Impact of Global Budget Payments on Cardiovascular Care in Maryland.

An Interrupted Time Series Analysis.

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Abstract:

Background: Global Budget Payments (GBP) are considered effective in containing healthcare expenditures, however information on their impact on quality of cardiovascular (CV) care is limited. We aimed to evaluate the effects of GBP on utilization, outcomes, and costs for three major CV conditions.

Methods: We analyzed claims data of hospital admissions in Maryland from fiscal year (FY) 2013 to 2018. Using segmented regression, we evaluated temporal trends in hospitalizations, length of stay (LOS), percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) volumes, case mix-adjusted 30-day readmission rates (CARR), risk-standardized mortality rates (RSMR) and hospitalization charges in patients with principal diagnosis of heart failure (CHF), acute ischemic stroke (IS) and acute myocardial infarction (AMI) in relation to GBP implementation. Trends in global CV procedure charges/volumes were also studied.

Results: Hospitalization rates for CHF and AMI remained unaffected by GBP, while the gradient of IS admissions decreased (-0.54/quarter; 95% CI: -0.7 to -0.4, $p_{trend}<0.0001$). LOS slightly increased for CHF patients (+0.04 days/quarter; $p_{trend}=0.03$). Inpatient CABG surgeries decreased (-0.28 x 1000 admissions/quarter; 95% CI: -0.3 to -0.2, $p_{trend} <0.0001$). We observed a significant decrease in CARR in the AMI cohort beyond the pre-policy trend (-0.4%; 95% CI: -0.7% to -0.1%, $p_{trend} =0.0069$). There were no significant changes in mortality for any of the three conditions. Hospitalization charges increased for IS (+228.04 USD, 95% CI:+163.2 to +292.9, $p_{trend} <0.0001$), remained constant for CHF (+142.26 USD, 95% CI:-22.9 to 307.5, $p_{trend}=0.1$), and decreased for AMI (-332.47 USD, 95% CI: -490.1 to -174.9, $p_{trend}=0.0005$). We observed a significant increase in electrocardiography rate charges (+0.25 Relative Value Units, 95% CI: 0.2 to 0.3, $p_{trend}<0.0001$), coincidentally with a reduction in volumes (-1.17 mln procedures; 95% CI: -1.5 to -0.8, p_{trend}=0.0003).

Conclusions: Introducing GBP in Maryland had no perceivable adverse effects on inpatient outcomes and quality indicators for three major CV conditions. Savings were observed in the AMI cohort, possibly due to reduced unnecessary readmissions, efficiency improvements, or shifts to outpatient care. Reduced CV procedure volumes were counterbalanced by a proportional rise in charges. State-level adoption of GBP with pay-for-performance incentives may be effective for cost containment without adversely impacting quality of CV care.

Non-standard Abbreviations and Acronyms:

GBP: global budget payments; CV: cardiovascular; FY: fiscal year; LOS: length of stay; PCI: percutaneous coronary intervention; CABG: coronary artery bypass grafting; CARR: casemix-adjusted 30-day readmission rates; RSMR: risk standardized mortality rates; CHF: congestive heart failure; IS: ischemic stroke; AMI: acute myocardial infarction; CMS: Centers for Medicare and Medicaid Services; CVD: cardiovascular diseases; HSCRC: Health Services Cost Review Commission; DRG: Diagnosis Related Groups; GBR: Global Budget Revenue; ICD: International Classification of Diseases; CPT: Current Procedural Terminology; EKG: Maryland revenue center "electrocardiography"; IRC: Maryland revenue center "interventional radiology/cardiology"; RVUs: Relative Value Units; ITS: interrupted time series; USD: U.S. dollars; P4P: pay-for-performance; AQC: Alternative Quality Contract; TPR: Total Patient Revenue; TCOC: Total Cost of Care.

Introduction

Many healthcare systems strive toward containing of expenditure growth and preserving quality of care. Among few innovative payment models, Global Budget Payments (GBP) are considered effective in cost reduction[1-4], with a fixed annual budget incentivizing hospitals to maximize efforts toward efficiency and eliminating waste[5]. However, GBP may have unintended consequences which could undermine cost control efforts and adversely impact quality. Among those, changes in patterns of care in favor of less expensive or more profitable services or providers[6-8], reducing the availability of necessary healthcare services to the population[9, 10]. Indeed, evidence on the impacts of GBP on healthcare delivery has been mixed. While improvements in quality measures were demonstrated in Massachusetts[2-4], studies from Taiwan reported increases in service volume and cost shifting to patients, causing unfair competition among hospitals[6, 11].

In agreement with the Centers for Medicare and Medicaid Services (CMS), Maryland implemented GBP in 2014 introducing the All Payer Model, with the objective of containing cost growth and improving healthcare quality. Early effects of Maryland GBP have shown a reduction in expenditures and inpatient utilization[12-14] particularly among Medicare patients, with associated savings of $586 million in its first three years[13]. Yet, limited information exists on the effects of GBP on quality of care for cardiovascular diseases (CVD), the leading cause of death in the U.S.[15] and major contributor to healthcare spending (14% of the national health expenditures in 2015)[16]. Given projected rises in treatment costs for CVD in the oncoming decades, policy changes affecting CVD outcomes will have a substantial impact on population's health and healthcare finances. The objective of our study was to analyze the effects of GBP on inpatient utilization, outcomes and costs in patients hospitalized with congestive heart failure (CHF), acute myocardial infarction (AMI) and acute ischemic stroke (IS). We further investigated the relationship between prices and CVD utilization following GBP implementation, with the aim to inform the debate about this policy's potential unintended consequences.

Methods

Study setting

For decades, Maryland has focused on addressing expenditure growth. In the 1970s, it adopted prospective payments, designating an independent state agency - the Health Services Cost Review Commission (HSCRC)- to set payment rates. Maryland was the first state to adopt *per case* payments through Diagnosis Related Groups (DRGs) in 1976[17], anticipating Medicare's prospective payment system (PPS). Unlike the national model, DRGs in Maryland are integrated within an "all payer" rate-setting mechanism, whereby payments are based on rates classified by unit of service (*e.g.*, operating room hours) adjusted with per case constraints. A waiver granted by the federal government allows charging identical rates to private and public payers. This model, initially effective in reducing cost shifting among payers and containing expenditures[18], was recently associated with escalating hospital volumes[19], then prices, after efforts to control utilization by restoring a previously removed volume adjustment system resulted in progressive increases in cost per admission[20]. To address these shortcomings, Maryland transitioned to GBP (or GBR: Global Budget Revenue) on January 1st, 2014. Although within an existing framework of regulated rate-setting, the policy represented a shift from reimbursement of individual services to population-based compensation, paired with significant value-based incentives, assessment of preventable conditions, patient safety outcomes and readmission programs[17]. With GBP, hospitals are assigned a predetermined budget based on their past activity, while maintaining their spending autonomy. Prices, set by HSCRC per unit of service (unit rates) at the beginning of the fiscal year, are adjusted according to volumes but also other factors such as local population growth, inflation, infrastructure investments, markups for uncompensated care, adherence to quality measures, and remain equal for private or public payers. Since no direct price negotiation is allowed, charges are almost equivalent to payments, excepts for discounts. In order to remain within the designated budget, hospitals have a restricted margin of 5% to adjust rates based on their volumes before incurring in penalties. Hospitals are mandated to transmit their data to HSCRC on a monthly basis to allow close monitoring of unit rate and budget revenue compliance.

Data Source

We obtained anonymized data from all hospital admissions in Maryland from the HSCRC inpatient claims database. The database used in our study is available upon formal request from the HSCRC (https://hscrc.maryland.gov/Pages/hsp-data-request.aspx). The study did not require individual patient consent or IRB approval since the database contains deidentified information. The HSCRC database is updated quarterly, and patients' admissions are tracked across hospitals through a unique ID (inpatient revisit file). We collected information on patients' demographics, discharge diagnosis, discharge status and disposition, CV procedures performed, rate charges, and payer from fiscal year (FY) 2013 to 2018.

Study population

We selected hospitalizations of adult (≥19 years) Maryland residents admitted with principal diagnosis of CHF, AMI, and IS based on the standard *International Classification of Diseases* 9th *Revision, Clinical Modification* (ICD-9) and *International Classification of Diseases* 10th *Revision, Clinical Modification* (ICD-10) diagnosis codes (see **Supplement**). Cohort selection followed criteria described by CMS for hospital payments and reporting[21-23]. For each condition, we selected readmission and mortality sub-cohorts, with index admissions as denominator for readmissions and mortality rate calculations. For readmissions, we excluded hospitalizations of individuals who left the hospital against medical advice, died during the hospitalization, were transferred to outside hospital, same day or palliative care discharges, patients with advanced CHF receiving a ventricular assist device or heart transplant, and any planned readmission (*i.e.*, recent admission for AMI readmitted for elective revascularization procedure). Readmissions within 30 days from a previous hospitalization were not considered as index admissions. For the mortality sub-cohort, one admission was randomly selected as index admission if the patient experienced more than one admission within 12 months, according to CMS criteria[23].

Outcome measures and risk-adjustment methodology

For each condition and hospital in Maryland, we calculated quarterly admissions, 30-day unplanned readmission rates (crude and risk-standardized), mortality rates (crude and risk-standardized), hospitalization charges, and coronary revascularization procedural volumes for angioplasty (PCI) and coronary bypass graft surgery (CABG). Quarterly admissions were transformed into rates per 100,000 residents using the US Census Bureau Maryland population estimates[24].

We computed procedure volumes from the entire admission cohort by using *ICD-9* and *ICD-10 Current Procedural Terminology* (CPT) codes for inpatient procedures. Quarterly PCI and CABG procedure volumes were transformed into rates per 1,000 admissions (*i.e.*, dividing the number of procedures by the cumulative number of admissions in each quarter).

Mean quarterly hospitalization charges for each condition were calculated as the ratio of total charges in all hospitals divided by the number of admissions with the same condition. Charges were adjusted for inflation to reflect real-term spending in 2018 using the CPI inflation calculator[25].

We gathered public data on rate unit charges and budget volumes for the revenue centers "electrocardiography" (EKG) and "interventional radiology/cardiology" (IRC) from FY 2008 to 2018[26]. Unit rates for each cost center are determined by the HSCRC based on direct and indirect expenses required for each service, expressed in "relative value units" (RVUs) for EKG and in procedure minutes for IRC[27]. Revenue center EKG includes procedures such as electrocardiogram, ambulatory electrocardiographic monitoring, cardioversions, echocardiograms, tilt table testing and pacemaker programming. Revenue center IRC combines interventional radiology and cardiology procedures, including cardiac catheterization and other invasive cardiac procedures.

We followed the HSCRC methodology of calculating 30-day casemix-adjusted readmission rates (CARR)[28]. The numerator represents the number of readmissions from the observed hospital performance given case-mix, and the denominator the number of readmissions expected based on state-level performance given case-mix. For each hospital, this ratio was multiplied by the statewide calendar year 2016 base annual readmission rate, transforming it into a rate for comparisons. Readmission rates from all hospitals were aggregated to obtain the CARR for each quarter. Risk standardized mortality rates (RSMRs) were calculated for each patient cohort and FY according to the CMS methodology[23]. RSMR is the ratio of predicted and expected mortality times the national observed mortality rate, accounting for variance in mortality rates within and between hospitals[29]. For each hospital, the numerator is the number of deaths within 30 days predicted given the hospital's observed performance with its case mix, calculated by logistic regression of risk factors and hospital-specific intercept on the risk of mortality. The denominator is the number of expected deaths based on average hospital performance given case mix, obtained through logistic regression of the risk factors and a common intercept on the mortality outcome across all hospitals. The ratio of predicted and expected mortality was multiplied by the national rate to calculate the yearly RSMR. Because of differences in available data between Maryland and CMS databases, we adjusted for sex, age groups (*i.e.*, dummy with category intervals every 4 years after age 65), race and comorbidities defined by the Charlson comorbidity index[30].

Statistical analysis

To evaluate changes in outcome measures before and after GBP, we adopted an interrupted time series analysis (ITS) according to published methods[31], with 1st January 2014 as a reference date for policy implementation. Ten rural hospitals (see **Table II**, **Supplemental material**) that adopted GBP in or before 2010 were excluded. Given available evidence of impact effects of policies similar to GBP[32], we considered a gradual effect or trend change as principal model, although immediate implementation effects (*i.e.*, level change) was also evaluated. Details on statistical methods are provided in the **Supplemental material**. We performed single-group segmented regression analysis, estimating the probability of autocorrelation by using ordinary least square regression (Durbin-Watson statistic) with the AUTOREG procedure function. We adjusted for seasonality of quarterly data using a maximum lag of four. First order autocorrelation (lag=1) was adopted by default, adjusting for autocorrelation with Newey-West standard errors. For RSMR, we adopted the Cochran-Armitage test for linear trends, testing the null hypothesis that no significant trend in mortality was present before and after policy implementation. Estimated trend and level changes were expressed with 95% confidence intervals (CI), and statistical significance was assumed at p value of 0.05. Sensitivity analysis was performed accounting for all Maryland hospitals. Statistical analyses were performed using SAS software (SAS Institute, Inc., Cary, NC).

Results

Characteristics of the study population are shown in **Table 1**. After excluding 237,242 admissions from 10 rural hospitals (see **Supplemental material**), a total of 1,701,179 Maryland admissions from FY 2013 to FY 2018 were analyzed. While the total number of admissions decreased from 310,012 in FY 2013 to 271,154 in FY 2018, the proportion of admissions with selected CV conditions increased across the same period (i.e., CHF: from 4.8% to 5.9%; AMI: from 2.4% to

2.6%; IS: from 2.3% to 2.9%). Medicare beneficiaries represented 73.6-75.0% of CHF, 56.7-58.9% of AMI, and 64.6-66.5% of IS admissions, respectively.

Findings of the ITS analysis are shown on **Table 2**. After GBP adoption, there were no significant changes in hospitalization trends for CHF and AMI. Although IS admissions continued to rise, a decline in trends by 1.8% per quarter compared to pre-policy was observed (absolute difference -0.54 admissions per 100,000/quarter, 95% CI: -0.7 to -0.4, $p_{trend}<0.0001$). Trends in charges increased from -88.5 to +139.5 USD per quarter for IS patients (+228.0/quarter, 95% CI: 163.2 to 292.8 USD, $p_{trend}<0.0001$), did not change significantly for CHF patients (+142.2 USD/quarter, 95% CI: -22.9 to +307.4, $p_{trend}=0.1$), and decreased from +336.1 to +3.6 USD per quarter for AMI patients (-332.4 USD/quarter, 95% CI: -490.0 to -174.8 USD, $p_{trend}=0.0005$, **Figures 1a,1b,1c**). CARR for CHF and IS patients remained unaffected by GBP, while an average decrease of 3.2% readmissions per quarter was observed in the AMI cohort (-0.4%/quarter, 95% CI: -0.7 to -0.1, $p_{trend}=0.0069$, **Figure 2**). LOS slightly increased in CHF patients (+0.04 days/quarter, 95% CI: 0.005 to 0.07, $p_{trend}=0.036$), while it was unaffected in the remaining cohorts (see **Figure 3a**). Trends in inpatient PCI procedures remained unchanged, whereas CABG surgeries decreased by 9.3% per quarter after GBP (absolute difference -0.28 procedures x 1,000 admissions/quarter, 95% CI: -0.3 to -0.2, $p_{trend}<0.0001$, **Figure 3b**). For all three conditions, we found no changes in yearly trends of RSMRs following GBP adoption (**Figure 4**).

Time series data of revenue centers EKG and IRC are shown in **Table 3** and **Figures 5a** and **5b**. Compared to the pre-policy period, EKG rates showed an increase of +0.25 RVU/quarter (95% CI: +0.2 to +0.3, $p_{trend}<0.0001$), while EKG volumes decreased by -1.2 mln/quarter (95% CI: -1.5 to -0.8, $p_{trend}=0.0003$). IRC rates fell by 89.3% per quarter compared to baseline (-13.8 RVUs/quarter, 95% CI: -18.2 to -9.4, $p_{trend}=0.0003$), offset by volume growth of 12.5% per quarter (+1.82

mln/quarter, 95% CI: +0.9 to + 2.7, p_{trend} =0.004). As shown in **Figure 5b**, most IRC changes occurred before FY 2010, and were therefore unrelated to GBP.

Discussion

Our retrospective cohort study of three CV conditions showed that GBP implementation in Maryland resulted in no significant changes in hospitalizations and risk-adjusted mortality rates. We found a small reduction in risk-standardized 30-day readmissions for AMI patients, but no changes in CHF and IS cohorts. Some of these changes could stem from effective community health initiatives or pay-for-performance (P4P) incentives introduced by Maryland GBP. While trends in hospitalization charges differed among conditions (*i.e.*, upward for IS, unchanged for CHF, and downtrend for AMI), inpatient CABG utilization decreased, possibly due to care shifts to outpatient settings. Following adoption of GBP, unit rates for CV procedures increased, perhaps because of compensatory rate adjustments applied to counteract reductions in volumes, or from hospital efforts to work within the allocated budget.

GBP are alternative payment models aimed to contain healthcare spending. Financial constraints induced on providers have been shown to help reducing costs[33], although the effects on quality have been ambiguous, with some concerns expressed about unintended consequences on preservation of healthcare quality[6, 7, 11]. There have been reports showing that strictly fixed budgets could lead to counterproductive provider behaviors, including increases in service volume, which paradoxically causes prices to fall[34], could favor unlevelled playground competition between larger and smaller hospitals[6], cream skimming[35], and discontinuation of unprofitable services. Providers might also restrict access to necessary care in an attempt to lower costs[36]. The combination of GBP with P4P initiatives and close monitoring of quality metrics is likely to minimize these adverse incentives. In Massachusetts, the significant reduction in spending growth noted with the Alternative Quality

Contract (AQC) by Blue Cross Blue Shields was associated with sustained improvement of performance measures (*i.e.*, chronic disease management, adult prevention, and pediatric care), while lower utilization was the main driver of cost reduction of the policy in its later years[4]. Cost containment in the era of value based care is mostly achieved by reducing avoidable utilization and waste[37]. Although preliminary results of GBP in Maryland demonstrated cost reductions for Medicare patients and improvements in quality measures[12], further analyses did not confirm these effects. The pilot program TPR (Total Patient Revenue) launched in ten rural hospitals in 2010, demonstrated only marginal effects in effective or avoidable utilization[38-40]. Similar observations were gathered from studies conducted on statewide GBP. Roberts et al. found no significant changes in hospital (admissions, observation stays, emergency visits, readmissions) or outpatient utilization for the first two years after policy adoption[41]. Another report showed that three years post implementation, GBP were associated with reductions in inpatient admissions for Medicare and private insurance carriers but resulted in no significant savings due to increases in charges. Medicare expenditures decreased by $330 million in FY 2017, likely from reduced costs of emergency visits and outpatient services; however, a consistent effect on avoidable inpatient utilization was not demonstrated[13].

Evidence on CV utilization with GBP is limited. Song et al showed that expenditures for CV services in the Massachusetts AQC cohort of beneficiaries decreased by 7.4% within the first two years, and that reduced expenditure growth for CV services was linked to lower prices[8]. In our study, we found a 1.4% increase in hospitalization charges in the IS cohort but no significant increases for the CHF cohort, despite a small increase in LOS. One could hypothesize that past efforts directed at reducing CHF hospital stays had already achieved their maximum beneficial effect, beyond which further reductions would result in worse patient outcomes and higher readmission rates. We noted a 1.5% reduction in charges for AMI patients which may have been due to reduced avoidable utilization, efficiency gains, or care shifts towards outpatient services, as documented by the reduction of inpatient CABG surgeries. This hypothesis should be verified by integrating our analysis with outpatient and observation data. There was no evidence of reduced costs of CV procedures; for example, a reduction of 5.4% in EKG volumes after GBP was counterbalanced by a 7.7% increase in rates. IRC data appears inconclusive since it combines CV activity with other services, and most changes occurred before GBP implementation. Because Maryland GBP allows only minimal price adjustments, cost savings are more likely to result from reduced volume of services and improvements in potentially avoidable utilization rather than price reductions. Whether this was the case with Maryland GBP will need to be studied in further detail. Although we did not identify unequivocal evidence of cost containment, our findings show that statewide GBP implementation in Maryland - combined with tailored policy incentives and performance targets- did not negatively affect the quality of in-hospital CV care.

Recent research has emphasized the issue of shifting care or costs outside the global budget. Pines et al found a significant drop in hospital admissions and outpatient care in TPR areas compared to controls, offset by higher admissions in hospitals outside TPR. While shifting care may improve hospital profit margins, transferring care outside the capitation model could dampen potential benefits of expenditure control[14] and negatively affect healthcare quality[42]. Attenuated effects of GBP have also been attributed to misaligned incentives between hospitals and physician, since most providers in Maryland are not employed by hospitals[39, 43]. Considering these limitations, Maryland - in partnership with CMS - introduced the Total Cost of Care (TCOC) model in 2019, extending its waiver until 2023[44]. Under TCOC, Maryland finances each beneficiary entire *continuum* of care, facilitating collaborations between hospitals, outpatient services, physicians and state agencies, setting specific quality and financial goals, promoting primary care services, and tracking performance targets[45].

Limitations

Our study has several limitations. First, information was obtained from claims data and therefore relied upon good coding practices, particularly concerning crosswalk of disease classification versions. Although coding mismatch and misclassification cannot be fully discounted, good concordance between CV codes has been demonstrated[46], and we adopted the same methods employed by CMS to assess reimbursement claims. Second, we studied the effects of GBP on inpatient cohorts across hospitals in Maryland. Because our analysis was limited to inpatients, we were unable to capture possible spillover effects to surrounding states, or care/cost shifts to unregulated portions of global budgets; moreover, we were not able to evaluate the "global" effects of GBP on CV utilization (*e.g.*, the relationship between inpatient and outpatient revascularization procedures) and outcomes in outpatient populations, observation units or emergency visits. Nonetheless, our study provides important evidence on the impact of GBP on inpatient care services, which represent approximately half of hospital revenues[47]. Additionally, we were able to show effects of GBP on hospitals' healthcare quality for acute CV conditions, and its implications on inpatient utilization. Finally, the absence of a comparison group makes the study susceptible to pre-existing trends and coincidental events. While a randomized controlled study was not feasible given statewide policy implementation, we adopted a quasi-experimental study design (ITS) that accounts for secular trends, assuming that observed changes are due to the adoption of GBP. This method has been widely used to evaluate the impact of healthcare interventions and policies[48].

Conclusions

Adoption of GBP in Maryland had no detrimental effects on inpatient quality of care for three major CV conditions. While RSMR remained unchanged by the policy, CARR for AMI patients decreased significantly with associated cost savings. We found a reduction in CV utilization, which was offset by a proportional increase in charges. This suggests that GBP may be successful in reducing healthcare expenditures without nurturing concerns of adverse effects on quality. The transition to a comprehensive population-based strategy with TCOC, promoting coordination between hospital and outpatient services, is likely to provide additional benefits for cost containment and quality of care. Rigorous monitoring of outcomes, performance targets, and multi-dimensional assessments will be required to weigh its efficacy and to guide future policy directions.

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Supplemental Materials:

Supplemental Methods

Supplemental Tables I-IV

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Table 1. Study population and demographics.

		Fiscal year	2013	2014	2015	2016	2017	2018
Total admissions								
	All		310,012	293,696	281,148	271,731	273,438	271,154
	CHF		15,087	14,898	15,513	15,674	15,676	16,009
	AMI		7502	7306	7619	7446	7503	7128
	IS		7273	7674	7672	7604	7672	7868
Male sex, *n* (%)								
	CHF		7552 (50.06)	7630 (51.21)	7766 (50.06)	7985 (50.94)	8038 (51.28)	8286 (51.76)
	AMI		4437 (59.14)	4344 (59.46)	4548 (59.69)	4436 (59.58)	4478 (59.68)	4261 (59.78)
	IS		3428 (47.13)	3608 (47.02)	3691 (48.11)	3613 (47.51)	3653 (47.61)	3805 (48.36)
Race, *n* (%)								
	CHF							
		White	7284 (48.46)	6075 (49.05)	6615 (48.90)	7678 (49.26)	7646 (49.02)	7469 (46.97)
		African American	7158 (47.62)	5799 (46.82)	6285 (46.46)	7248 (46.5)	7194 (46.12)	7671 (48.24)
		Asian	179 (1.19)	160 (1.29)	216 (1.6)	205 (1.32)	271 (1.74)	246 (1.55)
		Other	340 (2.26)	280 (2.26)	294 (2.17)	344 (2.21)	401 (2.57)	457 (2.87)
	AMI							
		White	4810 (65.53)	3980 (65.74)	4345 (65.39)	4702 (63.96)	4607 (61.96)	4213 (60.05)
		African American	1988 (27.08)	1606 (26.53)	1822 (27.42)	2162 (29.41)	2252 (30.29)	2179 (31.06)
		Asian	172 (2.34)	174 (2.87)	180 (2.71)	184 (2.5)	220 (2.96)	228 (3.25)
		Other	316 (4.31)	250 (4.13)	231 (3.48)	215 (2.92)	278 (3.74)	349 (4.97)
	IS							
		White	3871 (53.49)	3548 (52.99)	3639 (52.52)	3978 (52.83)	3989 (52.27)	3941 (50.52)
		African American	2914 (40.27)	2733 (40.82)	2853 (41.17)	3067 (40.73)	3145 (41.21)	3307 (42.39)
		Asian	168 (2.32)	179 (2.67)	179 (2.58)	215 (2.86)	192 (2.52)	216 (2.77)
		Other	238 (3.29)	187 (2.79)	180 (2.6)	196 (2.6)	246 (3.22)	290 (3.72)
Age group (years), *n* (%)								
	CHF							
		19-65	5077 (33.65)	5042 (33.84)	4974 (32.06)	5143 (32.81)	4957 (31.62)	5241 (32.74)
		65-69	1551 (10.28)	1449 (9.73)	1683 (10.85)	1763 (11.25)	1789 (11.41)	1831 (11.44)
		70-74	1681 (11.14)	1657 (11.12)	1768 (11.39)	1780 (11.36)	1863 (11.88)	1826 (11.41)
		75-79	1691 (11.21)	1756 (11.79)	1798 (11.59)	1888 (12.05)	1811 (11.55)	1958 (12.23)

		80-84	1830 (12.13)	1896 (12.73)	1926 (12.42)	1905 (12.15)	1927 (12.29)	1867 (11.66)
		85 or older	3257 (21.59)	3098 (20.79)	3364 (21.69)	3195 (20.38)	3329 (21.24)	3286 (20.53)
	AMI							
		19-65	3270 (43.59)	3246 (44.43)	3340 (43.84)	3400 (45.66)	3344 (44.57)	3201 (44.91)
		65-69	875 (11.66)	891 (12.2)	962 (12.63)	927 (12.45)	965 (12.86)	971 (13.62)
		70-74	870 (11.6)	848 (11.61)	900 (11.81)	850 (11.42)	936 (12.48)	885 (12.42)
		75-79	707 (9.42)	698 (9.55)	731 (9.59)	749 (10.06)	711 (9.48)	688 (9.65)
		80-84	745 (9.93)	669 (9.16)	675 (8.86)	619 (8.31)	670 (8.93)	594 (8.33)
		85 or older	1035 (13.80)	954 (13.06)	1011 (13.27)	901 (12.1)	877 (11.69)	789 (11.07)
	IS							
		19-65	2632 (36.19)	2821 (36.76)	2672 (34.83)	2658 (34.96)	2684 (34.98)	2703 (34.35)
		65-69	782 (10.75)	888 (11.57)	934 (12.17)	939 (12.35)	935 (12.19)	991 (12.6)
		70-74	817 (11.23)	825 (10.75)	865 (11.27)	831 (10.93)	891 (11.61)	951 (12.09)
		75-79	767 (10.55)	843 (10.99)	860 (11.21)	930 (12.23)	871 (11.35)	960 (12.2)
		80-84	857 (11.78)	847 (11.04)	883 (11.51)	868 (11.42)	874 (11.39)	879 (11.17)
		85 or older	1418 (19.5)	1450 (18.89)	1458 (19.0)	1378 (18.12)	1417 (18.47)	1384 (17.59)
Payer, n (%)								
	CHF							
		Commercial	1930 (12.89)	1869 (12.66)	1850 (12.04)	1944 (12.56)	1994 (12.88)	1905 (12.04)
		Medicaid	1531 (10.23)	1660 (11.24)	1836 (11.95)	1777 (11.48)	1731 (11.18)	2061 (13.02)
		Medicare	11030(73.69)	10869(73.62)	11503(74.85)	11579(74.82)	11615(75.03)	11688(73.85)
		Self-pay	477 (3.19)	366 (2.48)	180 (1.17)	176 (1.14)	140 (0.9)	172 (1.09)
	AMI							
		Commercial	2080 (28.11)	2074 (28.82)	2142 (28.59)	2156 (29.49)	2066 (28.02)	2006 (28.67)
		Medicaid	553 (7.47)	733 (10.18)	885 (11.81)	852 (11.65)	944 (12.81)	856 (12.24)
		Medicare	4304 (58.9)	4108 (57.08)	4310 (57.54)	4152 (56.79)	4224 (57.3)	4021 (57.48)
		Self-pay	462 (6.24)	282 (3.92)	154 (2.06)	151 (2.07)	138 (1.87)	113 (1.62)
	IS							
		Commercial	1560 (21.69)	1507 (19.9)	1530 (20.15)	1538 (20.52)	1564 (20.69)	1585 (20.38)
		Medicaid	646 (8.98)	891 (11.77)	892 (11.75)	883 (11.78)	903 (11.94)	929 (11.95)
		Medicare	4648 (64.62)	4891 (64.6)	5051 (66.53)	4960 (66.17)	4977 (65.82)	5141 (66.11)
		Self-pay	339 (4.71)	282 (3.72)	119 (1.57)	115 (1.53)	117 (1.55)	122 (1.57)

Table 2. Changes in study outcomes after implementation of global budgets.

Cohort	Outcome	Baseline value	Pre-intervention slope (95% CI)	Post-intervention slope (95% CI)	Absolute difference (95% CI)	p value (level)	p value (trend)
CHF							
	Hospitalizations*	63.83	-0.37(-1.97 to 1.21)	0.16(-0.21 to 0.55)	0.54(-1.10 to 2.19)	0.42	0.52
	Casemix adjusted readmission rate, *%*	25.1	-0.3(-0.5 to -0.06)	-0.11(-0.1 to -0.04)	0.2 (-0.05 to 0.4)	0.92	0.13
	Risk Standardized Mortality Rate†, *%*	11.6	NC	NC	NC	NC	0.99†
	Length of stay, *days*	5.05	-0.03(-0.06 to 0)	0.008 (-0.005 to 0.02)	0.04 (0.005 to 0.07)	0.001	0.036
	Mean inflation-adjusted charges, *$*	14198.01	-75.05 (-238.57 to 88.45)	67.20 (27.16 to 107.25)	142.26 (-22.97 to 307.49)	0.10	0.10
AMI							
	Hospitalizations*	32.65	-0.41(-0.84 to 0.01)	-0.12(-0.25 to 0.01)	0.29(-0.16 to 0.74)	0.03	0.22
	Casemix adjusted readmission rate, *%*	12.2	0.3 (0.07 to 0.6)	-0.09 (-0.18 to 0.002)	-0.4 (-0.7 to -0.1)	0.10	0.0069
	Risk Standardized Mortality Rate†, *%*	12.7	NC	NC	NC	NC	0.99†
	Length of stay, *days*	4.18	0(-0.04 to 0.06)	-0.006 (-0.02 to 0.005)	-0.016 (-0.07 to 0.04)	0.57	0.57
	Mean inflation-adjusted charges, *$*	21708.18	336.12 (198.65 to 473.60)	3.64 (-74.10 to 81.39)	-332.47 (-490.07 to -174.89)	0.06	0.0005
Ischemic stroke							
	Hospitalizations*	29.50	0.60 (0.45 to 0.76)	0.05 (0.01 to 0.1)	-0.54(-0.71 to -0.37)	0.0003	<0.0001
	Casemix adjusted readmission rate, *%*	9.8	0.1 (-0.2 to 0.4)	-0.03 (-0.09 to 0.01)	-0.1 (-0.4 to 0.2)	0.91	0.42
	Risk Standardized Mortality Rate†, *%*	14.6	NC	NC	NC	NC	0.99†
	Length of stay, *days*	5.10	-0.02(-0.05 to 0.002)	-0.01 (-0.02 to 0.002)	0.014 (-0.01 to 0.04)	0.77	0.42
	Mean inflation-adjusted charges, *$*	15812.86	-88.53 (-131.12 to -45.96)	139.50 (86.93 to 192.07)	228.04 (163.20 to 292.88)	0.90	<0.0001
Procedure volumes‡							
	PCI	13.90	0.13 (-0.06 to 0.33)	-0.02 (-0.07 to 0.01)	-0.15 (-0.36 to 0.04)	0.88	0.14
	CABG	2.99	0.26 (0.23 to 0.30)	-0.02 (-0.06 to 0.01)	-0.28 (-0.34 to-0.23)	0.62	<0.0001

*Hospitalization rates indicated as *n* of admissions per 100,000 residents. †Risk Standardized Mortality Rate was calculated yearly, Cochrane-Armitage test for trend was used instead of ITS. ‡Procedure volumes indicated as *n* of procedures per 1,000 admissions (see Table 1). p-value represents the significance of the test for the change in the slope (trend change), or the absolute change difference (level change) being equal to zero. NC: not calculated.

Table 3: Segmented regression analysis of rates and budget volumes for cardiovascular procedures in Maryland before and after GBP.

Revenue center	Outcome measure	Baseline value	Pre-intervention slope (95% CI)	Post-intervention slope (95% CI)	Absolute difference (95% CI)	p value (level)	p value (trend)
EKG							
	Rates, *RVUs*	3.21	0.06 (0.01 to 0.10)	0.32 (0.29 to 0.34)	0.25 (0.20 to 0.31)	0.001	<0.0001
	Budget volume, *n* x100,000	217.37	2.41 (0.61 to 4.2)	-9.33 (-13.09 to -5.5)	-11.75 (-15.5 to -7.9)	0.92	0.0003
IRC							
	Rates, *RVUs*	15.47	10.18 (6.46 to 13.90)	-3.65(-5.26 to -2.04)	-13.83(-18.23 to -9.43)	0.73	0.0003
	Budget volume, *n* x100,000	144.39	-17.03 (-25.72 to -8.34)	1.13 (0.29 to 1.96)	18.16 (9.25 to 27.07)	0.13	0.004

EKG: “electrocardiography”. IRC: interventional cardiology/radiology. RVU: relative value units.

Figure 1a: AMI hospitalization rates and charges.

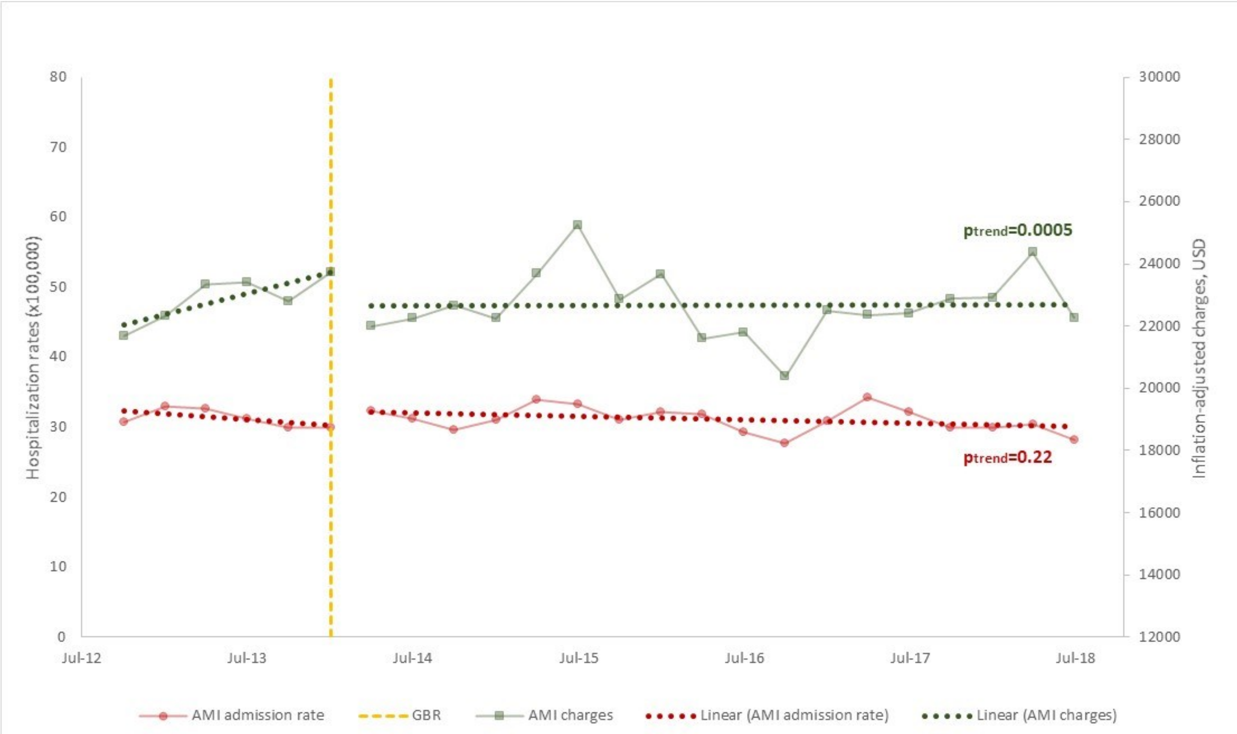


Figure 1b: IS hospitalization rates and charges.

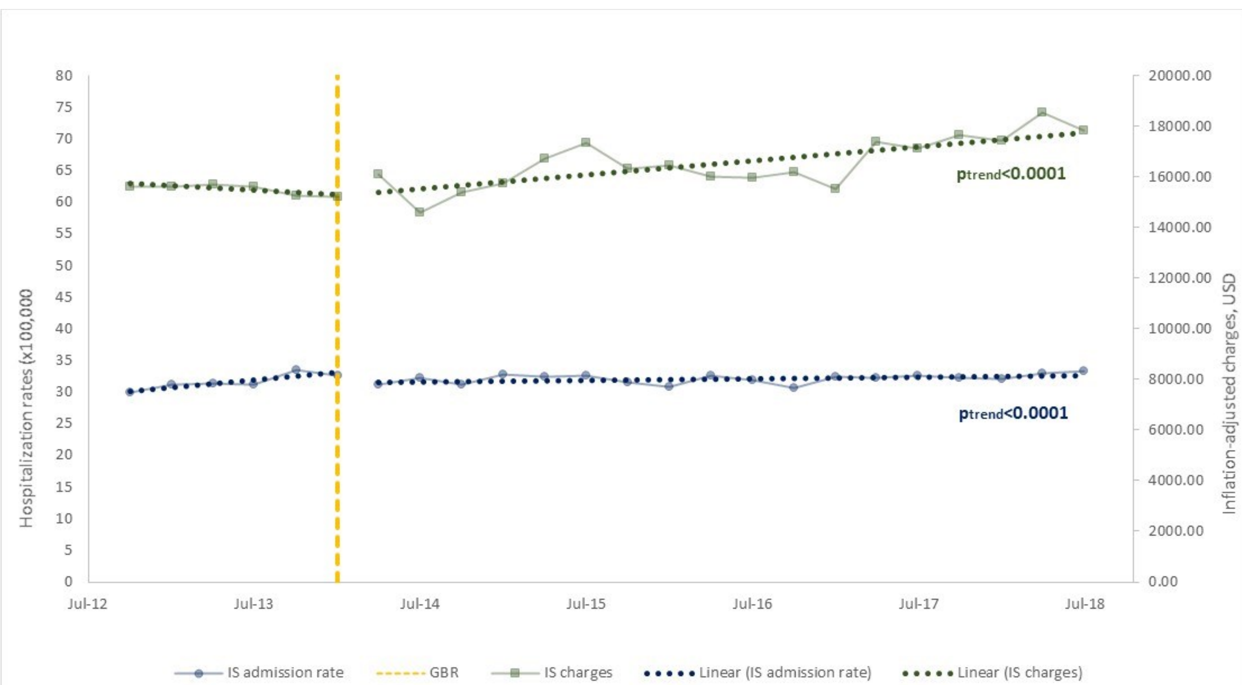


Figure 1c: CHF hospitalization rates and charges.

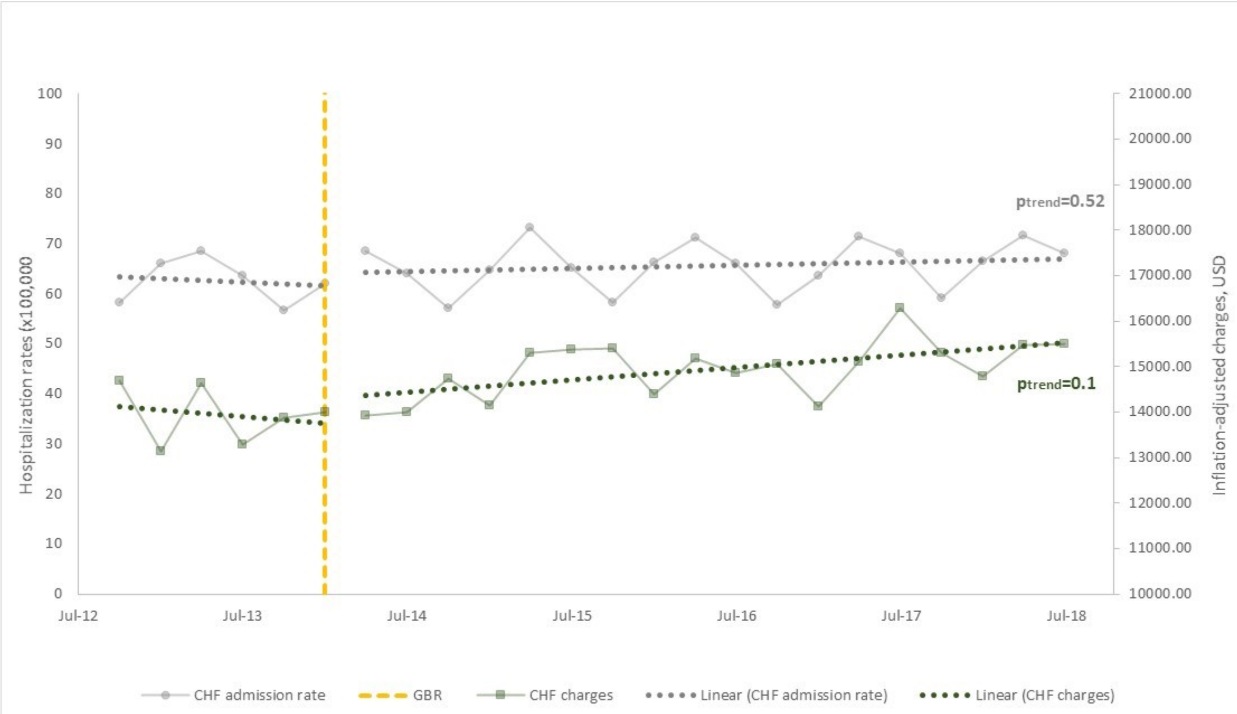


Figure 2: Risk-adjusted readmission rates by condition.

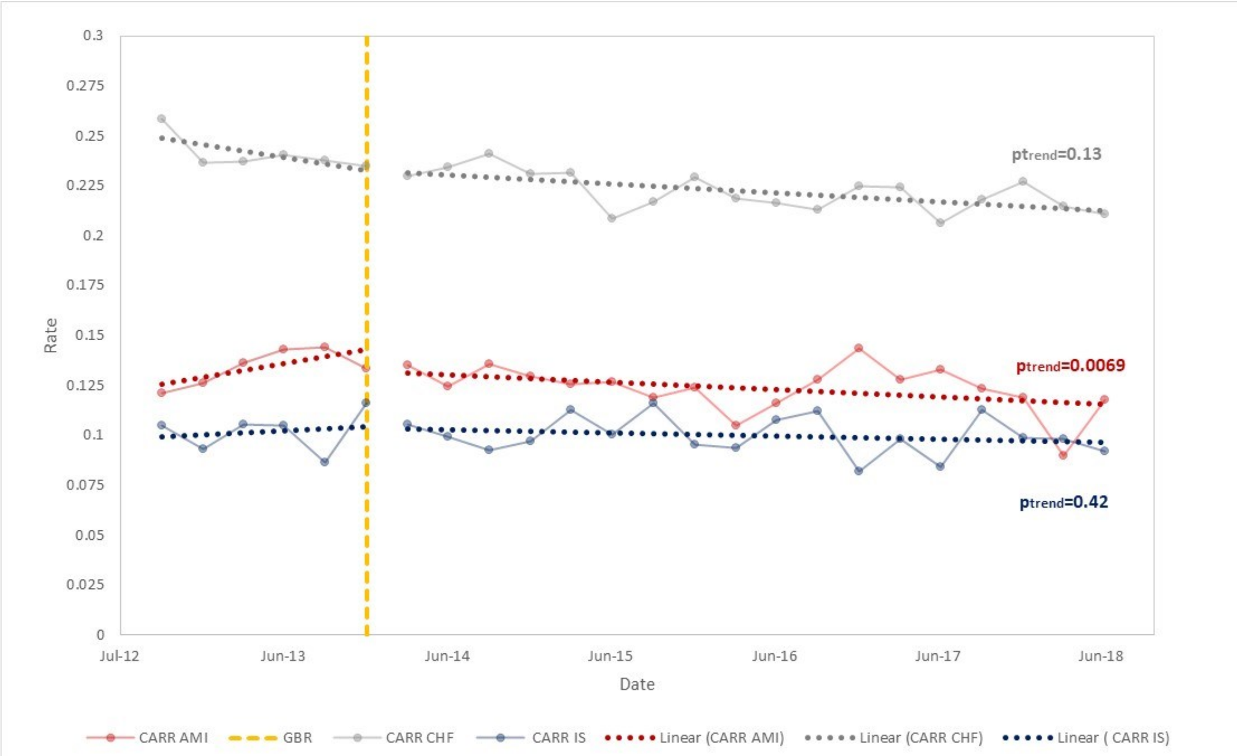


Figure 3a: Length of stay

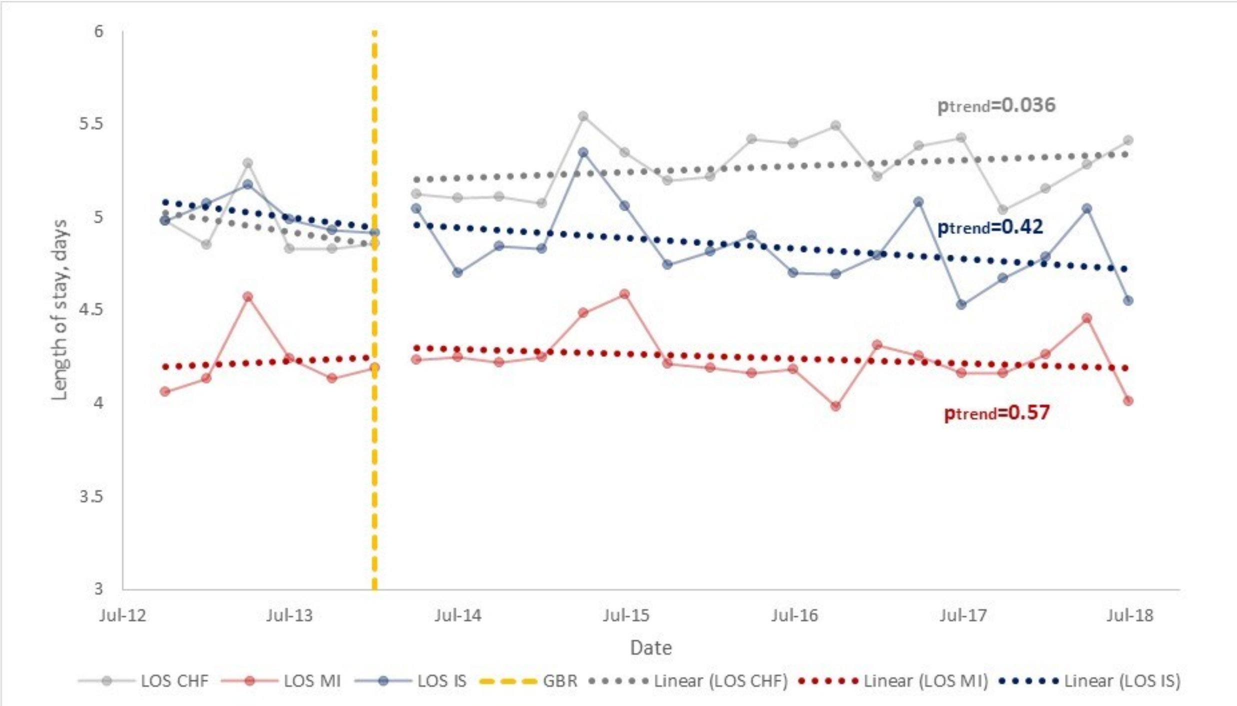


Figure 3b: Procedure volumes

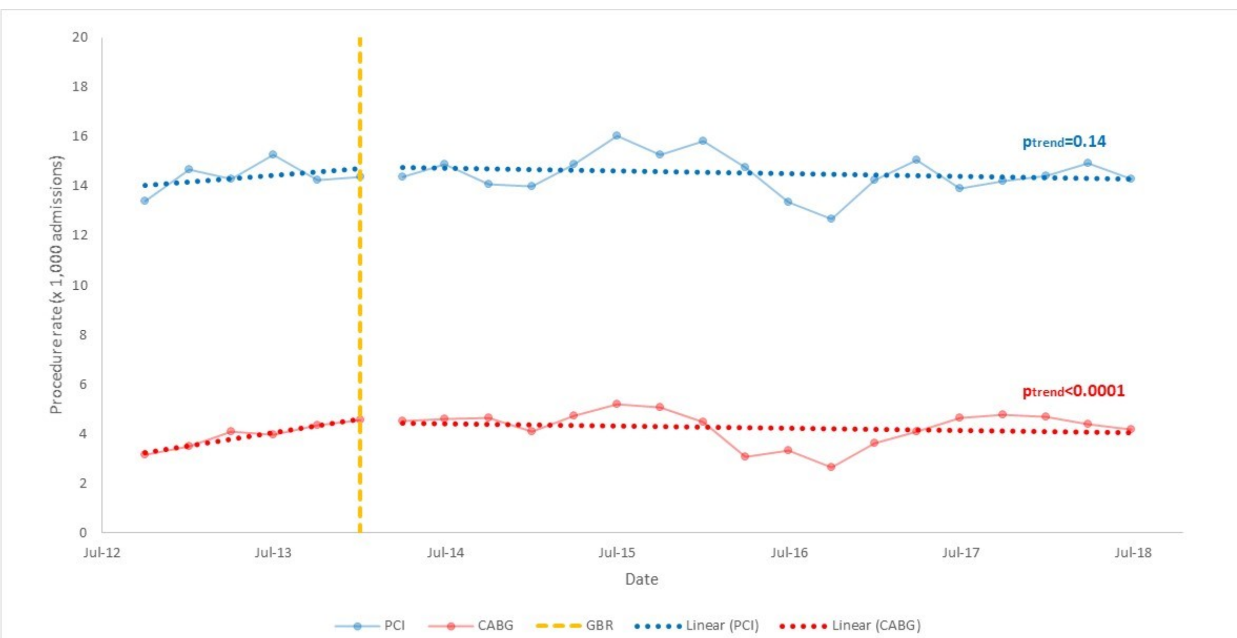


Figure 4: Yearly Risk Standardized Mortality Rates.

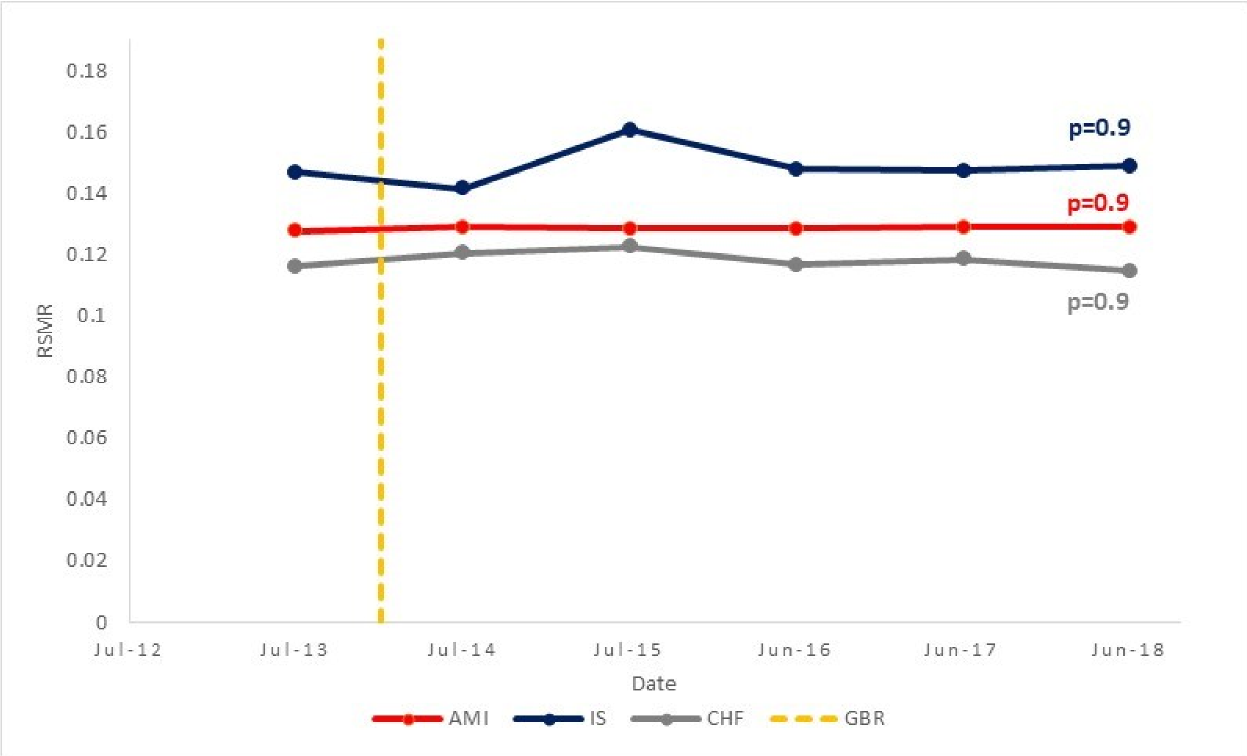


Figure 5a: EKG rates and volumes.

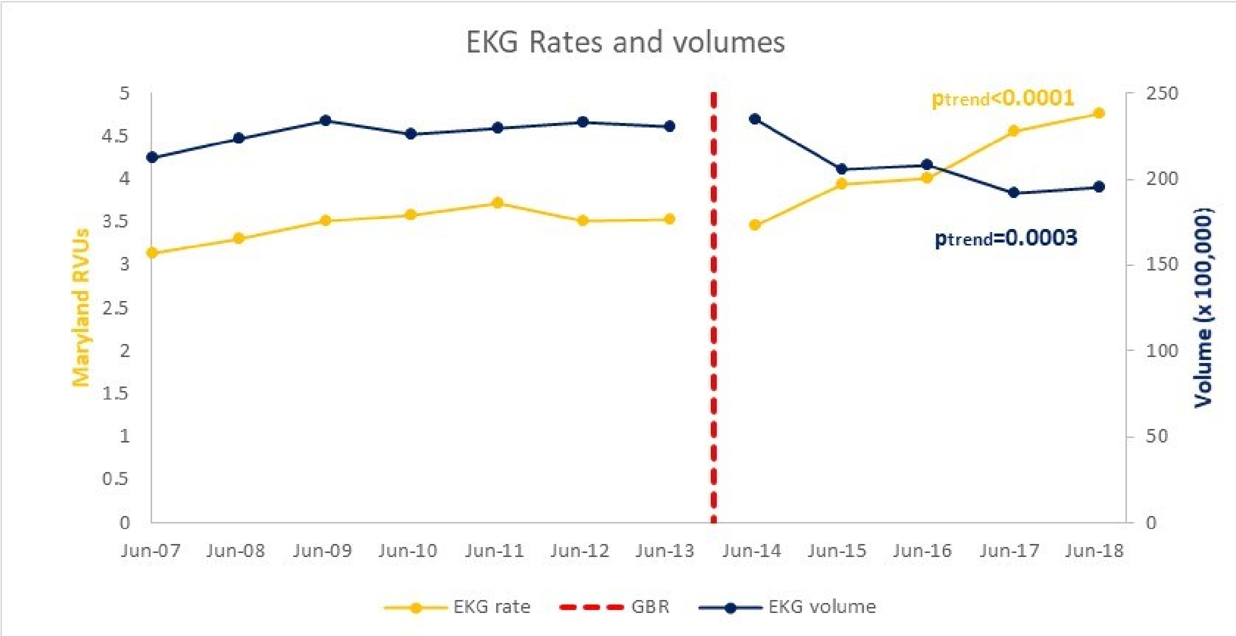


Figure 5b: IRC rates and volumes

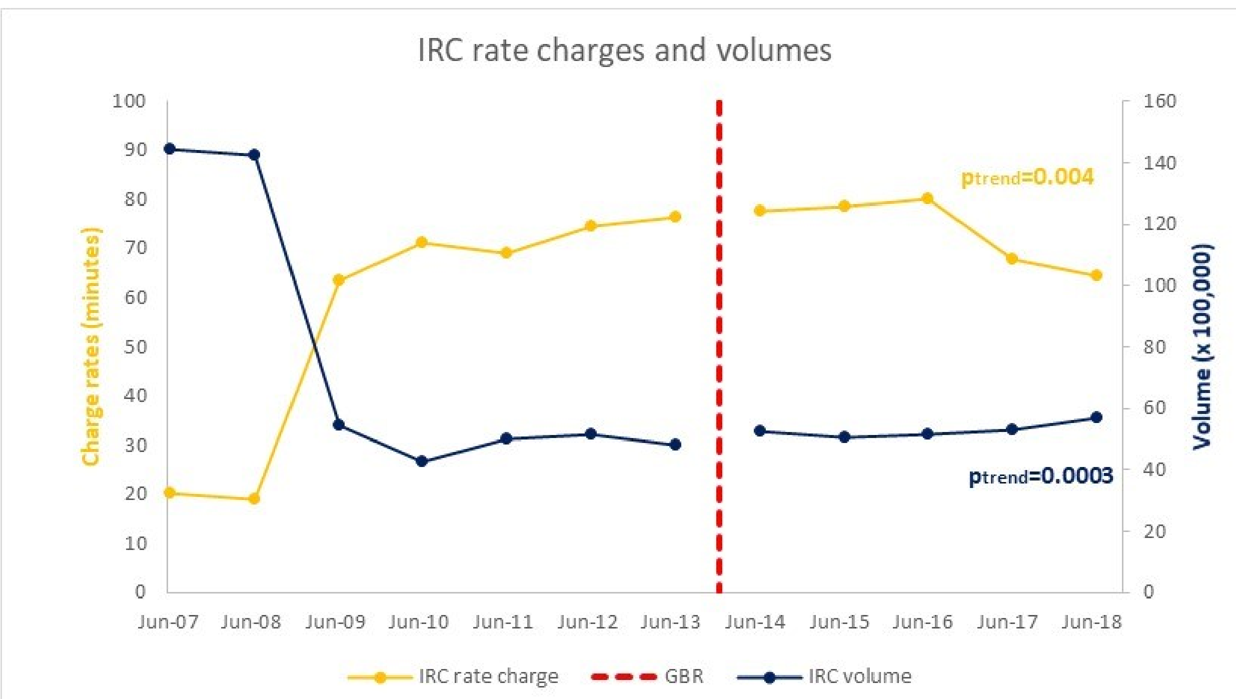


Figure Legends

Figure 1: Hospitalization rates and charges before and after implementation of global budgets in three cardiovascular conditions. Figure 1a: acute myocardial infarction (AMI) hospitalization and charges. Figure 1b: ischemic stroke (IS) hospitalization and charges. Figure 1c: congestive heart failure (CHF) hospitalization and charges. Circles represent hospitalizations and squares represent inflation adjusted charges. Yellow dashed line represents time of adoption of Global Budget Revenue (GBR). Dotted lines indicate linear trend. P value indicates p for trend.

Figure 2: Risk adjusted readmission rates by condition before and after implementation of global budgets. Circles represent casemix-adjusted readmission rates (CARR). Red: acute myocardial infarction (AMI). Dark blue: ischemic stroke (IS). Grey: congestive heart failure (CHF). Yellow dashed line represents time of adoption of Global Budget Revenue (GBR). Dotted lines indicate linear trend. P value indicates p for trend.

Figure 3a: Length of stay (days) in three cardiovascular conditions before and after implementation of global budgets. Red: acute myocardial infarction (AMI). Dark blue: ischemic stroke (IS). Grey: congestive heart failure (CHF). Yellow dashed line: time of adoption of Global Budget Revenue (GBR). Dotted lines indicate linear trend. P value indicates p for trend.

Figure 3b: Inpatient procedure volumes before and after implementation of global budgets. Blue: PCI. Red: coronary artery bypass graft surgery (CABG) procedures. Yellow dashed line represents time of adoption of Global Budget Revenue (GBR). Dotted lines indicate linear trend. P value indicates p for trend.

Figure 4: Yearly Inpatient Risk Standardized Mortality Rates before and after implementation of global budget. Red: acute myocardial infarction (AMI). Dark blue: ischemic stroke (IS). Grey: congestive heart failure (CHF). Yellow dashed line represents time of adoption of Global Budget Revenue (GBR). P value indicates trend by Cochran Armitage statistic.

Figure 5a: Revenue center "electrocardiography" ("EKG") rates and volumes before and after implementation of global budgets. Yellow: EKG rates. Blue: EKG volumes. Red dashed line: time of adoption of Global Budget Revenue (GBR). P value indicates p for trend.

Figure 5b: Revenue center "interventional radiology/cardiology"("IRC") rates and volumes before and after implementation of global budgets. Yellow: IRC rates. Blue: IRC volumes. Red dashed line: time of adoption of Global Budget Revenue (GBR). P value indicates p for trend.

SUPPLEMENTAL MATERIAL

Supplemental Methods

International disease classification codes defining discharge diagnoses

Congestive Heart Failure:

ICD-9: '402.01', '402.11', '402.91', '404.01', '404.03', '404.11', '404.13', '404.91', '414.93', '428.xx' (i.e., '428.0', '428.1', '428.20', '428.21', '428.22', '428.23', '428.30', '428.31', '428.32', '428.33', '428.40', '428.41', '428.42','428.43', or '428.9')

ICD-10:
'I11.0','I13.0','I13.2','I5.01','I50.20','I50.21','I50.22','I50.23','I50.30','I50.31','I50.32','I50.33','I50.40','I50.41','I50.42','I50.43','I50.9'

Ischemic stroke:

ICD-9: '433.01','433.11','433.21','433.31','433.81','433.91','434.01','434.11','434.91','436'.

ICD-10:
'I63.00','I63.011','I63.012','I63.019','I63.02','I63.031','I63.032','I63.039','I63.09','I63.10','I63.111','I63.112','I63.119','I63.12','I63.131','I63.132','I63.139','I63.19','I63.20','I63.211','I63.212','I63.219','I63.22','I63.231','I63.232','I63.239','I63.29','I63.30','I63.311','I63.312','I63.319', 'I63.321','I63.322','I63.329','I63.331','I63.332','I63.339', 'I63.341','I63.342','I63.349','I63.39','I63.40','I63.411','I63.412','I63.419','I63.421','I63.422','I63.429','I63.431','I63.432','I63.439','I63.441','I63.442','I63.449','I63.49','I63.50','I63.511','I63.512','I63.519','I63.521','I63.522','I63.529','I63.531','I63.532','I63.539','I63.541','I63.542','I63.549','I63.59','I63.6','I63.8','I63.9','I67.89';

Acute myocardial infarction:

ICD-9: '410.00','410.01','410.10','410.11','410.20','410.21','410.30','410.31','410.40', '410.41','410.50','410.51','410.60','410.61','410.70','410.71','410.80','410.81','410.90','410.91';

ICD-10: 'I21.01','I21.02','I21.09','I21.11','I21.19','I21.21','I21.29','I21.3','I21.4','I21.9'

Procedural codes used to identify percutaneous coronary intervention (PCI):

ICD-9: '00.66','36.09','17.55', '36.06','36.07'

ICD-10: '0270346', '027034Z', '02703D6', '02703DZ', '02703T6', '02703TZ', '02703Z6', '02703ZZ', '0270446', '027044Z', '02704D6', '02704DZ', '02704T6', '02704TZ', '02704Z6', '02704ZZ', '0271346', '027134Z', '02713D6', '02713DZ', '02713T6', '02713TZ', '02713Z6', '02713ZZ', '0271446', '027144Z', '02714D6', '02714DZ', '02714T6', '02714TZ', '02714Z6', '02714ZZ', '0272346', '027234Z', '02723D6', '02723DZ', '02723T6', '02723TZ', '02723Z6', '02723ZZ', '0272446', '027244Z', '02724D6', '02724DZ', '02724T6', '02724TZ', '02724Z6', '02724ZZ', '0273346', '027334Z', '02733D6', '02733DZ', '02733T6', '02733TZ', '02733Z6', '02733ZZ', '0273446', '027344Z', '02734D6', '02734DZ', '02734T6', '02734TZ', '02734Z6', '02734ZZ', /*ADDED IN RY2019*/'0270356', '027035Z', '0270366', '027036Z', '0270376', '027037Z', '02703E6', '02703EZ', '02703F6', '02703FZ', '02703G6', '02703GZ', '0270456', '027045Z', '0270466', '027046Z', '0270476', '027047Z', '02704E6', '02704EZ', '02704F6', '02704FZ', '02704G6', '02704GZ', '0271356', '027135Z', '0271366', '027136Z', '0271376', '027137Z', '02713E6', '02713EZ', '02713F6', '02713FZ', '02713G6', '02713GZ', '0271456', '027145Z', '0271466', '027146Z', '0271476', '027147Z', '02714E6', '02714EZ', '02714F6', '02714FZ', '02714G6', '02714GZ', '0272356', '027235Z', '0272366', '027236Z', '0272376', '027237Z', '02723E6', '02723EZ', '02723F6', '02723FZ', '02723G6', '02723GZ', '0272456', '027245Z', '0272466', '027246Z', '0272476', '027247Z', '02724E6', '02724EZ', '02724F6', '02724FZ', '02724G6', '02724GZ', '0273356', '027335Z', '0273366', '027336Z', '0273376', '027337Z', '02733E6', '02733EZ', '02733F6', '02733FZ', '02733G6', '02733GZ', '0273456', '027345Z', '0273466', '027346Z', '0273476', '027347Z', '02734E6', '02734EZ', '02734F6', '02734FZ', '02734G6', '02734GZ', '02C03Z6', '02C03ZZ', '02C04Z6', '02C04ZZ', '02C13Z6', '02C13ZZ', '02C14Z6', '02C14ZZ', '02C23Z6', '02C23ZZ', '02C24Z6', '02C24ZZ', '02C33Z6', '02C33ZZ', '02C34Z6', '02C34ZZ'

ICD CM codes used to identify coronary artery bypass grafting (CABG) surgery:

ICD-9: 36.10, 36.11, 36.12, 36.13, 36.14, 36.15, 36.16, 36.17, 36.18, 36.19.

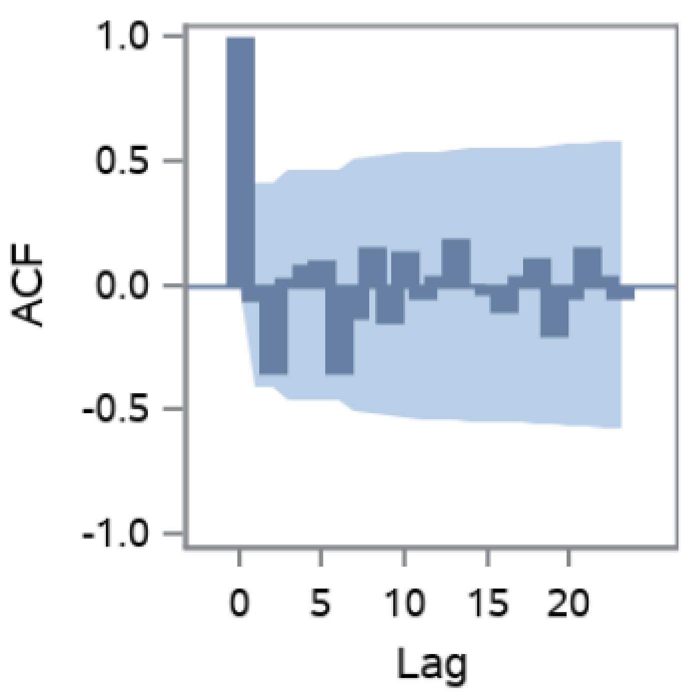
ICD-10: '0210093', '02100A3', '02100J3', '02100K3', '02100Z3', '0210493', '02104A3', '02104J3', '02104K3', '02104Z3', '021009W', '02100AW', '02100JW', '02100KW', '021049W', '02104AW', '02104JW', '02104KW', '021109W', '02110AW', '02110JW', '02110KW', '021149W', '02114AW', '02114JW', '02114KW', '021209W', '02120AW', '02120JW', '02120KW', '021249W', '02124AW', '02124JW', '02124KW', '021309W', '02130AW', '02130JW', '02130KW', '021349W', '02134AW', '02134JW', '02134KW', '0210098', '0210099', '021009C', '02100A8', '02100A9', '02100AC', '02100J8', '02100J9', '02100JC', '02100K8', '02100K9', '02100KC', '02100Z8', '02100Z9', '02100ZC', '0210498', '0210499', '021049C', '02104A8', '02104A9', '02104AC', '02104J8', '02104J9', '02104JC', '02104K8', '02104K9', '02104KC', '02104Z8', '02104Z9', '02104ZC', '0211098', '0211099', '021109C', '02110A8', '02110A9', '02110AC', '02110J8', '02110J9', '02110JC', '02110K8', '02110K9', '02110KC', '02110Z8', '02110Z9', '02110ZC', '0211498', '0211499', '021149C', '02114A8', '02114A9', '02114AC', '02114J8', '02114J9', '02114JC', '02114K8', '02114K9', '02114KC', '02114Z8', '02114Z9', '02114ZC', '0212098', '0212099', '021209C', '02120A8', '02120A9', '02120AC', '02120J8', '02120J9', '02120JC', '02120K8', '02120K9', '02120KC', '02120Z8', '02120Z9', '02120ZC', '0212498', '0212499', '021249C', '02124A8', '02124A9', '02124AC', '02124J8', '02124J9', '02124JC', '02124K8', '02124K9', '02124KC', '02124Z8', '02124Z9', '02124ZC', '0213098', '0213099', '021309C', '02130A8', '02130A9', '02130AC', '02130J8', '02130J9', '02130JC', '02130K8', '02130K9', '02130KC', '02130Z8', '02130Z9', '02130ZC', '0213498', '0213499', '021349C', '02134A8', '02134A9', '02134AC', '02134J8', '02134J9', '02134JC', '02134K8', '02134K9', '02134KC', '02134Z8', '02134Z9', '02134ZC', '0210083', '0210088', '0210089', '0210483', '0210488', '0210489', '0211083', '0211088', '0211089', '0211093', '0211483', '0211488', '0211489', '0211493', '0212083', '0212088', '0212089', '0212093', '0212483', '0212488', '0212489', '0212493', '0213083', '0213088', '0213089', '0213093', '0213483', '0213488', '0213489', '0213493', '021008C', '021008F', '021008W', '021009F', '02100AF', '02100JF', '02100KF', '02100ZF', '021048C', '021048F', '021048W', '021049F', '02104AF', '02104JF', '02104KF', '02104ZF', '021108C', '021108F', '021108W', '021109F', '02110A3', '02110AF', '02110J3', '02110JF', '02110K3', '02110KF', '02110Z3', '02110ZF', '021148C', '021148F', '021148W', '021149F', '02114A3', '02114AF', '02114J3', '02114JF', '02114K3', '02114KF', '02114Z3', '02114ZF', '021208C', '021208F', '021208W', '021209F', '02120A3', '02120AF', '02120J3', '02120JF', '02120K3', '02120KF', '02120Z3', '02120ZF', '021248C', '021248F', '021248W', '021249F', '02124A3', '02124AF', '02124J3', '02124JF', '02124K3', '02124KF', '02124Z3', '02124ZF', '021308C', '021308F', '021308W', '021309F', '02130A3', '02130AF', '02130J3', '02130JF', '02130K3', '02130KF', '02130Z3', '02130ZF', '021348C', '021348F', '021348W', '021349F', '02134A3', '02134AF', '02134J3', '02134JF', '02134K3', '02134KF', '02134Z3', '02134ZF'

Statistical Methods

We conducted a single series interrupted time series (ITS) analysis using segmental regression with autoregressive error modeling, accounting for sequential correlation of data across timepoints (autocorrelation). The analysis was conducted using the SAS software PROC AUTOREG, which tests for data correlation and provides estimates of autoregressive parameters (Penfold, et al. Use of interrupted time series analysis in evaluating health care quality improvements. Acad Pediatr 2013. doi: 10.1016/j.acap.2013.08.002). To fit the model, we used maximum likelihood testing up to 4 lags accounting for quarterly seasonal trends. A Durbin-Watson test was used to test for the presence of autocorrelation. Finally, the log likelihood for the overall model was produced to assess the overall quality of the model. An example is outlined below:

```
PROC AUTOREG DATA=work.ChargesIS_Autoreg OUTEST=ChargesIS_Autoreg_parmest;
MODEL mean_tot_chg =  t  x tx/
METHOD=ml  NLAG=4  BACKSTEP  DWPROB  LOGLIKL;
OUTPUT out=ITS_infl_chg_IS_AR  p=pvar  r=rvar;
RUN;
```

We identified the optimal order of autocorrelation by computing the autocorrelation function (ACF) up to a specified lag of 4, considering seasonality of quarterly data. The highest lag order with significance was chosen as the prespecified lag order. Based on ACF patterns, we adopted a default lag of 1, adjusting for autocorrelation with Newey-West standard errors. A visual example of ACF pattern is shown below:



To adjust for the presence of autocorrelation, we adopted the previously described SAS macro SITSA_VARS with Bartlett kernel, which provides autocorrelation-adjusted standard errors according to Newey-West (Caswell, https://www.linkedin.com/pulse/interrupted-time-series-analysis-single-comparative-designs-caswell-1/), as outlined in the following example:

```
proc model data=sitsa_vars;

   parms b0 b1 b2 b3;

   &outcome = b0+(b1*t)+(b2*x)+(b3*tx);

   fit &outcome / covb gmm kernel=(bart,&lagl,0) vardef=n;

   test b1+b3;

run; quit;
```

where &lagl is lag+1.

We adopted a different methodology to assess trends of Risk Standardized Mortality Rates (RSMR) over time. Since RSMR were calculated yearly by FY, given the scarcity of datapoints, we adopted the Cochran-Armitage trend test to evaluate the null hypothesis that no significant mortality trend was present between FY 2013 (before policy implementation) and 2018 (after policy implementation). We designed a 2-way table for the binomial proportion over time, and used the SAS command PROC FREQ to compute the 2-sided p value (https://support.sas.com/documentation/cdl/en/statug/63033/HTML/default/viewer.htm#statug_freq_a0000000645.htm) (as seen in the example):

```
proc freq data=HF_RSMR;
    tables FY*RSMR / trend measures cl ;
    test smdrc;
    weight Count;
    title 'Cochran-Armitage Test for HF RSMR';
  run;
```

Table I.

The following Maryland hospitals introduced GBP on January 1st, 2014 and were included in the main analysis:

HOSP ID	Acute Hospitals
210002	University of Maryland
210003	Prince George's
210004	Holy Cross Hospital
210005	Frederick Memorial
210006	Harford Memorial Hospital
210008	Mercy Medical Center
210009	Johns Hopkins
210011	St. Agnes Hospital
210012	Lifebridge Sinai Hospital
210013	Bon Secours
210015	MedStar Franklin Square
210016	Washington Adventist
210018	MedStar Montgomery General
210019	Peninsula Regional
210022	Suburban Hospital
210023	Anne Arundel Medical Center
210024	MedStar Union Memorial
210028	MedStar Saint Mary's Hospital
210029	Johns Hopkins Bayview (acute)
210034	MedStar Harbor Hospital
210035	UM Charles Regional Medical Center (Formerly Civista)
210038	UMM Center Midtown Campus (acute) (Formerly Maryland General)
210040	Lifebridge Northwest Hospital
210043	UM Baltimore Washington Medical Center
210044	Greater Baltimore Medical Center
210048	Howard General Hospital
210049	Upper Chesapeake Medical Center
210051	Doctors Community Hospital
210055	Greater Laurel
210056	MedStar Good Samaritan
210057	Shady Grove Adventist
210058	UM Rehab & Orthopaedic Institute (acute) (Formerly Kernan)
210060	Fort Washington
210061	Atlantic General
210062	MedStar Southern Maryland (Formerly 210054)
210063	UM Saint Joseph (Formerly 210007)

210065	Holy Cross Hospital- Germantown

Table II.

The following Maryland hospitals were excluded from the main analysis since they had enrolled in global budget prior to FY 2014:

Hospital	HOSPID
Calvert Memorial Hospital	210039
Carroll Hospital Center	210033
Chester River Hospital Center	210030
Dorchester General Hospital	210010
Edward W. McCready Hospital	210045
Garrett County Memorial Hospital	210017
Memorial Hospital at Easton	210037
Meritus Medical Center	210001
Union Hospital of Cecil County	210032
Western Maryland Regional Medical Center	210027

Table III. Sensitivity analysis including all Maryland hospitals (all admissions). Changes in study outcomes after implementation of global budgets.

Cohort	Outcome	Baseline value	Pre-intervention slope (95% CI)	Post-intervention slope (95% CI)	Absolute difference (95% CI)	p value (level)§	p value (trend)§
CHF							
	Hospitalizations*	71.98	-0.45(-2.32 to 1.41)	0.1(-0.3 to 0.52)	0.56(-1.35 to 2.48)	0.30	0.57
	Casemix adjusted readmission rate, *%*	24.8	-0.2(-0.5 to -0.02)	-0.1(-0.1 to -0.05)	0.1 (-0.09 to 0.4)	0.74	0.22
	Risk Standardized Mortality Rate, *%*	11.5	NC	NC	NC	NC	0.99ǂ
	Length of stay, *days*	4.94	-0.02(-0.05 to 0.01)	0.01 (-0.002 to 0.02)	0.03 (-0.003 to 0.06)	0.002	0.08
	Mean inflation-adjusted charges, *$*	13895.86	-34.02 (-176.01 to 107.97)	61.29 (26.75 to 95.85)	95.31 (-48.48 to 239.11)	0.16	0.20
AMI							
	Hospitalizations*	36.96	-0.46(-0.94 to 0.02)	-0.14(-0.30 to 0.01)	0.31(-0.18 to 0.82`q)	0.03	0.23
	Casemix adjusted readmission rate, *%*	12.3	0.3 (0.03 to 0.5)	-0.08 (-0.16 to 0.003)	-0.3 (-0.6 to -0.1)	0.07	0.01
	Risk Standardized Mortality Rate, *%*	12.8	NC	NC	NC	NC	0.99ǂ
	Length of stay, *days*	4.10	0(-0.04 to 0.04)	-0.004 (-0.01 to 0.005)	-0.005 (-0.05 to 0.04)	0.41	0.83
	Mean inflation-adjusted charges, *$*	21223.29	299.70 (191.52 to 407.89)	4.61 (-61.73 to 70.95)	-295.09 (-419.92 to - 177.26)	0.08	0.0002
Ischemic stroke							
	Hospitalizations*	33.52	0.68 (0.51 to 0.86)	0.09 (0.05 to 0.13)	-0.59(-0.78 to -0.4)	0.0002	<0.0001
	Casemix adjusted readmission rate, *%*	10.0	0.06 (-0.2 to 0.3)	-0.03 (-0.09 to 0.03)	-0.09 (-0.3 to 0.2)	0.78	0.53
	Risk Standardized Mortality Rate, *%*	14.7	NC	NC	NC	NC	0.98ǂ
	Length of stay, *days*	4.98	-0.03(-0.06 to 0.003)	-0.01 (-0.02 to 0.004)	0.019 (-0.01 to 0.05)	0.81	0.31
	Mean inflation-adjusted charges, *$*	15546.29	-77.86 (-138.86 to -16.86)	121.38 (72.87 to 169.90)	199.24 (127.40 to 271.09)	0.94	<0.0001
Procedure volumes†							
	PCI	13.19	0.13 (-0.05 to 0.32)	0.009 (-0.03 to 0.05)	-0.12 (-0.32 to 0.07)	0.98	0.23
	CABG	2.88	0.20 (0.18 to 0.22)	-0.02 (-0.06 to 0.01)	-0.22 (-0.27 to-0.18)	0.77	<0.0001

*Hospitalization rates indicated as *n* of admissions per 100,000 residents. †Procedure volumes indicated as *n* of procedures per 1,000 admissions (see Table 1). ǂCochrane-Armitage test for trend. §p-value represents the significance of the test for the change in the slope (trend change), or the absolute change difference (level change) being equal to zero. NC: not calculated.

Table IV: Sensitivity analysis including all Maryland hospitals. Segmented regression analysis of rates and budget volumes for cardiovascular procedures in Maryland before and after GBP.

Revenue center	Outcome measure	Baseline value	Pre-intervention slope (95% CI)	Post-intervention slope (95% CI)	Absolute difference (95% CI)	p value (level)	p value (trend)
EKG							
	Rates, *RVUs*	3.07	0.10 (0.08 to 0.13)	0.21 (0.15 to 0.27)	0.10 (0.03 to 0.17)	0.04	0.02
	Budget volume, *n* x100,000	253.83	1.16 (0.24 to 2.08)	-19.17 (-25.6 to -12.7)	-20.33 (-26.8 to -13.7)	0.03	0.0003
IRC							
	Rates, *RVUs*	11.75	10.67 (7.71 to 13.62)	-3.63(-5.24 to -2.02)	-14.30(-17.97 to -10.62)	0.95	<0.0001
	Budget volume, *n* x100,000	155.92	-18.69 (-28.19 to -9.2)	-0.08 (-0.82 to 0.65)	18.61 (9.08 to 28.14)	0.10	0.005

EKG: "electrocardiography". IRC: interventional cardiology/radiology. RVU: relative value units.