Management of Patients With Cardiac Arrest Complicating Myocardial Infarction in New York Before and After Public Reporting Policy Changes

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Background—In 2010, New York State began excluding selected patients with cardiac arrest and coma from publicly reported mortality statistics after percutaneous coronary intervention. We evaluated the effects of this exclusion on rates of coronary angiography, revascularization, and mortality among patients with acute myocardial infarction and cardiac arrest.

Methods and Results—Using statewide hospitalization files, we identified discharges for acute myocardial infarction and cardiac arrest January 2003 to December 2013 in New York and several comparator states. A difference-in-differences approach was used to evaluate the likelihood of coronary angiography, revascularization, and in-hospital mortality before and after 2010. A total of 26 379 patients with acute myocardial infarction and cardiac arrest (5619 in New York) were included. Of these, 17 141 (65%) underwent coronary angiography, 12 183 (46.2%) underwent percutaneous coronary intervention, and 2832 (10.7%) underwent coronary artery bypass grafting. Before 2010, patients with cardiac arrest in New York were less likely to undergo percutaneous coronary intervention compared with referent states (adjusted relative risk, 0.79; 95% confidence interval, 0.73–0.85; $P<0.001$). This relationship was unchanged after the policy change (adjusted relative risk, 0.82; 95% confidence interval, 0.76–0.89; interaction $P=0.359$). Adjusted risks of in-hospital mortality between New York and comparator states after 2010 were also similar (adjusted relative risk, 0.94; 95% confidence interval, 0.87–1.02; $P=0.152$ for post- versus pre-2010 in New York; adjusted relative risk, 0.88; 95% confidence interval, 0.84–0.92; $P<0.001$ for comparator states; interaction $P=0.103$).

Conclusions—Exclusion of selected cardiac arrest cases from public reporting was not associated with changes in rates of percutaneous coronary intervention or in-hospital mortality in New York. Rates of revascularization in New York for cardiac arrest patients were lower throughout. (***Circ Cardiovasc Interv*. 2017;10:e004833. DOI: 10.1161/CIRCINTERVENTIONS.116.004833.)**

Key Words: coronary artery bypass ■ heart arrest ■ myocardial infarction ■ New York ■ percutaneous coronary intervention

Public reporting of risk-adjusted mortality statistics after cardiovascular procedures is increasingly used as an outcome measure to compare the quality of physicians and hospitals. New York State was the first to publicly report in-hospital mortality after cardiac surgery and percutaneous coronary intervention (PCI), with other states subsequently implementing similar programs.[1] Healthcare payers have embraced these outcomes and considered using them to determine both individual- and hospital-level reimbursement to provide additional incentives to improve the overall quality of care.[2,3] Many changes have been made in the collection and analysis of clinical outcomes since the institution of public reporting 2 decades ago, possibly with an impact on patient care.[4,5]

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Public reporting of outcomes may lead to physician risk avoidance and inappropriate exclusion of patients from the potential life-saving benefits of revascularization because of perceived high risk.[6–8] This is of particular note in the setting of resuscitated out-of-hospital cardiac arrest where the majority of hospitalized patients do not survive to discharge, dying of neurological causes, or multiorgan failure rather than complications of their cardiovascular care.[9] As a result, the

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WHAT IS KNOWN

- Public reporting of outcomes after PCI is used to compare quality of physicians and hospitals.
- Public reporting of outcomes may lead to inappropriate exclusion of patients from PCI because of perceived high risk.
- Because of concern about physician risk avoidance, in 2010, the New York State Department of Public Health excluded selected patients with cardiac arrest and hypoxic brain injury who undergo PCI from public reporting, but the impact of this policy is unknown.

WHAT THE STUDY ADDS

- The New York State exclusion of selected patients with cardiac arrest from public reporting in 2010 did not impact rates of PCI or in-hospital mortality.
- Rates of coronary angiography or any revascularization remained lower in New York than in referent states throughout the study period.
- Mortality declined in all states over the study period but remained >40%.
- Results were similar when limited to those patients with coma or anoxic brain injury and cardiac arrest.

American Heart Association in 2013 published guidelines recommending against routine public reporting of PCI outcomes in resuscitated cardiac arrest.[9] Despite this report, exclusion of cardiac arrest from publicly reported mortality statistics has not been uniformly adopted by all states.[10–12]

As a result of increasing concern about the impact of physician risk aversion, the New York State Department of Public Health has excluded very selected patients with cardiac arrest and hypoxic brain injury who undergo PCI from public reporting of in-hospital mortality since January 1, 2010.[12] In contrast to the broad exclusion of patients with cardiogenic shock,[4,5] the cardiac arrest exclusion was narrowly defined, requiring documentation of anoxic encephalopathy by a consulting neurologist or intensivist and a chart documentation of consultant agreement with the decision to withdraw care or family requests for care to be withheld.[12] With this in mind, we assessed the change in rates of coronary angiography, PCI, and in-hospital mortality, first, among all myocardial infarction (MI) patients with cardiac arrest and, second, among those with arrest complicated by hypoxic brain injury before and after this policy change in 2010 in New York, compared with several other states during the same time period.

Methods

Study Population

The State Inpatient Databases consist of a group of comprehensive, all-payer, deidentified, inpatient discharge records from hospitals within a given state, published by the Agency for Healthcare Research and Quality as part of the Healthcare Cost and Utilization Project. In this analysis, we utilized the state inpatient databases for New York, Massachusetts, Michigan, and New Jersey from January 1, 2003, to December 31, 2013, and in California from January 1, 2003, to December 31, 2011 (because of availability). New York State was considered to be the primary analytic cohort with the other states included as comparators to control for secular trends. Michigan, New Jersey, and California do not publicly report mortality after PCI, whereas Massachusetts does publicly report mortality and includes patients with cardiac arrest.[10] Massachusetts was included as a comparator state as it lacks a cardiac arrest exclusion,[10] and thus was not expected to significantly affect conclusions on the specific exclusion policy evaluated. However, as Massachusetts, in 2009, began permitting exclusion of selected PCI cases from public reporting for exceptional risk as determined through an individual adjudication protocol,[10] a sensitivity analysis was also performed removing Massachusetts from the analysis to evaluate whether conclusions were altered.

Patients were included in the analysis if they were admitted with a primary or secondary discharge diagnosis of acute MI (AMI) and cardiac arrest in either order using *International Classification of Diseases*, Ninth Edition, Clinical Modification codes. We used discharge codes for AMI, defined by non–ST-segment–elevation MI (410.71 and 410.91) and ST-segment–elevation MI (410.11–410.61 and 410.81) that have been validated in other data sets previously.[13] Cardiac arrest was identified using code 427.5. Patients admitted to hospitals without the capacity to perform PCI or low-volume PCI centers (<10 PCI/y) were excluded. In addition, patients whose disposition was to a short-term facility were excluded to avoid double counting of hospitalizations for the same presentation, but patients transferred to a hospital were included in the analysis. As all patient-level data were deidentified, this study was considered to be exempt from institutional review board approval and research was conducted in accordance with the data use agreement as specified by the Healthcare Cost and Utilization Project, a product of the Agency for Healthcare Research and Quality.

Measurements

Demographic characteristics and pertinent covariates, including patient age, sex, race, and 29 comorbid conditions as defined by the risk-adjustment model developed by the Agency for Healthcare Research and Quality[14] were abstracted from the data set (Table I in the Data Supplement). Validated codes for coma (780.01) and anoxic brain injury (348.1) were used to define the subgroup of cardiac arrest patients with coma or anoxic brain injury.[15] Procedural codes for PCI (*International Classification of Diseases*, Ninth Edition, Clinical Modification codes 00.66, 17.55, 36.01, 36.02, 36.05, 36.06, and 36.07) and coronary angiography (*International Classification of Diseases*, Ninth Edition, Clinical Modification codes 37.21, 37.22, 37.23, 88.52, 88.53, 88.54, 88.55, 88.56, and 88.57) were used to identify those undergoing revascularization.[16] The primary outcomes of the study were the receipt of coronary angiography or PCI and in-hospital all-cause mortality.

Statistical Analysis

Continuous variables are expressed as means+SDs, and dichotomous categorical data are presented as percentages. The data set was stratified into 2 cohorts reflecting the period before the New York State policy change (2003–2010) and the period after this change (2010–2013). Patient characteristics were compared for the periods before and after the policy change for the total sample and in New York and comparator states separately using the t test for continuous variables and the χ^2 test for categorical variables. To evaluate the association of the policy change with rates of coronary angiography, PCI, and in-hospital death for the subgroup of patients with AMI and cardiac arrest, we used a difference-in-differences approach, utilizing a Modified Poisson regression model to evaluate the relative risk of outcomes between New York and comparator states in both the pre- and postpolicy periods (before and after 2010), and evaluating a state×time period interaction term (Figure I in the Data Supplement). Hospital site was included as a random effect in the model to adjust for the clustering of outcomes by hospital. In addition, the regression

model incorporated covariates for age, gender, ST-segment–elevation MI presentation, and the 29 comorbid medical conditions previously mentioned. In addition, to evaluate for yearly temporal trends in treatment and mortality before and after the policy, we constructed similar Modified Poisson multivariate regression models with calendar year as a categorical variable, using each year as a category and 2003 as the reference year.

Sensitivity analyses were performed through repetition of the primary analysis after serial removal of individual comparator states to ensure that the results were not driven by one state. To evaluate for changes in coding that could confound the observed results, we separately evaluated the overall rates of cardiac arrest (as a primary or secondary discharge diagnosis) during the study time period for individuals with AMI (as a primary or secondary diagnosis) and the subgroup of these individuals with coma or anoxic brain injury. All statistical analyses were performed using the statistical software, SAS version 9.4 (SAS Institute Inc, Cary, NC), utilizing 2-sided $P<0.05$ to denote significance.

Results

A total of 36 634 patients with AMI and cardiac arrest between 2003 and 2013 were identified, of whom 26 379 (72%) were included in the analysis (Figure 1). Of these, 5619 (21.3%) were in New York. The mean age (SD) of participants was 68.0 years (13.8) and 9668 were women (36.7%). There were 17 126 (64.9%) patients in the prepolicy period (2003–2010) and 9253 (35.1%) in the postpolicy period (2010–2013). Differences in patient-level covariates are listed in Table 1. In both New York and elsewhere, rates of coronary angiography and PCI were higher after 2010, whereas rates of coronary artery bypass grafting declined (Table 2). Unadjusted rates of coronary angiography or any revascularization (PCI or coronary artery bypass grafting) were lower in New York than in comparator states both before and after 2010. Unadjusted in-hospital mortality remained >40% but declined in both New York and comparator states over the study time period (New York: 42.9% post-2010 and 46.8% pre-2010; $P=0.003$ and comparator states: 45.6% post-2010 and 53.2% pre-2010; $P<0.001$).

After multivariable adjustment for patient demographics and comorbid risk factors, adjusted rates of coronary angiography for MI patients with cardiac arrest remained lower in New York than in comparator states, with no change after the policy implementation (adjusted relative risk [aRR], 0.93; 95% confidence interval [CI], 0.88–0.99; $P=0.035$ pre-2010 versus aRR, 0.90; 95% CI, 0.84–0.96; $P=0.003$ post-2010; interaction $P=0.323$; Figure 2). Similarly, the multivariable adjusted rates of PCI in New York remained lower than in comparator states (aRR, 0.79; 95% CI, 0.73–0.85; $P<0.001$ pre-2010 versus aRR, 0.82; 95% CI, 0.76–0.89; $P<0.001$ post; interaction $P=0.359$). Similar increases in PCI utilization for cardiac arrest patients were observed in both New York and comparator states (Figure 3).

Adjusted in-hospital mortality did not change significantly after implementation of the policy in New York, whereas declining in comparator states although the interaction term was not significant (New York: post-2010 versus pre-2010 aRR, 0.94; 95% CI, 0.87–1.02; $P=0.152$; comparator states: aRR, 0.88; 95% CI, 0.84–0.92; $P<0.001$; interaction $P=0.103$; Figure 4). Adjusted in-hospital mortality for AMI patients with cardiac arrest was lower in New York throughout the study period (New York versus comparator states: pre-2010: aRR, 0.86; 95% CI, 0.80–0.92; $P<0.001$; post-2010: aRR, 0.92; 95% CI, 0.85–1.00; $P=0.52$; P interaction 0.103). Overall, 103 patients (0.07%) in years 2010 to 2012 with cardiac arrest after AMI and anoxic brain injury who expired were excluded from the publicly reported risk-adjusted mortality.[12]

A sensitivity analysis was performed with sequential removal of each state from the analysis, which did not demonstrate any significant changes in the results (Figures II–IV in the Data Supplement). In addition, to assess whether changes in coding that could confound the results, we evaluated overall rates of coding for cardiac arrest over time in the cohort of patients with AMI. This analysis demonstrated numerically

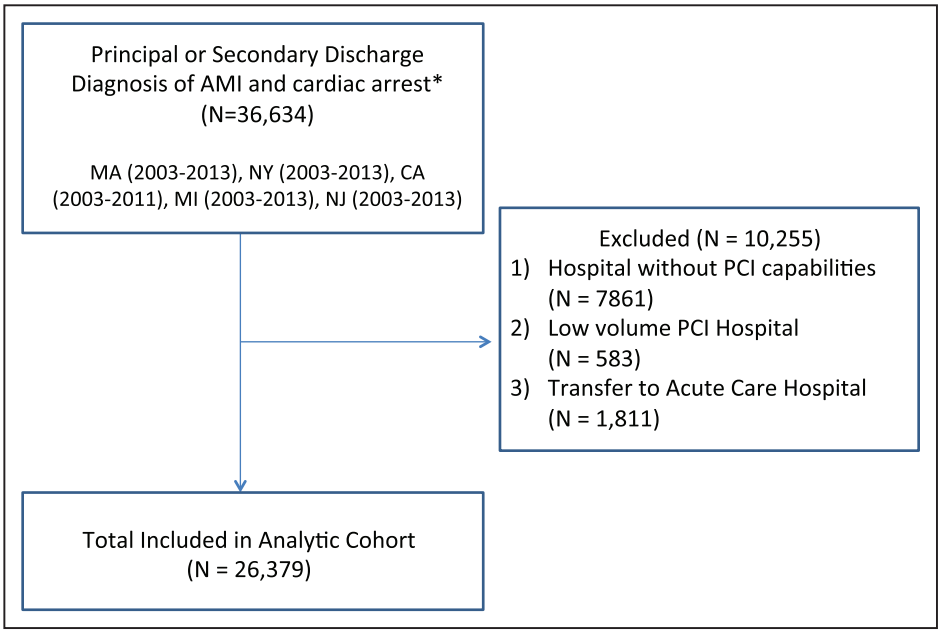

Figure 1. Study design and overview. *Individuals were included in the analysis with a primary or secondary discharge diagnosis of acute myocardial infarction (AMI) and cardiac arrest in either order. CA indicates California; MA, Massachusetts; MI, Michigan; NJ, New Jersey; NY, New York; and PCI, percutaneous coronary intervention.

Table 1. Baseline Characteristics of Patients Presenting With AMI and Cardiac Arrest by Study Period*

	Total (n=26 379)	2003–2009 (n=17 126)	2010–2013 (n=9 253)	*P* Value
Age, mean (SD), y*	68.0±13.8	68.3±13.8	67.4±13.8	<0.001
Female	9668 (36.7)	6435 (37.6)	3233 (34.9)	<0.001
ST-segment–elevation MI	13 188 (50.0)	8575 (50.1)	4613 (49.9)	0.737
Coma	1093 (4.1)	629 (3.7)	464 (5.0)	<0.001
Anoxic brain injury	5697 (21.6)	3630 (21.2)	2067 (22.3)	0.031
Hospital state				<0.001
California	8213 (31.1)	6288 (36.7)	1925 (20.8)	
Massachusetts	2846 (10.8)	1825 (10.7)	1021 (11.0)	
Michigan	6327 (24.0)	3902 (22.8)	2425 (26.2)	
New Jersey	3374 (12.8)	1931 (11.3)	1443 (15.6)	
New York	5619 (21.3)	3180 (18.6)	2439 (26.4)	
Congestive heart failure	689 (2.6)	444 (2.6)	245 (2.6)	0.788
Valvular disease	182 (0.7)	126 (0.7)	56 (0.6)	0.221
Pulmonary circulation disorders	76 (0.3)	50 (0.3)	26 (0.3)	0.874
Peripheral vascular disorders	2827 (10.7)	1695 (9.9)	1132 (12.2)	<0.001
Paralysis	522 (2.0)	334 (2.0)	188 (2.0)	0.650
Other neurological disorders	2510 (9.5)	1553 (9.1)	957 (10.3)	<0.001
Chronic pulmonary disease	4898 (18.6)	3127 (18.3)	1771 (19.1)	0.079
Diabetes mellitus, uncomplicated	6529 (24.8)	4066 (23.7)	2463 (26.6)	<0.001
Diabetes mellitus with chronic complications	1534 (5.8)	965 (5.6)	569 (6.1)	0.088
Renal failure	5438 (20.6)	3528 (20.6)	1910 (20.6)	0.936
Liver disease	347 (1.3)	199 (1.2)	148 (1.6)	0.002
Obesity	2348 (8.9)	1250 (7.3)	1098 (11.9)	<0.001
Hypertension, complicated, and uncomplicated	14 735 (55.9)	9070 (53.0)	5665 (61.2)	<0.001

All data are presented as n (%) of subjects unless otherwise indicated. MI indicates myocardial infarction.
*Age on admission.

lower overall cardiac arrest rates in New York versus comparator states post-AMI and lower rates of cardiac arrest with coma or brain injury (Figures V and VI in the Data Supplement).

In the subgroup with cardiac arrest post-AMI and coma or anoxic brain injury, no significant effect of the policy exclusion on outcomes was observed (Table 3). Adjusted coronary

Table 2. Number (%) of Treatment and Outcomes by State Overall

	New York			Comparator States		
	2003–2010 (n=3180)	2010–2013 (n=2439)	*P* Value	2003–2010 (n=13 946)	2010–2013 (n=6814)	*P* Value
Coronary angiography	1912 (60.1)	1529 (62.7)	0.050	8992 (64.5)	4708 (69.1)	<0.001
PCI	1141 (35.9)	1082 (44.4)	<0.001	6389 (45.8)	3571 (52.4)	<0.001
CABG	405 (12.7)	227 (9.3)	<0.001	1609 (11.5)	591 (8.7)	<0.001
Shock	803 (25.3)	811 (33.3)	<0.001	3415 (24.5)	2073 (30.4)	<0.001
Coma	108 (3.4)	123 (5.0)	0.002	521 (3.7)	341 (5.0)	<0.001
Anoxic brain injury	644 (20.3)	561 (23.0)	0.012	2986 (21.4)	1506 (22.1)	0.256
Any revascularization	1504 (47.3)	1282 (52.6)	<0.001	7688 (55.1)	4056 (59.5)	<0.001
Catheterization or revascularization	2027 (63.7)	1612 (66.1)	0.067	9442 (67.7)	4906 (72.0)	<0.001
In-hospital mortality	1489 (46.8)	1047 (42.9)	0.003	7406 (53.2)	3107 (45.6)	<0.001

Any revascularization is defined by PCI or CABG. CABG indicates coronary artery bypass grafting; and PCI, percutaneous coronary intervention.

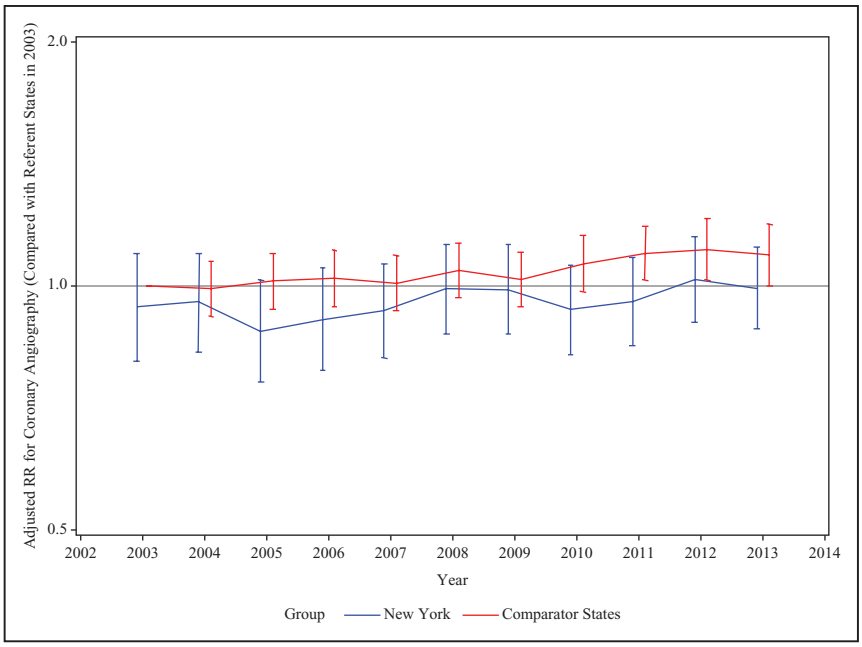

Figure 2. Adjusted relative risk (RR) of patients with acute myocardial infarction and cardiac arrest who undergo coronary angiography annually in New York and comparator states (reference comparator states in 2003). Error bars, 95% confidence interval.

angiography rates remained lower in New York than in comparator states (aRR, 0.79; 95% CI, 0.68–0.91; *P*=0.001 for New York versus comparator states pre-2010 and aRR, 0.74; 95% CI, 0.64–0.86; *P*<0.001 for New York versus comparator states post-2010; interaction *P*=0.526). Similarly, adjusted rates of PCI were lower in New York than in comparator states (aRR, 0.58; 95% CI, 0.48–0.71; *P*<0.001 for New York versus comparator states pre-2010 and aRR, 0.66; 95% CI, 0.55–0,79; *P*<0.001 for New York versus comparator states post-2010; interaction *P*=0.320). Finally, adjusted in-hospital mortality rates did not differ between New York and comparator states with respect to timing of the policy implementation (aRR, 0.94; 95% CI, 0.84–1.04; *P*=0.218 for New York versus comparator states pre-2010 and aRR, 1.01; 95% CI, 0.9–1.14; *P*=0.91 for New York versus comparator states post-2010; interaction *P*=0.370).

Discussion

In this study, we observed that the policy to exclude cardiac arrest patients with anoxic brain injury in New York did not significantly change rates of coronary angiography, PCI, or in-hospital mortality for those individuals with cardiac arrest after AMI. Although rates of coronary angiography, PCI, and any revascularization for patients with cardiac arrest increased in all states over time, they remained lower in New York than in California, Massachusetts, Michigan, and New Jersey throughout the study period. These differences in invasive management were strongest among patients with cardiac arrest with concomitant coma or brain death, despite the policy change targeted at addressing this population.

Many previous studies of have shown results consistent with avoidance of high-risk patients by physicians in public reporting environments.[4–8] To mitigate these effects,

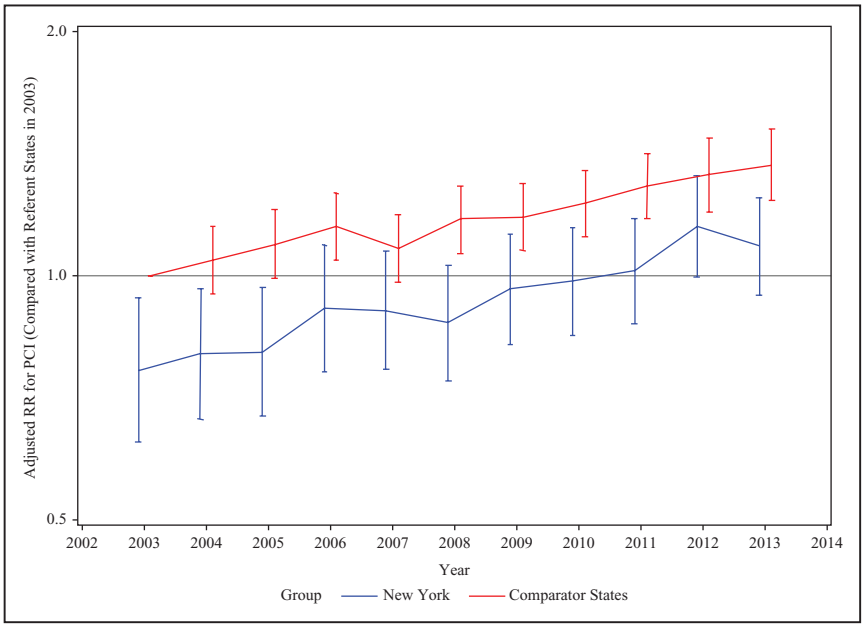

Figure 3. Adjusted relative risk (RR) of patients with acute myocardial infarction and cardiac arrest who undergo percutaneous coronary intervention (PCI) annually in New York and comparator states (reference comparator states in 2003). Error bars, 95% confidence interval.

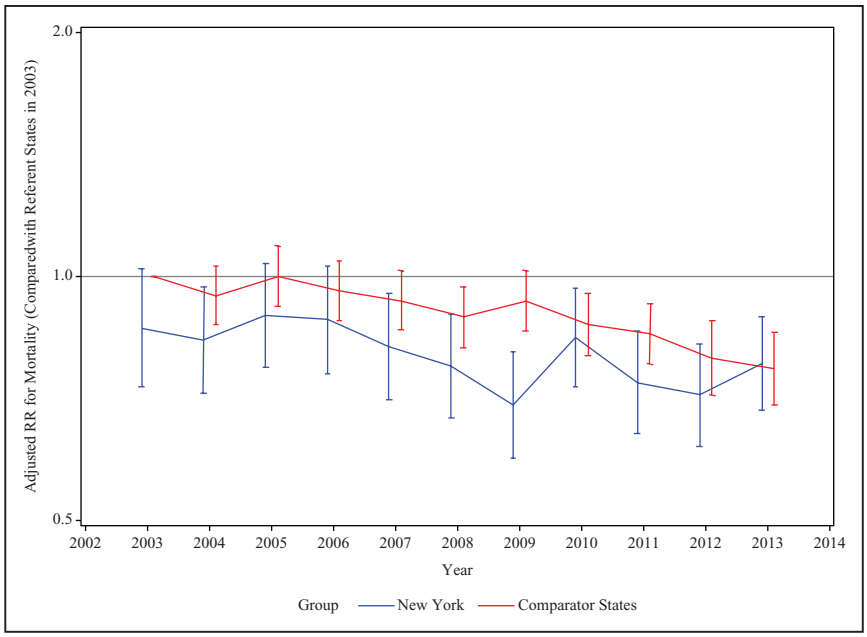

Figure 4. Adjusted relative risk (RR) of in-hospital mortality in patients with acute myocardial infarction and cardiac arrest annually in New York and comparator states (reference comparator states in 2003). Error bars, 95% confidence interval.

both Massachusetts and New York have changed their public reporting methodology, in both cases, to remove potential disincentives to treat high-risk patients such as those with cardiogenic shock or cardiac arrest. In 2006, New York began excluding patients with cardiogenic shock from publicly reported mortality metrics.[12] The 2006 policy in New York resulted in increased rates of PCI and decreased in-hospital mortality in New York despite persistently lower overall rates of PCI relative to other states.[4,5] However, the 2010 change in policy around the exclusion of selected patients with cardiac arrest had not been evaluated previously.

The results of this study are consistent with the idea that such a policy was not sufficient to mitigate physician reluctance to perform procedures in high-risk cases in a public reporting environment. This reluctance may be because of the limited scope of the policy change or continued skepticism among PCI operators on the adequacy of the publically reported risk-adjustment methods used.

The New York State policy exclusion for patients with cardiac arrest after AMI and anoxic brain injury was narrowly defined, and as such, only 103 patients in years 2010 to 2013 with cardiac arrest after AMI and anoxic brain injury who expired were excluded from the publicly reported risk-adjusted mortality, representing 0.07% of all PCI cases during 2010 to 2012 years.[12] Although the New York policy change may have increased the number of individuals with cardiac arrest receiving PCI meeting the narrow exclusion criteria, this information is not captured in the administrative data. However, our study demonstrates that this narrow exclusion was insufficient to alter rates of PCI for the overall population with cardiac arrest. It is possible, therefore, that the narrowly defined exclusion criteria would apply to a small number of patients and would be insufficient to counter

Table 3. Number (%) of Treatment and Outcomes by State in the Subgroup With Coma or Anoxic Brain Injury

	New York			Comparator States		
	2003–2010 (n=668)	2010–2013 (n=608)	*P* Value	2003–2010 (n=3133)	2010–2013 (n=1636)	*P* Value
Coronary angiography	236 (35.3)	256 (42.1)	0.013	1429 (45.6)	932 (57.0)	<0.001
PCI	129 (19.3)	178 (29.3)	<0.001	1046 (33.4)	694 (42.4)	<0.001
CABG	37 (5.5)	25 (4.1)	0.236	122 (3.9)	70 (4.3)	0.521
Shock	183 (27.4)	228 (37.5)	<0.001	793 (25.3)	536 (32.8)	<0.001
Coma	108 (16.2)	123 (20.2)	0.059	521 (16.6)	341 (20.8)	<0.001
Anoxic brain injury	644 (96.4)	561 (92.3)	0.001	2986 (95.3)	1506 (92.1)	<0.001
Any revascularization	202 (33.2)	163 (24.4)	<0.001	1150 (36.7)	756 (46.2)	<0.001
Catheterization or revascularization	267 (43.9)	249 (37.3)	0.015	1491 (47.6)	969 (59.2)	<0.001
In-hospital mortality	384 (63.2)	440 (65.9)	0.312	2176 (69.5)	1010 (61.7)	<0.001

Any revascularization is defined by PCI or CABG. CABG indicates coronary artery bypass grafting; and PCI, percutaneous coronary intervention.

physician concerns on inadequate risk adjustment and the perceived risk of public reporting and thereby would be unsuccessful in influencing PCI operator behavior. Guidelines from the American Heart Association published in 2013 currently recommend the broader exclusion of all cardiac arrests from public reporting.[9] Moreover, although there is robust evidence from randomized trials supporting the role of emergent PCI in cardiogenic shock,[17] there are currently no trials supporting the use of emergent PCI in cardiac arrest, with resultant equipoise in clinical management of these patients. Two studies, the PEARL trial (Pilot Randomized Clinical Trial of Early Coronary Angiography Versus No Early Coronary Angiography for Post-Cardiac Arrest Patients Without ECG ST Segment Elevation; NCT02387398) and the DISCO trial (Direct or Subacute Coronary Angiography for Out-of-Hospital Cardiac Arrest; NCT02309151) are currently enrolling.

In-hospital mortality rates among patients with cardiac arrest declined over time, but remained >40% throughout the study period in both New York and elsewhere. Notably, adjusted in-hospital mortality rates were similar or lower in New York than in comparator states despite the lower revascularization rates. This finding may reflect other difference in quality of care unrelated to coronary revascularization, as well as accurate identification of patients with cardiac arrest for whom PCI may be medically futile in New York, especially given the high-reported mortality in patients with cardiac arrest. Whether increasing the rates of coronary revascularization in New York would change overall mortality results significantly remains unknown.

There are several limitations to this study that are worth noting. First, the data are abstracted from claims data and have limitations including potential errors in coding, inability to capture all relevant comorbidities, and limited data on prehospital and post-resuscitative measures that may be potential confounders (eg, quality of cardiopulmonary resuscitation, response times, and temperature management). In addition, the *International Classification of Diseases*, Ninth Edition, code for cardiac arrest is not specific for out-of-hospital cardiac arrest and may include inpatient cardiac arrests as well for whom physician decision making may differ. The study is observational in nature, and although we conducted an analysis controlling for secular trends through a difference-in-difference approach, causal relationships between the New York policy change and subsequent outcomes cannot be assumed. Next, it is possible that certain regional trends may explain differences in patterns observed. We purposefully chose a geographically diverse control population to help mitigate this concern, and the results from the sensitivity analysis sequentially removing each state were consistent with overall findings. Finally, we were limited in the data set to study in-hospital outcomes.

Conclusions

Patients presenting the MI complicated by cardiac arrest in New York State have lower rates of angiography and PCI compared with other states. These trends continued after the implementation of a policy to excluded selected cardiac arrest patients from public reporting in New York. Mortality after cardiac arrest was high throughout the study period.

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Disclosures

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Management of Patients With Cardiac Arrest Complicating Myocardial Infarction in New York Before and After Public Reporting Policy Changes

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SUPPLEMENTAL MATERIAL

eTable 1. Comorbid Conditions Included in the Agency for Healthcare Research and Quality Risk Adjustment Model

Agency for Healthcare Research and Quality Risk Adjustment Model Variables	ICD-9CM Diagnosis Codes
Congestive heart failure	398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.0- 428.9
Valvular disease	093.20- 093.24, 394.0- 397.1, 397.9, 424.0- 424.99, 746.3- 746.6, V42.2, V43.3
Pulmonary circulation disorders	415.11- 415.19, 416.0- 416.9, 417.9
Peripheral vascular disorders	440-440.9, 441.00- 441.9, 442.0- 442.9, 443.1- 443.9, 444.21- 444.22, 447.1,449, 557.1, 557.9, V43.4
Paralysis	342.0- 344.9, 438.20- 438.53, 780.72
Other neurological disorders	330.1- 331.9, 332.0, 333.4, 333.5, 333.71, 333.72, 333.79, 333.85, 333.94, 334.0- 335.9, 338.0, 340, 341.1- 341.9, 345.00- 345.11, 345.2- 345.3, 345.40- 345.91, 347.00- 347.01, 347.10- 347.11, 649.40- 649.44, 768.7, 768.70, 768.71, 768.72, 780.3, 780.31, 780.32, 780.33, 780.39, 780.97, 784.3
Chronic pulmonary disease	490-492.8, 493.00- 493.92, 494-494.1, 495.0-505, 506.4
Diabetes, uncomplicated	249.00- 249.31, 250.00- 250.33, 648.00- 648.04
Diabetes with chronic complications	249.40- 249.91, 250.40- 250.93, 775.1
Hypothyroidism	243-244.2, 244.8, 244.9

Renal failure	403.01, 403.11, 403.90, 403.91, 404.02, 404.03, 404.12, 404.13, 404.92, 404.93, 585.3, 585.4, 585.5, 585.6, 585.9, 586, V42.0, V45.1, V45.11, V45.12, V56.0- V56.32, V56.8
Liver disease	070.22, 070.23, 070.32, 070.33 , 070.44, 070.54, 456.0, 456.1, 456.20, 456.21, 571.0, 571.2, 571.3, 571.40- 571.49, 571.5, 571.6, 571.8, 571.9, 572.3, 572.8, 573.5, V42.7
Peptic ulcer disease excluding bleeding	531.41, 531.51, 531.61, 531.70, 531.71, 531.91, 532.41, 532.51, 532.61, 532.70, 532.71, 532.91, 533.41, 533.51, 533.61, 533.70, 533.71, 533.91, 534.41, 534.51, 534.61, 534.70, 534.71, 534.91
Acquired immune deficiency syndrome	042-044.9
Lymphoma	200.00- 202.38, 202.50- 203.01, 203.02- 203.82, 203.8- 203.81, 238.6, 273.3
Metastatic cancer	196.0- 199.1, 209.70, 209.71, 209.72, 209.73, 209.74, 209.75, 209.79, 789.51
Solid tumor without metastasis	140.0- 172.9, 174.0- 175.9, 179-195.8, 209.00- 209.24, 209.25- 209.3, 209.30- 209.36, 258.01- 258.03
Rheumatoid arthritis/collagen vascular diseases	701.0, 710.0- 710.9, 714.0- 714.9, 720.0- 720.9, 725
Coagulopathy	286.0- 286.9, 287.1, 287.3- 287.5, 289.84, 649.30- 649.34

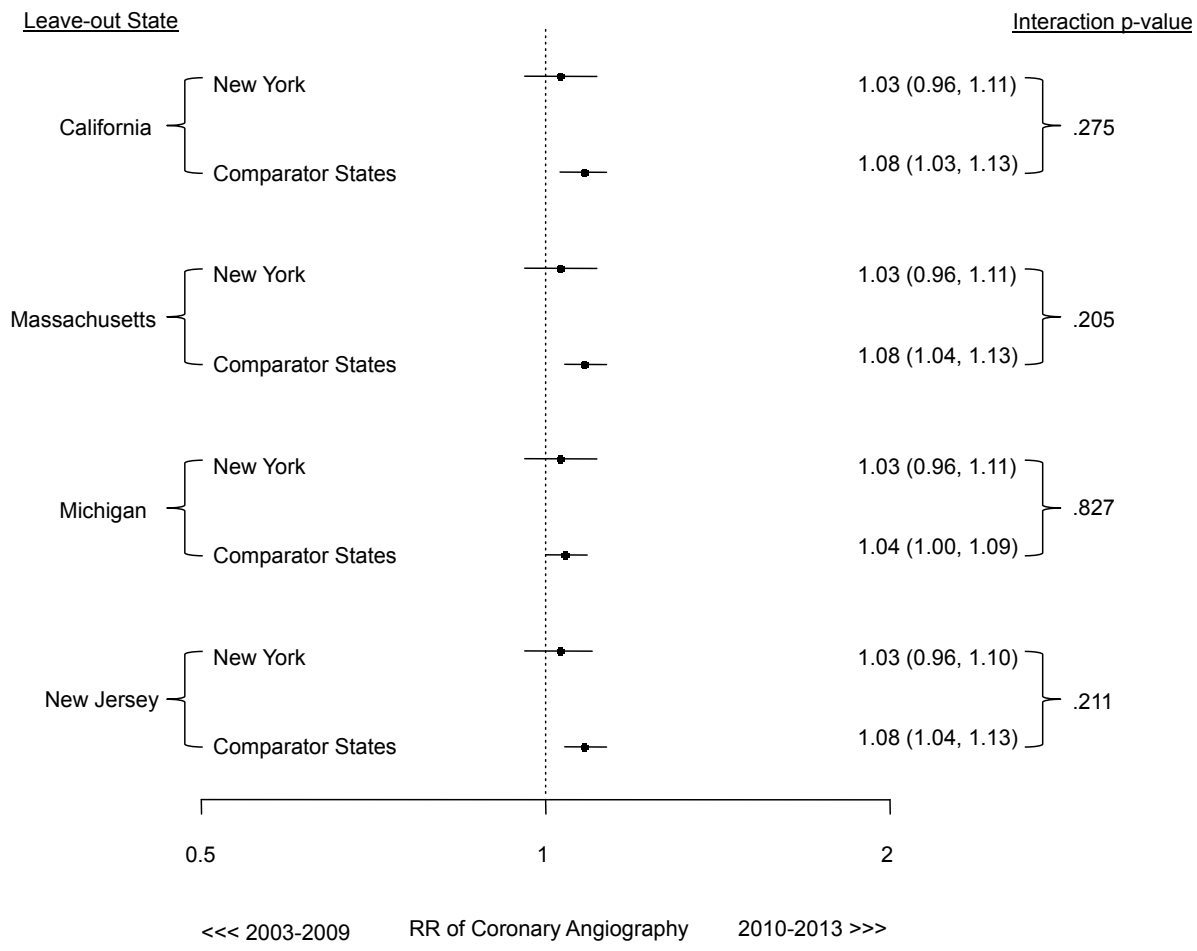
Obesity	278.0, 278.00, 278.01, 278.03, 649.10- 649.14, 793.91, V85.30- V85.39, V85.41- V85.45, V85.54
Weight loss	260-263.9, 783.21, 783.22
Fluid and electrolyte disorders	276.0- 276.9
Chronic blood loss anemia	280.0, 648.20- 648.24
Deficiency anemias	280.1- 281.9, 285.21- 285.29, 285.9
Alcohol abuse	291.0- 291.3, 291.5, 291.8, 291.81, 291.82, 291.89, 291.9, 303.00- 303.93, 305.00- 305.03
Drug abuse	292.0, 292.82- 292.89, 292.9, 304.00- 304.93, 305.20- 305.93, 648.30- 648.34
Psychoses	295.00- 298.9, 299.10, 299.11
Depression	300.4, 301.12, 309.0, 309.1, 311
Hypertension, complicated and uncomplicated	401.1, 401.9, 642.00- 642.04, 401.0, 402.00- 405.99, 437.2, 642.10- 642.24, 642.70- 642.94

eFigure 1.

$$\text{Logit(outcome)}=\beta_o + \beta_1*\text{NY} + \beta_2*\text{Post} + \beta_{12}*\text{Interaction}_{ny*post} + \beta_3*\text{Age} + \beta_4*\text{Sex} + \beta_5*\text{AHRQ1}+\ldots+ \beta_{34}*\text{AHRQ29}$$

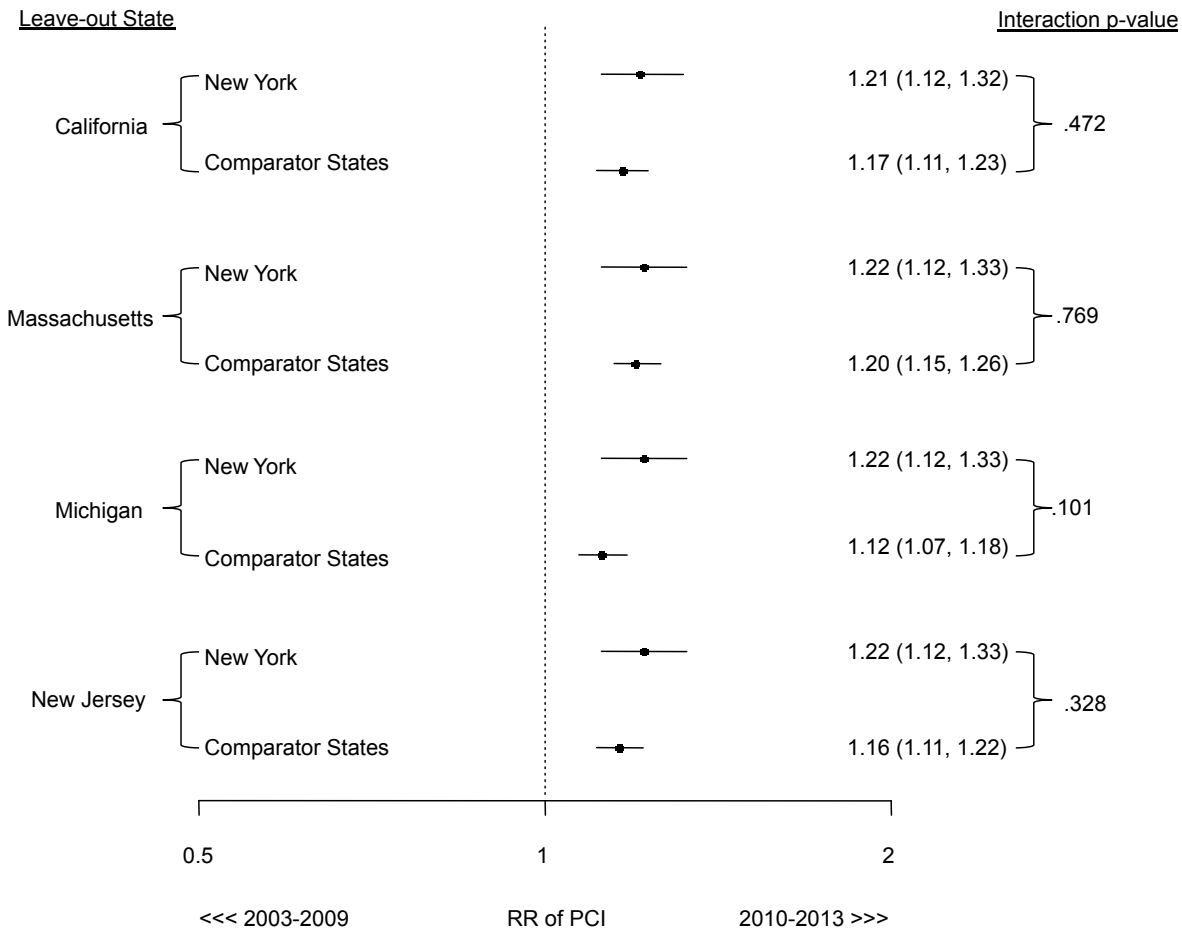
Regression Equation Used for Difference in Differences Analysis. Abbreviations: NY = New York, Post = After 2010. $Interaction_{ny*post}$ = multiplicative state x time period interaction term. AHRQ1-AHRQ29 = Categorical Elixhauser variables used as covariates.

eFigure 2.


Leave-out State
Interaction p-value
California
New York
Comparator States
1.03 (0.96, 1.11)
1.08 (1.03, 1.13)
.275
Massachusetts
New York
Comparator States
1.03 (0.96, 1.11)
1.08 (1.04, 1.13)
.205
Michigan
New York
Comparator States
1.03 (0.96, 1.11)
1.04 (1.00, 1.09)
.827
New Jersey
New York
Comparator States
1.03 (0.96, 1.10)
1.08 (1.04, 1.13)
.211
0.5
1
2
<<< 2003-2009
RR of Coronary Angiography
2010-2013 >>>

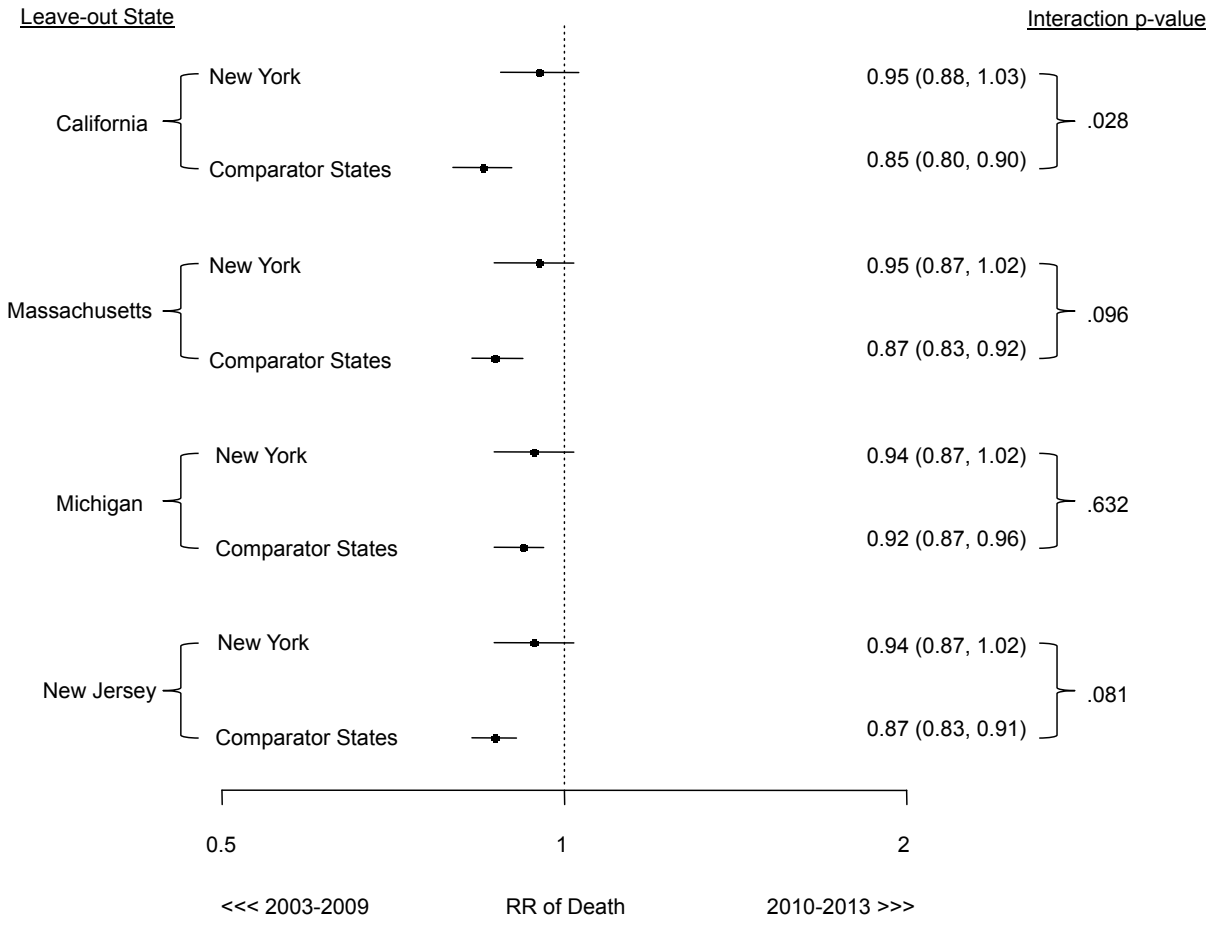
Sensitivity Analysis with Serial Removal of States from Regression Model Evaluating the Association Between Time Period and Receipt of Coronary Angiography in New York vs. Comparator States. Abbreviations: NY = New York. RR = Risk Ratio.

eFigure 3.


Leave-out State
Interaction p-value
California
New York
Comparator States
1.21 (1.12, 1.32)
1.17 (1.11, 1.23)
.472
Massachusetts
New York
Comparator States
1.22 (1.12, 1.33)
1.20 (1.15, 1.26)
.769
Michigan
New York
Comparator States
1.22 (1.12, 1.33)
1.12 (1.07, 1.18)
.101
New Jersey
New York
Comparator States
1.22 (1.12, 1.33)
1.16 (1.11, 1.22)
.328
0.5
1
2
<<< 2003-2009
RR of PCI
2010-2013 >>>

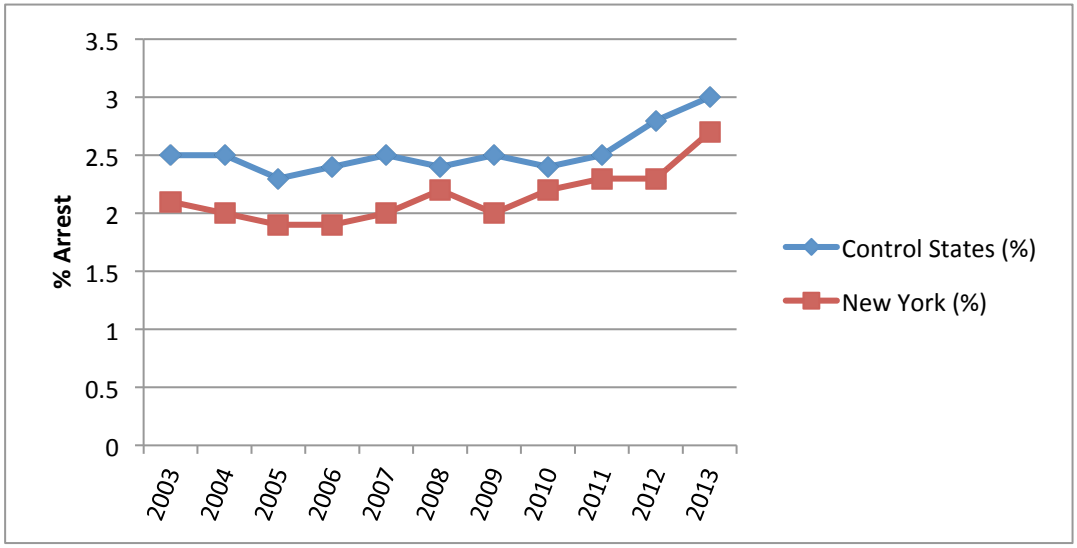
Sensitivity Analysis with Serial Removal of States from Regression Model Evaluating the Association Between Time Period and Receipt of Percutaneous Coronary Intervention (PCI) in New York vs. Comparator States. Abbreviations: NY = New York. RR = Risk Ratio. PCI = Percutaneous Coronary intervention.

eFigure 4.


Leave-out State
Interaction p-value
California
New York
Comparator States
0.95 (0.88, 1.03)
0.85 (0.80, 0.90)
.028
Massachusetts
New York
Comparator States
0.95 (0.87, 1.02)
0.87 (0.83, 0.92)
.096
Michigan
New York
Comparator States
0.94 (0.87, 1.02)
0.92 (0.87, 0.96)
.632
New Jersey
New York
Comparator States
0.94 (0.87, 1.02)
0.87 (0.83, 0.91)
.081
0.5
1
2
<<< 2003-2009
RR of Death
2010-2013 >>>

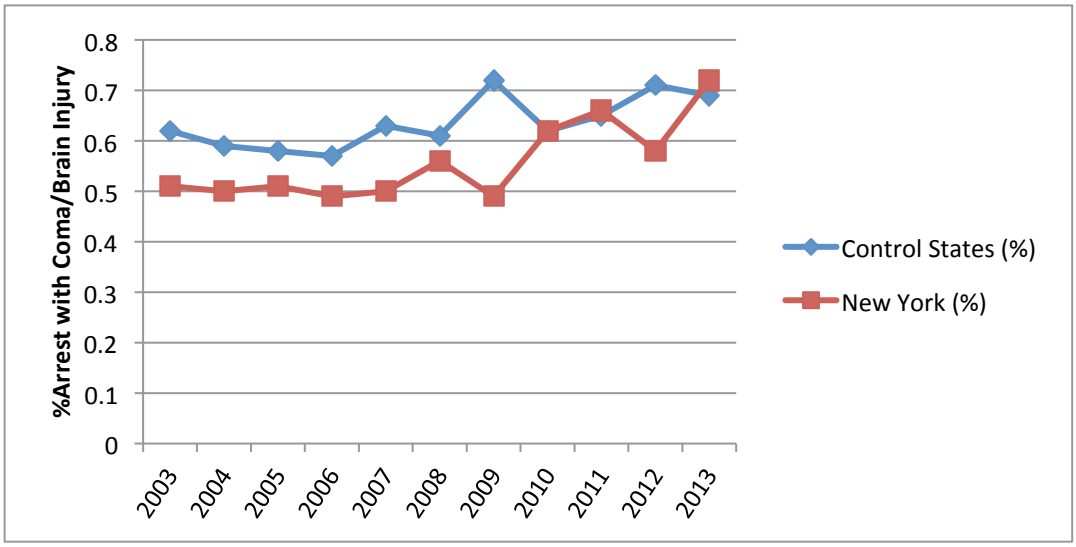
Sensitivity Analysis with Serial Removal of States from Regression Model Evaluating the Association Between Time Period and In-Hospital Mortality in New York vs. Comparator States. Abbreviations: NY = New York. RR = Risk Ratio. Death = In-hospital mortality

eFigure 5.


3.5
3
2.5
2
1.5
1
0.5
0
% Arrest
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Control States (%)
New York (%)

Percentage of Myocardial Infarction Patients with Concomitant Cardiac Arrest in New York and Comparator States from 2003-2013

eFigure 6.


%Arrest with Coma/Brain Injury
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Control States (%)
New York (%)

Percentage of Myocardial Infarction Patients with Concomitant Cardiac Arrest and Coma or Anoxic Brain Injury in New York and Comparator States from 2003-2013