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Economic analysis of mandated protocolized sepsis care in New York hospitals

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Abstract

Objective: Initial evidence suggests that state-level regulatory mandates for sepsis quality improvement are associated with decreased sepsis mortality. However, sepsis mandates require financial investments on the part of hospitals and may lead to increased spending. We evaluated the effects of the 2013 New York State sepsis regulations on the costs of care for patients hospitalized with sepsis.

Design: Retrospective cohort study using state discharge data from the United States Healthcare Costs and Utilization Project and a comparative interrupted time series analytic approach. Costs were calculated from admission-level charge data using hospital-specific cost-to-charge ratios.

Setting: General, short stay, acute care hospitals in New York and four control states: Florida, Massachusetts, Maryland, and New Jersey.

Patients: All patients hospitalized with sepsis between January 1, 2011 and September 30, 2015.

Interventions: The 2013 New York mandate that all hospitals develop and implement protocols for sepsis identification and treatment, educate staff, and report performance data to the state.

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Conflicts of Interest: None

Measurements and Main Results: The analysis included 1,026,664 admissions in 520 hospitals. Mean unadjusted costs per hospitalization in New York State were \$42,036 $\pm$ \$60,940 in the pre-regulation period and \$39,719 $\pm$ \$59,063 in the post-regulation period, compared to \$34,642 $\pm$ \$52,403 pre-regulation and \$31,414 $\pm$ \$48,155 post-regulation in control states. In the comparative interrupted time series analysis, the regulations were not associated with a significant difference in risk-adjusted mean cost per hospitalization ($p=0.12$) or risk-adjusted mean cost per hospital day ($p=0.44$). For example, in the 10th quarter after implementation of the regulations, risk-adjusted mean cost per hospitalization was \$3,627 (95% confidence interval: -\$681 to \$7,934) more than expected in New York State relative to control states.

Conclusions: Mandated protocolized sepsis care was not associated with significant changes in hospital costs in patients hospitalized with sepsis in New York State.

Keywords

sepsis; critical care; emergency departments; health policy; hospital costs

INTRODUCTION

Sepsis is a major financial burden to the United States (US) health care system, with annual hospital-based expenditures exceeding \$20 billion (1–4). These costs represent over 6 percent of total hospitalization costs, making sepsis the single costliest condition treated in US hospitals (2). Governments are increasingly mandating that hospitals develop and implement protocols for timely sepsis recognition and treatment (5). Although these mandates are primarily intended to improve sepsis outcomes, they are likely to have financial implications as well. Sepsis quality improvement is costly, requiring significant financial investments on the part of hospitals in terms of staff time and technological support (6). These costs must be shared among all hospitalized patients, affecting hospital margins in an era of ongoing fiscal constraints. In addition, protocolized sepsis care may be associated with increased intensive care unit (ICU) admission rates and antibiotic use, leading to increased costs at the individual patient level (7).

In this context it is important to understand the overall impact of state sepsis regulations on hospital resource utilization. Accordingly, we sought to evaluate the economic effects of the 2013 New York State sepsis regulations, the first state-level sepsis regulations in the US. These regulations, colloquially known as “Rory’s Regulations” after Rory Staunton, a 12-year old boy who died of sepsis in a New York hospital, mandate that all hospitals in the state develop and implement evidence-based protocols for timely sepsis identification and management; as well as educate staff about sepsis care and report data on protocol adherence and clinical outcomes annually to the state Department of Health (5). Early data suggest that these regulations were associated with improved clinical outcomes (8, 9). To examine their effects on costs we used a comparative interrupted time series approach, comparing changes in costs over time in New York with controls states that did not adopt sepsis regulations during this time.

MATERIALS AND METHODS

Study design and data

We performed a retrospective cohort study of hospitalized patients with sepsis. We used a comparative interrupted time series analytic approach, comparing hospital costs in New York State with four control states: Florida, Massachusetts, Maryland, and New Jersey. These control states were chosen because of their similar demographic characteristics and, except for Florida, geographical proximity to New York State. The analysis was specifically designed to understand the economic impact of the state-wide sepsis policy in New York. Such an analysis is distinct from an economic analysis of sepsis bundles themselves, for which the comparator group would be patients that did not receive the bundle, rather than states not subject to the policy.

To support the rigor and reproducibility of our results, all analyses were pre-specified and a complete statistical analysis plan was pre-published on Open Science Framework prior to beginning the analysis (<https://osf.io/jcwdv/>). Deviations from this plan due to unforeseen circumstances and additional details are described in the Supplementary Methods (see Supplementary Digital Content).

We obtained data from the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project (HCUP) State Inpatient Database (SID). The SID contains patient-level administrative data for all hospital admissions in participating states. We used SID data from January 1, 2011 to September 30, 2015. We linked the SID data to hospital-level data from the 2015 Centers for Medicare and Medicaid Healthcare Cost Reporting Information System (HCRIS) to obtain hospital characteristics such as hospital type, number of beds, academic status, and cost-to-charge ratios; and to the 2010 United States Census to obtain data on each hospital's metropolitan statistical area population.

Patients and hospitals

We identified hospital admissions with sepsis based on a modified Dombrovskiy definition using *International Classification of Diseases*, Version 9.0—Clinical Modification (ICD-9-CM) diagnosis and procedure codes for infection and organ failure (10). We excluded admissions for hospital births, admissions to hospitals that could not be identified in HCRIS, and admissions with missing or invalid data for key covariates. We excluded hospitals if they were not classified as short stay acute care hospitals by HCRIS or had no sepsis admissions. In order to increase the homogeneity of the sample, we also excluded hospital types that were not shared across New York State and control states both before and after the introduction of the regulations. Additional details are provided in the Supplementary Methods (see Supplementary Digital Content).

Variables

We defined the pre-regulation period as hospitalizations occurring from January 1, 2011 through March 31, 2013; and the post-regulation period as hospitalizations occurring from April 1, 2013 through September 30, 2015. We chose this cut-off because it most closely aligned with the date that hospitals were required to begin developing and implementing

sepsis protocols under the regulations. The primary outcome variables were cost per hospitalization and cost per hospital day, from the hospitals' perspective. We used the hospital perspective because hospitals are generally responsible for bearing the costs of sepsis quality improvement. We calculated costs per hospitalization by multiplying the total charges for each hospitalization from the SID by the hospital and year-specific all-payer inpatient cost-to-charge ratios from HCUP (11). In the case of missing cost-to-charge ratios we used a weighted mean of the cost-to-charge ratios for the hospital's peer group within each state. A secondary outcome was cost per day, calculated as total hospitalization cost divided by the hospital length of stay. All costs were adjusted for inflation using the consumer price index and are presented in 2019 US dollars (12). Additional patient- and hospital-level variables were defined as previously described (8).

Statistical analyses

We used chi-squares to compare hospital characteristics between New York State and control states. We examined patient characteristics between New York State and control states before and after implementation of the regulations, but did not formally test for differences since all tests were expected to be significant due to the large sample size.

To examine the association between the New York State sepsis regulations and costs we fit a series of comparative interrupted time series models. These models compare temporal changes in outcomes between New York State and control states, adjusting for potential confounders and underlying temporal trends (13, 14). We fit all models using linear regression with robust standard errors clustered at the hospital level. Variables for risk-adjustment are described in prior work (8, 15). All models included a continuous time variable, in quarters, as well as indicator covariates for each post-regulation quarter. To estimate the effect of the regulations we fit interaction terms between each post-regulation quarter and intervention group (i.e., New York State versus control states). The coefficients for these interaction terms are interpreted as the estimated effect of the regulations in the given quarter. This modelling approach allows for the effect of the regulations to vary over time, such as might occur if the major impact of the regulation did not occur until sometime after our selected cut-off date. Our overall test of the regulation's effect was a joint test that all of the quarter specific estimates were equal to zero.

Subgroup and sensitivity analyses

We performed three pre-specified subgroup analyses to understand potential heterogeneity of treatment effects. Subgroups were based on patient age (<18 years versus ≥18 years), admission through the emergency department (yes versus no), and admission to a hospital belonging to the Children's Hospital Association (yes versus no). These subgroups reflect *a priori* hypotheses that the regulations may have differential impacts in younger patients, since the regulations were specifically implemented in response to a pediatric death; patients admitted through the emergency department, who may be more sensitive to the regulation's effects; and patients admitted to Children's Hospital Association members, which may already provide high-quality sepsis care. For each subgroup we tested for heterogeneity of treatment effects using three-way interaction terms and applying the Bonferroni method to correct for multiple comparisons.

We performed three pre-specified sensitivity analyses to examine the robustness of our findings to the study assumptions. First, we repeated our analysis excluding New York City area hospitals that were members of the Greater New York Hospital Association—these hospitals had previously participated in a region-wide sepsis quality improvement initiative. This sensitivity analysis addressed the possibility that these hospitals had already invested in sepsis quality improvement prior to the regulations. Second, we repeated our analysis by successively limiting control states to those with pre-intervention trends that were most similar to New York, addressing the possibility that our control states may not be sufficiently similar to New York. Third, we repeated our analysis including interaction terms between all patient covariates and age, allowing for the effects of the model covariates to vary with age, potentially improving the quality of our risk-adjustment.

Full model specifications are provided in the Supplementary Methods (see Supplementary Digital Content). All statistical analyses were performed with Stata 15.1 (StataCorp, College Station, Texas). A p-value ≤ 0.05 was considered significant. This study was reviewed and approved by the University of Pittsburgh Human Research Protections Office.

RESULTS

Hospital and patient characteristics

After patient and hospital exclusions, there were 330,285 sepsis admissions in 163 hospitals in New York State, and 696,379 sepsis admissions in 346 hospitals in control states (Supplementary Figure 1 in the Supplementary Digital Content). Hospitals in New York and control states were generally similar, although hospitals in New York State were more likely to be teaching hospitals and have fewer than 100 beds (Table 1). Patients in New York and control states were also generally similar, although patients in New York State were less likely to be admitted to the ICU, both before and after the regulations (Table 2).

Unadjusted costs

Unadjusted costs per sepsis hospitalization were higher in New York State compared to control states, both before and after the regulations (Table 2). Mean costs in New York were $\$42,036 \pm \$60,940$ in the pre-regulation period and $\$39,719 \pm \$59,063$ in the post-regulation period, compared to $\$34,642 \pm \$52,403$ pre-regulation and $\$31,414 \pm \$48,155$ post-regulation in control states. Costs per hospital day, however, were similar in New York and control states: mean costs per day in New York were $\$2,761 \pm 1,682$ in the pre-regulation period and $\$2,874 \pm 1,777$ in the post-regulation period, compared to $\$2,961 \pm 2,113$ pre-regulation and $\$2,910 \pm 2,139$ post-regulation in control states (Table 2). Unadjusted costs per quarter are shown in Figure 1. The figures suggest that mean costs decreased steadily over time in both New York and control states, while mean costs per day remained generally constant over time.

Model-adjusted costs

The results of the comparative interrupted time series analyses are shown in Figure 2 and Table 3. Figure 2 shows adjusted costs per quarter in the post-regulation period in comparison to counterfactual trends. Table 3 shows the model estimates; i.e. the difference

between New York's adjusted and counterfactual costs, minus the difference between control states' adjusted and counterfactual costs, for each post-regulation quarter. A positive number means that costs were higher than expected after the regulations compared to controls. Controlling for patient characteristics, hospital characteristics, seasonality, and pre-regulation temporal trends, the regulations were associated with increased mean costs per hospitalization. However none of these differences were statistically significant ($p=0.12$ for the joint test of significance). The regulations were not associated with any differences in mean costs per hospital day ($p=0.44$ for the joint test of significance).

Subgroup and sensitivity analyses

In the pre-specified subgroup analyses we found no differences in the regulation's effects on costs per hospitalization by age group (Supplemental Table 1) or emergency department use (Supplemental Table 2). We found a differential effect of the regulation by Children's Hospital Association membership (Supplementary Table 3)—members of the Children's Hospital Association experienced a significant increase in costs per hospitalization after the regulations compared to non-Children's Hospital Association members ($p = 0.003$ for the joint test of significance of the three-way interaction terms between subgroup, group, and quarter, adjusted for multiple comparisons). However, the actual cost differences were modest and not consistent across all quarters.

In the pre-specified sensitivity analyses we found a significant effect of the regulations on hospitalization costs after excluding hospitals that participated in the Greater New York Hospital Association sepsis quality improvement program, demonstrating increased costs associated with the regulations in non-participating New York hospitals (p -value for the joint test of significance = 0.02; Supplementary Table 4 and Supplementary Figure 2). The effect was generally consistent across all post-regulation quarters and was greatest in the tenth post-regulation quarter (\$5,214 relative increase in hospitalization costs in New York State, 95% confidence interval: \$353 to \$10,057). Sensitivity analyses using different control states (Supplementary Table 5 and Supplementary Figure 3) and using a more flexible risk-adjustment model (Supplementary Table 6 and Supplementary Figure 4) were similar to our primary analysis, showing no significant overall effect of the regulations.

DISCUSSION

A novel health policy mandating protocolized sepsis care in New York State was not associated with major differences in either mean cost per hospitalization or cost per hospital day for patients hospitalized with sepsis, compared to similar states that had not adopted such regulations. Taken in context with prior work demonstrating that the New York policy was associated with improvements in risk-adjusted mortality (8, 9), these results provide reassurance that state sepsis mandates have the potential to improve outcomes without substantially increasing hospitalization costs across the state as a whole. Several states are currently considering regulations analogous to those in New York State (5). Policy makers and hospital administrators in those states, as well as evolving national programs, should take these results into account as they design their regulations (16).

Although we found no significant effect of the New York regulations on costs, our results should not be interpreted to mean that the regulations had no relationship with costs whatsoever. Indeed, there are several mechanisms by which these regulations might impact hospital costs. For one, hospitals typically respond to sepsis mandates by hiring dedicated sepsis coordinators and investing in information technology to facilitate sepsis identification and treatment through electronic screening and prompting (6). These costs must be borne by hospitals and are spread over the costs of all hospitalizations in the form of increased overhead (17). In addition, to the degree that sepsis protocols lead to increased ICU use and central line insertion rates (8), sepsis mandates may increase the direct cost for patients with sepsis. However, these increases may be balanced by decreased costs in the form of fewer organ failures and decreased need for organ support, resulting in no net differences (18). Alternatively, it's possible that the overall financial investments in response to sepsis mandates are small in comparison to the overall cost of a sepsis hospitalization, meaning that the net increase is real but negligible. Ultimately our analysis was designed to look at the overall economic impact of the regulations, such that small changes in specific types of costs might not be detected.

Importantly, we did demonstrate a relative increase in costs in New York hospitals that had not previously participated in a prior sepsis quality improvement initiative coordinated by the Greater New York Hospital Association. This initiative was similar to Rory's Regulations in that they both emphasize a protocolized approach to sepsis care. Since New York City hospitals had made earlier investments in protocolized sepsis care, they likely required lower capital investments compared to other hospitals in order to adhere to the regulations. This finding suggests that in regions without substantial prior investment in sepsis quality improvement, state-wide regulations may indeed increase costs. This is not to say that investing in sepsis quality isn't worth the costs—only that in many hospitals investments in quality might reasonably be associated with increases in costs.

We also found a statistically significant increase in hospital costs associated with the regulations in hospitals that are members of the Children's Hospital Association. This finding ran contrary to our hypothesis—that these hospitals would see smaller changes in costs compared to other hospitals. It is possible that these hospitals, which are not exclusively children's hospitals and therefore may see many non-pediatric patients, invested heavily in adult-focused sepsis quality improvement which drove increases in costs. Alternatively, it is possible that this finding was simply due to chance.

Our results are consistent with prior studies suggesting cost increases associated with sepsis bundle implementation (19–21). However, our results differ with others which suggest overall cost savings (22, 23). There are several potential reasons for this difference. For one, those studies evaluated the effects of bundle implementation within hospitals, in which the comparator groups were patients who did not receive the bundle. In contrast, our study evaluated the effects of a state-wide policy, in which the comparator group was states not subject to the policy. For two, prior work typically used a before-after study design, which could be biased by known temporal trends in sepsis outcomes and costs. We used a comparative interrupted time series design with concurrent controls, reducing the chance that temporal trends biased our results.

Our study has several limitations. First, we acknowledge the possibility that our results are sensitive to the modelling approach. However, we pre-specified and pre-published our analytic plan, and performed several sensitivity analyses, substantially reducing the probability of bias due to modelling assumptions. Our results could also be sensitive to our choice of control states, although we believe that is unlikely given our sensitivity analyses which limited the control states to those most similar to New York. Second, we evaluated the mean cost across the population of patients and hospitals, rather than hospital-specific costs. There is evidence that under the regulations some hospitals saw greater improvements in outcome than others (24), potentially due to differential resource investment. It is possible that the economic impact of the regulations was greater in those hospitals as well. Third, we used administrative data rather than granular clinical data, and thus our approach is subject to inaccuracies both in sepsis case identification and the calculation of costs (25). However, these data are uniquely suited to answer this research question, and our comparative interrupted study design specifically addresses potential sources of bias that might arise from the data, since to cause bias inaccuracies would have to occur differentially in New York and control states. Fourth, our results may not generalize outside of New York State. At baseline New York State had higher costs per hospitalization, potentially driven by longer lengths of hospitalizations. It is possible that states with lower sepsis costs may witness significant increases under state sepsis mandates. Fifth, to the degree that hospitals in our control states were actively pursuing sepsis quality improvement independent of any regulations, potentially through independent initiatives or potentially through “spillover effects” of the policy in states neighboring New York, our results might not reflect the true impact of state-level regulations in isolation.

CONCLUSIONS

The introduction of state-wide regulations mandating protocolized sepsis care was not associated with statistically significant changes in mean hospital costs, either per hospital stay or per hospital day. Future work should examine the consistency of these findings in other states and identify strategies for hospitals to respond to sepsis mandates as efficiently and effectively as possible.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1. Unadjusted mean quarter-specific costs in New York State and control states before and after introduction of the New York State sepsis regulations, including mean costs per hospitalization (panel A) and mean costs per hospital day (panel B). The pre-regulation period is shown in solid lines and markers; the post-regulation period is shown in dotted lines and outlined markers. All costs are in 2019 US dollars.

Figure 2.

Results of the comparative interrupted time-series analysis, including mean costs per hospitalization (panel A) and mean costs per hospital day (panel B). Adjusted pre-regulation temporal trends are shown by the dotted lines and are carried forward into the post-regulation period. Costs above the dotted line are higher than expected compared to the counterfactual, and costs below the dotted line are lower than expected. All costs are in 2019 US dollars.

Table 1.

Characteristics of study hospitals

Hospital Characteristics	New York State (N=166)	Control states (N=354)	P-value
Children's Hospital Association member			
Yes	12 (7.2%)	32 (9.0%)	0.49
No	154 (92.8%)	322 (91.0%)	
Teaching status ^a			
Teaching	88 (53.0%)	149 (42.1%)	0.02
Non-teaching	78 (47.0%)	205 (57.9%)	
Hospital size ^a			
>250 beds	62 (37.3%)	138 (39.0%)	0.02
100 to 250 beds	55 (33.1%)	149 (42.1%)	
<100 beds	49 (29.5%)	67 (18.9%)	
ICU size ^a			
25 beds	70 (42.2%)	161 (45.5%)	0.48
< 25 beds	96 (57.8%)	193 (54.5%)	
MSA population size ^b			
1 million	98 (59.0%)	229 (64.7%)	0.21
< 1 million	68 (41.0%)	125 (35.3%)	
Sepsis case volume ^c			
<51	68 (41.0%)	110 (31.1%)	0.07
51 and <125	46 (27.7%)	125 (35.3%)	
125	52 (31.3%)	119 (33.6%)	

All results are frequency (%).

ICU = intensive care unit; MSA = metropolitan statistical area

^aTeaching status, hospital size, and ICU size obtained from the 2015 Centers for Medicare and Medicaid Healthcare Cost Report and Information System. If 2015 data were not available, the most recent non-missing values back to 2010 were carried forward. Teaching status was defined using the full-time resident-to-bed ratio and categorized as: teaching, ratio >0; non-teaching, ratio = 0.

^bMSA size based on the population of the MSA of the hospital ZIP code.

^cSepsis case volume based on mean per quarter volume, during quarters with any observations.

Table 2.

Patient characteristics and unadjusted costs for patients with sepsis.

	New York State		Control states	
	Pre-regulation (n = 140,851)	Post-regulation (n = 189,434)	Pre-regulation (n = 293,412)	Post-regulation (n = 402,967)
Patient characteristics				
Age	70.4 ± 17.5	69.7 ± 17.8	68.6 ± 17.3	68.3 ± 17.3
Female	69,347 (49.2%)	92,177 (48.7%)	140,603 (47.9%)	189,872 (47.1%)
Race/ethnicity				
White	85,314 (60.6%)	114,326 (60.4%)	205,712 (70.1%)	281,148 (69.8%)
Black	24,015 (17.0%)	31,090 (16.4%)	52,696 (18.0%)	67,819 (16.8%)
Hispanic	14,031 (10.0%)	18,049 (9.5%)	25,284 (8.6%)	39,380 (9.8%)
Other	17,491 (12.4%)	25,969 (13.7%)	9,720 (3.3%)	14,620 (3.6%)
Emergency department use	119,778 (85.0%)	164,845 (87.0%)	259,693 (88.5%)	360,384 (89.4%)
Outside hospital transfer	6,995 (5.0%)	9,324 (4.9%)	12,333 (4.2%)	17,102 (4.2%)
ICU admission	83,749 (59.5%)	106,865 (56.4%)	224,387 (76.5%)	301,977 (74.9%)
Length of stay (days)	15.9 ± 19.7	14.4 ± 18.5	12.4 ± 15.2	11.5 ± 14.2
Comorbidities				
0	2,114 (1.5%)	2,571 (1.4%)	3,840 (1.3%)	4,612 (1.1%)
1	8,431 (6.0%)	8,860 (4.7%)	13,438 (4.6%)	17,406 (4.3%)
2 – 3	48,450 (34.4%)	52,289 (27.6%)	77,366 (26.4%)	105,100 (26.1%)
4 or more	81,856 (58.1%)	125,714 (66.4%)	198,768 (67.7%)	275,849 (68.5%)
Organ failures on admission				
0	38,483 (27.3%)	47,328 (25.0%)	70,205 (23.9%)	84,414 (20.9%)
1	63,074 (44.8%)	84,992 (44.9%)	125,278 (42.7%)	174,045 (43.2%)
2 – 3	36,073 (25.6%)	52,046 (27.5%)	88,511 (30.2%)	129,957 (32.3%)
4 or more	3,221 (2.3%)	5,068 (2.7%)	9,418 (3.2%)	14,551 (3.6%)
Costs (in thousands)				
Cost per hospitalization				
Mean ± SD	\$42.0 ± 60.9	\$39.7 ± 59.1	\$34.6 ± 52.4	\$31.4 ± 48.2
Median [IQR]	\$23.1 [11.7 – 47.7]	\$21.8 [11.4 – 44.1]	\$19.4 [10.3 – 38.9]	\$17.5 [9.4 – 34.8]
Cost per hospital day				
Mean ± SD	\$2.8 ± 1.7	\$2.9 ± 1.8	\$3.0 ± 2.1	\$2.9 ± 2.1
Median [IQR]	\$2.4 [1.8 – 3.2]	\$2.5 [1.9 – 3.3]	\$2.4 [1.8 – 3.4]	\$2.4 [1.8 – 3.3]

All results are frequency (%), mean ± standard deviation, or median [interquartile range]

ICU = intensive care unit; SD = standard deviation IQR = inter-quartile range

Table 3.

Risk-adjusted cost differences between New York State and control states, by quarter

Post-intervention quarter	Mean cost difference per hospitalization (95% CI)	Mean cost difference per hospital day (95% CI)
1 (4/1/13 – 6/30/13)	\$1,793 (–198 – 3,784)	–\$65 (–143 – 14)
2 (7/1/13 – 9/30/13)	\$1,479 (–576 – 3,534)	\$5 (–83 – 94)
3 (10/1/13 – 12/31/13)	\$950 (–1,405 – 3,305)	\$30 (–70 – 130)
4 (1/1/14 – 3/21/14)	\$216 (–2,730 – 3,162)	\$5 (–89 – 138)
5 (4/1/14 – 6/30/14)	\$2,555 (–908 – 6,019)	–\$61 (–172 – 90)
6 (7/1/14 – 9/30/14)	\$1,818 (–1,548 – 5,186)	\$10 (–120 – 141)
7 (10/1/14 – 12/31/14)	\$1,782 (–1,435 – 4,998)	\$16 (–121 – 154)
8 (1/1/15 – 3/21/15)	\$2,707 (–1,166 – 6,580)	\$27 (–130 – 184)
9 (4/1/15 – 6/30/15)	\$2,528 (–1,675 – 6,730)	–\$47 (–219 – 125)
10 (7/1/15 – 9/30/15)	\$3,627 (–681 – 7,934)	\$10 (–162 – 182)
Joint test of significance^a	p = 0.12	p = 0.44

CI = confidence interval

Values are the comparative interrupted time series estimates. Estimates adjust for all patient and hospital characteristics as well as pre-regulation temporal trends and season. Estimates are interpreted as the difference between the adjusted outcome and the adjusted counterfactual trend in New York State compared to control states in that quarter. All costs are adjusted for inflation using the consumer price index and are presented in 2019 US dollars.

^aThe joint test of significance examines whether the overall differences between the counterfactual versus actual outcomes are different between New York State and control states.