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Trends in 30-Day Readmission Rates for Medicare and Non-Medicare Patients in the Era of the Affordable Care Act



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ABSTRACT

BACKGROUND: Temporal changes in the readmission rates for patient groups and conditions that were not directly under the purview of the Hospital Readmissions Reduction Program (HRRP) can help assess whether efforts to lower readmissions extended beyond targeted patients and conditions.

METHODS: Using the Nationwide Readmissions Database (2010-2015), we assessed trends in all-cause readmission rates for 1 of the 3 HRRP conditions (acute myocardial infarction, heart failure, pneumonia) or conditions not targeted by the HRRP in age-insurance groups defined by age group (≥ 65 years or < 65 years) and payer (Medicare, Medicaid, or private insurance).

RESULTS: In the group aged ≥ 65 years, readmission rates for those covered by Medicare, Medicaid, and private insurance decreased annually for acute myocardial infarction (risk-adjusted odds ratio [OR; 95% confidence interval] among Medicare patients, 0.94 [0.94-0.95], among Medicaid patients, 0.93 [0.90-0.97], and among patients with private-insurance, 0.95 [0.93-0.97]); heart failure (ORs, 0.96 [0.96-0.97], 0.96 [0.94-0.98], and 0.97 [0.96-0.99], for the 3 payers, respectively), and pneumonia (ORs, 0.96 [0.96-0.97], 0.94 [0.92-0.96], and 0.96 [0.95-0.97], respectively). Readmission rates also decreased in the group aged < 65 years for acute myocardial infarction (ORs: Medicare 0.97 [0.96-0.98], Medicaid 0.94 [0.92-0.95], and private insurance 0.93 [0.92-0.94]), heart failure (ORs, 0.98 [0.97-0.98]: 0.96 [0.96-0.97], and 0.97 [0.95-0.98], for the 3 payers, respectively), and pneumonia (ORs, 0.98 [0.97-0.99], 0.98 [0.97-0.99], and 0.98 [0.97-1.00], respectively). Further, readmission rates decreased significantly for non-target conditions.

CONCLUSIONS: There appears to be a systematic improvement in readmission rates for patient groups beyond the population of fee-for-service, older, Medicare beneficiaries included in the HRRP.

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BACKGROUND

The Hospital Readmissions Reduction Program (HRRP) has been associated with substantial reductions in readmission within 30 days of discharge among fee-for-service Medicare beneficiaries aged ≥ 65 years who are hospitalized with acute myocardial infarction, heart failure, or pneumonia—the target population for this program.^{1,2} There have been suggestions that hospitals might have pursued reductions in readmissions through efforts mainly directed toward Medicare beneficiaries aged ≥ 65 years without pursuing systematic improvements in the care of patients.³ Other reports have suggested an inconsistent cross-sectional association between hospital-level readmission rates for Medicare beneficiaries for conditions covered under the HRRP compared with other patient groups.^{4,5} However, an assessment of the temporal association between the HRRP's introduction and changes in readmissions for patient groups other than the Medicare beneficiaries targeted in the program is essential to assess how rates of readmission have evolved in an era with emphasis on readmission reduction for patients who were not directly being targeted for quality improvement nationally.

Accordingly, we used the Healthcare Cost and Utilization Project's Nationwide Readmissions Database (NRD), a nationally representative all-payer database, for 2010-2015 to assess temporal trends in 30-day readmission rates for the 3 HRRP target conditions (acute myocardial infarction, heart failure, and pneumonia) and other conditions not targeted by the HRRP, across age-insurance groups.

METHODS

Data Source and Variables

We used the NRD for the years 2010-2015.⁶ The NRD is a nationally representative, all-payer dataset that has been constructed using discharge-level data for all hospitalizations from the Healthcare Cost and Utilization Project's State Inpatient Databases of geographically dispersed participating states (18-27 states during 2010-2015). The sample includes nearly half of all US hospitalizations each year. In 2015, for example, the NRD included 56.6% of hospitalizations in the United States, representing all hospitalizations for 57.8% of the total population. The NRD uses a year-specific, patient-level identifier that allows tracking of patients across hospitalizations in a state within a calendar year.

The NRD includes clinical and demographic variables for each hospitalization and information on the primary

insurance payer for each hospitalization. To ensure the uniformity of coding across different data sources, the payer in NRD is classified into broad insurance groups of Medicare, Medicaid, private insurance, self-pay, no charge, other, and missing or invalid. For this study, we included the patients with Medicare, Medicaid, or private insurance as the payers of the hospitalization; Medicare and Medicaid both include fee-for-service and managed care patients, and private insurance includes commercial insurance providers. Given the variability in reporting across participating states, only 1 payer is associated with each person in the NRD. In patients with more than 1 source of insurance coverage, only the insurance program expected to reimburse the hospital for the clinical encounter (the primary payer) is included in the NRD.

CLINICAL SIGNIFICANCE

- Between 2010 and 2015, all-cause 30-day readmission rates for acute myocardial infarction, heart failure, and pneumonia, the three conditions originally targeted under the Hospital Readmissions Reduction Program (HRRP), decreased significantly across three payer groups of Medicare, Medicaid and Private Insurance.
- For hospitalizations not targeted by HRRP, there was a modest decrease in readmission rates.

Study Population

We included all hospitalizations among adults (≥ 18 years) with a primary discharge diagnosis of acute myocardial infarction, heart failure, and pneumonia, identified using the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes for discharges between January 2010 and September 2015, and the *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) codes for discharges between October and December 2015. These definitions are consistent with those used by the Centers for Medicare & Medicaid Services (CMS) for its readmission metrics for the respective conditions.⁷⁻⁹ We also identified nontarget conditions, representing hospitalizations for conditions that were not subject to financial penalties under the HRRP. To define index hospitalizations for nontarget conditions, we excluded the hospitalizations for the 3 target conditions (acute myocardial infarction, heart failure, and pneumonia). We also excluded hospitalizations for chronic obstructive pulmonary disease and hip and knee arthroplasty because these types were included in the HRRP toward the end of the study period.¹⁰ The ICD-9-CM and ICD-10-CM codes used to identify each of these conditions are included in [Supplementary Tables 1-10](#) (available online). We stratified all hospitalizations into age-insurance subgroups defined by age (≥ 65 years or < 65 years) and insurance payer (Medicare, Medicaid, or private insurance).

For each of the 4 conditions (acute myocardial infarction, heart failure, pneumonia, and nontarget hospitalizations), there were 6 age-insurance groups based on age and insurance payer: ≥ 65 years with Medicare, Medicaid, or

private insurance, and <65 years with Medicare, Medicaid, or private insurance.

Outcome

The outcome of interest was all-cause 30-day readmission. Readmission was defined as any hospitalization within 30 days of the discharge after an index hospitalization to the same or a different hospital within the state. A hospitalization classified as a readmission was not an index hospitalization for a subsequent readmission event. Data in the NRD are restricted to calendar years, without an ability to track patients across years. Therefore, as recommended by the Agency for Healthcare Research and Quality, we used data for 11 months (January–November) to allow 30-day follow-up for all patients for each year in the analyses.¹¹

Statistical Analysis

We defined an index hospitalization as one in which patients were discharged alive and did not leave the hospital against medical advice. Further, hospitalizations with missing information on either the date of admission or hospital length of stay were excluded because that information was required for the assessment of postdischarge, 30-day events. Multiple index admissions were possible for each patient, regardless of the time elapsed between 2 hospitalizations.

To account for the complex survey design of the NRD, we used survey-specific methodology with hospital as cluster, NRD stratum as strata, and discharge-level weights as weight to obtain weighted nationwide, annual 30-day readmission rates and further evaluate the risk-adjusted annual trends in readmission.^{11–13} For risk adjustment, we created a patient-level survey logistic regression model with 30-day readmission as the outcome and risk factors that are part of the risk adjustment in the CMS publicly reported measure for acute myocardial infarction, heart failure, and pneumonia (age, gender, and comorbidities) based on the secondary diagnoses in the index hospitalization as independent variables. For nontarget conditions, we used the set of risk factors that are included in the CMS hospital-wide readmission measure.¹⁴ In contrast to the CMS measures, where risk factors are defined based on the diagnoses in the index hospitalization as well as a preceding 12-month period before the index event, the comorbidities used in our survey logistic regression were defined in the index event. To allow assessment of risk-adjusted odds of readmission over years, we assessed calendar year as a dummy coded continuous variable in the model, allowing for an assessment of odds of annual changes in readmission stratified by the 6 age-insurance groups. To further evaluate the differences in annual trends of readmission between older Medicare and other patient groups, we tested the interaction between the calendar year and age-payer patient groups with Medicare patients aged ≥ 65 years as the reference group.

All analyses were conducted using SAS 9.4 software (SAS Institute, Cary, NC), and the level of significance was set at 0.05. The study was exempted by the institutional review board at Yale University (New Haven, Conn)

because the data were de-identified. The data are available publicly through the Agency for Healthcare Research and Quality.

RESULTS

Between 2010 and 2015, there were 1,051,140 hospitalizations for acute myocardial infarction, 2,128,140 for heart failure, 2,067,240 for pneumonia, and 53,734,220 for nontarget conditions in the NRD, representing an estimated 2,364,371, 4,795,327, 4,900,012, and 121,093,299 hospitalizations nationally for acute myocardial infarction, heart failure, pneumonia, and nontarget conditions, respectively (Supplementary Figure 1, available online). Overall, there were an estimated 349,139 readmissions nationally for acute myocardial infarction (14.8%), 1,111,593 for heart failure (23.2%), 817,431 for pneumonia (16.7%), and 16,290,748 for nontarget conditions (13.5%). The selected characteristics of index hospitalizations in the 6 patient age-insurance groups for acute myocardial infarction, heart failure, pneumonia, and nontarget conditions are included in Table 1, and the characteristics of the patients hospitalized for target conditions are included in Supplementary Table 11 (available online).

Readmission Trends for Target Conditions

Over the 6 years of the study period (2010–2015), 30-day readmission rates for acute myocardial infarction decreased for all 6 age-insurance groups (Figures 1A and 2A) (Supplementary Table 12, available online). The baseline characteristics of the patients hospitalized for acute myocardial infarction are shown in Supplementary Table 13 (available online). In those who were aged ≥ 65 years and covered by Medicare, readmission rates decreased from 19.2% in 2010 to 15.8% in 2015 (risk-adjusted odds ratio [OR] for yearly change in readmission, 0.94; 95% confidence interval [CI], 0.94–0.95) (Table 2 and Supplementary Figure 2 [available online]). In those aged ≥ 65 years, readmission rates decreased from 14.6% to 12.4% (risk-adjusted OR, 0.95; 95% CI, 0.93–0.97) for the privately insured, and from 23.4% to 18.3% (risk-adjusted OR, 0.93; 95% CI, 0.90–0.97) for those insured by Medicaid. Privately insured and Medicaid patients aged <65 years had a relative decline in readmission rates (privately insured: risk-adjusted OR, 0.93, 95% CI, 0.92–0.94; Medicaid: risk-adjusted OR, 0.94, 95% CI, 0.92–0.95) similar to that of the Medicare population aged ≥ 65 years. Medicare patients aged <65 years also observed a decrease in readmission rates (19.7% to 18.6%; risk-adjusted OR, 0.97, 95% CI, 0.96–0.98), but the decrease was lower than that of the reference group of Medicare aged ≥ 65 years (*P* for calendar-year*age-insurance group interaction, .001).

Similar to acute myocardial infarction, all-cause 30-day readmission rates for heart failure decreased in all age-insurance groups between 2010 and 2015, with a similar relative decline in all groups (*P* for calendar-year*age-insurance

Table 1 Characteristics of Patients Hospitalized for Acute Myocardial Infarction, Heart Failure, Pneumonia, and Nontarget Conditions Stratified by Age/Insurance Groups

Patient Characteristics, % (SE)	Patients Aged ≥65 years			Patients Aged <65 years		
	Medicare	Medicaid	Private Insurance	Medicare	Medicaid	Private Insurance
Acute Myocardial Infarction						
Age, mean (SE)	77.8 (0.03)	74.4 (0.1)	72.7 (0.07)	56.2 (0.03)	52.3 (0.04)	54.1 (0.02)
Female	47.4 (0.11)	52.9 (0.64)	33.1 (0.33)	35.9 (0.21)	37.3 (0.24)	25.4 (0.12)
History of coronary artery bypass graft surgery	11.3 (0.08)	7.5 (0.32)	9.2 (0.17)	9.8 (0.14)	5.2 (0.1)	3.2 (0.05)
Diabetes mellitus or diabetes mellitus complications	38 (0.12)	49 (0.61)	36.4 (0.3)	51.2 (0.24)	40.8 (0.24)	27.9 (0.13)
Iron deficiency or other/unspecified anemias and blood disease	28.6 (0.16)	33.1 (0.6)	23 (0.29)	25.3 (0.25)	20.8 (0.22)	13.2 (0.14)
Chronic obstructive pulmonary disease	20.3 (0.11)	17 (0.5)	15.8 (0.23)	24.8 (0.24)	18.4 (0.23)	7.4 (0.09)
Renal failure	35.4 (0.16)	35.6 (0.63)	27.2 (0.34)	33 (0.32)	19.3 (0.24)	9.5 (0.11)
Heart Failure						
Age, mean (SE)	79.9 (0.02)	75.6 (0.09)	76.1 (0.07)	55.3 (0.04)	51.7 (0.04)	54.3 (0.04)
Female	54.2 (0.09)	61.5 (0.46)	43.2 (0.3)	41.1 (0.18)	42.7 (0.23)	37.6 (0.2)
History of coronary artery bypass graft surgery	18.2 (0.1)	13.5 (0.3)	17.9 (0.24)	12.2 (0.13)	7.6 (0.1)	9.2 (0.12)
Diabetes mellitus or diabetes mellitus complications	43.4 (0.1)	52.8 (0.43)	46.6 (0.29)	58.1 (0.21)	48.2 (0.21)	47.9 (0.21)
Iron deficiency or other/unspecified anemias and blood disease	35.2 (0.14)	38.4 (0.41)	31.1 (0.28)	34.7 (0.23)	29.7 (0.2)	26.5 (0.21)
Chronic obstructive pulmonary disease	34 (0.11)	28.7 (0.46)	31.9 (0.29)	35.8 (0.22)	31.3 (0.23)	20 (0.18)
Renal failure	52.6 (0.14)	51.9 (0.44)	50.7 (0.32)	57.1 (0.24)	44.3 (0.28)	41 (0.26)
Pneumonia						
Age, mean (SE)	79.8 (0.02)	76.5 (0.09)	75.6 (0.09)	53.5 (0.04)	47.1 (0.06)	49.9 (0.05)
Female	53.1 (0.08)	58.3 (0.51)	44.4 (0.33)	49.3 (0.18)	55 (0.19)	52 (0.16)
History of coronary artery bypass graft surgery	8.2 (0.06)	4.6 (0.19)	7.6 (0.15)	3.4 (0.06)	1.8 (0.05)	1.9 (0.04)
Diabetes mellitus or diabetes mellitus complications	31 (0.09)	39.3 (0.47)	31.2 (0.27)	34.4 (0.18)	26.5 (0.17)	22.7 (0.13)
Iron deficiency or other/unspecified anemias and blood disease	33.5 (0.16)	36.1 (0.48)	29.7 (0.3)	31.7 (0.22)	28.9 (0.2)	24.9 (0.18)
Chronic obstructive pulmonary disease	41.2 (0.13)	35.2 (0.53)	40.8 (0.32)	39.6 (0.25)	33.8 (0.25)	21.5 (0.17)
Renal failure	30.1 (0.12)	28.4 (0.46)	26.4 (0.31)	25.3 (0.19)	14.7 (0.16)	12.1 (0.12)
Nontarget Conditions						
Age, mean	77.7 (0.02)	74.4 (0.05)	73.1 (0.05)	51.1 (0.03)	36.4 (0.06)	42 (0.06)
Female	57.3 (0.05)	60.9 (0.34)	47 (0.15)	50.8 (0.07)	72.8 (0.18)	67.8 (0.19)
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance	32.7 (0.1)	32.8 (0.24)	27.4 (0.12)	30.7 (0.13)	15.3 (0.1)	14 (0.08)
Diabetes mellitus	31.7 (0.07)	40.2 (0.22)	30.4 (0.1)	34.6 (0.1)	14.1 (0.07)	12.6 (0.07)
Iron deficiency or other/unspecified anemias and blood disease	31.3 (0.12)	32.1 (0.25)	26.5 (0.14)	27.3 (0.18)	18.7 (0.13)	15.7 (0.11)
Chronic obstructive pulmonary disease	18.1 (0.06)	14.5 (0.21)	14.6 (0.1)	16.4 (0.1)	6 (0.06)	3.2 (0.03)
Renal failure	28 (0.1)	27.7 (0.23)	22.2 (0.14)	25.4 (0.15)	7.4 (0.07)	5.9 (0.06)

SE = standard error.

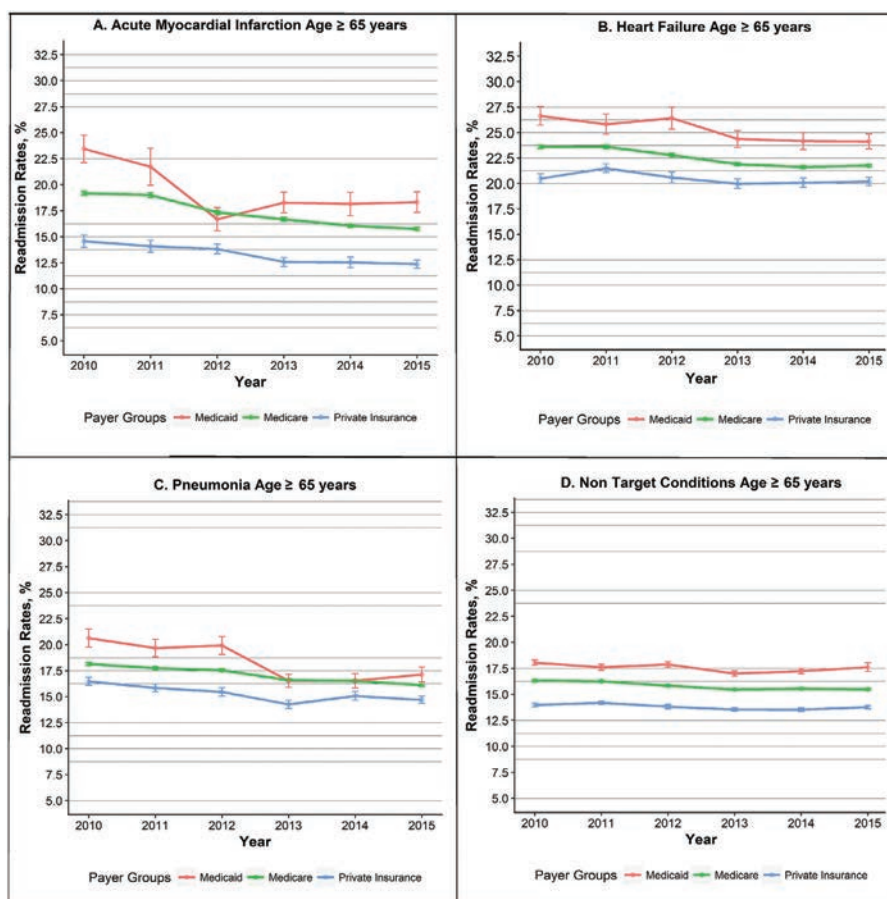


Figure 1 Trends of readmission rates in patients aged ≥ 65 years by different payer types.

group interaction, .056) (Figures 1B and 2B) (Supplementary Table 11, available online). The baseline characteristics of the patients hospitalized for heart failure are shown in Supplementary Table 14 (available online). In patients aged ≥ 65 years, readmission rates decreased from 23.6% in 2010 to 21.8% in 2015 in those covered by Medicare (risk-adjusted OR for yearly change in readmission, 0.96; 95% CI, 0.96-0.98), from 26.4% to 24.1% in those covered by Medicaid (risk-adjusted OR, 0.96; 95% CI, 0.94-0.98), and from 20.5% to 20.2% in those privately insured (risk-adjusted OR, 0.97; 95% CI, 0.96-0.99) (Table 2 and Supplementary Figure 2 [available online]). For those aged < 65 years and covered by Medicare, readmission rates increased from 28.9% in 2010 to 29.2% in 2011 and decreased to 28.0% in 2015 (risk-adjusted OR, 0.98; 95% CI, 0.97-0.98). In this age group, readmissions decreased uniformly across the study period for both Medicaid (risk-adjusted OR, 0.97; 95% CI, 0.96-0.98) and privately insured (risk-adjusted OR, 0.97; 95% CI, 0.95-0.98) patients.

Readmission rates for pneumonia decreased across age-insurance groups, but with differences in relative decline across the groups (P for calendar year*age-insurance group interaction $< .001$) (Figures 1C and 2C) (Supplementary

Table 11, available online). The baseline characteristics of the patients hospitalized for pneumonia are shown in Supplementary Table 15 (available online). Among those aged ≥ 65 years, readmission rates decreased from 18.1% in 2010 to 16.1% in 2015 in those covered by Medicare (risk-adjusted OR for yearly change in readmission, 0.96; 95% CI, 0.96-0.97), from 20.6% to 17.1% in those covered by Medicaid (risk-adjusted OR, 0.94; 95% CI, 0.92-0.96), and from 16.5% to 14.7% in the privately insured (risk-adjusted OR, 0.96; 95% CI, 0.96-0.97) (Table 2 and Supplementary Figure 2 [available online]). There was a much smaller relative decrease in readmission rates for all insurance groups in the aged < 65 years age group, relative to the trends in the reference group of those covered by Medicare and who were aged ≥ 65 years (P for calendar year*age-insurance interaction $< .05$ for all groups aged < 65 years). Specifically, in this age group, readmission rates decreased from 20.1% in 2010 to 19.4% in 2015 for those covered by Medicare (risk-adjusted OR, 0.98; 95% CI, 0.97-0.99), from 18.2% to 17.4% for Medicaid patients (risk-adjusted OR, 0.98; 95% CI, 0.97-0.99), and from 11.0% to 10.9% for the privately insured (risk-adjusted OR, 0.98; 95% CI, 0.97-1.00).

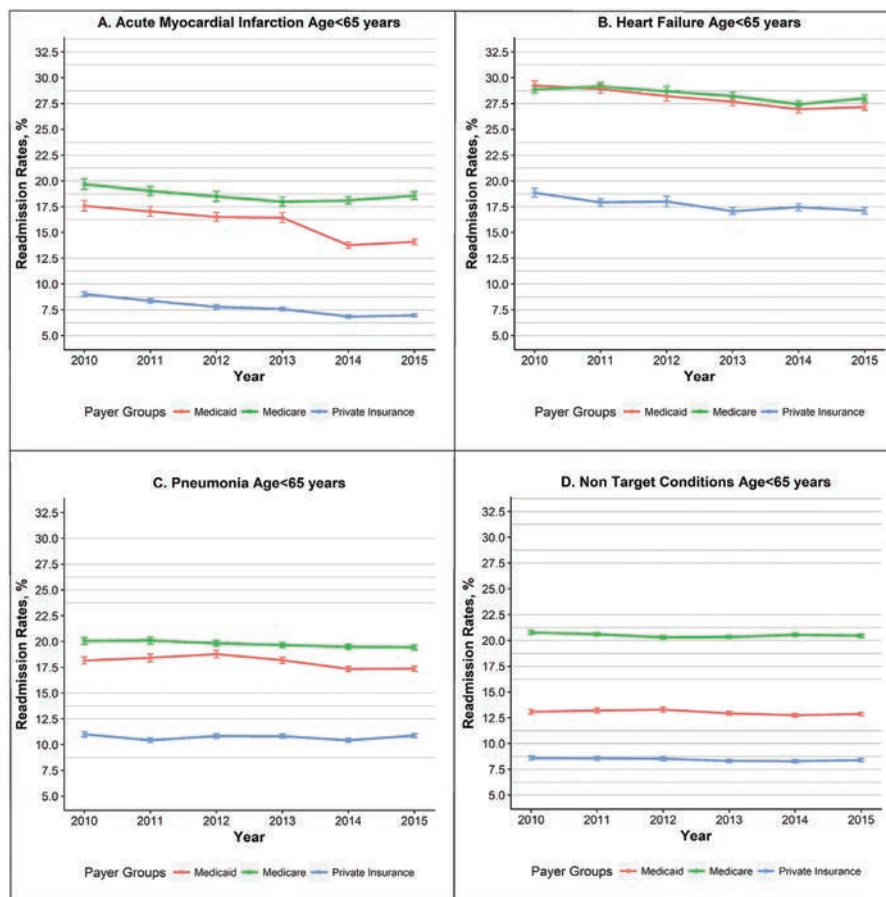


Figure 2 Trends of readmission rates in patients aged <65 years by different payer types.

Readmission Trends for Nontarget Conditions

Patients hospitalized for nontarget conditions who were covered by either Medicare or Medicaid were more frequently readmitted than patients who were privately insured; this was found in patients both aged >65 and <65 years. Further, there was a small decrease in observed readmission rates in most age-insurance groups (Figures 1D and 2D) (Supplementary Table 12, available online). In patients aged ≥ 65 years who were covered by Medicare, readmission rates decreased from 16.3% in 2010 to 15.5% in 2015 (risk-adjusted OR for yearly change in readmission rates, 0.97; 95% CI, 0.97-0.97) (Table 2 and Supplementary Figure 2 [available online]). Those covered by Medicaid followed a similar pattern (risk-adjusted OR, 0.98; 95% CI, 0.96-0.99). Among the privately insured, readmission rates decreased from 14.0% in 2010 to 13.5% in 2013, then increased to 13.8% in 2015 (risk-adjusted OR, 0.97; 95% CI, 0.97-0.98). In contrast, there was a small relative decrease in readmission rates in patients aged <65 years over the study period: 20.8% to 20.5% for those covered by Medicare (risk-adjusted OR, 0.98; 95% CI, 0.98-0.99), 13.1% to 12.9% for those covered by Medicaid (risk-

adjusted OR, 0.97; 95% CI, 0.96-0.98), and 8.6% to 8.4% for those privately insured (risk-adjusted OR, 0.98; 95% CI, 0.97-0.98).

Overall, the decrease in readmission rates was significantly higher for target conditions than for nontarget conditions ($P < .001$). A similar pattern of a larger decrease in readmission rates for target vs nontarget conditions was observed across age-insurance groups ($P < .05$ for all).

DISCUSSION

From 2010-2015, 30-day all-cause readmission rates for acute myocardial infarction, heart failure, and pneumonia declined across all age-insurance groups. Readmission rates decreased modestly for conditions not targeted by the HRRP in all age-payer groups, with larger declines among Medicare patients aged ≥ 65 years. These results are consistent with the hypothesis that interventions designed to reduce readmissions due to the HRRP were implemented broadly rather than exclusively applied to older Medicare fee-for-service beneficiaries.

Under the HRRP, hospitals are financially incentivized to lower excess readmissions among fee-for-service

Table 2 Risk Adjusted Odds Ratios for Annual Decrease in Readmission Rates by Age-Payer Groups

	Odds Ratio (95% CI)
Acute Myocardial Infarction	
Medicare patients aged ≥ 65 years	0.94 (0.94-0.95)
Medicaid patients aged ≥ 65 years	0.93 (0.90-0.97)
Private insurance patients aged ≥ 65 years	0.95 (0.93-0.97)
Medicare patients aged < 65 years	0.97 (0.96-0.98)
Medicaid patients aged < 65 years	0.94 (0.92-0.95)
Private insurance patients aged < 65 years	0.93 (0.92-0.94)
Heart Failure	
Medicare patients aged ≥ 65 years	0.96 (0.96-0.97)
Medicaid patients aged ≥ 65 years	0.96 (0.94-0.98)
Private insurance patients aged ≥ 65 years	0.97 (0.96-0.99)
Medicare patients aged < 65 years	0.98 (0.97-0.98)
Medicaid patients aged < 65 years	0.96 (0.96-0.97)
Private insurance patients aged < 65 years	0.97 (0.95-0.98)
Pneumonia	
Medicare patients aged ≥ 65 years	0.96 (0.96-0.97)
Medicaid patients aged ≥ 65 years	0.94 (0.92-0.96)
Private insurance patients aged ≥ 65 years	0.96 (0.95-0.97)
Medicare patients aged < 65 years	0.98 (0.97-0.99)
Medicaid patients aged < 65 years	0.98 (0.97-0.99)
Private insurance patients aged < 65 years	0.98 (0.97-1.00)
Nontarget Conditions	
Medicare patients aged ≥ 65 years	0.97 (0.97-0.97)
Medicaid patients aged ≥ 65 years	0.98 (0.96-0.99)
Private insurance patients aged ≥ 65 years	0.97 (0.97-0.98)
Medicare patients aged < 65 years	0.98 (0.98-0.99)
Medicaid patients aged < 65 years	0.97 (0.96-0.98)
Private insurance patients aged < 65 years	0.98 (0.97-0.98)

Medicare patients aged ≥ 65 years. Studies have shown that since the announcement of the HRRP, readmission rates in Medicare have improved for patients aged ≥ 65 years with conditions specifically targeted under the HRRP, exceeding the decrease in readmission rates for conditions that are not included in the program.^{2,15} Our study further extends our understanding of the trends of readmission rates across the non-Medicare population, including privately insured patients who also have value-based payment models with a consideration for readmissions.

Our findings may reflect that hospital-wide efforts were implemented to improve quality of care to decrease readmission rates. Some of the structural changes might have been spurred by CMS itself, which has initiated several programs aimed at reducing readmissions. One such program, Hospital Engagement Networks, was established by the CMS Partnership for Patients in 2011 and focuses on patient safety, particularly the prevention of patient harm after discharge.¹⁶ The program operated through dissemination of information and the development of collaborations between hospitals. Hospital to Home is a nationwide initiative to develop resources for hospitals to improve transitions through discharge and reduce their readmission rates.¹⁷ The program emphasized early postdischarge ambulatory care follow-up and patient education. Further, new programs are being initiated to address the burden of

unplanned readmissions. The Patient Navigator Program of the American College of Cardiology aims to reduce avoidable hospital readmissions for patients discharged with acute myocardial infarction by supporting a culture of patient-centered care during the hospital stay and in the weeks following discharge.¹⁸ Adoption of these programs may have led to much wider improvements in readmission rates through improved healthcare delivery, patient education, and improved follow-up, which were not limited to the patients covered under the HRRP directly. This information also represents critical feedback to health policy makers, since health policy interventions may have wider implications for patient health and wellness.

The findings of the study should be interpreted in light of certain limitations. First, we used serial cross-sectional data and assessed secular trends. Therefore, the findings cannot be interpreted to represent a direct causal relationship between health policy implementation and changes in readmission outcomes. Second, hospitalizations are included in the NRD at the time of discharge and cannot be tracked across years. To assess 30-day readmission rates, data from December were excluded. However, this exclusion was consistent across study years and has been recommended by the Agency for Healthcare Research and Quality.¹⁹ Third, we are unable to specifically account for the competing risk of posthospitalization mortality. However, our analysis compares temporal trends in specific insurance groups, and therefore trends may be consistent across study years. Fourth, changing trends may be subject to directional changes in coding practices. However, it is unclear if such coding changes would disproportionately affect certain patient groups. Fifth, insurance categories defined in the study rely on those reported as the primary payer in the NRD. Moreover, individuals reported as covered under Medicare include both fee-for-service and managed care beneficiaries. Therefore, trends may vary if payers are defined differently. Last, the hospitals cannot be tracked across years, precluding an assessment of hospital-specific readmission rates.

CONCLUSIONS

There was a significant decline in readmission rates for the 3 conditions targeted by the HRRP across age and payer groups. Readmission rates also declined modestly for conditions not targeted by the HRRP. These patterns are consistent with the hypothesis that implementation of the HRRP was associated with systematic changes in the care of patients and reduced readmission risk beyond the HRRP's target population of fee-for-service Medicare beneficiaries.

REFERENCES

1. Patient Protection and Affordable Care Act, 42 USC § 18001 (2010).
2. Zuckerman RB, Sheingold SH, Orav EJ, Ruhter J, Epstein AM. Readmissions, observation, and the Hospital Readmissions Reduction Program. *N Engl J Med*. 2016;374:1543-1551.

3. Ibrahim AM, Dimick JB, Sinha SS, et al. Association of coded severity with readmission reduction after the Hospital Readmissions Reduction Program. *JAMA Intern Med.* 2018;178:290–292.
4. Sukul D, Sinha SS, Ryan AM, et al. Patterns of readmissions for three common conditions among younger US adults. *Am J Med.* 2017;130:1220.e1221–1220.e1216. <https://doi.org/10.1016/j.amjmed.2017.05.025>
5. Wasfy JH, Zigler C, Choirat C, et al. Readmission rates after passage of the hospital readmissions reduction program: a pre-post analysis. *Ann Intern Med.* 2017;166:324–331.
6. Healthcare Cost and Utilization Project. Overview of the Nationwide Readmissions Database (NRD). Available at: <https://www.hcup-us.ahrq.gov/nrdoverview.jsp>. Accessed April 13, 2018.
7. Krumholz HM, Lin Z, Drye EE, et al. An administrative claims measure suitable for profiling hospital performance based on 30-day all-cause readmission rates among patients with acute myocardial infarction. *Circ Cardiovasc Qual Outcomes.* 2011;4:243–252.
8. Krumholz HM, Wang Y, Mattera JA, et al. An administrative claims model suitable for profiling hospital performance based on 30-day mortality rates among patients with heart failure. *Circulation.* 2006;113:1693–1701.
9. Bratzler DW, Normand SL, Wang Y, et al. An administrative claims model for profiling hospital 30-day mortality rates for pneumonia patients. *PLoS One.* 2011;6:e17401. <https://doi.org/10.1371/journal.pone.0017401>
10. Centers for Medicare & Medicaid Services. Readmissions Reduction Program (HRRP). Available at: <https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Readmissions-Reduction-Program.html>. Accessed April 13, 2018.
11. Agency for Healthcare Research and Quality Healthcare Cost and Utilization Project. Introduction to the HCUP Nationwide Readmission Database (NRD), 2014. Available at: https://www.hcup-us.ahrq.gov/db/nation/nrd/NRD_Introduction_2010-2014.jsp. Accessed April 13, 2018.
12. Khera R, Jain S, Pandey A, et al. Comparison of readmission rates after acute myocardial infarction in 3 patient age groups (18 to 44, 45 to 64, and ≥ 65 years) in the United States. *Am J Cardiol.* 2017;120:1761–1767.
13. Khera R, Angraal S, Couch T, et al. Adherence to methodological standards in research using the National Inpatient Sample. *JAMA.* 2017;318:2011–2018.
14. Centers for Medicare & Medicaid Services. Measure methodology; 2018. Available at <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HospitalQualityInits/Measure-Methodology.html>. Accessed April 13, 2018.
15. 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. *JAMA.* 2016;316:2647–2656.
16. Centers for Medicare & Medicaid Services. Hospital Engagement Networks: connecting hospitals to improve care; Available at: <https://www.cms.gov/Newsroom/MediaReleaseDatabase/Fact-sheets/2011-Fact-sheets-items/2011-12-14.html>. Accessed April 13, 2018.
17. Institute for Healthcare Improvement, American College of Cardiology. Hospital to Home; 2018. Available at <https://cvquality.acc.org/initiatives/hospital-to-home>. Accessed April 13, 2018.
18. American College of Cardiology. Patient Navigator Program: Focus MI. Available at: <https://cvquality.acc.org/initiatives/patient-navigator>. Accessed April 13, 2018.
19. Khera R, Pandey A, Ayers CR, et al. Contemporary epidemiology of heart failure in fee-for-service Medicare beneficiaries across health-care settings. *Circ Heart Fail.* 2017;10:e004402. doi:10.1161/CIRCHEARTFAILURE.117.004402.

SUPPLEMENTARY APPENDIX

Supplementary Material accompanying this article can be found in the online version at [10.1016/j.amjmed.2018.06.013](https://doi.org/10.1016/j.amjmed.2018.06.013)

Conflict of Interest: NRD, SMB, EED, LIH, and HMK work under contract with the Centers for Medicare & Medicaid Services to develop and maintain performance measures that are publicly reported. KD is chief scientific officer of Clover Health, a Medicare Advantage company. NRD and HMK are recipients of research agreements from Johnson & Johnson (Janssen), through Yale University, to develop methods of clinical trial data sharing. HMK was a recipient of a grant from Medtronic and the Food and Drug Administration, through Yale University, to develop methods for post-market surveillance of medical devices; chairs a cardiac scientific advisory board for UnitedHealth; is a participant/participant representative of the IBM Watson Health Life Sciences Board; is a member of the Advisory Board for Element Science and the Physician Advisory Board for Aetna; and is the founder of Hugo, a personal health information platform. The other authors report no potential conflicts of interest.

Supplementary Table 1: ICD-9 Codes Used to Define AMI Cohort

ICD-9-CM Diagnosis Codes	Description
410.00	Acute myocardial infarction of anterolateral wall, episode of care unspecified
410.01	Acute myocardial infarction of anterolateral wall, initial episode of care
410.10	Acute myocardial infarction of other anterior wall, episode of care unspecified
410.11	Acute myocardial infarction of other anterior wall, initial episode of care
410.20	Acute myocardial infarction of inferolateral wall, episode of care unspecified
410.21	Acute myocardial infarction of inferolateral wall, initial episode of care
410.30	Acute myocardial infarction of inferoposterior wall, episode of care unspecified
410.31	Acute myocardial infarction of inferoposterior wall, initial episode of care
410.40	Acute myocardial infarction of other inferior wall, episode of care unspecified
410.41	Acute myocardial infarction of other inferior wall, initial episode of care
410.50	Acute myocardial infarction of other lateral wall, episode of care unspecified
410.51	Acute myocardial infarction of other lateral wall, initial episode of care
410.60	True posterior wall infarction, episode of care unspecified
410.61	True posterior wall infarction, initial episode of care
410.70	Subendocardial infarction, episode of care unspecified
410.71	Subendocardial infarction, initial episode of care
410.80	Acute myocardial infarction of other specified sites, episode of care unspecified
410.81	Acute myocardial infarction of other specified sites, initial episode of care
410.90	Acute myocardial infarction of unspecified site, episode of care unspecified
410.91	Acute myocardial infarction of unspecified site, initial episode of care

Supplementary Table 2: ICD-9 Codes Used to Define Heart Failure Cohort

ICD-9-CM Diagnosis Codes	Description
402.01	Malignant hypertensive heart disease with heart failure
402.11	Benign hypertensive heart disease with heart failure
402.91	Unspecified hypertensive heart disease with heart failure
404.01	Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.03	Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage V or end stage renal disease
404.11	Hypertensive heart and chronic kidney disease, benign, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.13	Hypertensive heart and chronic kidney disease, benign, with heart failure and chronic kidney disease stage V or end stage renal disease
404.91	Hypertensive heart and chronic kidney disease, unspecified, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.93	Hypertensive heart and chronic kidney disease, unspecified, with heart failure and chronic kidney disease stage V or end stage renal disease
428.0	Congestive heart failure, unspecified
428.1	Left heart failure
428.20	Systolic heart failure, unspecified
428.21	Acute systolic heart failure
428.22	Chronic systolic heart failure
428.23	Acute on chronic systolic heart failure
428.30	Diastolic heart failure, unspecified
428.31	Acute diastolic heart failure
428.32	Chronic diastolic heart failure
428.33	Acute on chronic diastolic heart failure
428.40	Combined systolic and diastolic heart failure, unspecified
428.41	Acute combined systolic and diastolic heart failure
428.42	Chronic combined systolic and diastolic heart failure
428.43	Acute on chronic combined systolic and diastolic heart failure
428.9	Heart failure, unspecified

Supplementary Table 3: ICD-9 Codes Used to Define Pneumonia Cohort

ICD-9-CM Diagnosis Codes	Description
480.0	Pneumonia due to adenovirus
480.1	Pneumonia due to respiratory syncytial virus
480.2	Pneumonia due to parainfluenza virus
480.3	Pneumonia due to SARS-associated coronavirus
480.8	Pneumonia due to other virus not elsewhere classified
480.9	Viral pneumonia, unspecified
481	Pneumococcal pneumonia [Streptococcus pneumoniae pneumonia]
482.0	Pneumonia due to Klebsiella pneumoniae
482.1	Pneumonia due to Pseudomonas
482.2	Pneumonia due to Hemophilus influenzae [H. influenzae]
482.30	Pneumonia due to Streptococcus, unspecified
482.31	Pneumonia due to Streptococcus, group A
482.32	Pneumonia due to Streptococcus, group B
482.39	Pneumonia due to other Streptococcus
482.40	Pneumonia due to Staphylococcus, unspecified
482.41	Methicillin susceptible pneumonia due to Staphylococcus aureus
482.42	Methicillin resistant pneumonia due to Staphylococcus aureus
482.49	Other Staphylococcus pneumonia
482.81	Pneumonia due to anaerobes
482.82	Pneumonia due to escherichia coli [E. coli]
482.83	Pneumonia due to other gram-negative bacteria
482.84	Pneumonia due to Legionnaires' disease
482.89	Pneumonia due to other specified bacteria
482.9	Bacterial pneumonia, unspecified
483.0	Pneumonia due to mycoplasma pneumoniae
483.1	Pneumonia due to chlamydia
483.8	Pneumonia due to other specified organism
485	Bronchopneumonia, organism unspecified
486	Pneumonia, organism unspecified
487.0	Influenza with pneumonia
488.11	Influenza due to identified 2009 H1N1 influenza virus with pneumonia
507.0	Pneumonitis due to inhalation of food or vomitus

Supplementary Table 4: ICD-9 Codes Used to Define Chronic Obstructive Pulmonary Disease Cohort

ICD-9-CM Diagnosis Codes	Description
491.21	Obstructive chronic bronchitis with (acute) exacerbation
491.22	Obstructive chronic bronchitis with acute bronchitis
491.8	Other chronic bronchitis
491.9	Unspecified chronic bronchitis
492.8	Other emphysema
493.20	Chronic obstructive asthma, unspecified
493.21	Chronic obstructive asthma with status asthmaticus
493.22	Chronic obstructive asthma with (acute) exacerbation
496	Chronic airway obstruction, not elsewhere classified
Principal discharge diagnosis codes included in cohort if combined with a secondary diagnosis of COPD with exacerbation (491.21, 491.22, 493.21, or 493.22)	
518.81	Acute respiratory failure
518.82	Other pulmonary insufficiency, not elsewhere classified
518.84	Acute and chronic respiratory failure
799.1	Respiratory arrest

Supplementary Table 5: ICD-9 Codes Used to Define Hip/Knee Arthroplasty Cohort

ICD-9-CM Procedure Codes	Description
81.51	Total hip replacement
81.54	Total knee replacement

Supplementary Table 6: ICD-10 Codes Used to Define Acute Myocardial Infarction

ICD-10-CM Codes	Description
I21.01	ST elevation (STEMI) myocardial infarction involving left main coronary artery
I21.02	ST elevation (STEMI) myocardial infarction involving left anterior descending coronary artery
I21.09	ST elevation (STEMI) myocardial infarction involving other coronary artery of anterior wall
I21.11	ST elevation (STEMI) myocardial infarction involving right coronary artery
I21.19	ST elevation (STEMI) myocardial infarction involving other coronary artery of inferior wall
I21.21	ST elevation (STEMI) myocardial infarction involving left circumflex coronary artery
I21.29	ST elevation (STEMI) myocardial infarction involving other sites
I21.3	ST elevation (STEMI) myocardial infarction of unspecified site
I21.4	Non-ST elevation (NSTEMI) myocardial infarction

Supplementary Table 7: ICD-10 Codes Used to Define Heart Failure

ICD-10-CM Codes	Description
I11.0	Hypertensive heart disease with heart failure
I13.0	Hypertensive heart and chronic kidney disease with heart failure and stage 1 through stage 4 chronic kidney disease, or unspecified chronic kidney disease
I13.2	Hypertensive heart and chronic kidney disease with heart failure and with stage 5 chronic kidney disease, or end stage renal disease
I50.1	Left ventricular failure
I50.20	Unspecified systolic (congestive) heart failure
I50.21	Acute systolic (congestive) heart failure
I50.22	Chronic systolic (congestive) heart failure
I50.23	Acute on chronic systolic (congestive) heart failure
I50.30	Unspecified diastolic (congestive) heart failure
I50.31	Acute diastolic (congestive) heart failure
I50.32	Chronic diastolic (congestive) heart failure
I50.33	Acute on chronic diastolic (congestive) heart failure
I50.40	Unspecified combined systolic (congestive) and diastolic (congestive) heart failure
I50.41	Acute combined systolic (congestive) and diastolic (congestive) heart failure
I50.42	Chronic combined systolic (congestive) and diastolic (congestive) heart failure
I50.43	Acute on chronic combined systolic (congestive) and diastolic (congestive) heart failure
I50.9	Heart failure, unspecified

Supplementary Table 8: ICD-10 Codes Used to Define Pneumonia

ICD-10-CM Codes	Description
A48.1	Legionnaires' disease
J10.00	Influenza due to other identified influenza virus with unspecified type of pneumonia
J10.01	Influenza due to other identified influenza virus with the same other identified influenza virus pneumonia
J10.08	Influenza due to other identified influenza virus with other specified pneumonia
J11.00	Influenza due to unidentified influenza virus with unspecified type of pneumonia
J11.08	Influenza due to unidentified influenza virus with specified pneumonia
J12.0	Adenoviral pneumonia
J12.1	Respiratory syncytial virus pneumonia
J12.2	Parainfluenza virus pneumonia
J12.3	Human metapneumovirus pneumonia
J12.81	Pneumonia due to SARS-associated coronavirus
J12.89	Other viral pneumonia
J12.9	Viral pneumonia, unspecified
J13	Pneumonia due to <i>Streptococcus pneumoniae</i>
J14	Pneumonia due to <i>Hemophilus influenzae</i>
J15.0	Pneumonia due to <i>Klebsiella pneumoniae</i>
J15.1	Pneumonia due to <i>Pseudomonas</i>
J15.20	Pneumonia due to staphylococcus, unspecified
J15.211	Pneumonia due to Methicillin susceptible <i>Staphylococcus aureus</i>
J15.212	Pneumonia due to Methicillin resistant <i>Staphylococcus aureus</i>
J15.29	Pneumonia due to other staphylococcus
J15.3	Pneumonia due to streptococcus, group B
J15.4	Pneumonia due to other streptococci
J15.5	Pneumonia due to <i>Escherichia coli</i>
J15.6	Pneumonia due to other aerobic Gram-negative bacteria
J15.7	Pneumonia due to <i>Mycoplasma pneumoniae</i>
J15.8	Pneumonia due to other specified bacteria
J15.9	Unspecified bacterial pneumonia
J16.0	Chlamydial pneumonia
J16.8	Pneumonia due to other specified infectious organisms
J18.0	Bronchopneumonia, unspecified organism
J18.1	Lobar pneumonia, unspecified organism
J18.8	Other pneumonia, unspecified organism
J18.9	Pneumonia, unspecified organism
J69.0	Pneumonitis due to inhalation of food and vomit

Supplementary Table 9: ICD-10 Codes Used to Define Chronic Obstructive Pulmonary Disease

ICD-10-CM Codes	Description
J41.8	Mixed simple and mucopurulent chronic bronchitis
J42	Unspecified chronic bronchitis
J43.0	Unilateral pulmonary emphysema [MacLeod's syndrome]
J43.1	Panlobular emphysema
J43.2	Centrilobular emphysema
J43.8	Other emphysema
J43.9	Emphysema, unspecified
J44.0	Chronic obstructive pulmonary disease with acute lower respiratory infection
J44.1	Chronic obstructive pulmonary disease with (acute) exacerbation
J44.9	Chronic obstructive pulmonary disease, unspecified
Principal discharge diagnosis codes included in cohort if combined with a secondary diagnosis of J44.0 or J44.1	
J96.00	Acute respiratory failure, unspecified whether with hypoxia or hypercapnia
J96.01	Acute respiratory failure with hypoxia
J96.02	Acute respiratory failure with hypercapnia
J96.20	Acute and chronic respiratory failure, unspecified whether with hypoxia or hypercapnia
J96.21	Acute and chronic respiratory failure with hypoxia
J96.22	Acute and chronic respiratory failure with hypercapnia
J96.90	Respiratory failure, unspecified, unspecified whether with hypoxia or hypercapnia
J96.91	Respiratory failure, unspecified with hypoxia
J96.92	Respiratory failure, unspecified with hypercapnia
R09.2	Respiratory arrest

Supplementary Table 10: ICD-10 Codes Used to Define Hip/Knee Arthroplasty

ICD-10-PCS Codes	Description
0SR9019	Replacement of Right Hip Joint with Metal Synthetic Substitute, Cemented, Open Approach
0SR901A	Replacement of Right Hip Joint with Metal Synthetic Substitute, Uncemented, Open Approach
0SR901Z	Replacement of Right Hip Joint with Metal Synthetic Substitute, Open Approach
0SR9029	Replacement of Right Hip Joint with Metal on Polyethylene Synthetic Substitute, Cemented, Open Approach
0SR902A	Replacement of Right Hip Joint with Metal on Polyethylene Synthetic Substitute, Uncemented, Open Approach
0SR902Z	Replacement of Right Hip Joint with Metal on Polyethylene Synthetic Substitute, Open Approach
0SR9039	Replacement of Right Hip Joint with Ceramic Synthetic Substitute, Cemented, Open Approach
0SR903A	Replacement of Right Hip Joint with Ceramic Synthetic Substitute, Uncemented, Open Approach
0SR903Z	Replacement of Right Hip Joint with Ceramic Synthetic Substitute, Open Approach
0SR9049	Replacement of Right Hip Joint with Ceramic on Polyethylene Synthetic Substitute, Cemented, Open Approach
0SR904A	Replacement of Right Hip Joint with Ceramic on Polyethylene Synthetic Substitute, Uncemented, Open Approach
0SR904Z	Replacement of Right Hip Joint with Ceramic on Polyethylene Synthetic Substitute, Open Approach
0SR90J9	Replacement of Right Hip Joint with Synthetic Substitute, Cemented, Open Approach
0SR90JA	Replacement of Right Hip Joint with Synthetic Substitute, Uncemented, Open Approach
0SR90JZ	Replacement of Right Hip Joint with Synthetic Substitute, Open Approach
0SRB019	Replacement of Left Hip Joint with Metal Synthetic Substitute, Cemented, Open Approach
0SRB01A	Replacement of Left Hip Joint with Metal Synthetic Substitute, Uncemented, Open Approach
0SRB01Z	Replacement of Left Hip Joint with Metal Synthetic Substitute, Open Approach
0SRB029	Replacement of Left Hip Joint with Metal on Polyethylene Synthetic Substitute, Cemented, Open Approach
0SRB02A	Replacement of Left Hip Joint with Metal on Polyethylene Synthetic Substitute, Uncemented, Open Approach
0SRB02Z	Replacement of Left Hip Joint with Metal on Polyethylene Synthetic Substitute, Open Approach
0SRB039	Replacement of Left Hip Joint with Ceramic Synthetic Substitute, Cemented, Open Approach
0SRB03A	Replacement of Left Hip Joint with Ceramic Synthetic Substitute, Uncemented, Open Approach
0SRB03Z	Replacement of Left Hip Joint with Ceramic Synthetic Substitute, Open Approach
0SRB049	Replacement of Left Hip Joint with Ceramic on Polyethylene Synthetic Substitute, Cemented, Open Approach
0SRB04A	Replacement of Left Hip Joint with Ceramic on Polyethylene Synthetic Substitute, Uncemented, Open Approach
0SRB04Z	Replacement of Left Hip Joint with Ceramic on Polyethylene Synthetic Substitute, Open Approach
0SRB0J9	Replacement of Left Hip Joint with Synthetic Substitute, Cemented, Open Approach
0SRB0JA	Replacement of Left Hip Joint with Synthetic Substitute, Uncemented, Open Approach
0SRB0JZ	Replacement of Left Hip Joint with Synthetic Substitute, Open Approach
0SRC0J9	Replacement of Right Knee Joint with Synthetic Substitute, Cemented, Open Approach
0SRC0JA	Replacement of Right Knee Joint with Synthetic Substitute, Uncemented, Open Approach
0SRC0JZ	Replacement of Right Knee Joint with Synthetic Substitute, Open Approach
0SRD0J9	Replacement of Left Knee Joint with Synthetic Substitute, Cemented, Open Approach
0SRD0JA	Replacement of Left Knee Joint with Synthetic Substitute, Uncemented, Open Approach
0SRD0JZ	Replacement of Left Knee Joint with Synthetic Substitute, Open Approach

Supplementary Table 11: Characteristics of Patients Hospitalized for Acute Myocardial Infarction, Heart Failure and Pneumonia According to the Primary Payer

Patient Characteristics, % (SE)	Patients aged ≥65 years			Patients aged <65 years		
	Medicare	Medicaid	Private Insurance	Medicare	Medicaid	Private Insurance
No. of Index Admissions, weighted (SD)	7824671 (63563)	109437 (2181)	434416 (7463)	1215957 (12753)	953466 (12010)	1521762 (14695)
Acute Myocardial Infarction	1310180 (13862)	17337 (417)	98738 (1767)	186158 (2625)	165828 (2406)	586130 (7136)
Congestive Heart Failure	3354561 (27782)	49455 (1149)	169450 (3221)	487817 (6787)	386078 (6437)	347967 (4435)
Pneumonia	3159930 (26032)	42646 (829)	166229 (3083)	541983 (5010)	401560 (4333)	587665 (5549)
Age, mean (SE)	79.5 (0.02)	75.8 (0.07)	75.1 (0.07)	54.7 (0.03)	49.9 (0.03)	52.5 (0.02)
Female	52.6 (0.06)	58.9 (0.34)	41.4 (0.23)	44 (0.11)	46.9 (0.15)	38.5 (0.12)
History of coronary artery bypass graft (CABG) surgery	13 (0.07)	9 (0.18)	12 (0.13)	7.9 (0.07)	4.7 (0.05)	4.1 (0.04)
Metastatic cancer or acute leukemia	1.7 (0.01)	1.4 (0.07)	2.2 (0.05)	1.4 (0.03)	1.9 (0.04)	2.3 (0.05)
Diabetes mellitus (DM) or DM complications	37.5 (0.09)	46.9 (0.31)	38.4 (0.19)	46.6 (0.14)	37.8 (0.13)	30.5 (0.1)
Protein-calorie malnutrition	6.2 (0.06)	6.2 (0.18)	5.1 (0.11)	5.1 (0.07)	4.6 (0.07)	2.7 (0.04)
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance	34.3 (0.11)	34.8 (0.3)	30.5 (0.18)	35.8 (0.16)	31.2 (0.15)	25.3 (0.12)
Iron deficiency or other/unspecified anemias and blood disease	33.3 (0.13)	36.6 (0.31)	28.6 (0.19)	31.9 (0.18)	27.8 (0.15)	20.8 (0.13)
Dementia or other specified brain disorders	17.3 (0.07)	14.8 (0.24)	9.8 (0.13)	2.7 (0.03)	1.6 (0.03)	0.5 (0.01)
Hemiplegia, paraplegia, paralysis, functional disability	3.8 (0.02)	5.9 (0.13)	3 (0.05)	9.1 (0.07)	6.1 (0.06)	2.1 (0.03)
Congestive heart failure	55.7 (0.13)	54.8 (0.36)	49.1 (0.25)	49.1 (0.24)	46.1 (0.25)	29.6 (0.19)
Acute coronary syndrome	3.8 (0.04)	4 (0.11)	3.6 (0.07)	2.7 (0.04)	2.7 (0.05)	2.3 (0.03)
Valvular and rheumatic heart disease	18.4 (0.11)	14.6 (0.25)	14.8 (0.17)	9 (0.09)	9 (0.1)	7.6 (0.08)
Specified arrhythmias and other heart rhythm disorders	45.2 (0.11)	35.3 (0.29)	40.2 (0.23)	23.5 (0.15)	20.4 (0.14)	21.5 (0.14)
Stroke	0.6 (0.01)	0.6 (0.04)	0.5 (0.02)	0.4 (0.01)	0.5 (0.01)	0.4 (0.01)
Vascular or circulatory disease	21.1 (0.1)	16.4 (0.23)	19.2 (0.18)	18.6 (0.11)	13.7 (0.09)	12.2 (0.08)
Chronic obstructive pulmonary disease (COPD)	34.6 (0.1)	29.6 (0.34)	31.7 (0.21)	35.9 (0.18)	30.2 (0.17)	15.8 (0.1)
Asthma	3.2 (0.02)	5.5 (0.13)	3.8 (0.06)	6.4 (0.06)	9.2 (0.09)	7.8 (0.06)
Pneumonia	10.2 (0.05)	9.9 (0.16)	8.7 (0.1)	8.2 (0.06)	7.5 (0.06)	5.7 (0.04)
Dialysis status	2.3 (0.02)	4.6 (0.12)	1.6 (0.04)	9.1 (0.11)	2.6 (0.04)	1.2 (0.02)
Renal failure	40.7 (0.12)	40.3 (0.33)	36.1 (0.25)	39.3 (0.23)	27.6 (0.22)	17.7 (0.14)
Other urinary tract disorders	5.4 (0.04)	4.9 (0.12)	5 (0.08)	3.7 (0.04)	3.4 (0.04)	3.1 (0.04)
Decubitus ulcer or chronic skin ulcer	5 (0.03)	4.8 (0.12)	3.7 (0.06)	5 (0.05)	3.5 (0.04)	1.6 (0.02)

Supplementary Table 12: Annual Readmission Rates of Acute Myocardial Infarction, Heart Failure, Pneumonia, and Non-Target Conditions.

	Readmission Rates (%)					
	2010	2011	2012	2013	2014	2015
Acute Myocardial Infarction						
Medicare patients aged ≥ 65 years	19.2	19.0	17.3	16.7	16.1	15.8
Medicaid patients aged ≥ 65 years	23.4	21.7	16.7	18.3	18.2	18.3
Private Insurance patients aged ≥ 65 years	14.6	14.1	13.8	12.6	12.5	12.4
Medicare patients aged < 65 years	19.7	19.0	18.5	18.0	18.1	18.6
Medicaid patients aged < 65 years	17.6	17.0	16.5	16.4	13.8	14.1
Private Insurance patients aged < 65 years	9.0	8.4	7.8	7.6	6.8	7.0
Heart Failure						
Medicare patients aged ≥ 65 years	23.6	23.6	22.8	21.9	21.6	21.8
Medicaid patients aged ≥ 65 years	26.6	25.8	26.4	24.4	24.2	24.1
Private Insurance patients aged ≥ 65 years	20.5	21.5	20.6	20.0	20.1	20.2
Medicare patients aged < 65 years	28.9	29.2	28.7	28.2	27.4	28.0
Medicaid patients aged < 65 years	29.3	28.9	28.2	27.7	26.9	27.2
Private Insurance patients aged < 65 years	18.9	17.9	18.0	17.1	17.5	17.1
Pneumonia						
Medicare patients aged ≥ 65 years	18.1	17.7	17.5	16.6	16.5	16.1
Medicaid patients aged ≥ 65 years	20.6	19.7	19.9	16.5	16.5	17.1
Private Insurance patients aged ≥ 65 years	16.5	15.8	15.5	14.3	15.1	14.7
Medicare patients aged < 65 years	20.1	20.1	19.8	19.7	19.5	19.4
Medicaid patients aged < 65 years	18.2	18.4	18.8	18.2	17.3	17.4
Private Insurance patients aged < 65 years	11.0	10.4	10.8	10.8	10.4	10.9
Non-Target Conditions						
Medicare patients aged ≥ 65 years	16.3	16.3	15.8	15.5	15.5	15.5
Medicaid patients aged ≥ 65 years	18.0	17.6	17.9	17.0	17.2	17.6
Private Insurance patients aged ≥ 65 years	14.0	14.2	13.8	13.5	13.5	13.8
Medicare patients aged < 65 years	20.8	20.6	20.3	20.3	20.5	20.5
Medicaid patients aged < 65 years	13.1	13.2	13.3	12.9	12.7	12.9
Private Insurance patients aged < 65 years	8.6	8.6	8.5	8.3	8.3	8.4

Supplementary Table 13: Characteristics of Patients Hospitalized for Acute Myocardial Infarction According to the Primary Payer

Patient Characteristics, N (%)	Patients aged ≥65 years			Patients aged <65 years		
	Medicare	Medicaid	Private Insurance	Medicare	Medicaid	Private Insurance
No. of Index Admissions, weighted (SD)	1310180 (13862)	17337 (417)	98738 (1767)	186158 (2625)	165828 (2406)	586130 (7136)
Age, mean (SE)	77.8 (0.03)	74.4 (0.1)	72.7 (0.07)	56.2 (0.03)	52.3 (0.04)	54.1 (0.02)
Female	47.4 (0.11)	52.9 (0.64)	33.1 (0.33)	35.9 (0.21)	37.3 (0.24)	25.4 (0.12)
Anterior myocardial infarction	7.6 (0.06)	9 (0.33)	10 (0.18)	8.5 (0.12)	13 (0.17)	15 (0.11)
Other location of myocardial infarction	12.1 (0.1)	10.5 (0.37)	16.5 (0.23)	15.3 (0.19)	18.2 (0.22)	24.4 (0.15)
History of coronary artery bypass graft (CABG) surgery	11.3 (0.08)	7.5 (0.32)	9.2 (0.17)	9.8 (0.14)	5.2 (0.1)	3.2 (0.05)
History of percutaneous transluminal coronary angioplasty (PTCA)	15.7 (0.12)	12.1 (0.45)	16 (0.26)	21 (0.23)	15.8 (0.2)	12.4 (0.12)
Severe infection; other infectious diseases	5.6 (0.05)	6.7 (0.3)	3.8 (0.12)	5.3 (0.1)	4.4 (0.1)	1.9 (0.04)
Metastatic cancer or acute leukemia	1.1 (0.02)	0.9 (0.13)	0.9 (0.06)	0.6 (0.04)	0.6 (0.03)	0.4 (0.02)
Cancer	4.7 (0.04)	3.6 (0.32)	4.1 (0.13)	2.6 (0.08)	2.2 (0.07)	1.6 (0.03)
Diabetes mellitus (DM) or DM complications	38 (0.12)	49 (0.61)	36.4 (0.3)	51.2 (0.24)	40.8 (0.24)	27.9 (0.13)
Protein-calorie malnutrition	3.4 (0.05)	3.9 (0.26)	2.2 (0.09)	2.3 (0.07)	1.9 (0.07)	0.7 (0.02)
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance	24.9 (0.14)	28.1 (0.55)	19.8 (0.26)	25.3 (0.25)	20.4 (0.22)	13.3 (0.13)
Iron deficiency or other/unspecified anemias and blood disease	28.6 (0.16)	33.1 (0.6)	23 (0.29)	25.3 (0.25)	20.8 (0.22)	13.2 (0.14)
Dementia or other specified brain disorders	12.1 (0.08)	9.9 (0.36)	5.4 (0.15)	1.5 (0.05)	0.8 (0.04)	0.2 (0.01)
Hemiplegia, paraplegia, paralysis, functional disability	3.1 (0.03)	4.7 (0.24)	2.1 (0.08)	6.9 (0.13)	3.7 (0.08)	0.9 (0.02)
Congestive heart failure	43 (0.16)	46.1 (0.67)	32.4 (0.32)	36.5 (0.27)	29.7 (0.25)	15.2 (0.14)
Acute coronary syndrome	2.4 (0.04)	2.7 (0.21)	2.6 (0.1)	2.6 (0.07)	2.9 (0.08)	2.5 (0.06)
Angina pectoris	1.1 (0.03)	1.1 (0.14)	1 (0.06)	1.2 (0.05)	1.2 (0.06)	1.2 (0.04)
Coronary atherosclerosis/other chronic ischemic heart disease	81 (0.16)	79.3 (0.53)	84.5 (0.26)	85.2 (0.2)	82.4 (0.21)	85.8 (0.15)
Valvular and rheumatic heart disease	17.8 (0.13)	14.7 (0.55)	13 (0.21)	8.5 (0.14)	7.3 (0.13)	5.6 (0.08)
Specified arrhythmias and other heart rhythm disorders	41.5 (0.14)	34.2 (0.61)	36.7 (0.28)	24.5 (0.21)	22.2 (0.21)	22.5 (0.15)
Stroke	1.2 (0.02)	1.6 (0.16)	1 (0.05)	0.9 (0.04)	1.2 (0.05)	0.5 (0.02)
Cerebrovascular disease	6.4 (0.06)	5.6 (0.27)	4.7 (0.12)	4.9 (0.1)	3.4 (0.1)	1.6 (0.04)
Vascular or circulatory disease	24.3 (0.13)	20.5 (0.52)	20.7 (0.26)	23.6 (0.2)	16.7 (0.18)	12.2 (0.11)
Chronic obstructive pulmonary disease (COPD)	20.3 (0.11)	17 (0.5)	15.8 (0.23)	24.8 (0.24)	18.4 (0.23)	7.4 (0.09)
Asthma	2.6 (0.03)	4 (0.22)	2.9 (0.1)	3.8 (0.09)	4.8 (0.1)	3.3 (0.05)
Pneumonia	10.1 (0.08)	11.9 (0.39)	7.6 (0.16)	7.6 (0.12)	6.7 (0.11)	3.5 (0.05)
Dialysis status	2 (0.03)	3.4 (0.21)	1.1 (0.06)	8 (0.16)	1.6 (0.06)	0.5 (0.02)
Renal failure	35.4 (0.16)	35.6 (0.63)	27.2 (0.34)	33 (0.32)	19.3 (0.24)	9.5 (0.11)
Other urinary tract disorders	5.3 (0.05)	5.1 (0.26)	4.7 (0.12)	3.2 (0.08)	2.7 (0.07)	2.2 (0.04)
Decubitus ulcer or chronic skin ulcer	2.5 (0.03)	2.9 (0.22)	1.5 (0.07)	2.9 (0.07)	1.6 (0.05)	0.5 (0.02)

Supplementary Table 14: Characteristics of Patients Hospitalized for Heart Failure According to the Primary Payer

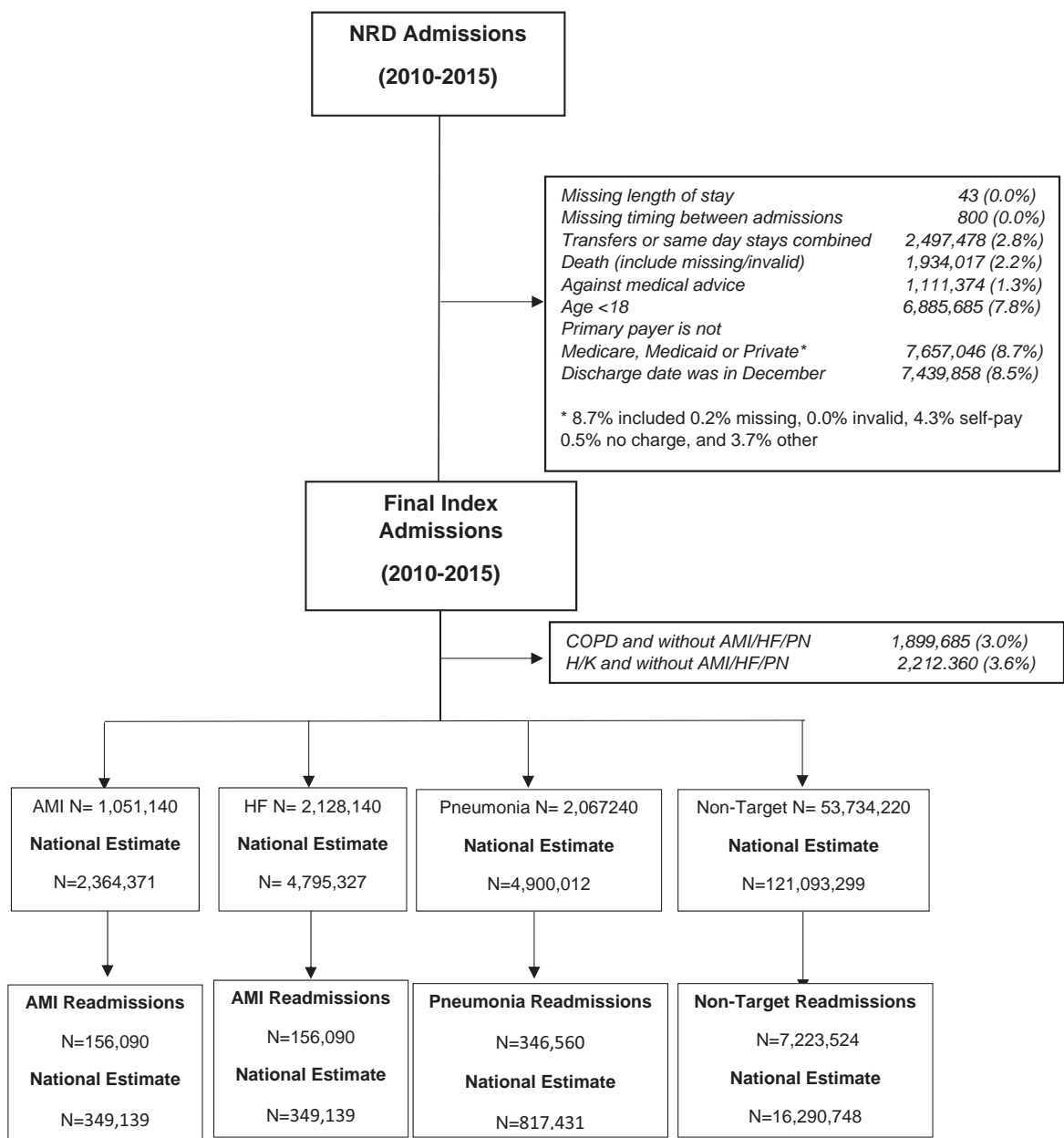
Patient Characteristics, N (%)	Patients aged ≥65 years			Patients aged <65 years		
	Medicare	Medicaid	Private Insurance	Medicare	Medicaid	Private Insurance
No. of Index Admissions, weighted (SD)	3354561 (27782)	49455 (1149)	169450 (3221)	487817 (6787)	386078 (6437)	347967 (4435)
Age, mean (SE)	79.9 (0.02)	75.6 (0.09)	76.1 (0.07)	55.3 (0.04)	51.7 (0.04)	54.3 (0.04)
Female	54.2 (0.09)	61.5 (0.46)	43.2 (0.3)	41.1 (0.18)	42.7 (0.23)	37.6 (0.2)
History of coronary artery bypass graft (CABG) surgery	18.2 (0.1)	13.5 (0.3)	17.9 (0.24)	12.2 (0.13)	7.6 (0.1)	9.2 (0.12)
Metastatic cancer or acute leukemia	1 (0.01)	0.6 (0.07)	1.1 (0.05)	0.5 (0.02)	0.5 (0.02)	1 (0.04)
Cancer	5.1 (0.03)	3.5 (0.15)	5.2 (0.1)	2.6 (0.05)	2.2 (0.05)	3.7 (0.07)
Diabetes mellitus (DM) or DM complications	43.4 (0.1)	52.8 (0.43)	46.6 (0.29)	58.1 (0.21)	48.2 (0.21)	47.9 (0.21)
Protein-calorie malnutrition	4.5 (0.06)	4.1 (0.21)	4 (0.11)	3.5 (0.08)	3.1 (0.09)	2.7 (0.07)
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance	32.4 (0.12)	32.1 (0.38)	29.5 (0.24)	36.1 (0.22)	30.9 (0.2)	30 (0.21)
Liver or biliary disease	3.4 (0.03)	6.4 (0.25)	3.9 (0.1)	9.3 (0.15)	12.1 (0.16)	7.4 (0.12)
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders	3.5 (0.02)	3.2 (0.14)	3.1 (0.08)	2.8 (0.05)	2.4 (0.05)	2.3 (0.05)
Other gastrointestinal disorders	27.7 (0.14)	25.1 (0.37)	23.9 (0.29)	26.2 (0.24)	21.2 (0.23)	20.4 (0.21)
Severe hematological disorders	1.3 (0.02)	0.8 (0.07)	1.1 (0.05)	0.9 (0.03)	0.6 (0.03)	0.7 (0.03)
Iron deficiency or other/unspecified anemias and blood disease	35.2 (0.14)	38.4 (0.41)	31.1 (0.28)	34.7 (0.23)	29.7 (0.2)	26.5 (0.21)
Dementia or other specified brain disorders	13 (0.06)	10.4 (0.26)	8 (0.14)	1.4 (0.03)	0.9 (0.03)	0.5 (0.02)
Drug/alcohol abuse/dependence/psychosis	6.8 (0.05)	9.6 (0.31)	8.8 (0.15)	24.7 (0.21)	37 (0.3)	20.6 (0.19)
Major psychiatric disorders	2.2 (0.03)	3.4 (0.16)	1.8 (0.08)	6.8 (0.08)	6.1 (0.11)	2.4 (0.06)
Depression	9.6 (0.07)	6.4 (0.21)	7.9 (0.15)	12.8 (0.13)	9.7 (0.12)	9 (0.13)
Other psychiatric disorders	6.7 (0.05)	4.4 (0.15)	5.8 (0.12)	8.4 (0.1)	7.4 (0.1)	6.9 (0.12)
Hemiplegia, paraplegia, paralysis, functional disability	3.2 (0.03)	4.8 (0.17)	3 (0.08)	6.5 (0.09)	4.1 (0.07)	2.6 (0.05)
Cardio-respiratory failure and shock	25 (0.17)	20 (0.35)	23.3 (0.34)	24.1 (0.22)	18.3 (0.2)	19.9 (0.19)
Congestive heart failure	81.1 (0.18)	80.3 (0.42)	79.7 (0.33)	84 (0.21)	85 (0.23)	86.2 (0.18)
Acute coronary syndrome	5.5 (0.06)	6 (0.19)	5.5 (0.13)	4.3 (0.07)	4.5 (0.09)	4.8 (0.08)
Coronary atherosclerosis or angina	56.8 (0.15)	53.2 (0.46)	55.7 (0.32)	48.1 (0.23)	39.3 (0.22)	39.9 (0.22)
Valvular and rheumatic heart disease	28.6 (0.17)	22.8 (0.39)	24.5 (0.3)	15.4 (0.16)	16.6 (0.18)	19.5 (0.2)
Specified arrhythmias and other heart rhythm disorders	57.8 (0.13)	45.9 (0.43)	53.8 (0.32)	34.9 (0.24)	30.8 (0.21)	38.4 (0.26)
Other and unspecified heart disease	3.7 (0.05)	4.2 (0.17)	3.7 (0.09)	3.7 (0.08)	5 (0.11)	5.2 (0.1)
Stroke	0.4 (0.01)	0.4 (0.03)	0.4 (0.02)	0.3 (0.01)	0.4 (0.02)	0.4 (0.02)
Vascular or circulatory disease	23.7 (0.12)	18.2 (0.32)	22.1 (0.26)	22.2 (0.16)	16.4 (0.14)	17.6 (0.16)
Chronic obstructive pulmonary disease (COPD)	34 (0.11)	28.7 (0.46)	31.9 (0.29)	35.8 (0.22)	31.3 (0.23)	20 (0.18)
Fibrosis of lung or other chronic lung disorders	3.3 (0.03)	2.3 (0.11)	2.9 (0.08)	2.5 (0.06)	1.7 (0.04)	2.4 (0.06)
Asthma	2.9 (0.03)	4.8 (0.16)	3.1 (0.08)	5.3 (0.08)	7.2 (0.11)	6.4 (0.09)
Pneumonia	15.8 (0.08)	14.5 (0.28)	13.8 (0.18)	11.6 (0.11)	10.2 (0.1)	10.1 (0.11)
Dialysis status	2.8 (0.03)	5.7 (0.19)	2.3 (0.07)	12 (0.16)	3.9 (0.08)	2.6 (0.06)
Renal failure	52.6 (0.14)	51.9 (0.44)	50.7 (0.32)	57.1 (0.24)	44.3 (0.28)	41 (0.26)
Nephritis	2.2 (0.03)	3.3 (0.14)	2.6 (0.09)	5.1 (0.08)	4.2 (0.08)	4.2 (0.07)
Other urinary tract disorders	5.8 (0.05)	5.1 (0.16)	5.5 (0.12)	4.3 (0.07)	4.4 (0.08)	4.7 (0.09)
Decubitus ulcer or chronic skin ulcer	5.1 (0.04)	4 (0.15)	4.6 (0.1)	5.5 (0.07)	4.1 (0.07)	3.5 (0.06)

Supplementary Table 15: Characteristics of Patients Hospitalized for Pneumonia According to the Primary Payer

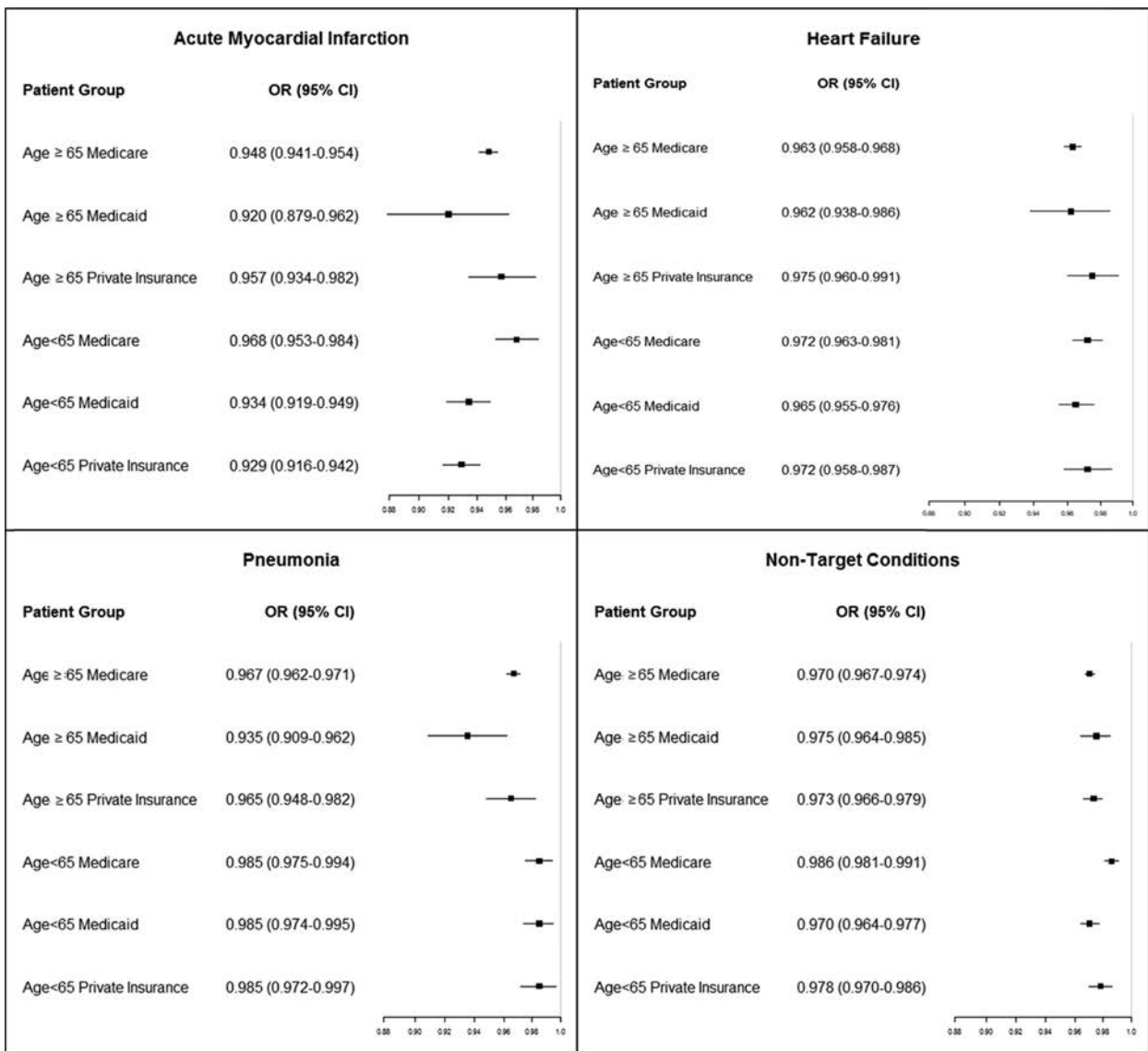
Patient Characteristics, N (%)	Patients aged ≥65 years			Patients aged <65 years		
	Medicare	Medicaid	Private Insurance	Medicare	Medicaid	Private Insurance
No. of Index Admissions, weighted (SD)	3159930 (26032)	42646 (829)	166229 (3083)	541983 (5010)	401560 (4333)	587665 (5549)
Age, mean (SE)	79.8 (0.02)	76.5 (0.08)	75.6 (0.08)	53.5 (0.03)	47.2 (0.05)	49.9 (0.04)
Female	53.1 (0.07)	58.4 (0.48)	44.4 (0.3)	49.3 (0.16)	55 (0.17)	52.1 (0.14)
History of coronary artery bypass graft (CABG) surgery	8.3 (0.06)	4.4 (0.16)	7.6 (0.14)	3.4 (0.05)	1.8 (0.04)	1.9 (0.04)
Severe infection; other infectious diseases	11.4 (0.05)	12.2 (0.27)	10.2 (0.15)	12.9 (0.11)	13.2 (0.14)	9.7 (0.09)
Septicemia, sepsis, systemic inflammatory response syndrome/shock	2.4 (0.03)	3.3 (0.15)	2.4 (0.08)	3.2 (0.06)	3.3 (0.07)	2.6 (0.05)
Metastatic cancer or acute leukemia	2.8 (0.03)	2.5 (0.14)	4 (0.11)	2.5 (0.06)	3.9 (0.09)	5 (0.11)
Lung and other severe cancers	4.5 (0.03)	3.9 (0.18)	6.1 (0.13)	3.3 (0.06)	4.4 (0.09)	4.9 (0.08)
Lymphoma; other cancers	5.2 (0.03)	4 (0.16)	6.2 (0.13)	3.4 (0.06)	4.4 (0.07)	5.7 (0.1)
Diabetes mellitus (DM) or DM complications	31 (0.08)	39.4 (0.43)	31.3 (0.24)	34.6 (0.16)	26.6 (0.15)	22.7 (0.11)
Protein-calorie malnutrition	9.2 (0.09)	9.7 (0.29)	8 (0.19)	7.6 (0.1)	7.2 (0.1)	4.7 (0.08)
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance	40.2 (0.12)	40.5 (0.44)	37.8 (0.26)	39.1 (0.19)	35.8 (0.19)	34.4 (0.16)
Other gastrointestinal disorders	36 (0.14)	32.1 (0.46)	32.9 (0.29)	37.2 (0.19)	29.9 (0.19)	29.6 (0.16)
Severe hematological disorders	1.4 (0.02)	0.9 (0.07)	1.5 (0.07)	1.7 (0.04)	2 (0.06)	1.5 (0.04)
Iron deficiency or other/unspecified anemias and blood disease	33.2 (0.14)	36.1 (0.44)	29.5 (0.27)	31.6 (0.2)	28.8 (0.18)	24.9 (0.16)
Dementia or other specified brain disorders	24 (0.09)	21.9 (0.4)	14.2 (0.21)	4.3 (0.06)	2.5 (0.05)	0.8 (0.02)
Drug/alcohol abuse/dependence/psychosis	8.6 (0.06)	9.9 (0.31)	11.2 (0.17)	28.5 (0.21)	39.7 (0.25)	23.7 (0.16)
Major psychiatric disorders	4.1 (0.04)	7.5 (0.29)	2.8 (0.08)	13.9 (0.12)	11.3 (0.12)	3.8 (0.06)
Other psychiatric disorders	8.5 (0.06)	5.6 (0.2)	7.4 (0.15)	13.6 (0.13)	12.3 (0.14)	10 (0.1)
Hemiplegia, paraplegia, paralysis, functional disability	4.9 (0.03)	7.6 (0.22)	3.7 (0.09)	12.3 (0.12)	9.1 (0.12)	2.9 (0.05)
Respirator dependence/tracheostomy status	0.9 (0.02)	2.3 (0.14)	0.9 (0.05)	3.1 (0.06)	3.6 (0.08)	1.2 (0.03)
Respiratory arrest; cardio-respiratory failure and shock	31.5 (0.19)	26.4 (0.43)	30.2 (0.43)	34.9 (0.25)	28.3 (0.22)	27.1 (0.2)
Congestive heart failure	33.9 (0.1)	28.9 (0.42)	27.8 (0.24)	22 (0.14)	15.6 (0.13)	10.4 (0.09)
Acute coronary syndrome	2.5 (0.03)	2.3 (0.12)	2.2 (0.08)	1.2 (0.03)	0.9 (0.03)	0.8 (0.02)
Coronary atherosclerosis or angina	32.3 (0.12)	24.6 (0.4)	28.9 (0.25)	18 (0.13)	11.3 (0.11)	9.6 (0.09)
Valvular and rheumatic heart disease	7.9 (0.06)	5.1 (0.18)	6 (0.14)	3.3 (0.05)	2.3 (0.05)	2.5 (0.04)
Specified arrhythmias and other heart rhythm disorders	33.4 (0.1)	23.4 (0.39)	28.5 (0.28)	12.8 (0.11)	9.7 (0.1)	10.5 (0.09)
Stroke	0.5 (0.01)	0.6 (0.07)	0.5 (0.03)	0.2 (0.01)	0.2 (0.01)	0.2 (0.01)
Vascular or circulatory disease	16.9 (0.08)	12.8 (0.3)	15.4 (0.2)	13.7 (0.11)	9.8 (0.1)	9 (0.09)
Chronic obstructive pulmonary disease (COPD)	41.2 (0.12)	35.7 (0.49)	40.9 (0.29)	39.8 (0.23)	34 (0.22)	21.7 (0.15)

Supplementary Table 15: (Continued)

Patient Characteristics, N (%)	Patients aged ≥ 65 years			Patients aged < 65 years		
	Medicare	Medicaid	Private Insurance	Medicare	Medicaid	Private Insurance
Fibrosis of lung or other chronic lung disorders	6.1 (0.04)	6.4 (0.21)	6 (0.11)	5.1 (0.07)	4.1 (0.06)	4.8 (0.07)
Asthma	3.9 (0.03)	6.8 (0.22)	5.1 (0.11)	8.2 (0.08)	13 (0.13)	13.2 (0.1)
Pneumonia	4.3 (0.05)	3.6 (0.16)	4.2 (0.11)	5.4 (0.07)	5.2 (0.07)	5.3 (0.07)
Pleural effusion/pneumothorax	7.3 (0.05)	6.7 (0.22)	7.4 (0.14)	5.8 (0.08)	6.1 (0.08)	7.5 (0.08)
Other respiratory disorders	14 (0.08)	12.9 (0.32)	15.1 (0.21)	21 (0.15)	16.3 (0.14)	18.9 (0.13)
Dialysis status	1.9 (0.02)	3.8 (0.16)	1.3 (0.05)	7 (0.1)	1.9 (0.04)	1 (0.03)
Renal failure	30.3 (0.11)	28.7 (0.42)	26.4 (0.28)	25.5 (0.17)	14.9 (0.14)	12.2 (0.11)
Urinary tract infection	12.6 (0.05)	14.1 (0.31)	8.9 (0.15)	8 (0.08)	7 (0.09)	4.2 (0.05)
Other urinary tract disorders	5 (0.04)	4.5 (0.18)	4.8 (0.11)	3.3 (0.05)	2.7 (0.05)	3.1 (0.05)
Decubitus ulcer or chronic skin ulcer	5.9 (0.04)	6.5 (0.21)	4.2 (0.11)	5.3 (0.07)	3.8 (0.06)	1.5 (0.03)
Vertebral fractures without spinal cord injury	0.9 (0.01)	0.7 (0.06)	0.8 (0.05)	0.4 (0.02)	0.3 (0.01)	0.3 (0.01)
Other injuries	7.6 (0.07)	6.6 (0.21)	6.9 (0.15)	8.2 (0.11)	7.2 (0.1)	5.8 (0.09)



Supplementary Figure 1. Patient Selection Flowsheet. AMI= acute myocardial infarction; COPD= chronic obstructive pulmonary disease; HF= heart failure; H/K= hip/knee replacement; NRD= National Readmission Database; PN= pneumonia



Supplementary Figure 2. Risk-Adjusted Odds Ratios for Yearly Change in Readmission Rates, According to Different Age-Payer Groups. CI= confidence interval; OR= odds ratio