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Enduring inequalities: Revascularization before and after the ACA

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Abstract

The use of revascularization (coronary artery bypass surgery [CABG] and percutaneous coronary intervention [PCI]) in the United States is declining, but they remain important procedures for the treatment of patients with coronary artery disease. There are large and long-standing disparities in the use of revascularization among patients hospitalized with heart disease. In this article, we investigate whether the implementation of the Patient Protection and Affordable Care Act (ACA) is associated with a reduction in disparities in the use of revascularization. We use data from the Agency for Healthcare Research and Quality (AHRQ)'s National Inpatient Sample (NIP) of the Healthcare Cost and Utilization Project (HCUP) project to compare the use of revascularization among patients 45 years and older in the United States in 2012 and 2018. For both years, we conducted multiple logistic regression analysis to assess the factors associated with coronary revascularization among patients hospitalized with heart disease. Hospitalizations for heart disease and the use of revascularization both fell between 2012 and 2018 at a rate that was greater than the reduction in heart disease deaths in the country. These findings are consistent with the clinical literature on the growth of medical management of heart disease. Disparities in the use of revascularization, by gender, insurance status, neighborhood, and race/ethnicity, were just as large after the implementation of the ACA in 2014. The expansion of insurance by the ACA, alone, was insufficient to reduce

disparities in the use of revascularization in patients with diagnosed coronary heart disease in the United States.

KEYWORDS

Affordable Care Act, health inequalities, heart disease

Key points

- Hospitalizations for heart disease and the use of revascularization both fell in the United States between 2012 and 2018 at a rate that was greater than the reduction in heart disease deaths in the country.
- Disparities in the use of revascularization, by gender, insurance status, neighborhood, and race/ethnicity, have remained large following the implementation of the Patient Protection and Affordable Care Act (ACA) in 2014.
- The expansion of insurance by the ACA, alone, was insufficient to reduce disparities in the use of revascularization in patients with diagnosed coronary heart disease in the United States.

INTRODUCTION

Previous research has found that, in the United States, patients without health insurance, those covered by US public insurance (Medicare and Medicaid), minoritized populations, women, and people living in lower income neighborhoods, are far less likely to receive a revascularization in the United States, even after they have been hospitalized with heart disease, than privately insured, White patients, men, and those living in wealthier neighborhoods (Exworthy et al., 2006; Graham, 2016; Gusmano et al., 2014, 2019; Jabagi et al., 2018). The full implementation of the ACA in the United States has expanded access to insurance and, according to several studies, has improved access to health care. It is not clear, however, whether the implementation of the ACA, since 2014, has had a similar effect the use of surgical care, more specifically whether the use of revascularization among heart patients reflects any reduction in disparities, including the gender gap, among coronary heart patients in the United States.

BACKGROUND

Heart disease and the evolving role of revascularization

Mortality from coronary artery disease (CAD) and/or congestive heart failure (CHF) has declined, moderately, in the United States over the past decade, but continues to be a leading cause of death (Bray et al., 2021; Centers for Disease Control and Prevention, 2021). Although the use of medical management and lifestyle interventions have increased, revascularization procedures continue to serve as critical procedures for improving survival for patients with severe heart disease (Boden et al., 2007; Hawkes et al., 2006; Jia et al., 2020; Pflieger et al., 2011; Serruys et al., 2009).

Implementation of the ACA in the United States

Since 2014, the Affordable Care Act (ACA) has been fully implemented in most of the United States with the goal of improving access to health care by reducing the number of uninsured through insurance subsidies, Medicaid expansion (adopted in 40 states and the District of Columbia by 2023), and the formation of the Health Insurance Marketplace, along with insurance regulation reforms that improve coverage (Eltorai & Eltorai, 2017). The increased access to health insurance due to the ACA is associated with improvements in health measures such as chronic disease prevalence, age-adjusted mortality, and overall perceived health status (Sohn, 2017). In addition, the ACA has led to more equitable access to and use of health care (Buchmueller et al., 2016; Chen et al., 2016; Decker et al., 2017; Gutierrez, 2018; Renna et al., 2021). In particular, while a few studies found that Medicaid expansion in the United States was associated with reductions in rates of cardiovascular deaths, cardiovascular hospitalizations for the uninsured, and uninsured patients presenting with common surgical conditions (Akhabue et al., 2018; Charles & McEligot, 2018; Khatana et al., 2019; Metzger et al., 2021; Yuen et al., 2019). In this paper, we compare the use of revascularization in the United States during the years 2012 and 2018. It is important to note that, after 2018, several additional states expanded their Medicaid programs. Virginia and Maine expanded Medicaid in 2019, Idaho and Nebraska expanded in 2020, Oklahoma expanded in 2021, and South Dakota and North Carolina expanded Medicaid in 2023 (Kaiser Family Foundation, 2024). Currently, 10 states have still not expanded Medicaid.

In light of such findings, it seems reasonable to assume that the ACA has also improved access to specialized health services such as revascularization. There has, however, been mixed evidence in assessing whether the ACA reduced inequities in coverage and access to care (French et al., 2016). For example, some studies indicate that the ACA reduced gender and racial disparities in insurance coverage, but others find that the uninsured rate remained significantly higher in Black and Hispanic populations compared to White populations (Buchmueller & Levy, 2020; Buchmueller et al., 2016; Courtemanche et al., 2019; O'Hara & Brault, 2013). It is important to recognize that health insurance coverage is a helpful, but insufficient factor for improving access to necessary care. There are other substantial barriers to care (Cole et al., 2018; Mahkoul et al., 2023). Although high- and middle-income adults have reported a reduction in health-care access difficulties, disparities have persisted for younger adults, Hispanic patients, and patients of lower socioeconomic status (Karpman et al., 2015). Previous studies exploring access to revascularization services for patients hospitalized with CAD have come to different conclusions about whether there was a reduction in disparities following the passage of the ACA (Glance et al., 2020; Valdovinos et al., 2020).

METHODS

Data

We use data from the Agency for Healthcare Research and Quality (AHRQ) to identify patients diagnosed with CAD and CHF, age 45 and older, diagnosed and those who receive coronary revascularization. Specifically, we use the AHRQ's National Inpatient Sample (NIP) from the Healthcare Cost and Utilization Project (HCUP). The NIP includes data from more than 7 million hospital stays each year, drawn from all states participating in HCUP, which covers more than 97% of the US population. Weighted NIP data includes clinical diagnoses, procedures, length of stay, discharge status, demographics and insurance

TABLE 1 ICD Codes for patient diagnoses and procedures.

	ICD-9-CM Diagnosis Codes	ICD-9-CM Procedures Codes
CAD and/or CHF	401, 402, 404, 410-414.9, 428, 429, V12.50, V12.53, V12.59, V15.1, V17.3, V17.41, V45.81, V45.82	00.66, 36.03-36.19, 36.31, 36.39
	ICD-10-CM Diagnosis Codes	**ICD-10-PCS Procedures Codes**
Coronary revascularization	I10, I11, I13, I20-I25, I46.2, I46.9, I51, I70, Z82.4, Z86.7, Z95.5-Z95.9	0210x, 0211x, 0212x, 0213x, 0270x, 0271x, 0272x, 0273x, 02C0x, 02C1x, 02C2x, 02C3x, 02Q0x, 02Q1x, 02Q2x, 02Q3x

status, for more than 35 million national hospitalizations. To calculate age-adjusted population rates, we use weights derived from the 2000 US Census.

Identifying patients for analysis

To identify patients with heart disease and those who received coronary revascularization procedures, we use the International Classification of Disease Codes. For the year 2012, our analysis relies on the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). For the year 2018, we use the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM). The specific diagnoses and procedure codes used in the analysis are listed in Table 1. We include patients diagnosed with CAD and CHF because these are patients for whom coronary revascularization is appropriate. We are confident that this is an appropriate population for the analysis because patients diagnosed with CAD and CHF account for just over 99 percent of the coronary revascularization procedures in the NIP data set.

Regression analysis to identify factors associated with coronary revascularization

For both years, we present multiple logistic regression models to identify factors correlated with the use of coronary revascularization for hospital inpatients admitted with CAD or CHF. All models estimate the probability that patients receive a revascularization procedure. The independent variables in our regression models include age, gender, race/ethnicity, primary payer, and number of diagnoses, and median household income quartile of the patient's zip code of residence. The models also include, “age squared,” as well as a continuous age variable, to capture the curve of the relationship between age and the use of revascularization.

We ran two additional models as checks, but do not present either here because they did not generate significantly different outcomes. First, to check whether patients may be receiving revascularizations at nearby hospitals, we also ran a hospital fixed effects model. Second, we ran separate models on patients who were diagnosed with CAD and CHF, but both models generated similar results.

RESULTS

Age-Adjusted Rates of Inpatient Discharges for Heart Disease and Revascularization. Over the 2012–2018 period, the age-adjusted rates of inpatient hospital discharges for CAD and CHF decreased (Table 2). Among patients 45-64 years of age, the age-adjusted rate of

TABLE 2 Age-adjusted rates (per 100,000) of coronary revascularization and hospitalization with CAD and/or CHF in the United States; 2012 and 2018.

United States	2012	2018
Coronary revascularization		
45–64 years	365.1	306.8
≥65 years	852.6	686.5
CAD and/or CHF		
45–64 years	1845.4	1715.8
≥65 years	9050.8	7627.6

Note: Age-adjustment based on the 2000 US Census population.

hospitalization with CAD and/or CHF decreased by about 7%. Among patients 65 years of age and older, this rate decreased by about 15.7% (Table 2).

Among hospitalized patients in our sample, aged 45–46, the age-adjusted rate of coronary revascularization decreased by almost 16.9% (Table 2), The age-adjusted rate of coronary revascularization among those 65 and older, decreased by 19.4%. For both age cohorts, the decline in the use of revascularization exceeds the decline in hospitalization for heart disease.

Logistic regression analysis

In 2012 and 2018, age, gender, number of diagnoses, and income quartile zip code residence are all significantly associated with coronary revascularization in the United States (Table 3). The odds of women receiving a revascularization procedure were about 39% lower than among men in 2012 and about 41% lower in 2018. In 2012, the odds of receiving a revascularization were about 21% lower among people living in the lowest-income quartile postal codes, about 6% lower among patients living in the second lowest-income quartile postal codes, and about 3% lower among patients living in the third lowest-income quartile postal codes, compared with patients living in the highest-income quartile postal codes. In 2018, the odds of receiving a coronary revascularization were about 22% lower among people living in the lowest-income quartile postal codes, about 9% lower among patients living in the second lowest quartile income postal codes, and about 3% lower among patients living in the third lowest-income quartile postal codes, compared with patients living in the highest-income quartile postal codes.

When we examine the second set of models for the United States, which include the race/ethnicity and primary payer models, we find that in 2012 and 2018, age, insurance status, race/ethnicity, gender, number of diagnoses, and income quartile zip code residence were all associated with statistically significant odds ratios for revascularization in the United States (Table 3). The odds of women receiving a revascularization were about 36% lower than among men in 2012% and 38% lower than among men in 2018. The odds of revascularization were 50% lower among Non-Hispanic (NH) Black patients than NH White patients in 2012 and about 53% lower than NH White patients in 2018. The odds of revascularization were about 14% lower among Hispanic patients compared with NH White patients in 2012 and about 12% lower in 2018. The odds of revascularization were about 7% lower among Native American patients compared with NH White patients in 2012 and about 7% lower in 2018. In both years, NH Asian, Pacific Islander, and patients whose race was coded as "other," were more likely to receive a revascularization compared to NH White patients (Table 3).

TABLE 3 Logistic regression predicting revascularization among patients hospitalized with CAD and/or CHF in the United States, 2012 and 2018.

Variable	*B*	S.E.	Wald	df	Sig	Exp(B)	95% CI for Exp(B)	
							Lower	Upper
2012								
Age in years	0.192	0.001	19,054.75	1	0.000	1.212	1.208	1.215
Age squared	−0.002	0.000	27,548.72	1	0.000	0.998	0.998	0.998
Number of diagnoses on the record	−0.066	0.000	57,489.44	1	0.000	0.937	0.936	0.937
Female	−0.445	0.003	23,695.42	1	0.000	0.641	0.637	0.645
Omitted: Male								
NH Black	−0.701	0.005	19,769.12	1	0.000	0.496	0.491	0.501
Hispanic	−0.151	0.006	719.23	1	0.000	0.860	0.850	0.869
NH Asian/Pacific Islander	0.121	0.010	1009.18	1	0.000	1.129	1.107	1.151
Native American	−0.069	0.018	15.13	1	0.000	0.934	0.902	0.967
Other race	0.233	0.007	1009.18	1	0.000	1.262	1.244	1.280
Omitted: NH White								
Medicare	−0.486	0.004	17,549.18	1	0.000	0.615	0.610	0.619
Medicaid	−0.710	0.006	13,302.97	1	0.000	0.492	0.486	0.498
Self Pay (uninsured)	−0.025	0.021	2.644	1	0.000	0.975	0.963	0.988
No charge	0.034	0.021	2.64	1	0.104	1.035	0.993	1.078
Other payer	−0.312	0.008	1370.10	1	0.000	0.732	0.720	0.744
Omitted: Private Insurance								
Lowest income quartile zip	−0.083	0.004	451.86	1	0.000	0.920	0.913	0.927
Second income quartile zip	−0.003	0.004	0.432	1	0.511	0.997	0.990	1.005
Third income quartile zip	−0.004	0.004	0.841	1	0.359	0.996	0.988	1.004
Omitted: highest income quartile zip								
Constant	−5.48	0.047	13,606.74	1	0.000	0.004		
2018								
Age in years	0.200	0.001	18,719.34	1	0.000	1.222	1.218	1.225
Age squared	−0.002	0.000	26,360.93	1	0.000	0.998	0.998	0.998
Number of diagnoses on the record	−0.076	0.000	65,386.51	1	0.000	0.927	0.927	0.928
Female	−0.474	0.003	24,864.18	1	0.000	0.623	0.619	0.626
Omitted: Male								
NH Black	−0.766	0.005	23,273.85	1	0.000	0.465	0.460	0.469
Hispanic	−0.131	0.005	646.20	1	0.000	0.877	0.868	0.886

TABLE 3 (Continued)

Variable	*B*	S.E.	Wald	df	Sig	Exp(B)	95% CI for Exp(B) Lower	Upper
NH Asian/Pacific Islander	0.144	0.009	265.64	1	0.000	1.154	1.135	1.174
Native American	−0.072	0.018	15.35	1	0.000	0.930	0.897	0.965
Other Race	0.83	0.008	101.99	1	0.000	1.087	1.070	1.105
Omitted: NH White								
Medicare	−0.490	0.004	16,423.82	1	0.000	0.613	0.608	0.617
Medicaid	−0.678	0.006	13,950.73	1	0.000	0.508	0.503	0.514
Self Pay (Uninsured)	−0.168	0.008	451.13	1	0.00	0.845	0.832	0.859
No charge	−0.046	0.025	3.43	1	0.064	0.955	0.910	1.003
Other payer	−0.249	0.009	801.61	1	0.000	0.780	0.766	0.793
Omitted: private insurance								
Lowest income quartile zip	−0.077	0.004	348.03	1	0.000	0.925	0.918	0.933
Second income quartile zip	−0.034	0.004	67.88	1	0.000	0.967	0.959	0.975
Third income quartile zip	−0.002	0.004	0.26	1	0.608	0.998	0.990	1.006
Omitted: highest income quartile zip								
Constant	−5.58	0.050	12,614.85	1	0.000	0.004		

In 2012, the odds of revascularization for the uninsured (Self Pay) in the United States were 2% lower compared with patients who had private health insurance. Medicaid recipients had 51% lower odds than those with private insurance. Medicare beneficiaries had 39% lower odds of receiving a revascularization compared with patients with private insurance. The odds of revascularization were 27% lower for those with "other Government Insurance" compared with those with private insurance. For the year 2018, the odds of revascularization among uninsured patients were 15% lower than patients with private insurance 3). The odds of revascularization in 2018 were 49% lower among patients with Medicaid, 39% lower among patients with Medicare, and 22% lower among patients with "other Government Insurance," compared with patients with private insurance (Table 3). In both years, patients living in the first and second-income quartiles had lower odds of revascularization compared with patients living in the highest-income quartile neighborhoods. The odds of revascularization among the lowest- income quartile residents were 8% lower in 2012 and about 7% lower in 2018, after ACA implementation, compared with patients living in the highest-income quartile neighborhoods.

DISCUSSION

Hospitalizations for CAD and CHF as well as the use of revascularization for these patients declined between 2012 and 2018 at a rate that was greater than the reduction in heart disease deaths in the country. These findings are consistent with the clinical literature on the growth of medical management of heart disease (Gusmano et al., 2019; Kaasenbrood

et al., 2018). Our analysis is based on administrative data that do not include clinical information, so it is possible that the decline in revascularization reflects a decline in the severity of heart disease among patients hospitalized for CAD and CHF. Similarly, we cannot account for individual patient characteristics that may influence the decision to proceed with hospital admission and revascularization. Although we cannot rule out these factors, neither are likely explanations of the declines in revascularization.

With regard to inequalities within the United States, our findings are consistent with previous research (Gusmano et al., 2014, 2019). At both dates (2012 and 2018) we examined, women had lower odds than men to receive a revascularization. This is striking because we limited the logistic regressions to patients age 45 and older when gender disparities in the incidence of. heart disease narrow so these disparities cannot be easily explained by the well-known gender differences in heart disease (Kentner & Grace, 2017). Despite extensive efforts by clinicians and advocates to promote awareness of heart disease among women, the gender disparities did not change over time.

With respect to household income by zip code, these findings are consistent with our expectations. There is significant income inequality in the United States and lower-income patients, even after the implementation of the ACA, face multiple barriers to access health-care services (Gusmano et al., 2023). Neighborhood-level differences in the use of revascularization among patients hospitalized with heart disease fell, only slightly, after the implementation of the ACA.

Patients hospitalized with heart disease who identified as Non-Hispanic Black, Hispanic, and Native American all had lower odds of receiving a revascularization than Non-Hispanic White patients. Moreover, these differences did not narrow after the implementation of the ACA. This stands in contrast to a recent analysis of New York City, the largest city in one of the states that expanded Medicaid under the ACA, in which racial and ethnic differences in the use of revascularization did narrow over the same time period (Weisz et al., 2024). When we examine the entire country and include both expansion and non-expansion states, the racial and ethnic difference not only remained, but the differences between Non-Hispanic Black and Non-Hispanic White patients, as well as the difference between Hispanic and Non-Hispanic White patients grew even larger.

The use of revascularization among patients on the Medicare and Medicaid programs, as well as those without health insurance, were lower than among those with private health insurance in both years we examined. Perhaps not surprisingly, the difference between uninsured patients and those with private insurance was larger after the implementation of the ACA. This may be due to the fact that patients who remain uninsured after the implementation of the ACA are more likely to be undocumented immigrants who face even greater barriers to care than other previously uninsured patients now covered by Medicaid or an ACA marketplace health insurance plan.

LIMITATIONS

Our findings indicate that any changes in treatment decisions for heart disease patients cannot be attributed, simply, to changes in disease. The decline in the use of revascularization may reflect a greater use of medical management and more appropriate treatment of disease, but it is not possible for us to evaluate this hypothesis with hospital administrative data alone. What is clear, however, is that inequities, by gender, race and ethnicity, and place, have remained high. There is strong evidence that the ACA has expanded insurance coverage and improved access to care for many lower and middle-income Americans (Sommers et al., 2015), but the overall impact of the law, especially given its uneven implementation among the US states, has not reduced, significantly, socioeconomic, racial/ethnic and gender disparities in the use of revascularization procedures.

CONCLUSIONS

The ACA dramatically expanded access to health insurance and improved access to health-care services in the United States. There was great optimism that the law would also help to address long-standing socioeconomic inequities in access to care. Unfortunately, our analysis of the use of revascularization among patients hospitalized with heart disease, before and after the implementation of the ACA, suggests that inequities by gender, race/ethnicity, insurance status and place have only increased. What explains this surprising finding?

One possibility is the uneven implementation of the law. Following the Supreme Court's decision in NFIB v. Sebelius, states could opt not to expand Medicaid without fear that they would lose federal matching funds for the existing Medicaid program. Several Republican states have not expanded Medicaid and we know that access to care for patients in non-expansion states is worse than expansion states. It is possible that the results from the national inpatient sample reflect the fact that the failure of some states to expand Medicaid limited the effect of the ACA on reducing inequities in the use of care. A previous study examining the use of revascularization within New York City found that there was some reduction in the differences between non-Hispanic White and Hispanic patients after the implementation of the law, so this suggests that our results may have been different if all states had expanded Medicaid. Nevertheless, differences in the use of revascularization by gender, between non-Hispanic Whites and non-Hispanic Blacks, and by place, in New York City, remained large after the implementation of the ACA, so the failure of some states to expand Medicaid is unlikely to explain the results we report here. It is more plausible to suggest that insurance expansion alone is insufficient to eliminate inequities in the use of health care. Even after controlling for insurance status, women, people from minority groups, and people who live in lower-income neighborhoods, are less likely to receive revascularization procedures after they are hospitalized with heart disease. Although we cannot rule out the possibility that these differences are the result of differences in patient need or preference, we do not think this is likely to explain the magnitude of the differences we document. Instead, our findings suggest that there are systematic biases within the health care system, which have not yet been addressed. Future research should investigate the clinical decisions of physicians and patients hospitalized with heart disease to better understand why these large inequities in care persist.

ETHICS STATEMENT

None of the authors report a conflict of interest. The study did not require Institutional Review Board approval because it relies on data from the U.S. Agency for Healthcare Research and Quality that do not include geographic identifiers below the zip code level.

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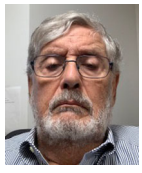

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