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# Did the Hospital Readmissions Reduction Program Reduce Readmissions without Hurting Patient Outcomes at High Dual-Proportion Hospitals Prior to Stratification?

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## Abstract

Since the implementation of Medicare's Hospital Readmissions Reduction Program (HRRP), safety-net hospitals have received a disproportionate share of financial penalties for excess readmissions, raising concerns about the fairness of the policy. In response, the HRRP now stratifies hospitals into five quintiles by low-income Medicare (dual Medicare–Medicaid eligible) stay proportion and compares readmission rates within quintiles. To better understand the potential effects of the revised policy, we used difference-in-differences models to compare changes in 30-day readmission, 30-day mortality, and 90th-day community-dwelling rates after discharge of fee-for-service Medicare beneficiaries hospitalized for acute myocardial infarction, heart failure and pneumonia during 2007–2014, for hospitals in the highest ( $N = 677$ ) and lowest ( $N = 678$ ) dual-proportion quintiles before and after the original HRRP implementation in fiscal year 2013. We find that high dual-proportion hospitals lowered readmissions for all three conditions, while their patients' health outcomes remained largely stable. We also find that for heart failure, high dual-proportion hospitals reduced readmissions more than low dual-proportion hospitals, albeit with a relative increase in mortality. Contrary to concerns about fairness, our findings imply that, under the original HRRP, high dual-proportion hospitals improved readmissions performance generally without adverse effects on patients' health. Whether these gains could be retained under the new policy should be closely monitored.

## Keywords

readmissions, safety-net hospitals, hospital penalties, dual eligible Medicare beneficiaries, Medicare policy

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**What do we already know about this topic?**

Medicare's Hospital Readmissions Reduction Program (HRRP) now stratifies hospitals into five quintiles of Medicare–Medicaid dual eligible stays and compares readmission rates within quintiles, in response to safety-net hospitals having received disproportionate financial penalties for excess readmissions.

**How does your research contribute to the field?**

We compare changes in 30-day readmission, 30-day mortality, and 90th-day community-dwelling rates for HRRP-targeted Medicare patients between hospitals in the highest and lowest dual eligible quintiles before and after the original HRRP implementation in fiscal year 2013, to better understand the potential effects of the revised policy.

**What are your research's implications towards theory, practice, or policy?**

Our findings imply that, under the original HRRP, hospitals with high proportions of dual eligible beneficiaries improved readmissions performance generally without adverse effects on health. The effects of the new policy should be closely monitored to ensure these gains are retained in the future.

## Introduction

Hospitals that treat high proportions of low-income patients have been disproportionately penalized under the Hospital Readmissions Reduction Program (HRRP), raising concerns about the equity of the policy as well as the possibility of inadvertent harm to vulnerable populations.<sup>1–3</sup> The HRRP, implemented in fiscal year (FY) 2013, is a mandatory Medicare pay-for-performance program that penalizes hospitals with higher-than-expected 30-day readmission rates for several conditions.<sup>4</sup> Under the original penalty formula, hospitals' readmission rates were adjusted for medical risk factors (i.e., age, sex, and comorbidities) and compared to national averages.<sup>4</sup> Hospitals with higher-than-expected readmission rates are assessed penalties of up to 3% of Medicare fee-for-service base operating diagnosis-related group payments.<sup>4</sup>

In the first years of the policy's implementation, several studies found that hospitals treating low-income patients were penalized more often.<sup>1–3</sup> At the same time, researchers worried that the higher readmission rates at such hospitals were due in part to factors outside the hospitals' control, such as patients' limited access to post-discharge care services and lower social supports.<sup>5,6</sup> They also worried that the substantial HRRP penalties may further strain these hospitals' financial ability to provide key safety-net services to low-income populations.<sup>7–9</sup>

Given these concerns, the Centers for Medicare and Medicaid Services (CMS) modified the policy beginning in FY 2019. The HRRP now stratifies hospitals into five quintiles based on the proportion of Medicare fee-for-service and managed care inpatient stays where the patient is dually eligible for both Medicare and full-benefit Medicaid (a surrogate for low-income status), and then compares readmission rates among hospitals within each quintile.<sup>10</sup> However, in the new stratified penalty formula, differences in performance between hospitals with high and low proportions of dual eligible beneficiaries will cease to influence

penalties even if they may remain substantial, raising questions about diminished incentives for within-strata improvement going forward.

Most of the extant research on the effects of the HRRP has focused on the original HRRP methodology. The few key studies examining the new stratified methodology primarily focused on changes in the penalty itself.<sup>5,11,12</sup> In this paper, we aim to answer two principal questions: First, were hospitals with high proportions of dual eligible Medicare beneficiaries already reducing admission rates before the enactment of the stratified methodology? Second, if so, did the practices implemented by these hospitals to reduce readmissions adversely affect a range of relevant post-discharge patient outcomes? To answer these questions, we needed to use data collected prior to the implementation of the new stratified methodology without its associated potential change in incentives across hospital strata. Therefore, we retroactively applied the stratification methodology to hospitals subject to the HRRP at its inception (FY 2013) and investigated how readmission rates and other key patient outcomes changed at hospitals in the highest vs lowest dual eligible beneficiary proportion quintiles from 2007 to 2014. In agreement with prior HRRP studies, we included post-discharge 30-day mortality among our outcomes.<sup>13,14</sup> Additionally, we included community-dwelling status after hospital discharge, a proxy measure of functional status for older adults that could be influenced by changes in hospital admissions and transitional care policy but has not been explored in previous HRRP research, although other research on older adults have already studied it.<sup>15–17</sup>

The study included three time periods of interest: pre-HRRP, the period before the legislation authorizing the HRRP was passed (January 2007 to March 2010); HRRP anticipation, the period after the legislation was passed but before the HRRP was implemented (April 2010 to September 2012); and the HRRP implementation period of the original penalty system (October 2012 to November 2014).

**Table 1.** Hospital Characteristics and Baseline Risk-Adjusted Patient Outcomes by Hospital's Medicare–Medicaid Dual Eligible Proportion Quintile.

	Hospitals by Dual Eligible Proportion Quintile (1 = Lowest; 5 = Highest)				
	1	2	3	4	5
<b>Hospital characteristics:</b>					
Hospitals, number	678	678	677	678	677 <sup>a</sup>
Percentage of dual eligible Medicare stays <sup>b</sup> , mean (SD)	9.8 (3.4)	16.5 (1.3)	21.1 (1.5)	27.6 (2.4)	47.0 (14.2)
Number of beds, mean (SD)	208 (207)	260 (229)	260 (238)	223 (221)	215 (238)
Location, %					
Urban	88.9	79.2	68.7	57.5	64.5
Rural	11.1	20.8	31.3	42.5	35.5
Medical school affiliation, %					
Major, limited, or graduate	25.5	33.5	35.2	30.4	29.6
No affiliation	74.5	66.5	64.8	69.6	70.4
Ownership status, %					
For-profit	31.9	15.2	16.4	18.4	26.9
Nonprofit	56.6	69.8	63.2	61.4	43.3
Government	9.3	14.2	20.4	19.9	29.4
Physician-owned	2.2	.9	.0	.3	.3
All-payer profit margin, %, mean (SD)	10.8 (21.2)	5.0 (17.3)	3.8 (11.4)	3.2 (11.6)	.0 (15.8)
	(N = 646)	(N = 664)	(N = 660)	(N = 662)	(N = 632)
Proportion of uncompensated care cost among total income <sup>c</sup> , %, mean (SD)	3.1 (2.2)	4.5 (2.9)	5.1 (5.0)	5.5 (4.9)	9.2 (46.3)
	(N = 636)	(N = 660)	(N = 657)	(N = 653)	(N = 615)
<b>Baseline patient outcomes<sup>d</sup>:</b>					
30-day unplanned readmission rate, %					
AMI	17.1	17.4	18.1	19.6	22.2
HF	21.7	22.2	22.9	24.3	26.4
Pneumonia	16.5	17.0	17.5	18.6	20.2
30-day post-discharge mortality rate, %					
AMI	7.4	7.4	7.4	7.6	7.0
HF	8.5	8.5	8.3	8.2	7.3
Pneumonia	7.9	8.2	8.2	8.5	8.1
Community-dwelling rate on the 90th day after discharge, %					
AMI	56.8	55.3	54.5	52.4	50.3
HF	45.9	43.6	42.8	40.4	38.8
Pneumonia	52.9	49.5	47.9	45.5	42.7

<sup>a</sup>One (1) hospital in quintile 5 was not matched with the 2012 POS file data.

<sup>b</sup>Proportion of Medicare fee-for-service and managed care stays in a specific hospital, where the patient was dually eligible for Medicare and full-benefit Medicaid in the month of discharge, calculated during January 1, 2009–June 30, 2011. Under the HRRP, FY 2013 penalties were calculated based on readmission rates during July 1, 2008–June 30, 2011. Therefore, ideally, we wanted to use the information on dual eligibility status for hospitalized patients during this entire period. However, we did not have hospitalized patients' dual eligibility status data for July–December 2008, which led us to use such data during January 1, 2009–June 30, 2011 to calculate the proportions of dual eligible beneficiaries for the study hospitals. Given that the hospitals' case mixes should have remained fairly stable during such a narrow window of time, it is extremely unlikely that the hospitals' dual eligible proportions and classification across quintiles would have changed significantly with the addition of patients' dual eligibility status data from the last six months of 2008.

<sup>c</sup>Only for hospitals with positive income and non-negative uncompensated care cost.

<sup>d</sup>Baseline is the pre-HRRP period. Risk-adjusted with age, gender, and comorbidities.

Additionally, we compared the highest and lowest dual-proportion quintiles of hospitals in terms of their patient populations, organizational and financial characteristics, and changes in penalty status between the old and new HRRP methodologies. We studied hospitalizations for the three conditions subject to the HRRP from its inception: acute myocardial infarction (AMI), heart failure (HF), and pneumonia.

## Methods

### Setting and Population

The study included hospitals subject to the HRRP in FY 2013. We analyzed index hospital stays by fee-for-service Medicare beneficiaries aged 65 and older with a principal diagnosis of AMI, HF, or pneumonia and dates of discharge

between January 1, 2007 and November 30, 2014 (September 30, 2014 for the post-discharge 90<sup>th</sup>-day community-dwelling rate). Per the HRRP, we excluded beneficiaries who died during hospitalization; who were discharged to another hospital, released against medical advice, hospitalized for more than 365 days, or discharged for the same condition in the preceding 30 days; and who had discontinuous Medicare Part A and B enrollment in the year before or month after the index hospitalization. For each hospital admission, we obtained information on the index hospitalization and outcome measures defined below.

### Data Sources

We used the 2007-2014 Medicare Provider and Analysis Review (MedPAR) files, which contain information on 100% fee-for-service hospitalizations, and the Master Beneficiary Summary Files (MBSF) to obtain demographic, clinical and enrollment information (including full-benefit Medicaid status) on Medicare beneficiaries. We used the Minimum Data Set, which provides information on nursing home stays, to obtain information on whether study beneficiaries dwelled in a care facility vs the community. We used the 2012 Medicare Provider of Services (POS) file to obtain hospital organizational characteristics (e.g., teaching status) and the Medicare Healthcare Cost Report Information System data to obtain information on hospital financial characteristics (e.g., profit margin).<sup>18,19</sup>

We obtained hospitals' HRRP eligibility and actual FY 2013 penalty status from the CMS,<sup>20</sup> and calculated hospitals' proportions of dual eligible beneficiaries for the corresponding time period using the MBSF (see Table 1 for details). Note that Maryland hospitals were not included, as the state is exempt from the HRRP policy.<sup>21</sup>

### Measures

Outcomes included: (1) all-cause unplanned readmission rate within 30 days after the index discharge (defined per HRRP), (2) all-cause mortality rate within 30 days after the index discharge, and (3) community-dwelling rate on the 90th day after the index discharge (a proxy measure of functional status). We considered Medicare beneficiaries to be community-dwelling if they were alive and not in a hospital or post-acute care facility, or not taking home health services.

Other variables included in the models included demographics (age and gender) and comorbidities (see Supplementary Appendix Table A1 for a list of comorbidities). We ascertained comorbidities from MedPAR secondary diagnoses present at discharge, adapting definitions used in Medicare's risk adjustment approach under the HRRP.<sup>22</sup> We included up to nine comorbidities, given recent concerns about bias due to upcoding when more fields are included.<sup>23</sup>

### Statistical Analyses

First, we compared hospital and patient characteristics for hospitals in the highest, middle, and lowest quintiles. We also

compared the penalty status of hospitals under the old and new methodologies across the quintiles.

Next, we used difference-in-differences models to compare changes from the pre-HRRP period to the HRRP implementation period in study outcomes (readmission, mortality, and community-dwelling rates) among the highest vs lowest quintile hospitals. To capture differential changes in outcomes between hospitals with high vs low dual proportions, our models included interactions between quarter indicators in the anticipation and implementation periods and hospital dual-proportion quintile. We also controlled for patient-level covariates (age, gender, and comorbidities) and season and hospital fixed effects. Because some trends in outcomes may have been already differing for the highest vs lowest quintile hospitals prior to the HRRP, our models also included a quintile-specific linear time trend, allowing pre-HRRP trends (slope) and any changes in outcomes (intercept) to differ by hospital dual eligible quintile (see Technical Appendix). We conducted event study analyses in order to flexibly examine changes in outcomes after the HRRP and to examine the extent to which the outcome trends of the highest vs lowest dual eligible quintile hospitals were parallel in the pre-HRRP period, a critical assumption of the difference-in-differences models (also see Technical Appendix).

We used linear regression models, which, given the presence of interactions, are more straightforward and easier to interpret than nonlinear models.<sup>24</sup> All models employed cluster-robust standard errors at the hospital level, allowing for correlation of regression errors within hospitals. We provide model specifications and outcome trend analyses in the Technical Appendix.

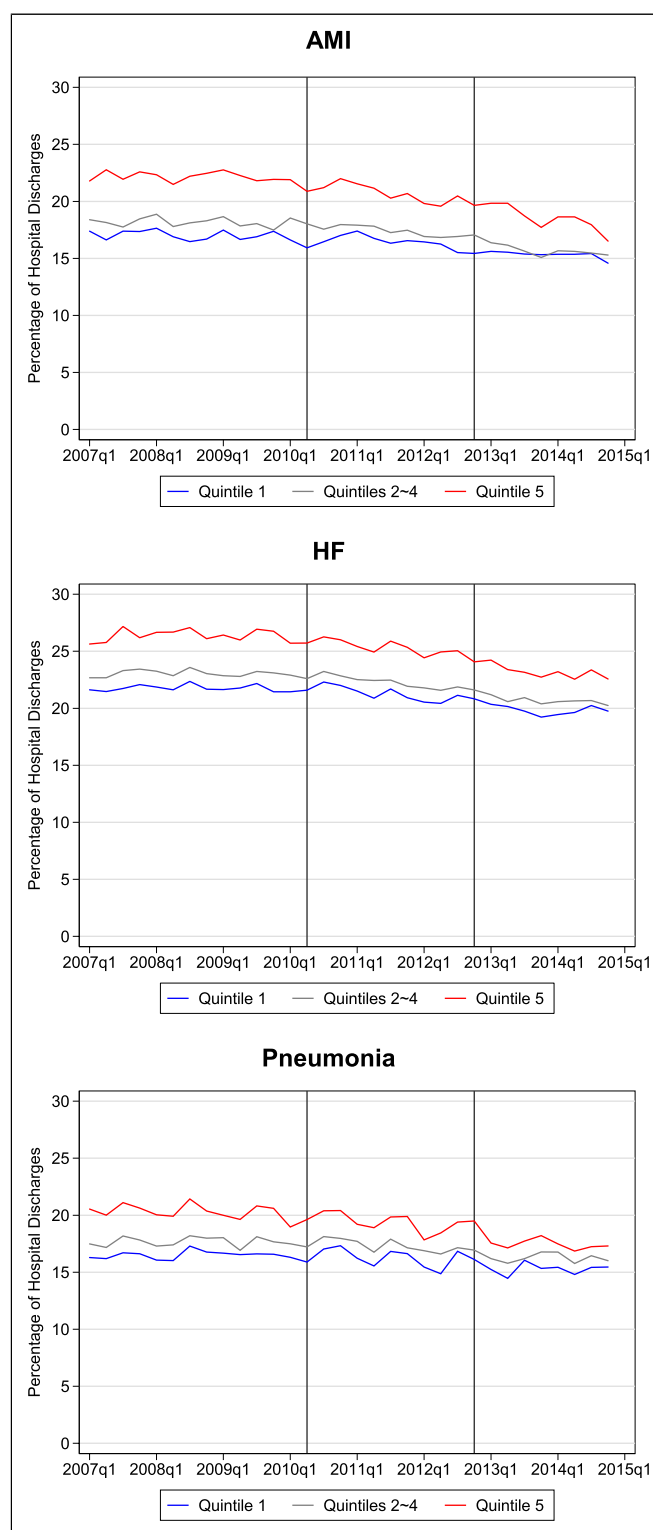
We performed all analyses using Stata, version 14. The study was deemed exempt by the Cedars Sinai and USC IRBs and was approved after expedited review by the UMN and UCLA IRBs.

## Results

### Comparing Characteristics of Highest vs Lowest Quintiles of Hospitals

In FY 2013, 3388 hospitals were subject to the HRRP, resulting in 677 or 678 hospitals per dual-proportion quintile. The mean dual eligible proportion was 9.8% for hospitals in the lowest quintile and 47.0% for hospitals in the highest quintile.

Characteristics of hospitals across dual-proportion quintiles are compared in Table 1. Compared to hospitals in the lowest quintile, those in the highest quintile were more likely to be rural (35.5% vs 11.1%), more likely affiliated with medical schools (29.6% vs 25.5%), and less likely for-profit (26.9% vs 31.9%). Highest quintile hospitals had worse financial performance compared to those in the lowest quintile, including a much lower all-payer profit margin (mean .0% vs 10.8%) and spent proportionally more revenue on uncompensated care (mean 9.2% vs 3.1%).



**Figure 1.** Risk-adjusted quarterly 30-day readmission rates (2007–2014) for AMI, HF, and pneumonia, by hospital's dual eligible quintile.

Compared to Medicare beneficiaries treated at the lowest quintile hospitals, those treated at the highest quintile hospitals were more likely to be female (57.5% vs 51.8%) and non-white (33.9% vs 7.5%); the mean number

of comorbidities was similar (both mean 2.1). (Supplementary Appendix Table A1)

Finally, if the revised penalty methodology had been implemented in FY 2013, 31 of 2214 hospitals (1.4%) that were penalized in FY 2013 would not have been penalized; all these hospitals were in the highest dual-proportion quintile. Conversely, 412 of 1173 hospitals (35.12%) that were not penalized in FY 2013 would have been penalized under the revised policy; 167 of these were in the lowest dual-proportion quintile. (Supplementary Appendix Table A2)

Compared to other hospitals in the sample, those hospitals that would have benefited from the revised methodology were more likely to be rural, less likely to be medical school-affiliated and had poorer financial performance. (Supplementary Appendix Table A2)

### *Comparing Highest vs Lowest Quintiles of Hospitals on Trends in Patient Outcomes Under the HRRP*

**30-Day post-discharge readmission rate.** At baseline (pre-HRRP), beneficiaries at hospitals in the highest quintile had higher risk-adjusted readmission rates than those at hospitals in the lowest quintile for all three conditions (22.2% vs 17.1% for AMI; 26.4% vs 21.7% for HF; 20.2% vs 16.5% for pneumonia). (Table 1)

Figure 1 shows the trends of risk-adjusted readmission rates for AMI, HF, and pneumonia in hospitals in the highest, middle, and lowest quintiles. Pre-HRRP readmission rates were highest at the highest quintile and lowest at the lowest quintile hospitals. Between pre-HRRP and HRRP implementation, readmissions decreased for all three conditions and across all hospital quintiles. However, readmissions decreased more for hospitals in the highest quintile as compared to the lowest quintile, resulting in the reduction of the gap. Linear model results (Table 2) confirmed that, in the highest quintile hospitals, readmissions declined significantly between the pre-HRRP period and the implementation period for all three conditions (−3.3 percentage points change,  $p = .004$  for AMI; −3.5 percentage points change,  $p < .001$  for HF; and −1.3 percentage points,  $p = .019$  for pneumonia; the relative change to baseline was 14.9%, 13.3%, and 6.4%, respectively). At the lowest quintile hospitals, however, readmission rates declined significantly only for HF and pneumonia (−1.5 percentage points,  $p = .003$  for HF, and −1.5 percentage points,  $p = .006$  for pneumonia; the relative change to baseline was 6.9% and 9.1%, respectively). The difference in the rate of decline between the highest and lowest quintile hospitals, that is, the difference-in-differences estimate, was only significant for HF (−1.9 percentage points,  $p = .020$ ; or 7.2% relative to the highest quintile hospitals' baseline), suggesting that, under the original HRRP, the highest quintile hospitals decreased their HF readmission rates significantly more than the lowest quintile hospitals.

**Table 2.** Differential Changes in Risk-Adjusted Health Outcomes Between Highest vs Lowest Quintile Hospitals during the HRRP Implementation Period.

	AMI	HF	Pneumonia
<b>30-day unplanned readmission rate</b>			
Hospitals, number	3163	3231	3247
Index hospitalizations, number	1,307,188	3,006,444	2,468,730
Percentage point difference, <b>Quintile 1</b> hospitals (lowest dual proportion); mean (95% CI), <i>P</i> -value	−.7 (−2.0 to .5), <i>p</i> = .258	−1.5 (−2.5 to −.5), <i>p</i> = .003	−1.5 (−2.5 to −.4), <i>p</i> = .006
Percentage point difference, <b>Quintile 5</b> hospitals (highest dual proportion); mean (95% CI), <i>P</i> -value	−3.3 (−5.5 to −1.0), <i>p</i> = .004	−3.5 (−4.8 to −2.2), <i>p</i> < .001	−1.3 (−2.4 to −.2), <i>p</i> = .019
Differential percentage point difference, <b>between Quintile 5 and Quintile 1</b> hospitals; mean (95% CI), <i>P</i> -value	−2.5 (−5.1 to .0), <i>p</i> = .052	−1.9 (−3.6 to −.3), <i>p</i> = .020	.1 (−1.4 to 1.7), <i>p</i> = .854
<b>30-Day post-discharge mortality rate</b>			
Hospitals, number	3163	3231	3247
Index hospitalizations, number	1,307,188	3,006,444	2,468,730
Percentage point difference, <b>Quintile 1</b> hospitals (lowest dual proportion); mean (95% CI), <i>P</i> -value	.1 (−.7 to .9), <i>p</i> = .764	.0 (−.6 to .7), <i>p</i> = .960	.1 (−.6 to .8), <i>p</i> = .715
Percentage point difference, <b>Quintile 5</b> hospitals (highest dual proportion); mean (95% CI), <i>P</i> -value	.6 (−.9 to 2.0), <i>p</i> = .428	1.4 (.7 to 2.1), <i>p</i> < .001	.6 (−.2 to 1.5), <i>p</i> = .139
Differential percentage point difference, <b>between Quintile 5 and Quintile 1</b> hospitals; mean (95% CI), <i>P</i> -value	.5 (−1.2 to 2.1), <i>p</i> = .582	1.3 (.4 to 2.3), <i>p</i> = .006	.5 (−.6 to 1.6), <i>p</i> = .358
<b>Community-dwelling rate on the 90<sup>th</sup> day after discharge</b>			
Hospitals, number	3163	3231	3247
Index hospitalizations, number	1,282,103	2,950,933	2,432,959
Percentage point difference, <b>Quintile 1</b> hospitals (lowest dual proportion); mean (95% CI), <i>P</i> -value	3.8 (2.2 to 5.3), <i>p</i> < .001	4.4 (3.2 to 5.6), <i>p</i> < .001	.5 (−.8 to 1.7), <i>p</i> = .484
Percentage point difference, <b>Quintile 5</b> hospitals (highest dual proportion); mean (95% CI), <i>P</i> -value	3.6 (1.1 to 6.0), <i>p</i> = .004	3.9 (2.3 to 5.4), <i>p</i> < .001	.8 (−.7 to 2.4), <i>p</i> = .296
Differential percentage point difference, <b>between Quintile 5 and Quintile 1</b> hospitals; mean (95% CI), <i>P</i> -value	−.2 (−3.1 to 2.7), <i>p</i> = .888	−.5 (−2.5 to 1.4), <i>p</i> = .587	.4 (−1.6 to 2.4), <i>p</i> = .715

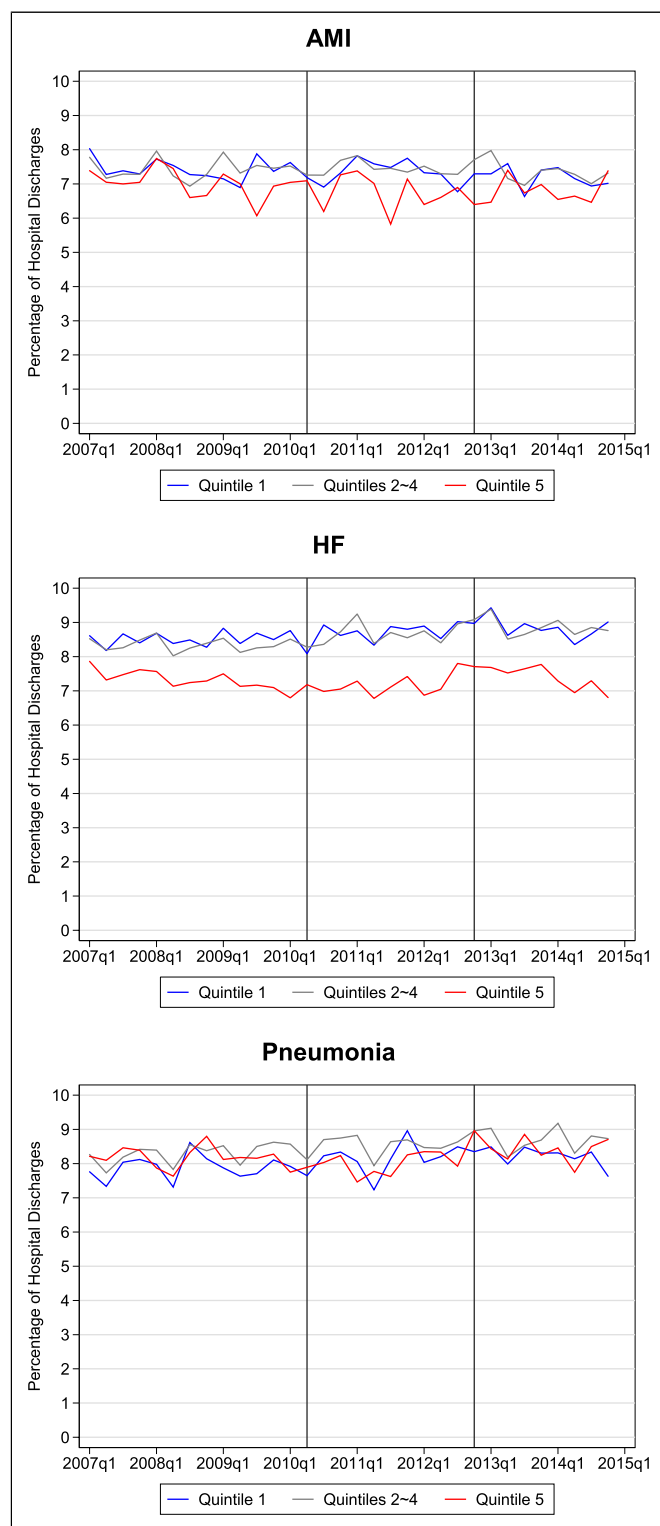
**30-Day post-discharge mortality rate.** During the baseline (pre-HRRP) period, beneficiaries treated at the highest quintile hospitals had lower risk-adjusted mortality rates for AMI (7.0% vs 7.4%) and HF (7.3% vs 8.5%) but higher rates for pneumonia (8.1% vs 7.9%) than those treated at lowest quintile hospitals. (Table 1)

Figure 2 depicts the risk-adjusted mortality rate trends during the study period for the three conditions and across highest, middle, and lowest hospital dual eligible quintiles. Pre-HRRP mortality rates were lower for AMI and HF but higher for pneumonia at the highest dual-proportion quintile hospitals compared to lowest dual-proportion quintile hospitals. Between the pre-HRRP period and the end of the HRRP implementation period, there was little or no change in mortality for AMI and pneumonia, across all dual eligible quintiles. However, there was divergent trend in mortality for HF between the highest vs lowest dual-proportion quintile hospitals. Results of linear models (Table 2) confirmed the non-significant trends for AMI and pneumonia. Models also showed that, for HF, the divergent trends were due to an increase in mortality at hospitals in the highest dual-proportion quintile relative to the linear pre-HRRP time trend (1.4 percentage point change,  $p < .001$ ; 19.2%

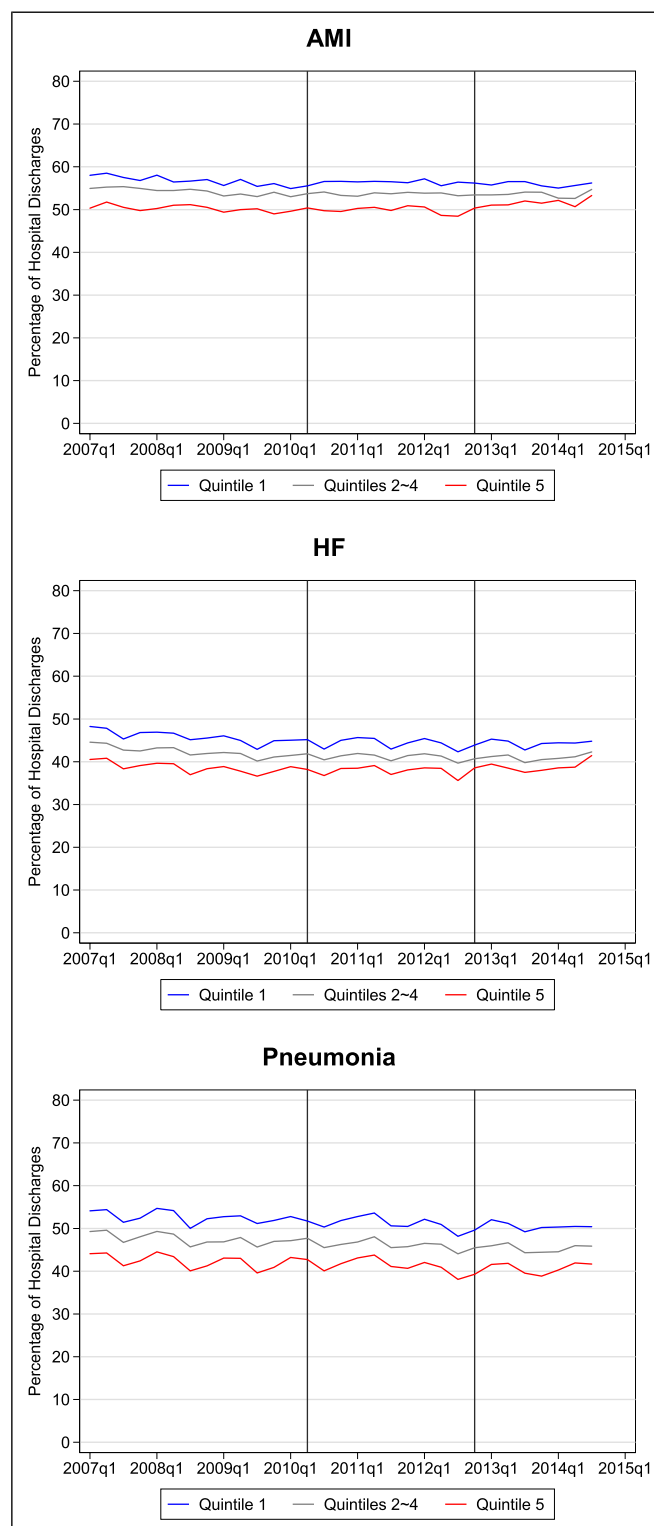
relative change to baseline). The difference in rates of change (i.e., the difference-in-differences) between the mortality of the highest and lowest dual-proportion quintile hospitals was also significant for HF (1.3 percentage point change,  $p = .006$ ; 17.8% relative to the highest quintile hospitals' baseline).

**90<sup>th</sup>-day post-discharge community-dwelling rate.** At the baseline, patients in the highest quintile hospitals had lower rates of community dwelling on the 90<sup>th</sup> day after discharge than those in the lowest quintile hospitals for all three conditions (50.3% vs 56.8% for AMI; 38.8% vs 45.9% for HF; 42.7% vs 52.9% for pneumonia). (Table 1)

Figure 3 illustrates the trends of community-dwelling rates on the 90<sup>th</sup> day after discharge for the three conditions and across hospital quintiles. During the pre-HRRP period, rates of community-dwelling were lowest at the highest dual-proportion quintile hospitals, and the rates were highest at the lowest dual-proportion quintile hospitals. Models suggested that relative to the linear pre-HRRP time trend, there were significant increases for AMI and HF at hospitals in both the lowest and highest dual-proportion quintiles (3.8 and 3.6 percentage points, respectively, for AMI,  $p < .001$



**Figure 2.** Risk-adjusted quarterly 30-day post-discharge mortality rates (2007–2014) for AMI, HF, and pneumonia, by hospital's dual eligible quintile.



**Figure 3.** Risk-adjusted quarterly community-dwelling rates on the 90th day after discharge (2007–2014) for AMI, HF, and pneumonia, by hospital's dual eligible quintile.

and  $p = .004$ , and 4.4 and 3.9 percentage points respectively for HF, both  $p < .001$ ; relative change to baseline was, respectively, 6.7% and 7.2% for AMI, and, respectively, 9.6% and 10.1% for HF) but not significant for pneumonia. However, the difference in rates of change under the HRRP between the highest and lowest dual-proportion quintile hospitals (i.e., difference-in-differences) was not significant for any condition. (Table 2)

## Discussion

The current study, which compares hospitals subject to the HRRP in FY 2013 across quintiles with the highest and lowest proportions of dually eligible beneficiaries, has several notable findings. First, hospitals in the highest quintile had higher readmission rates over the study period, and worse financial performance. Further, if the revised policy had been implemented in 2013, few of these hospitals would have changed status from penalized to non-penalized. However, hospitals relieved from the penalties would have been among the most financially vulnerable ones. Recent research found an actual redistribution of penalties from the lowest dual eligible quintile hospitals to the highest quintile ones under the 2019 revised policy, although the change in penalty amount was likely small for many hospitals.<sup>5,12</sup> Thus, the new policy may achieve a modest Robin Hood effect, but longer-term studies are necessary to understand its consequences.

Second, the study shows several significant changes in readmission rates and other outcomes between the pre-HRRP period and the first few years of the HRRP implementation, outlined below.

Given the pressures to decrease 30-day readmission rates brought on by the HRRP, we found, unsurprisingly, that readmission rates decreased significantly for all hospitals, irrespective of the proportion of dual eligible patients served. Reductions in readmissions were more pronounced at hospitals in the highest dual-proportion quintile, resulting in a narrowing of the gap between the highest and lowest quintile hospitals, especially for HF. Further, we found that, for AMI and pneumonia, trends in 30-day mortality were similar and relatively stable across hospital quintiles. However, for HF, mortality rates were lowest but increased more at the highest quintile hospitals during the study period. Hospitals in both the highest and lowest quintiles increased community-dwelling rates on the 90<sup>th</sup> day after discharge for AMI and HF, relative to the linear pre-HRRP time trend, but the gaps remained stable across hospital quintiles, with the highest dual eligible quintile hospitals still trailing the lowest ones in performance.

The finding that readmission rates declined following the HRRP implementation is in line with prior research,<sup>13,25,26</sup> although whether the HRRP was responsible for the decline vs other factors (e.g., regression to the mean or more intensive coding of patient diagnoses in the hospital) remains unclear.<sup>23,27</sup> Additionally, the current study suggests that the

hospitals with the highest dual eligible patient proportions have reduced their readmission rates successfully under the original HRRP and even more so for HF than the hospitals with the lowest dual eligible proportions. Prior research has shown that readmission rates have decreased more at safety-net hospitals than at non-safety-net hospitals during the first years after HRRP implementation.<sup>3</sup> However, this research has used a different definition for safety-net hospitals following the new stratified HRRP policy, that is, the hospitals with the highest dual eligible patient proportions. Moreover, while there is a degree of overlap, recent research has shown that different safety-net hospital definitions result in hospitals with different vulnerabilities being identified as safety-net hospitals.<sup>28</sup> Thus, our study is among the first to show the effects of the HRRP on hospitals with high vs low dual eligible proportions of beneficiaries. Specifically, we show that the original HRRP policy appeared to have been effective in reducing readmissions for the highest dual-proportion hospitals and narrowing the gap in HF readmissions between the highest and lowest dual-proportion hospitals, generally without major negative effects on patient outcomes, except for a relative increase in HF mortality.

While it is reassuring that the reduction in readmissions in the highest dual-proportion quintile hospitals was not associated with worsening outcomes for AMI and pneumonia, the relative increase in HF mortality rates accompanying the relative decrease in HF readmission rates at the highest vs lowest quintile hospitals is notable, adding to the inconsistent prior literature. Several studies have shown mortality increases under the HRRP despite divergent conclusions. Some research pointed out that the HRRP may have the unintended consequence of increasing mortality for HF patients.<sup>29</sup> However, other research found that changes in HF mortality were nearly identical at penalized and non-penalized hospitals under the HRRP, suggesting that the HRRP penalties may not explain the increasing HF mortality.<sup>30</sup> Instead, other Medicare policies, such as the Two Midnight Rule, may have shifted lower-acuity care from inpatient to outpatient settings.<sup>31</sup> Other research also found that HF mortality rates were already increasing even before the HRRP.<sup>14</sup> Thus, further studies are needed to clarify whether the HRRP may indeed result in inadvertent harm to vulnerable populations or whether other mechanisms for increased HF mortality are at play.

The diverse findings suggest that the new policy may have several potential trade-offs. On one hand, as discussed, the new methodology may achieve a modest effect mitigating the inequitable treatment of hospitals serving high proportions of vulnerable populations. On the other hand, given that hospitals are now compared within their peer group, it remains to be seen if the new stratified methodology will retain the gains under the original HRRP. Under the new stratified methodology, a hospital's own readmission rates relative to its peer group will determine the size of the penalty, if any; however, differences in performance between hospitals with high and

low proportions of dual eligible beneficiaries will cease to influence penalties. Therefore, it will be important to monitor future changes in peer group performance to evaluate whether changes in performance across peer groups warrant further policy modifications.

The study has several limitations. First, because the HRRP was a national policy, there is no optimal control group of hospitals that were unaffected by the HRRP; thus, we cannot directly assess any causal effect of the HRRP on outcomes of hospitals in different dual eligible quintiles. Second, analyses were limited to three prevalent conditions included in the HRRP, and to Medicare fee-for-service beneficiaries; thus, results cannot be generalized to other conditions or populations (e.g., non-HRRP conditions or Medicare Advantage beneficiaries). Third, there may be other health outcomes affected for patients in high dual-proportion hospitals that are unobservable within Medicare data.

Despite these limitations, taken together, our results suggest that hospitals serving high proportions of dual eligible beneficiaries were lowering readmission rates under the original HRRP, without widespread adverse effects on major health outcomes, although the relative increase in HF mortality accompanying the relative decrease in HF re-emissions between the highest vs lowest dual-proportion hospitals warrant the need for future research. The new methodology intends to lighten the HRRP burden on hospitals serving a high proportion of low-income patients, but its effects on quality across hospital peer groups should be closely monitored in the future to ensure that hospitals serving vulnerable populations maintain these initial gains in readmissions reduction.

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### Supplemental Material

Supplemental material for this article is available online.

### References

1. Gilman M, Hockenberry JM, Adams EK, et al. The Financial Effect of Value-Based Purchasing and the Hospital Readmissions Reduction Program on Safety-Net Hospitals in 2014: A Cohort Study. *Ann Intern Med*. 2015;163(6):427-436. doi:10.7326/M14-2813.

2. Joynt KE, Jha AK. Characteristics of hospitals receiving penalties under the Hospital Readmissions Reduction Program. *J Am Med Assoc*. 2013;309(4):342-343. doi:10.1001/jama.2012.94856.
3. Carey K, Lin MY. Hospital Readmissions Reduction Program: Safety-Net Hospitals Show Improvement, Modifications To Penalty Formula Still Needed. *Health Aff*. 2016;35(10):1918-1923. doi:10.1377/hlthaff.2016.0537.
4. Centers for Medicare & Medicaid Services (CMS). *Hospital Readmissions Reduction Program (HRRP)*. Updated 08/06/2021 10:22 AM <https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Readmissions-Reduction-Program>.
5. Joynt Maddox KE, Reidhead M, Qi AC, Nerenz DR. Association of Stratification by Dual Enrollment Status With Financial Penalties in the Hospital Readmissions Reduction Program. *JAMA Intern Med*. 2019;179(6):769-776. doi:10.1001/jamainternmed.2019.0117.
6. Sheingold SH, Zuckerman R, Shartzer A. Understanding Medicare Hospital Readmission Rates And Differing Penalties Between Safety-Net And Other Hospitals. *Health Aff (Millwood)*. 2016;35(1):124-131. doi:10.1377/hlthaff.2015.0534.
7. Bhalla R, Kalkut G. Could Medicare readmission policy exacerbate health care system inequity? *Ann Intern Med*. 2010;152(2):114-117. doi:10.7326/0003-4819-152-2-201001190-00185.
8. Williams KAS, Javed AA, Hamid MS, Williams AM. Medicare readmission penalties in Detroit. *N Engl J Med*. 2014;371(11):1077-1078. doi:10.1056/NEJMc1405047.
9. Kaplan CM, Thompson MP, Waters TM. How Have 30-Day Readmission Penalties Affected Racial Disparities in Readmissions?: an Analysis from 2007 to 2014 in Five US States. *J Gen Intern Med*. 2019;34(6):878-883. doi:10.1007/s11606-019-04841-x.
10. Centers for Medicare & Medicaid Services (CMS). *New Stratified Methodology Hospital-Level Impact File User Guide, Hospital Readmissions Reduction Program*; 2017. [https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Downloads/HRRP\\_StratMethod\\_ImpactFile\\_UG.PDF](https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Downloads/HRRP_StratMethod_ImpactFile_UG.PDF). Accessed Nov 14, 2021.
11. Baker MC, Alberti PM, Tsao TY, Fluegge K, Howland RE, Haberman M. Social Determinants Matter For Hospital Readmission Policy: Insights From New York City. *Health Aff*. 2021;40(4):645-654. doi:10.1377/hlthaff.2020.01742.
12. McCarthy CP, Vaduganathan M, Patel KV, et al. Association of the New Peer Group-Stratified Method With the Reclassification of Penalty Status in the Hospital Readmission Reduction Program. *JAMA Netw Open*. 2019;2(4):e192987. doi:10.1001/jamanetworkopen.2019.2987.
13. Medicare Payment Advisory Commission (MedPAC). Update: MedPAC's evaluation of Medicare's Hospital Readmission Reduction Program. 2019. <http://medpac.gov/-blog/-update-on-medpac-s-evaluation-of-medicare-s-hospital-readmission-reduction-program/2019/12/02/update-medpac-s-evaluation->

- of-medicare-s-hospital-readmission-reduction-program. Accessed Nov 13, 2021.
14. Khera R, Dharmarajan K, Wang Y, et al. Association of the Hospital Readmissions Reduction Program With Mortality During and After Hospitalization for Acute Myocardial Infarction, Heart Failure, and Pneumonia. *JAMA Netw Open*. 2018;1(5):e182777. doi:10.1001/jamanetworkopen.2018.2777.
  15. Buntin MB, Colla CH, Deb P, Sood N, Escarce JJ. Medicare spending and outcomes after postacute care for stroke and hip fracture. *Med Care*. 2010;48(9):776-784. doi:10.1097/MLR.0b013e3181e359df.
  16. Burke RE, Xu Y, Ritter AZ. Outcomes of post-acute care in skilled nursing facilities in Medicare beneficiaries with and without a diagnosis of dementia. *J Am Geriatr Soc*. 2021; 69(10):2899-2907. doi:10.1111/jgs.17321.
  17. Ireland AW, Kelly PJ, Cumming RG. Associations between hospital-based rehabilitation for hip fracture and two-year outcomes for mortality and independent living: An Australian database study of 1,724 elderly community-dwelling patients. *J Rehabil Med*. 2016;48(7):625-631. doi:10.2340/16501977-2108.
  18. National Bureau of Economic Research (NBER). *Provider of Services Files*. Updated 2019/02/19/ <https://www.nber.org/data/provider-of-services.html>.
  19. Sacarny A. *CMS Hospital Cost Report (HCRIS) Data 2000-2017*. Updated 2018/12/26/T06:07:27Z <https://github.com/asacarny/hospital-cost-reports>.
  20. Centers for Medicare & Medicaid Services (CMS). *FY 2013 IPPS Final Rule: Hospital Readmissions Reduction Program Supplemental Data File*. (updated March 2013); 2013.
  21. Centers for Medicare & Medicaid Services (CMS). *Medicare Value-Based Programs: Hospital Readmissions Reduction Program (HRRP)*. 08/06/2021 09:19 AM 2021.
  22. Yale New Haven Health Services Corporation/Center for Outcomes Research and Evaluation (YNHHSC/CORE). *2013 Measures Updates and Specifications: Acute Myocardial Infarction, Heart Failure, and Pneumonia 30-Day Risk-Standardized Mortality Measure (Version 7.0)*. 2013. Accessed April 28, 2019. [https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HospitalQualityInits/Mortality\\_AMI-HF-PN\\_Measures\\_Updates\\_Report\\_FINAL\\_06-13-2013.pdf](https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HospitalQualityInits/Mortality_AMI-HF-PN_Measures_Updates_Report_FINAL_06-13-2013.pdf)
  23. Ody C, Msall L, Dafny LS, Grabowski DC, Cutler DM. Decreases In Readmissions Credited To Medicare's Program To Reduce Hospital Readmissions Have Been Overstated. *Health Aff (Millwood)*. 2019;38(1):36-43. doi:10.1377/hlthaff.2018.05178.
  24. Karaca-Mandic P, Norton EC, Dowd B. Interaction terms in nonlinear models. *Health Serv Res*. 2012;47(1 Pt 1):255-274. doi:10.1111/j.1475-6773.2011.01314.x.
  25. Zuckerman RB, Sheingold SH, Orav EJ, Ruhter J, Epstein AM. Readmissions, Observation, and the Hospital Readmissions Reduction Program. *N Engl J Med*. 2016;374(16):1543-1551. doi:10.1056/NEJMs1513024.
  26. Desai NR, Ross JS, Kwon JY, et al. Association Between Hospital Penalty Status Under the Hospital Readmission Reduction Program and Readmission Rates for Target and Nontarget Conditions. *J Am Med Assoc*. 2016;316(24): 2647-2656. doi:10.1001/jama.2016.18533.
  27. Joshi S, Nuckols T, Escarce J, Huckfeldt P, Popescu I, Sood N. Regression to the Mean in the Medicare Hospital Readmissions Reduction Program. *JAMA Intern Med*. 2019;179(9): 1167-1173. doi:10.1001/jamainternmed.2019.1004.
  28. Popescu I, Fingar KR, Cutler E, Guo J, Jiang HJ. Comparison of 3 Safety-Net Hospital Definitions and Association With Hospital Characteristics. *JAMA Netw Open*. 2019;2(8): e198577. doi:10.1001/jamanetworkopen.2019.8577.
  29. Gupta A, Allen LA, Bhatt DL, et al. Association of the Hospital Readmissions Reduction Program Implementation With Readmission and Mortality Outcomes in Heart Failure. *JAMA Cardiol*. 2018;3(1):44-53. doi:10.1001/jamacardio.2017.4265.1
  30. Huckfeldt P, Escarce J, Wilcock A, et al. HF Mortality Trends Under Medicare Readmissions Reduction Program at Penalized and Nonpenalized Hospitals. *J Am Coll Cardiol*. 2018;72(20): 2539-2540. doi:10.1016/j.jacc.2018.08.2174.
  31. Nuckols TK, Fingar KR, Barrett M, Steiner CA, Stocks C, Owens PL. The Shifting Landscape in Utilization of Inpatient, Observation, and Emergency Department Services Across Payers. *J Hosp Med*. 2017;12(6):443-446. doi:10.12788/jhm.2751.