Follow-up Post-discharge and Readmission Disparities Among Medicare Fee-for-Service Beneficiaries, 2018

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BACKGROUND: Previous studies have identified disparities in readmissions among Medicare beneficiaries hospitalized for the Hospital Readmissions Reduction Program's (HRRP's) priority conditions. Evidence suggests timely follow-up is associated with reduced risk of readmission, but it is unknown whether timely follow-up reduces disparities in readmission.

OBJECTIVE: To assess whether follow-up within 7 days after discharge from a hospitalization reduces risk of readmission and mitigates identified readmission disparities.

DESIGN: A retrospective cohort study using Cox proportional hazards models to estimate the associations between sociodemographic characteristics (race and ethnicity, dual-eligibility status, rurality, and area social deprivation), follow-up, and readmission. Mediation analysis was used to examine if disparities in readmission were mitigated by follow-up.

PARTICIPANTS: We analyzed data from 749,402 Medicare fee-for-service beneficiaries hospitalized for acute myocardial infarction, chronic obstructive pulmonary disease, heart failure, or pneumonia, and discharged home between January 1 and December 1, 2018.

MAIN MEASURE: All-cause unplanned readmission within 30 days after discharge.

KEY RESULTS: Post-discharge follow-up within 7 days of discharge was associated with a substantially lower risk of readmission (HR: 0.52, 95% CI: 0.52–0.53). Across all four HRRP conditions, beneficiaries with dual eligibility and beneficiaries living in areas with high social deprivation had a higher risk of readmission. Non-Hispanic Black beneficiaries had higher risk of readmission after hospitalization for pneumonia relative to non-Hispanic Whites. Mediation analysis suggested that 7-day follow-up mediated 21.2% of the disparity in the risk of readmission between dually and non-dually eligible beneficiaries and 50.7% of the disparity in the risk of readmission between beneficiaries living in areas with the highest and lowest social deprivation. Analysis suggested that after hospitalization for pneumonia, 7-day follow-up mediated nearly all (97.5%) of the increased risk of readmission between non-Hispanic Black and non-Hispanic White beneficiaries.

CONCLUSIONS: Improving rates of follow-up could be a strategy to reduce readmissions for all beneficiaries and reduce disparities in readmission based on sociodemographic characteristics.

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INTRODUCTION

Hospital readmissions are costly and can indicate poor quality health care.[1] In 2012, the Centers for Medicare & Medicaid Services (CMS) implemented the Hospital Readmissions Reduction Program (HRRP), which aims to improve quality and reduce the cost of care through financial penalties for hospitals with a higher-than-expected rate of readmission.[2] Since the implementation of HRRP, there has been a decrease in avoidable readmissions among Medicare beneficiaries;[3] however, readmission disparities persist within key sociodemographic strata, including between racial and ethnic groups, having and not having Medicaid as a primary insurer, and others.[4–6]

Multiple approaches have been proposed to reduce disparities in readmission, including improving transitions of care between hospital, home, and community settings.[7–9] While studies indicate that timely outpatient follow-up after a hospitalization is associated with fewer complications and better health outcomes,[7, 10, 11] there is a lack of representative, methodologically robust studies that assess whether timely follow-up reduces the likelihood of readmission.[12] Literature describing the association between follow-up and readmission varies by conditions, payers (e.g., Medicaid), and clinical settings (e.g., single hospitals and large health systems). Several studies have found that timely follow-up reduces the likelihood of readmission,[7, 10, 11, 13, 14] but the impact varies when follow-up is assessed against all-cause or condition-specific readmissions.[10, 15, 16] Other studies have found timely follow-up has no—or a very small—association with readmissions for certain populations and conditions.[17, 18]

Moreover, while studies have found lower rates of follow-up and higher rates of readmission among racial and ethnic minorities, individuals with low socioeconomic status, and

those living in rural areas,[7, 19] it is unclear whether insufficient follow-up contributes to readmission disparities.

Understanding whether timely follow-up is associated with reduced readmissions is important for quality improvement and advancing the HRRP quality improvement goals, as is identifying if follow-up plays a role in readmission disparities. Low rates of timely follow-up among beneficiaries from historically underserved populations may help explain factors that contribute to disparities in readmission. To address these questions, we first measured whether timely follow-up was associated with a reduced risk of readmission among hospitalizations for the HRRP target conditions among Medicare fee-for-service (FFS) beneficiaries. We then assessed whether timely follow-up mitigated disparities in readmission risk between beneficiaries with and without vulnerability due to sociodemographic characteristics.

METHODS

Data Sources

We conducted a retrospective cohort study using data from the CMS Chronic Conditions Data Warehouse, which includes administrative claims from the Medicare FFS program, as well as enrollment information for Medicare beneficiaries. Hospitalization data came from the Medicare Provider and Analysis Review file for 2018, supplemented with beneficiary demographic characteristics from the Master Beneficiary Summary File and the Geographic Variation Database. Post-discharge follow-up was identified using institutional and non-institutional claims. Hospital characteristics data were obtained from CMS's Provider of Service file and 2018 Medicare Cost Reports. We also used data from 2012–2016 American Community Survey 5-year estimates to measure area-level deprivation.

Study Population

This study included all beneficiaries enrolled in Medicare Part A and Part B and hospitalized for one of the four HRRP target conditions—acute myocardial infarction (AMI), chronic obstructive pulmonary disease (COPD), heart failure (HF), and/or pneumonia—and discharged home or to home health care between January 1 and December 1, 2018. The HRRP includes six target condition and procedure-specific measures, but this paper did not address the two procedures measures. Condition-specific hospitalizations were identified by primary, and in some cases secondary, diagnoses with International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10) codes following guidance from CMS's hospital-level 30-day risk-standardized readmission measures (Appendix Methods 1).[20]

Our cohort included beneficiaries who were discharged from short-term and critical-access hospitals and were enrolled in Medicare Part A and B (i.e., FFS) without enrollment in managed care for at least 30 days after the index hospitalization and at least 1 year prior. Prior eligibility was required to allow an adequate look-back period for clinical risk scores.

Of the 1,554,099 discharges with a primary diagnosis of AMI, COPD, HF, or pneumonia, 1,427,955 met FFS enrollment criteria. Observations were excluded if the beneficiary died during the index stay (n=47,454), had a discharge status other than to-home or home health care (n=440,419), lived outside the USA (n=4,125), or was under age 18 (n=24), which resulted in 935,933 eligible discharges. One hospital event was randomly selected for beneficiaries who had more than one hospitalization during the study period, resulting in a final cohort of 749,402 beneficiaries (see Study Inclusion Diagram, Appendix Methods 2).

Post-discharge Follow-up

We defined timely post-discharge follow-up as interactive contact with a patient and/or caregiver within 7 days of discharge using guidance from the Transitions of Care Healthcare Effectiveness Data and Information Set (HEDIS) measure,[21] which assesses patient engagement via office visits, home visits, and telehealth following discharge from inpatient hospitalization. For patients with a hospital readmission, only contact occurring before the first readmission counted as a follow-up.

Hospital Readmission

A hospital readmission was defined as an unplanned all-cause inpatient admission within 30 days of the index admission discharge date, following the exclusion criteria developed by CMS's Hospital-wide Readmission measure.[20] For each index hospitalization, the first readmission within 30 days was included in the analysis.

Sociodemographic Characteristics

Analysis explored disparities associated with sociodemographic characteristics, including race and ethnicity (non-Hispanic White, non-Hispanic Black, Asian/Pacific Islander, Hispanic, American Indian/Alaska Native, Other, Unknown), rurality (rural including micropolitan and non-Core Based Statistical Area, metropolitan), and Medicare-Medicaid dual-eligibility status. We also explored readmission disparity by area-level deprivation using the standardized Social Deprivation Index (index is Z-scored with mean=0 and standard deviation=1) for the beneficiary's ZIP code of residence.[22] The Social Deprivation Index (SDI) is a psychometrically tested measure that compiles area-level data on sociodemographic attributes including poverty, education, family structure, housing, and employment.[23] We categorized the index by quartiles, ranging from least to most deprivation (Q1 [least]: −1.885 to <−0.394; Q2: −0.394 to <0.109; Q3: 0.109 to <0.722; Q4 [most]: 0.722–6.25).

Covariates

Additional covariates included age and sex. Clinical variables included length of index hospitalization, hierarchical condition categories (HCC) risk score (score in the month of index hospitalization discharge), and discharge type (home/self-care vs. home health care). Date of death occurring within the 30-day follow-up period was included as a censoring variable in our models. Hospital characteristics of the index stay included disproportionate share hospital percentage, number of beds, and medical school affiliation.

Statistical Analysis

We first examined the unadjusted rates of post-discharge follow-up and readmission for each sociodemographic characteristic. We conducted all analyses on the overall cohort and by the primary condition of index hospitalizations (AMI, COPD, HF, pneumonia). We then used Cox proportional hazards to identify the risk of readmission by sociodemographic characteristics, constructing a series of multivariable models that added clinical and hospital-related characteristics, and a final model including post-discharge follow-up (Appendix Table 1). We confirmed that the proportional hazards assumption of a constant ratio of hazards between groups was met by assessing survival functions for predictors over time using Schoenfeld residuals. All p-values were from 2-sided tests, and statistical significance was set at $p<0.05$.

Where a disparity was identified, we conducted a mediation analysis to identify whether the intermediary factor of timely follow-up (mediator) could help to explain the association between sociodemographic characteristics (the exposure) and readmission (the outcome) (Appendix Methods 3). This method is helpful to identify underlying and modifiable factors that exist on the causal pathway between sociodemographic characteristics and readmission (i.e., living in an area with high social deprivation may lead to less frequent follow-up, which increases the risk of readmission). We were then able to quantify the excess risk of readmission among a particular group (e.g., dually eligible beneficiaries) that could be attributed to lower use of timely follow-up. We used a counterfactual mediation approach that provided a decomposition of the total effect of each sociodemographic characteristic into a direct and indirect effect.[24] From this decomposition, we calculated the percent of the total association between the characteristic and readmission that was mediated by post-discharge follow-up. Mediation was conducted using a SAS macro created by Valeri and VanderWeele.[24] We specified Cox proportional hazard models using the delta method to generate confidence intervals. Each model contained all sociodemographic characteristics and additional demographic, clinical, and hospital-related covariates.

Analyses were conducted using SAS Enterprise Guide 7.12 (SAS Institute Inc, 2016).

RESULTS

Among 749,402 Medicare FFS beneficiaries with an eligible index hospitalization, the majority were 65–84 years old (63.2%) and female (50.4%) (see Table 1). The overall cohort was predominantly non-Hispanic White (79.1%); beneficiaries who were non-Hispanic Black comprised 11.5%; Hispanic, 5.4%; Asian/Pacific Islander, 1.8%; and American Indian/Alaska Native, 1%. Beneficiaries who were dually eligible made up 27.7% of the cohort; 23.9% lived in rural areas, and the median social deprivation score was 0.11 (IQR: −0.39–0.72).

Rate of Timely Post-discharge Follow-up

Less than half (43.6%) of beneficiaries had a follow-up visit within 7 days of discharge (Table 2). The rate was lowest among beneficiaries who were non-Hispanic Black (34.1%) while 45.3% of discharges among non-Hispanic White beneficiaries had a follow-up. Among Hispanics, the rate was 40.0%; among American Indian/Alaska Native, 37.7%; and among Asian/Pacific Islanders, 43.1%. Follow-up occurred less frequently for beneficiaries with dual eligibility (38.3% vs. 45.7%) and was slightly higher for beneficiaries who lived in rural relative to metropolitan counties (44.8% vs. 43.3%). As area-level deprivation increased, the rate of follow-up decreased: 47.1% of beneficiaries in the lowest quartile of the SDI had a follow-up, compared with 38.8% of those in the highest quartile.

Risk of Readmission

Overall, 16.2% of beneficiaries had a hospital readmission within 30 days of discharge. In models adjusted for demographic, clinical, and hospital characteristics among the overall cohort, the risk of readmission varied by dual-eligibility status and area social deprivation (Table 3). Dual eligibility was associated with an increase in the hazard of readmission relative to non-duals (hazard ratio [HR]: 1.12, 95% confidence interval [CI]: 1.11–1.14) as did increasing quartiles of area social deprivation (HR Q4 [most deprivation] vs. Q1 [least]: 1.05, 95% CI: 1.03–1.07). Non-Hispanic Black, Hispanic, and Asian/Pacific Islander beneficiaries were at a slightly decreased risk of readmission relative to non-Hispanic Whites (respectively, HR: 0.97, 95% CI: 0.96–0.99; HR: 0.91, 95% CI: 0.89–0.94; and HR: 0.84, 95% CI: 0.80–0.88). There was no significant difference in risk of readmission among beneficiaries who were American Indian/Alaska Native relative to non-Hispanic Whites (HR: 0.97, 95% CI: 0.91–1.03), nor based on rurality status (HR: 0.99, 95% CI: 0.97–1.00).

Across HRRP index conditions, there were additional differences in the association between sociodemographic characteristics and readmission. Non-Hispanic Black beneficiaries hospitalized for pneumonia were at increased risk of readmission relative to non-Hispanic Whites (HR: 1.05, 95% CI: 1.01–1.09). For the other conditions, non-Hispanic Black

Table 1 Descriptive Characteristics of Patients Discharged for AMI, COPD, HF, and Pneumonia, Overall and by Condition at Index Visit

	No. (%) of beneficiaries				
	Total	Condition at index hospitalization			
	n=749,402 (100%)	AMI *n*=115,302 (15.4%)	COPD *n*=172,013 (23.0%)	HF *n*=263,746 (35.2%)	Pneumonia *n*=198,341 (26.5%)
Race and ethnicity					
Non-Hispanic White	592,810 (79.1)	93,312 (80.9)	143,675 (83.5)	195,307 (74.1)	160,516 (80.9)
Non-Hispanic Black	86,320 (11.5)	9,947 (8.6)	16,842 (9.8)	41,666 (15.8)	17,865 (9.0)
Hispanic	40,377 (5.4)	6,514 (5.7)	6,536 (3.8)	16,040 (6.1)	11,287 (5.7)
Asian/Pacific Islander	13,304 (1.8)	2,286 (2.0)	1,799 (1.1)	5,342 (2.0)	3,877 (2.0)
American Indian/Alaska Native	6,569 (0.9)	961 (0.8)	1,452 (0.8)	1,954 (0.7)	2,202 (1.1)
Other	4,629 (0.6)	849 (0.7)	816 (0.5)	1,786 (0.7)	1,178 (0.6)
Unknown	5,393 (0.7)	1,433 (1.2)	893 (0.5)	1,651 (0.6)	1,416 (0.7)
Dual eligibility	207,619 (27.7)	22,453 (19.5)	59,579 (34.6)	69,871 (26.5)	55,716 (28.1)
Rural	178,815 (23.9)	29,559 (25.6)	45,633 (26.5)	54,552 (20.7)	49,071 (24.7)
Social deprivation index (median, IQR)	0.11 (−0.39, 0.72)	0.06 (−0.43, 0.64)	0.15 (−0.34, 0.73)	0.14 (−0.39, 0.80)	0.07 (−0.43, 0.67)
Q1 (least deprivation; −1.885 to <−0.394)	187,140 (25.0)	30,706 (26.6)	38,674 (22.5)	65,523 (24.8)	52,237 (26.3)
Q2 (−0.394 to <0.109)	187,159 (25.0)	30,080 (26.1)	43,497 (25.3)	63,238 (24.0)	50,344 (25.4)
Q3 (0.109 to <0.722)	187,141 (25.0)	28,799 (25.0)	46,222 (26.9)	62,899 (23.9)	49,221 (24.8)
Q4 (most deprivation; 0.722-6.25)	187,102 (25.0)	25,574 (22.2)	43,448 (25.3)	71,802 (27.2)	46,278 (23.3)
Female	377,415 (50.4)	45,886 (39.8)	99,068 (57.6)	129,801 (49.2)	102,660 (51.8)
Age group					
<65 years	117,260 (15.6)	15,045 (13.1)	34,381 (20.0)	35,025 (13.3)	32,809 (16.5)
65–84 years	473,761 (63.2)	82,895 (71.9)	116,921 (68.0)	155,931 (59.1)	118,014 (59.5)
85 years and older	158,381 (21.1)	17,362 (15.1)	20,711 (12.0)	72,790 (27.6)	47,518 (24.0)
Index visit length of stay					
1–2 days	259,421 (34.6)	53,535 (46.4)	61,722 (35.9)	83,253 (31.6)	60,911 (30.7)
3–4 days	263,544 (35.2)	34,083 (29.6)	62,258 (36.2)	92,580 (35.1)	74,623 (37.6)
5 days or longer	226,437 (30.2)	27,684 (24.0)	48,033 (27.9)	87,913 (33.3)	62,807 (31.7)
HCC risk score in month of discharge (median, IQR)	1.81 (0.98, 3.26)	1.00 (0.58, 1.87)	1.90 (1.08, 3.15)	2.27 (1.29, 3.83)	1.73 (0.96, 3.21)
Q1 (lowest risk; 0.143 to <0.984)	187,385 (25.0)	56,916 (49.4)	37,497 (21.8)	41,981 (15.9)	50,991 (25.7)
Q2 (0.984 to <1.814)	187,371 (25.0)	28,429 (24.7)	44,997 (26.2)	61,466 (23.3)	52,479 (26.5)
Q3 (1.814 to <3.256)	187,370 (25.0)	16,257 (14.1)	49,272 (28.6)	75,450 (28.6)	46,391 (23.4)
Q4 (3.256–47.131)	187,269 (25.0)	13,698 (11.9)	40,246 (23.4)	84,847 (32.2)	48,478 (24.4)
Discharge setting					
Home/self-care	531,385 (70.9)	94,131 (81.6)	125,826 (73.2)	170,524 (64.7)	140,904 (71.0)
Home care of home health service organization	218,017 (29.1)	21,171 (18.4)	46,187 (26.9)	93,222 (35.4)	57,437 (29.0)
Hospital characteristics of index visit					
Hospital with medical school affiliation	339,981 (45.4)	60,570 (52.5)	69,081 (40.2)	128,178 (48.6)	82,152 (41.4)
Disproportionate share hospital (DSH) Percentage					
No DSH identified	345,677 (46.1)	51,482 (44.7)	78,976 (45.9)	120,797 (45.8)	94,422 (47.6)
Low share, 2.5 to <10.3%	138,629 (18.5)	20,755 (18.0)	32,489 (18.9)	47,797 (18.1)	37,588 (19.0)
Medium, 10.3 to <15.0%	108,238 (14.4)	16,160 (14.0)	26,267 (15.3)	37,525 (14.2)	28,286 (14.3)
High 15.0–82.4%	156,858 (20.9)	26,905 (23.3)	34,281 (19.9)	57,627 (21.9)	38,045 (19.2)
Number of beds					
Small (less than 100 beds)	99,629 (13.3)	5,710 (5.0)	30,357 (17.7)	28,188 (10.7)	35,374 (17.8)
Medium (100–199 beds)	138,682 (18.5)	17,184 (14.9)	35,599 (20.7)	47,185 (17.9)	38,714 (19.5)
Large (greater than 200 beds)	510,480 (68.1)	92,384 (80.1)	105,845 (61.5)	188,210 (71.4)	124,041 (62.5)

Abbreviations: AMI, acute myocardial infarction; COPD, chronic obstructive pulmonary disease; HF, heart failure; IQR, interquartile range

beneficiaries were either less likely to have a readmission than non-Hispanic White (heart failure HR: 0.94, 95% CI: 0.91–0.96) or there was no statistical difference (AMI HR: 0.96, 95% CI: 0.90–1.01; COPD HR: 0.98, 95% CI: 0.94–1.03). The association between the SDI and readmission was strongest among discharges from AMI hospitalizations (HR Q4 [most deprivation] vs. Q1 [least]: 1.10, 95% CI: 1.05–1.16) and was also significantly associated among COPD and heart failure (respectively, HR: 1.07, 95% CI: 1.03–1.11; and HR: 1.04, 95% CI: 1.01–1.07), but not among hospitalizations for pneumonia (HR: 1.00, 95% CI: 0.98–1.04).

Follow-up within 7 days of hospital discharge was associated with reduced 30-day hospital readmission. After adjusting for sociodemographic, clinical, and hospital characteristics, follow-up led to a 48% reduced risk of readmission (HR: 0.52, 95% CI: 0.52–0.53).

Mediation of Readmission Disparities by Timely Follow-up

In mediation models adjusted for sociodemographic, clinical, and hospital characteristics, follow-up was estimated to mediate 97.5% of the increased risk of readmission after hospitalization for pneumonia among non-Hispanic Black beneficiaries relative to non-Hispanic Whites (Table 4; also see indirect and direct effect estimates in Appendix Table 2). Follow-up partially mediated disparities in the risk of readmission between dually and non-dually eligible beneficiaries in the overall cohort by 21.2%. By condition of index hospitalization, the

Table 2 Unadjusted Rate of Post-discharge Follow-up Within 7 days from an Inpatient Hospitalization and 30-Day Readmission, Overall and by Index Condition

	Percentage of beneficiaries									
	Overall cohort		By index condition							
			AMI		COPD		HF		Pneumonia	
	Follow-up	30-day readmit	Follow-up	30-day readmit	Follow-up	30-day readmit	Follow-up	30-day readmit	Follow-up	30-day readmit
Overall	43.6	16.2	43.7	13.0	40.1	15.6	45.5	19.6	44.1	14.1
Follow-up within 7 days										
Yes	—	11.2	—	9.2	—	10.0	—	13.6	—	10.0
No	—	20.1	—	15.9	—	19.3	—	24.5	—	17.4
Race and ethnicity										
Non-Hispanic White	45.3	15.8	44.9	12.6	41.2	15.4	48.3	19.3	45.7	13.8
Non-Hispanic Black	34.1	18.7	35.2	15.8	32.0	17.4	34.7	20.6	34.3	17.0
Hispanic	40.0	17.2	40.0	15.5	37.8	15.4	41.3	20.7	39.6	14.4
Asian/Pacific Islander	43.1	15.4	44.1	13.7	41.3	13.0	45.0	18.0	40.7	13.9
American Indian/ Alaska Native	37.7	15.7	36.6	13.3	36.2	15.3	39.1	21.0	38.1	12.3
Other	43.5	15.7	42.6	10.8	42.4	14.1	45.0	18.6	42.5	16.0
Unknown	45.0	13.3	44.9	8.5	41.8	14.5	47.6	16.2	44.0	14.0
Dual eligibility										
No	45.7	15.0	44.6	12.0	42.1	14.3	48.1	18.4	46.0	13.1
Yes	38.3	19.2	40.0	17.0	36.4	18.0	38.5	22.9	39.2	16.8
Rurality										
Urban	43.3	16.5	43.9	13.2	39.3	15.9	45.3	19.6	43.4	14.4
Rural	44.8	15.3	43.0	12.4	42.3	14.7	46.6	19.2	46.2	13.2
Social deprivation index										
Q1 (least deprivation; −1.885 to <−0.394)	47.1	15.3	47.1	11.8	43.3	14.6	50.0	18.7	46.2	13.6
Q2 (−0.394 to <0.109)	45.4	15.7	44.4	12.6	41.8	15.2	47.8	19.2	46.0	13.7
Q3 (0.109 to <0.722)	43.2	16.1	42.7	12.9	40.1	15.6	45.3	19.6	43.8	14.2
Q4 (most deprivation; 0.722–6.25)	38.8	17.6	39.6	15.0	35.6	16.6	39.7	20.7	40.0	15.1

Abbreviations: AMI, acute myocardial infarction; COPD, chronic obstructive pulmonary disease; HF, heart failure

percent mediated was 12.1% for AMI, 25.2% for COPD, 12.9% for HF, and 18.5% for pneumonia. Follow-up partially mediated disparities in the risk of readmission between beneficiaries living in areas with the highest and lowest social deprivation (overall cohort, 50.7%). By condition of index hospitalization, the percent mediated was 23.8% for AMI, 45.2% for COPD, and 72.4% for HF.

DISCUSSION

About half of Medicare FFS beneficiaries received follow-up within 7 days after hospital discharge across all HRRP priority conditions. Unadjusted rates of readmission were consistently higher among patients without timely follow-up. Beneficiaries who were non-Hispanic Black, dually eligible, or living in areas with high social deprivation had the lowest rate of timely follow-up and highest unadjusted rate of readmission. Notably, beneficiaries living in rural areas had higher rates of follow-up and lower rates of readmission compared to national averages.[25] Our findings are consistent with previous studies that have found patients with social risk are less likely to have a follow-up appointment scheduled before discharge or to complete a scheduled follow-up.[7, 19, 26] Follow-up within 7 days was strongly associated with reduced risk of readmission for beneficiaries with one or more of the HRRP priority conditions after controlling for sociodemographic, clinical, and hospital characteristics, and substantially mediated readmission disparities among beneficiaries from historically underserved populations.

Timely follow-up is not only an important measure for reducing avoidable readmissions for all beneficiaries, but also could be a key strategy for reducing readmission disparities. Timely follow-up consistently mitigated disparities in readmission across HRRP priority conditions between the dually and non-dually eligible beneficiaries and between those living in areas of high and low social deprivation. We also found nearly all of the relative difference in readmission risk between non-Hispanic Black and non-Hispanic White beneficiaries hospitalized for pneumonia was mediated by follow-up in our model. In other words, this suggests that equal follow-up rates between non-Hispanic Black beneficiaries and non-Hispanic Whites are associated with a significant reduction in readmission risk. Similar to other studies, our study did not identify disparities in readmission among beneficiaries who were non-Hispanic Black and initially hospitalized for acute myocardial infarction, heart failure, or COPD, though unadjusted rates of readmission were higher.[27–29]

Table 3 Association of Sociodemographic Characteristics and Post-discharge Follow-up with 30-Day Readmission

	Hazard ratio (95% CI)									
	Overall		Index condition							
			AMI		COPD		HF		Pneumonia	
	Model 1	Model 2 (including follow-up)	Model 1	Model 2 (including follow-up)	Model 1	Model 2 (including follow-up)	Model 1	Model 2 (including follow-up)	Model 1	Model 2 (including follow-up)
Race and ethnicity (ref = White)										
Non-Hispanic Black	0.97* (0.96–0.99)	0.93*** (0.91–0.95)	0.96 (0.90–1.01)	0.92* (0.87–0.97)	0.98 (0.94–1.03)	0.95* (0.91–0.99)	0.94*** (0.91–0.96)	0.89*** (0.87–0.91)	1.05* (1.01–1.09)	1.00 (0.96–1.04)
Hispanic	0.91*** (0.89–0.94)	0.90*** (0.88–0.92)	0.98 (0.91–1.04)	0.97 (0.90–1.03)	0.86*** (0.81–0.92)	0.86*** (0.81–0.92)	0.92*** (0.89–0.96)	0.91*** (0.88–0.95)	0.87*** (0.83–0.92)	0.86*** (0.82–0.91)
Asian/Pacific Islander	0.84*** (0.80–0.88)	0.84*** (0.80–0.88)	0.88* (0.78–0.89)	0.89* (0.79–1.00)	0.71*** (0.62–0.80)	0.72*** (0.63–0.82)	0.83*** (0.78–0.89)	0.83*** (0.78–0.89)	0.89* (0.81–0.97)	0.87* (0.80–0.95)
American Indian/ Alaska Native	0.97 (0.91–1.03)	0.94* (0.88–1.00)	0.92 (0.78–1.10)	0.90 (0.75–1.07)	1.01 (0.89–1.16)	0.99 (0.87–1.13)	1.04 (0.94–1.15)	1.01 (0.91–1.11)	0.87* (0.77–0.98)	0.84* (0.74–0.94)
Other	0.92* (0.86–0.99)	0.91* (0.85–0.98)	0.78* (0.63–0.95)	0.77* (0.63–0.95)	0.88 (0.73–1.06)	0.89 (0.74–1.06)	0.90 (0.81–1.00)	0.89* (0.80–0.99)	1.08 (0.94–1.25)	1.07 (0.92–1.23)
Unknown	0.87* (0.81–0.94)	0.88* (0.82–0.94)	0.80* (0.67–0.95)	0.81* (0.67–0.96)	0.98 (0.82–1.16)	0.99 (0.83–1.18)	0.80** (0.70–0.90)	0.80** (0.71–0.91)	1.03 (0.89–1.18)	1.02 (0.89–1.17)
Dual eligibility (vs. non-dual)	1.12*** (1.11–1.14)	1.10*** (1.08–1.11)	1.11*** (1.06–1.16)	1.09*** (1.05–1.14)	1.11*** (1.08–1.14)	1.08*** (1.05–1.11)	1.13*** (1.10–1.15)	1.10*** (1.07–1.12)	1.14*** (1.11–1.17)	1.11*** (1.08–1.15)
Rural (vs. urban)	0.99 (0.97–1.00)	0.99 (0.98–1.01)	0.97 (0.93–1.00)	0.96* (0.92–1.00)	0.98 (0.95–1.01)	0.99 (0.96–1.03)	1.00 (0.98–1.02)	1.00 (0.98–1.03)	1.00 (0.97–1.03)	1.00 (0.97–1.04)
Social deprivation index (ref = Q1 least deprivation)										
Q2 (−0.395 to <0.097)	1.02* (1.00–1.04)	1.02 (1.00–1.03)	1.04 (1.00–1.09)	1.03 (0.98–1.08)	1.04* (1.01–1.08)	1.04* (1.00–1.08)	1.02 (0.99–1.04)	1.01 (0.98–1.03)	0.99 (0.96–1.03)	0.99 (0.96–1.03)
Q3 (0.097 to <0.688)	1.03** (1.02–1.05)	1.02 (1.00–1.03)	1.05 (1.00–1.10)	1.02 (0.98–1.07)	1.06* (1.02–1.10)	1.04* (1.00–1.08)	1.02 (1.00–1.05)	1.01 (0.98–1.03)	1.01 (0.98–1.05)	1.00 (0.97–1.04)
Q4 (most deprivation; 0.688–6.25)	1.05*** (1.03–1.07)	1.02* (1.00–1.04)	1.10*** (1.05–1.16)	1.07** (1.02–1.13)	1.07** (1.03–1.11)	1.04* (1.00–1.08)	1.04* (1.01–1.07)	1.01 (0.98–1.04)	1.00 (0.97–1.04)	0.99 (0.96–1.03)
Post-discharge follow-up within 7 days (Ref = no)		0.52*** (0.52–0.53)		0.53*** (0.52–0.55)		0.49*** (0.47–0.50)		0.51*** (0.50–0.52)		0.55*** (0.54–0.57)

*p<.05, **p<.001, ***p<.0001. Abbreviations: CI, confidence interval; AMI, acute myocardial infarction; COPD, chronic obstructive pulmonary disease; HF, heart failure
Models adjusted for sex, age, HCC at month of index discharge, length of index stay, discharge setting, hospital medical school affiliation, disproportionate share hospital percentage, and number of beds

Table 4 Percent of Sociodemographic Characteristic Disparity of 30-Day Readmission Mediated by Post-discharge Follow-up

	Percent of disparity mediated through follow-up		
	Non-Hispanic Black vs non-Hispanic White	Dually-eligible vs not	SDI Q4 (most deprivation) vs Q1 (least deprivation)
Overall cohort	-	21.2%	50.7%
Condition-specific			
AMI	-	12.1%	23.8%
COPD	-	25.2%	45.2%
HF	-	12.9%	72.4%
Pneumonia	97.5%	18.5%	-

SDI, social deprivation index
Models adjusted for all sociodemographic characteristics, sex, age, HCC at month of index discharge, length of index stay, discharge setting, hospital medical school affiliation, disproportionate share hospital percentage, and number of beds

Lower rates of follow-up among historically disadvantaged groups could be partially explained by greater exposure to harmful social determinants of health. Patients who lack adequate housing, transportation, and food (i.e., social risk factors) have been found to have a higher likelihood of readmission.[30] For example, beneficiaries who are racial and ethnic minorities, low-income, and/or living in areas that are characterized by a high level of disadvantage (e.g., crowded housing, without a car, and high unemployment) have relatively higher levels of housing insecurity.[31–33] A recent systematic review of 17 peer-reviewed studies identified housing insecurity among the most common factors associated with poor transitions of care and lower rates of post-discharge follow-up.[34] Housing insecurity is also associated with higher rates of hospitalization and readmission.[35, 36]

Patients with social risk factors may face barriers to follow-up including low health literacy and an inability to obtain transportation to appointments. Increasing the use of telehealth services for health education and convenient virtual follow-up appointments could increase rates of timely follow-up. The expansion of telehealth because of the COVID-19 pandemic creates an unprecedented opportunity to increase access to virtual follow-up appointments for Medicare beneficiaries.[37] A recent randomized control trial found follow-up care via a mobile app averted in-person visits and increased patient perception of convenience.[38]

Our findings have implications for improving equity in the HRRP. The HRRP has been criticized for disproportionately penalizing hospitals that primarily serve beneficiaries with social risk factors (e.g., food and housing insecurity).[39] While higher penalties for safety-net hospitals that serve a higher volume of minority patients may improve patient transitions of care,[40] penalties may place higher burdens on hospitals that are already financially strained, leaving them with fewer resources for improvement.[41] The HRRP now uses a stratified methodology that assesses a hospital's performance relative to that of other hospitals with a similar proportion of patients dually eligible for Medicare and Medicaid, but the potential for reducing disparities remains unclear. Efforts to improve transitions of care, particularly for the dually eligible, should consider the use of a follow-up visit within 7 days after a discharge for HRRP priority conditions to reduce readmissions. For instance, Kaiser Permanente in Northern California was able to improve follow-up with 7 days by implementing procedures for remote patient monitoring and a follow-up protocol. [19] Other studies have found scheduling an outpatient appointment before discharge increases the likelihood of follow-up. [10, 42]

Our study has several limitations. First, the most advantageous timeframe for follow-up may vary by the condition at hospitalization. Nevertheless, we found 7-day follow-up is generally associated with lower readmission risk for the target conditions. Second, we used area-level sociodemographic characteristics as a proxy for distinct social risk factors, such as neighborhood safety and lack of public transportation, as they are not available in claims data. Further studies are needed to understand the effects of individual-level social risk factors (e.g., discrimination) on risk of readmission. Third, because we modeled death as a censoring event rather than a competing risk, our estimates may include bias when the probability of readmission is modified by death as an antecedent event. Finally, underlying assumptions of mediation analysis include the absence of confounding in the relationships between the exposure and outcome, the exposure and mediator, and the mediator and outcome. While we adjusted for many known confounders (age, length of index stay, etc.), our study was observational and unmeasured confounding could lead to bias of estimates. Findings cannot be assumed to imply causation. Still, we used a precise measure of follow-up (the mediator) that temporally precedes readmission.

CONCLUSION

Our study tested two hypotheses: (1) whether timely follow-up is associated with reduced readmission risk and (2) timely follow-up mediates disparities in readmission risk based on sociodemographic factors. We found an association between timely follow-up and readmission among beneficiaries with HRRP priority conditions, as found in prior research. In addition, timely follow-up was associated with reduced disparities in readmission across conditions for the dually eligible (compared to beneficiaries who are not dually eligible) and reduced the increased risk among non-Hispanic Black beneficiaries hospitalized with pneumonia. Future research should assess the drivers of disparities in timely follow-up to inform interventions.

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