## Title

# Impact of Mandated Public Reporting in California on 30-Day readmission following CABG surgery: A Health policy analysis



ISBN
9781728108582

Authors
Ray, Monika
Sadeghi, Banafsheh
Ritley, Dominique
et al.

Publication Date
2019-12-12

DOI
10.1109/bigdata47090.2019.9006332

Peer reviewed

**Impact of Mandated Public Reporting in California on 30-Day readmission following CABG surgery: A Health policy analysis**

Monika Ray
*General Internal Medicine,*
*Center for Healthcare Policy and Research*
*University of California, Davis*
Sacramento, USA

Banafsheh Sadeghi
*General Internal Medicine*
*University of California, Davis*
Sacramento, USA

Dominique Ritley
*Center for Healthcare Policy and Research*
*University of California, Davis*
Sacramento, USA

Patrick S. Romano
*General Internal Medicine,*
*Center for Healthcare Policy and Research*
*University of California, Davis*
Sacramento, USA, psromano@ucdavis.edu

***Abstract*—The 30-day all-cause readmission rate following coronary artery bypass graft (CABG) surgery is considered an important outcome measure for patients because higher rates can be an indicator of low quality and unnecessary health care costs. Our research uses rigorous methods to explore the impact of mandatory public reporting of all-cause readmission rates following CABG surgery in California. We used a hierarchical logistic regression model on 173,823 CABG patient records. This model standardised outcomes across 10 U.S. states that were not previously comparable due to different CABG definitions and metrics. Additionally, in order to account for the differences in medical practice across different states, we applied a difference-in-difference method to estimate the impact of public reporting. Finally, a recycled prediction method was used to estimate the number of averted readmissions following public reporting initiation in California.**

***Index Terms*—coronary artery bypass graft surgery, mandating public reporting, all-cause readmission rate, hierarchical logistic regression, difference-in-difference model, recycled predictions, risk-adjustment**

## INTRODUCTION

The Office of Statewide Health Planning and Development (OSHPD) oversees the California CABG Outcomes Reporting Program (CCORP), which publicly reports the risk-adjusted rates for CABG mortality, post-operative 30-day readmission, and post-operative stroke at the hospital level. Over the past 25 years, a handful of states have implemented similar mandatory public reporting programmes for CABG surgery outcomes. The post-operative 30-day readmission rate is recognised as an important outcome measure for coronary artery bypass graft (CABG) surgeries and the healthcare system because it can be an indicator of low quality due to potentially preventable postoperative complications, and therefore avoidable hospital costs. Of the 5 states - New York (NY), Massachusetts (MA), Pennsylvania (PA), New Jersey (NJ) and California (CA) - mandating public reporting of CABG outcomes, California has the largest programme with approximately 12,498 CABG cases/year.

All-cause readmission rates vary widely across different states in the USA. This variation may be attributable to differences in CABG surgery complication rates, differences in the likelihood of readmissions given a complication, or differences in the selection of patients for CABG surgery. Past reports on impact of public reporting have shown mixed results on whether public reporting improved quality of care or impacted consumer choice of hospitals [1]–[3]. Yet, none of the previous studies compared CABG outcome trends in CA with those in other states with or without public reporting.

We use rigorous analytic methods to identify **IF California experienced a reduction in its rate of 30-day readmission after the initiation of public reporting, in comparison with other states**. We leverage the use of messy real-world BIG DATA in Healthcare to understand the effects of public policy on patient outcomes. Highlighting such areas of research will lead to collaboration among scientists across disciplines to solve problems affecting rising healthcare costs in the US. Our report is the first such analysis of readmissions following isolated CABG in order to assess the impact of health policy on public health.

## DATA AND METHODS

Figure 1 shows the numbers of CABG encounters, isolated CABG encounters, and 30-day post-CABG readmissions in the State Inpatient Databases available in our analysis. Because CA and NY instituted public reporting during this period, their data are stratified into pre-reporting and post-reporting periods.

In order to compare different patient populations in different states, we had to risk-adjust for patient sickness or comorbidities. We input 26 patient risk factors (features) identified by the Centers for Medicare and Medicaid Services (CMS) in a hierarchical logistic regression (HLR) model [4]. Hierarchical models deal with data that is nested or hierarchical. In our data, multiple datapoints, i.e. patients, are from the same hospital. Hence, these datapoints/measurements are not independent but will be more similar to each other than datapoints of patients from different hospitals. We analysed the prior 12 months from each patient's *first* CABG surgery to identify comorbidities/risk factors. We also included time (calculated in months beginning from January 2010 to the date of patient discharge), US state, and PR status to explore the effect of time and geography on the 30-day readmission rates. Lastly,

978-1-7281-0858-2/19/$31.00 ©2019 IEEE

| | State | Data Years | # All Encounters | # All CABG Encounters | # Isolated CABG (denominator) | # CABG 30-Day Readmissions | Raw Rate of 30-Day Readmission (%) |
|---|---|---|---|---|---|---|---|
| States with Mandated Public Reporting | California Pre-PR | Jan 2010-Jul 2011 | 6,278,213 | 26,134 | 17,834 | 2653 | 14.88 |
| | California Post-PR | Aug 2011-Dec 2014 | 13,118,888 | 52,825 | 33,712 | 4697 | 13.93 |
| | NY Pre-PR | Jan 2010-Jul 2014 | 11,536,281 | 50,513 | 35,773 | 4,884 | 13.65 |
| | NY Post-PR | Aug 2014-Dec 2014 | 970,937 | 4,293 | 3,192 | 134* | 4.20* |
| States without Mandated Public Reporting | AR | 2010-2013 | 1,620,235 | 13,666 | 9,646 | 1301 | 13.49 |
| | FL | 2010-2014 | 13,382,333 | 75,952 | 53,031 | 7858 | 14.82 |
| | IA | 2010-2014 | 1,638,845 | 8,368 | 4,779 | 547 | 11.45 |
| | MA | 2011-2013 | 2,464,047 | 11,724 | 6,712 | 824 | 12.28 |
| | NE | 2010-2014 | 1,042,681 | 7,762 | 5,590 | 713 | 12.75 |
| | NM | 2010-2014 | 1,012,164 | 3,670 | 2,769 | 320 | 11.56 |
| | VT | 2012-2014 | 152,955 | 897 | 613 | 56 | 9.14 |
| | WI | 2014 | 602,982 | 4,237 | 2,324 | 248 | 10.67 |

*Note*: Only index isolated CABG encounters are included in the analysis. California and New York are the only two states in this analysis with mandated public reporting of 30-readmission rates for CABG surgery. California commenced reporting in 2011 and New York commenced reporting in 2014. PR= mandated public reporting
*Readmission rate is unreliable as the NY dataset only contained 5 months of data in the post-mandate reporting period.

Fig. 1. HCUP SID Data from publicly reporting and NON-reporting states (N=131,549,298)

we added temporal variables for California- one for its pre-reporting period (January 2010 through July 2011) and one for its post-reporting period (August 2011 through December 2014) to analyse the readmissions trend before and after public reporting. Therefore, the final model had risk factors such as patient's age, gender, cancer, chronic obstructive pulmonary disease, malnutrition, diabetes, and various other comorbidities along with factors like state, time, CA post-reporting, CA pre-reporting, and interactions between time and state or CA pre/post reporting. Each row/record referred to a single patient and his/her risk factors were columns.

Risk-adjustment models do not use features that are modifiable by entities or people, such as hospital length of stay, on/off ventilator, etc. or factors that reflect medical practices in that state/hospital as these can be manipulated or 'gamed' by people. Therefore, the risk-adjusted readmission rates across states can only be compared (hypothesis testing) if we also account time-invariant differences in medical practice across the states we wish to compare. For this analysis, we were primarily interested in comparing CA to two other large, diverse states: NY, which did not start publicly reporting post-CABG readmission rates until August 2014, and Florida (FL), which has never public reported post-CABG readmission rates. To account for differences in medical practice and other influences, we used a simplified interrupted time series design - difference-in-difference (DID) model (Figure 2) - to calculate the effect of public reporting on readmissions by comparing the change in California between the pre-reporting period and the post-reporting period to the change in either NY or FL. The DID analysis is a quasi-experimental design that uses longitudinal data from exposed and control groups to estimate a causal effect of a specific intervention [5], [6]. The parallel trends assumption present in the DID analysis implies that, in the absence of public reporting, 30-day readmissions in California *after* public reporting and other non-reporting states would be *expected to change at the same rate*. Finally, a recycled prediction method was used to estimate the number of potentially averted readmissions in California (i.e. predicted the marginal probability of readmissions). The recycled predictions method computes the mean predicted marginal probability of readmission by CA's reporting period, thereby facilitating the comparison of CA's predicted marginal probability of readmission while holding constant all other model covariates except the reporting period [7]–[9].

## Results and Conclusion

This is the first time that California's public reporting experience for 30-day all-cause readmissions following isolated CABG surgery has been compared to other states. Using a modified hierarchical logistic regression (HLR) model on hospital discharge data from the Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases, we computed the risk-adjusted all-cause readmission rates (Table A in Figure 3) . The highest readmission rates occurred in New Mexico (NM) in 2014 (16.16%) followed by Florida (15.97%),although these differences were not tested for statistical significance.

In the three largest states - NY, CA and FL - the readmissions rate for New York and California appear to be decreasing compared to Florida. Table B in Figure 3 shows that the odds of readmission in California were 17.4% ((1 - 0.8260)*100) lower at the end of Dec 2014 vs. at the end of July 2011. The DID analysis controls for state effects and patient characteristics that may otherwise influence CABG readmission rates before and after California initiated public reporting in August 2011. Table C in Figure 3 presents the DID analysis results for California compared with NY and FL. If there was no effect of public reporting, then the adjusted odds ratio (OR) would be equal to 1 when CA (pre or post-reporting stage) is compared to a non-reporting state (either NY or FL). However, there was an effect of public reporting in California, which was also statistically significant (NY compared to CA-postPR OR = 1.28; $p$ = 0.01 and FL compared to CA-postPR OR = 1.54; $p < 0.0001$). By comparison, if California had not begun reporting, then the adjusted odds of readmission in California would be 1.06 (1/OR = 1/0.9461) that of NY; and the adjusted odds of readmission in FL would be 1.14 that of California. Whereas, since California began reporting, the odds of readmission in NY was 1.28 that of California and the odds of readmission in FL was 1.54 that of California. Finally, since the initiation of the 30-day readmission public reporting in California through the end of 2014, approximately 176 post-CABG readmissions were potentially averted. Our analyses show that mandated public reporting marginally contributed to California's lower 30-day readmission rates following isolated CABG surgery compared with non-publicly reporting states.

This is the first time that California's experience with 30-day all-cause readmissions following isolated CABG surgery, before and after the advent of public reporting, has been compared to that in other states. Our analyses show that mandated public reporting marginally but significantly contributed to lower 30-day readmission rates following isolated CABG surgery between August 2011 and December 2014, compared with non-publicly reporting states. To the extent that readmissions represent a marker of postoperative complications that can be prevented, in some cases, or treated aggressively on an outpatient basis, this finding suggests a measurable social benefit from the policy intervention of public reporting.

Through this analysis we showcase opportunities for collaborative work among various disciplines - economics, public policy, medicine, and statistics in the current climate of BIG Data. As others have suggested more research is necessary to determine if public reporting is truly helpful. Due to the nature of data required for such analyses, more data and advanced methods that can measure the impact of an intervention are necessary to add confidence to the results. The public report of this work was submitted to The Office of Statewide Health Planning and Development in July 2018.

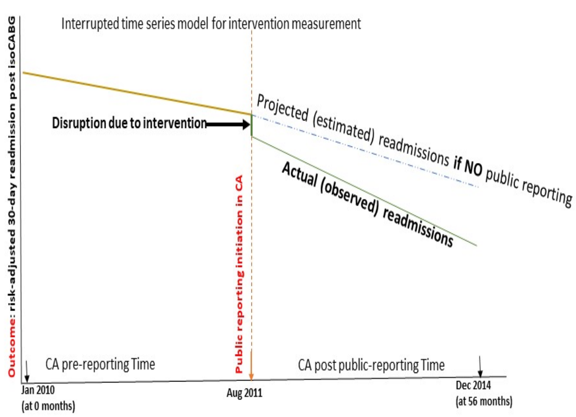


Fig. 2. Interrupted time series model to measure effect of policy intervention

A

| | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|
| AR | 0.1495 | 0.1516 | 0.1388 | 0.1393 | |
| CA | 0.1444 | 0.1449 | 0.1468 | 0.1364 | 0.1312 |
| FL | 0.1434 | 0.1515 | 0.1554 | 0.1478 | 0.1597 |
| IA | 0.1188 | 0.1286 | 0.1207 | 0.1287 | 0.1055 |
| MA | | 0.1262 | 0.1190 | 0.1188 | |
| NE | 0.1501 | 0.1419 | 0.1351 | 0.1381 | 0.1243 |
| NM | 0.1374 | 0.1184 | 0.1054 | 0.1367 | 0.1616 |
| NY | 0.1423 | 0.1371 | 0.1350 | 0.1316 | 0.1375 |
| VT | | | 0.1506 | 0.0734 | 0.0961 |
| WI | | | | | 0.1161 |

B

| California (Pre- vs Post-PR) | Coefficients | P-Value | Odds Ratio | Odds Ratio Lower Bound | Odds Ratio Upper Bound |
|---|---|---|---|---|---|
| Risk adjusted 30-day readmission at the end of pre-PR time period subtracted from the Risk adjusted 30-day readmission at the end of post-PR time period | -0.1911 | 0.0002 | 0.8260 | 0.7482 | 0.9119 |

C

| DID Models | Coefficients | P-Value | Odds Ratio (Odds of readmissions) | Odds Ratio Lower Bound | Odds Ratio Upper Bound |
|---|---|---|---|---|---|
| New York Compared to CA | | | | | |
| CA(if CA had not reported) | -0.05538 | 0.7964 | 0.9461 | 0.6212 | 1.4411 |
| CA(CA began reporting) | 0.2468 | 0.0121 | 1.2799 | 1.0554 | 1.5521 |
| Florida Compared to CA | | | | | |
| CA(if CA had not reported) | 0.1327 | 0.5382 | 1.1419 | 0.7483 | 1.7426 |
| CA (CA began reporting) | 0.4349 | <.0001 | 1.5447 | 1.2694 | 1.8798 |

Fig. 3. (A) Risk-adjusted readmission rates; (B) Pre- and post-PR analysis for CA; (C) DID analysis to compare CA (pre and post-PR) to NY and FL (Take reciprocal of odds ratio when OR $< 1$)

## ACKNOWLEDGEMENT

We extend our appreciation to UC Davis colleagues - Daniel Tancredi and Oluseun Atolagbe and our partners at The Office of Statewide Health Planning and Development- Holly Hoegh and Chris Krawczyk. We also thank David Chin at UMASS, Amherst.

## REFERENCES

[1] D. Dunt, K.H. Prang and H. Sabanovic and M. Kelaher, "The Impact of Public Performance Reporting on Market Share, Mortality, and Patient Mix Outcomes Associated With Coronary Artery Bypass Grafts and Percutaneous Coronary Interventions (2000-2016): A Systematic Review and Meta-Analysis," Medical Care, vol. 56(11), pp. 956 – 966, November 2018.

[2] P. Campanella, V. Vukovic, P. Parente, A. Sulejmani, W. Ricciardi and M. L. Specchia "The impact of Public Reporting on clinical outcomes: a systematic review and meta-analysis," BMC Health Serv Res., vol. 16, pp. 296, July 2016.

[3] M.A. Cavender, K.E. Joynt, C.S. Parzynski, F.S. Resnic, J.S. Rumsfeld, M. Moscucci, F.A. Masoudi, J.P. Curtis, E.D. Peterson and H.S. Gurm, "State mandated public reporting and outcomes of percutaneous coronary intervention in the United States," Am J Cardiol., vol. 115(11), pp. 1494-1501, June 2015.

[4] G. Y. Wong and W. M. Mason, "The Hierarchical Logistic Regression Model for Multilevel Analysis," Journal of the American Statistical Assoc., vol. 80(391), pp. 513 – 524, September 1985.

[5] H. Zhou, C. Taber, S. Arcona and Y. Li, "Difference-in-Differences Method in Comparative Effectiveness Research: Utility with Unbalanced Groups," Appl Health Econ Health Policy, vol. 14, pp. 419—429, July 2016.

[6] M. Lechner, "The Estimation of Causal Effects by Difference-in-Difference Methods," Foundations and Trends in Econometrics, vol. 4(3), pp. 165–224, 2010.

[7] Z. Li and G. Mahendra, "Using Recycled Predictions for Computing Marginal Effects," SAS Global Forum 2010: Statistics and Data Analysis, Paper 272-2010.

[8] R. Oaxaca, "Male-female Wage Differentials in Urban Labor Markets," International Economic Review, vol.14, pp.693—709, 1973.

[9] W.G. Manning, J.P. Newhouse, N. Duan, E.B. Keeler, A. Leibowitz and M.S. Marquis, "Health insurance and the demand for medical care: evidence from a randomized experiment," American Econ Rev., vol. 77(3), pp. 251–277, June 1987.