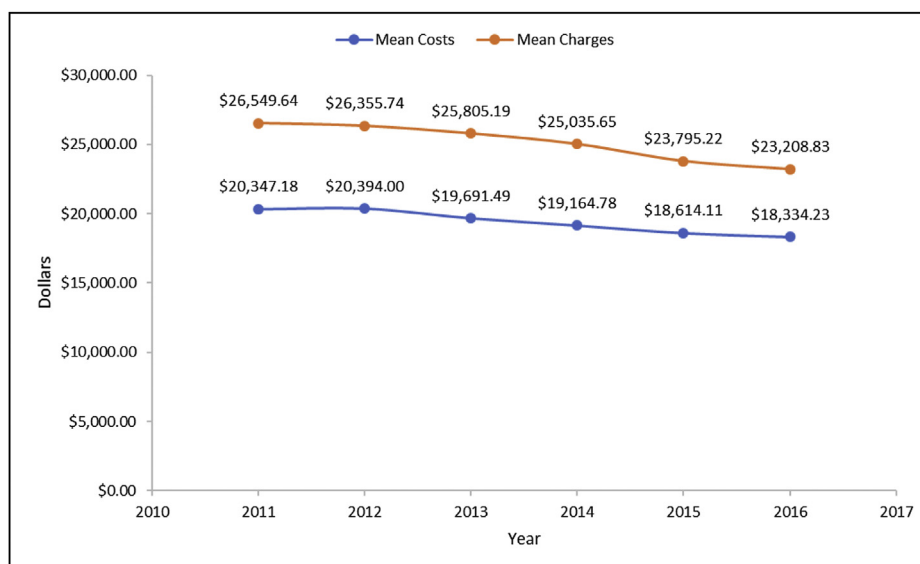


Figure 2. Chart detailing differences in mean costs and charges by year for total hip arthroplasty recipients during the pre- and post-Global Budget Revenue period.

a population-based approach, a hospital may take on more upfront costs if it improves quality of life for the patient, thus leading to cost savings from decreased future procedures and readmissions. A study by Ponnusamy et al. [21] emphasized the cost-effectiveness of THA across all BMI categories when compared with conservative treatments and suggested that BMI cutoffs may unfairly lead to loss of access to care for those who would benefit from THA. Ostensibly, hospitals under GBR are able to reduce cost while maintaining access to THA for obese and morbidly obese patients.

We found a significant increase in the proportion of patients discharged home and lower LOS in the post-GBR period. Delanois et al. [8] demonstrated similar results in a retrospective review evaluating GBR's impact on THA within a single Maryland institution. The authors reported an increase in home discharge (72.3% vs 78.9%; $P = .0262$) and a decrease in LOS (2.97 vs 2.63 days; $P < .001$) during the post-GBR period. The members of this group then expanded to evaluate GBR's impact on THA across 6 tertiary centers in Maryland and reported an increase in home discharge (72.3% vs 78.9%; $P = .0262$) and lower LOS after GBR (2.75% vs 2.33 days; $P < .001$), further supporting our statewide findings [22]. The increased rates of home discharge coupled with decreased LOS may be direct consequences of acute-care facility measures aimed to improve care coordination. Specifically, in the single-institution study mentioned previously, the authors believe their findings were attained through evidence-based changes designed to standardize patient management [8]. This coordination included the nursing staff, physicians, physical therapists, and physician assistants and involved a preoperative arthroplasty course, enrollment in a digital patient-engagement platform during the perioperative period, and a multimodal analgesic pathway. Thus, these changes may be comparable with other institutional variations across the state aiming to improve the patient experience and also effectively utilize their designated global budget [23].

Our analysis demonstrated lower inpatient costs during the post-GBR period. In their retrospective review, Delanois et al. [8] analyzed how costs and readmission rates changed after the implementation of GBR. Their study reported a decrease in mean inpatient hospital costs (\$26,575 vs \$23,712) in a single Maryland institution through 2015. In their follow-up study across 6 tertiary-care centers, the authors reported that mean inpatient costs decreased by 19% between 2012 and 2015 ($P < .001$). However, there is concern hospital and outpatient costs are being off-loaded to unregulated spaces [5] and overall hospital spending may increase. This concern has been recognized by the Health Services Cost Review Commission and has prompted the commission to create the total cost of care model, an expansion of GBR to unregulated settings. In addition, our study found slightly decreased readmissions among THA patients, which may represent increased quality of care for patients undergoing these types of procedures. This modest decrease occurred over the same 3 years in which hospital revenue growth was held to 1.58% [24]. Furthermore, in a report by the Center for Medicare and Medicaid Innovation, the total hospital expenditures for Medicare patients decreased by \$554 million during the first 3 years after implementation when compared with a matched control group [25]. These savings did not stop hospitals from increasing profit margins, which were higher in each year after GBR implementation than any of the previous 3 years before implementation [25]. Although the decrease in readmissions may be modest, it demonstrates that cost savings and growth restrictions incurred under GBR did not have a significant impact on quality. Furthermore, efforts to improve quality by adapting to global budgets did not have a significant impact of hospital profit.

Conclusions

The GBR model has been implemented in the State of Maryland as an attempt to reduce costs and to improve quality of care. Although previous studies have reported overall cost reductions and favorable health care outcomes, there have been no studies specifically assessing the statewide effects of GBR on THA. Our study evaluated the effects of GBR in Maryland and revealed a higher percentage of THA recipients with Medicaid insurance and reduced LOS, inpatient costs, and readmissions during the post-GBR period when compared with the pre-GBR period. These preliminary results may be encouraging for patients undergoing THA under the GBR model. Owing to early success, 26 states have applied to participate in the global budget workshop. Future studies should assess if these quality and cost improvements translate to other parts of the country.

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