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Post-Discharge Follow-Up Visits and Hospital Utilization by Medicare Patients, 2007–2010

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Objective: Document trends in time to post-discharge follow-up visit for Medicare patients with an index admission for heart failure (HF), acute myocardial infarction (AMI), or community-acquired pneumonia (CAP). Determine factors predicting whether the first post-discharge utilization event is a follow-up visit, treat-and-release emergency department (ED) visit, or readmission.

Methods: Using Medicare claims data from 2007–2010, we plotted annual cumulative incidence functions for the time frame post-discharge to follow-up visit, accounting for competing risks with censoring at 30 days. We used multinomial probit regression to determine factors predicting the probability of first-occurring post-discharge utilization events within 30 days.

Results: For each cohort, the cumulative incidence of follow-up visits increased during the study period. For example, in 2010, 54.6% of HF patients had a follow-up visit within 10 days of discharge compared to 47.9% in 2007. Within each cohort, the largest increase in follow-up visits took place between 2008 and 2009. Follow-up visits were less likely for patients who were Black, Hispanic, and enrolled in Medicaid or Medicare Advantage, and they were more likely for patients with greater comorbidities and prior procedures as well as those with private or supplemental Medicare coverage. There were no changes in 30-day readmission rates.

Discussion: Although increases in follow-up visits may have been influenced by the introduction of publicly reported readmission rates in 2009, these increases did not continue in 2010 and were not associated with a change in readmissions. Patients who were Black, Hispanic, and/or enrolled in Medicaid or Medicare Advantage were less likely to have follow-up visits.

Keywords: Medicare, primary care, health policy, politics, law, regulation, quality improvement, report cards (interventions), biostatistical methods, econometrics

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Introduction

Hospital readmission is often used as an indicator of healthcare quality (Benbassat & Taragin, 2000; Jencks, Williams, & Coleman, 2009; Medicare Payment Advisory Commission, 2008). Although some readmissions are part of a planned course of treatment or inevitable complications among the most complex patients, others are the result of inadequate care during the original hospital stay or lack of appropriate community-based follow-up care after hospital discharge. Thus, the reduction of "excess" hospital readmissions has become a focal point for healthcare delivery reform.

The most prominent readmission-based reform is Medicare's Hospital Readmission Reduction Program (HRRP). Created under the Patient Protection and Affordable Care Act (ACA), the HRRP imposes reimbursement penalties on hospitals that have more than the expected amount of 30-day all-cause readmissions for heart failure (HF), acute myocardial infarction (AMI), and community-acquired pneumonia (CAP; Centers for Medicare & Medicaid Services, 2013). Readmissions are also targeted by accountable care organizations (ACOs) and the Community-Based Care Transitions Program, which makes funding available to hospitals and community-based organizations to work collaboratively to reduce readmissions (Centers for Medicare & Medicaid Services, 2011, n.d.).

Although many readmissions are not avoidable (van Walraven *et al.,* 2011; van Walraven, Jennings, & Forster, 2012 ; van Walraven & Forster, 2013), hospitals can directly prevent some readmissions by ensuring that patients are fully ready for discharge and understand their self-care instructions. Further reduction in readmissions requires the management of transitions from the hospital to the community

and ensuring that patients receive appropriate ambulatory follow-up care. However, the relationship between post-discharge follow-up visits and readmissions is confounded by unmeasured severity of illness. Specifically, clinicians will often try to ensure that the more severely ill or less stable patients receive a follow-up visit soon after discharge; but these patients are also at higher risk of readmission. Hernandez *et al.* (2010) addressed this "endogeneity" of follow-up visits for individuals by analyzing the association between hospital-level rates of follow-up visits within 14 days of discharge and patient-level likelihood of readmission. They found that HF patients discharged from hospitals with higher follow-up visit rates were less likely to experience readmission within 30 days. Although they did not address the endogeneity issue, two additional studies have found inverse relationships between early follow-up visits and readmissions (Sharma, Kuo, Freeman, Zhang, & Goodwin, 2010; McAlister *et al.,* 2013).

Despite the likely benefits from timely post-discharge follow-up care, it is not well documented how frequently patients receive this care and whether it is received quickly enough to avert readmission. Timely access to post-discharge follow-up visits may be quite difficult to obtain in light of growing limitations on the availability of primary care across the United States (Bodenheimer, Berenson, & Rudolf, 2007; Bodenheimer & Pham, 2010; Sandy, Bodenheimer, Pawlson, & Starfield, 2009). Access problems may be especially acute for Medicare patients due to problems of low and uncertain Medicare reimbursement for primary care services, which has raised concern that general practice physicians are finding it increasingly difficult to sustain their practices with revenue from Medicare patients (Bodenheimer *et al.,* 2007; Merlis, 2010).

Reports from the Dartmouth Atlas provide ecological and qualitative perspectives on the availability of post-discharge follow-up visits for Medicare patients. One report found that the percentage of patients visiting a primary care clinician within 14 days of discharge from a medical admission varied from less than one-third in some Hospital Referral Regions to more than 60% in others (Goodman, Fisher, & Chang, 2011). Another report, based on responses to open-ended interviews of patients and clinicians, uncovered several barriers that prevent access to timely post-discharge follow-up care (Perry, 2013). Patients do not always have a follow-up appointment scheduled before leaving the hospital and those who do may not keep their appointments if they do not feel well enough to leave home or have limited transportation options. Other patients reported the lack of an ongoing primary care relationship or confusion about whether community-based or hospital-based physicians were ultimately in charge of their care. Faced with these barriers, many patients return to the hospital via the emergency department (ED), which is often perceived as an easier and more efficient way to have post-discharge issues resolved.

Return visits to the ED can be an important (negative) marker of post-discharge follow-up and care coordination. Although hospital readmissions have received significant research and policy attention, very little work has examined the extent to which patients receiving inpatient care return to the ED soon after discharge. One exception is a study based on data from three states that showed 7.5% of all inpatients had a treat-and-release ED visit within 30 days of their initial discharge (Vashi *et al.,* 2013). This study found further that the 30-day post-discharge ED visit rate varied from a low of 2.2% for patients with an index admission for breast malignancy to a high of 28.3% for patients with an index

admission for uncomplicated benign prostatic hypertrophy. A second study based on inpatients who were discharged from a single urban academic hospital found that 23.8% of them returned to the hospital for a treat-and-release ED visit within 30 days (Rising, White, Fernandez, & Boutwell, 2013). (The study authors concluded that post-discharge ED use is likely to be higher than this percentage, however, since patient visits to EDs at other hospitals were not recorded.)

In response to these gaps in the literature, this paper provides a detailed analysis of post-discharge follow-up visits and hospital utilization by Medicare patients with an index admission for HF, AMI, or CAP. We focused primarily on first-occurring post-discharge utilization events as a way to identify potential opportunities for improved post-discharge care coordination. If the first-occurring utilization event is a readmission or ED visit, then the opportunity to prevent such an event with early follow-up care was clearly missed. Alternatively, if the first-occurring utilization event is a community-based follow-up visit, then any subsequent hospital use is less likely to be the result of a missed opportunity for early intervention and more likely to be driven by other more complex factors, such as unmeasured illness severity, lack of self-management skills, or socioeconomic disadvantage (Arbaje *et al.,* 2008).

Our analysis was divided into three parts. First, we used techniques from survival analysis to measure the time frame post-discharge to follow-up visit within a competing risks framework (Gooley, Leisenring, Crowley, & Storer, 1999; Kalbfleisch & Prentice, 1980). Second, we analyzed trends in the first-occurring post-discharge utilization event (i.e., follow-up visit, ED visit, or readmission) and trends in 30-day all-cause readmission rates. Third, we used multinomial probit models to determine the strongest predictors of each first-occurring post-discharge utilization event.

Methods

Data

This paper is an extension of work conducted by the authors to pilot test the Multi-Payer Claims Database (MPCD), which was recently developed under contract by OptumInsight on behalf of the Department of Health and Human Services. The MPCD incorporated data from public and private payers to enable projects in health services research. The work in this paper is based primarily on the part of the MPCD that was derived from Medicare fee-for-services claims, which were obtained from the Chronic Conditions Warehouse (CCW). These claims were supplemented by Medicaid fee-for-service claims for dual eligibles (also derived from the CCW) as well as information from private health plans for Medicare enrollees who were covered by Medicare Advantage, supplemental Medicare, or other forms of private coverage. Private health plan information was provided by UnitedHealthcare and several other private insurers that participated in the MPCD Pilot. The MPCD included a single encrypted identifier for individuals covered by more than one payer. The research in this paper is based on an MPCD extract that included patients with at least one inpatient hospitalization for HF, AMI, or CAP during the years 2007–2010.

Inclusion/Exclusion Criteria

In this study, we focused on individuals who were enrolled in Medicare and over the age of 65 at the time of their index hospitalization. (The MPCD provided patient ages only in predefined ranges including a 61–65 range, which made it impossible to identify 65 year olds.) We defined the index hospitalization as the first inpatient hospitalization identified in the MPCD for one of the three conditions listed above. Following the HRRP, we analyzed patient activity during a 30-day observation window after the index discharge date.

Patients were excluded from the analysis if they died during the index admission, left the hospital during the index episode against medical advice, or did not have continuous insurance coverage in the MPCD from the date of the index admission through 30 days after the index discharge date.

Although patients could die within 30 days of discharge, we could not fully account for patient mortality due to restrictions on the kinds of personal information that could be released in the MPCD extract. In the case of decedents, the extract included the month and year of death but not the exact date. This restriction posed no problem in the vast majority of cases where the patient did not die during the study period or clearly died well after the 30-day post-discharge observation window. But there are some cases where the date of death might have occurred within 30 days of index discharge. For example, consider a patient who was discharged on September 15, 2008 and then died sometime in October of 2008. This patient clearly died within 46 days of the index discharge and possibly within 30 days. In cases such as this, we classified patients as "may have died within 30 days." Since we are interested in the first post-discharge utilization event, we included in our analysis patients who had a record of post-discharge utilization within 30 days of the index discharge, even if they may have died at a later time in the 30-day post-discharge window of observation. We excluded individuals who had no post-discharge event and may have died within 30 days, since we do not know when these individuals stopped being at risk for post-discharge utilization. This exclusion reduced our cohort sizes by 0.9% for HF, 0.8% for AMI, and 0.9% for CAP.

Post-Discharge Utilization Events

Following the HRRP, we measured post-discharge utilization events during a 30-day observation window after the index discharge date. During this 30-day window, we marked claims indicating that an outpatient follow-up visit, all-cause ED treat-and-release visit, or all-cause readmission had taken place. Following Hernandez *et al.* (2010), we defined follow-up visits as outpatient claim records for evaluation and management (E&M) services (CPT or HCPCS codes in the range 992.xx–994.xx). For AMI, we excluded planned readmissions as defined by the HRRP (Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation, 2012). Patients experiencing none of these three events within 30 days were censored. In dealing with hospital transfers, we followed the HRRP by counting the date of discharge from the receiving hospital as the discharge date.

Independent Variables

We hypothesized that the first-occurring post-discharge event would be related to patient demographics, sources of additional coverage, and health risk factors. Patient demographics included age, sex, and race/ethnicity. Additional coverage sources included Medicaid, Medicare Advantage, and sources of private coverage classified as commercial/capitated or commercial/non-capitated. These commercial coverage sources included supplemental Medicare in addition to separate private coverage. To account for health risk factors, we used information from each patient's medical claims history in the 12 months prior to and during the index admission. These variables indicate the presence of specific conditions or use of procedures as defined in the implementation methods for the HRRP (Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation, 2012). Since they depend on 12 prior months of information, health risk factors were calculated only for patients with an index admission in 2008–2010. To simplify the presentation of findings, we grouped patients into terciles based on their number of prior conditions and procedures.

To determine whether this simplification had a substantial effect on the findings, we estimated additional models that include separate variables for each prior condition and procedure.

Finally, since patients discharged to a medical facility (e.g., nursing home, skilled nursing facility) may have follow-up care provided within the facility itself, our analysis might be biased against finding visits for this care to the extent that follow-up services are not billed separately within these facilities. To address this issue, we calculated descriptive statistics and estimated additional models where the sample is restricted to individuals who were discharged home after their index admission.

Although geographic and provider specific factors are also likely to affect outcomes, the MPCD does not release information about patient residence or provider identities. We were, however, able to identify the region where the index admission took place, classified as Northeast, Midwest, South, or West.

Analysis

We assessed the time frame post-discharge to follow-up visit for each of the three HRRP conditions by plotting cumulative incidence functions (CIFs) that take into account the competing risks of treat-and-release ED visit and readmission with censoring at 30 days (Gooley *et al.,* 1999; Kalbfleisch & Prentice, 1980). To determine whether the cumulative incidence of follow-up visits changed during the study years, we plotted CIF curves for each year in 2007–2010 separately for each HRRP condition. To test whether observed differences were statistically significant, we used the "stcrreg" command in STATA 11.1 to estimate competing risk regression models where time to follow-up visit was the dependent variable and 0-1 indicators for the years 2008–2010 were the independent variables (i.e., year 2007 was the reference category). Then we performed Chi-square tests for the joint significance of the time indicators.

To provide more detail on changes in the first post-discharge medical event, we tabulated the percentage of patients who had each of the four post-discharge utilization events. For comparative purposes, we also plotted trends in 30-day readmission rates (regardless of whether the readmission was preceded by a follow-up or ED visit).

To determine the extent to which each independent variable influenced the probability of each first-occurring post-discharge utilization event, we estimated multinomial probit models for each of the three HRRP conditions (Cameron & Trivedi, 2005). These models are an extension of more commonly used binary outcome models, such as ordinary probit and logistic regression, to situations where more than two outcomes (i.e., utilization events) are possible. Censoring (i.e., none of these events) at 30 days served as the reference category in the multinomial probit models. To facilitate interpretation, we transformed the coefficient estimates into marginal effects expressed as percentage point changes in event probabilities associated with each independent variable. (We also considered multinomial logit models, but rejected this approach because the required assumption of independence of irrelevant alternatives was routinely violated.)

Finally, we used a simple (and conservative) Bonferroni adjustment to account for multiple comparisons in 5% level statistical significance tests (Proschan & Waclawiw, 2000). Since there are three outcome variables, we considered a marginal effect to be statistically significant if the p-value was less than 0.016 (i.e., 0.05/3).

Findings

Exhibit 1 describes the characteristics of patients with index admissions for the HRRP conditions.

These patients were predominantly White and over the age of 80. Medicare Advantage and commercial/supplemental Medicare were fairly common among the study population, while

Exhibit 1. Patient and Index Admission Characteristics

Variable	Type of Index Admission		
	HF (N=233,641)	AMI (N=130,624)	CAP (N=132,498)
Year of index admission			
2007	31.6	27.0	31.4
2008	25.3	25.8	26.9
2009	23.1	24.6	22.8
2010	20.0	22.6	18.9
Number of comorbidities/prior procedures[1]			
Bottom terciles	35.7	34.9	32.1
Middle terciles	32.0	38.1	35.5
Top tercile	32.3	26.3	32.5
Age			
66–70	12.9	20.0	12.8
71–75	15.2	19.3	15.5
76–80	19.2	19.8	19.1
81 and over	52.7	40.9	52.5
Sex			
Male	43.7	50.9	44.8
Female	56.3	49.1	55.2
Race			
White	80.1	83.6	84.5
Black	12.1	8.2	8.3
Hispanic	3.2	3.1	2.8
Other/Unknown	4.6	5.2	4.4
Region			
Northeast	18.9	18.2	17.2
Midwest	25.3	25.5	26.7
South	39.8	38.5	39.5
West	15.6	17.4	16.3
Unknown	0.5	0.5	0.4
Other insurance coverage[2]			
Medicare Advantage	19.6	21.6	16.2
Commercial/capitated	13.0	14.4	10.9
Commercial/non-capitated	9.1	10.1	8.1
Medicaid	4.2	2.7	4.1

NOTES. [1]For HF, terciles are 08, 9–12, & 13+. For AMI, terciles are 0–6, 7-10, & 11+. For CAP, terciles are 0–9, 10-14, & 15+.

[2]Based on all sources of coverage during the index admission.

SOURCE: Multi-Payer Claims Data (MPCD), 2007–2010.

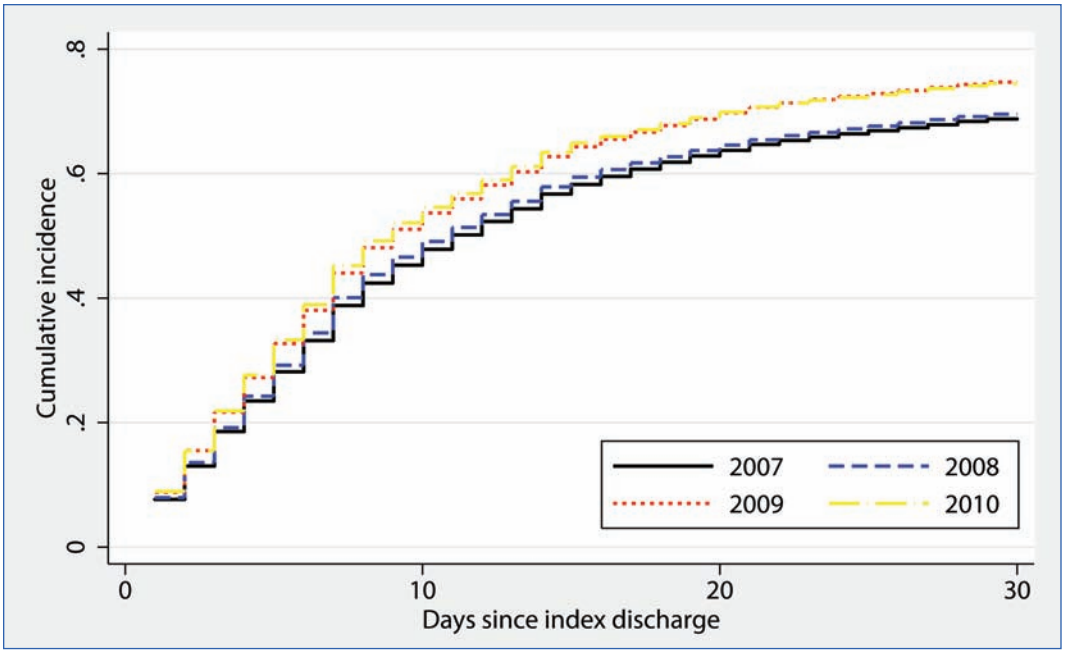
only a small percentage had additional Medicaid coverage. The South and the Midwest were the most heavily represented regions followed by the Northeast and West.

The cumulative incidence of post-discharge follow-up visits for HF patients generally increased (i.e., shifted upward) from 2007–2010 *(Exhibit 2)*. For example, in 2010, 54.6% of HF patients had a follow-up visit within 10 days of discharge compared to 47.9% in 2007. The largest increase occurred between 2008 and 2009, although all observed differences over time were statistically significant (Chi-square=1,290.12, $p<0.001$). As shown in the Appendix, changes in the cumulative incidence of follow-up visits for AMI and CAP patients are similar.

Among HF patients, the growth in post-discharge follow-up visits displaced readmissions and censoring (i.e., no event within 30 days) as the first post-discharge event, although the magnitude of these changes were somewhat small (Exhibit 3). There was no trend in ED visits as the first-occurring post-discharge event within the HF cohort. Among AMI patients, the general rise in post-discharge follow-up visits coincided with a general decline in readmission as the first post-discharge event. Within the AMI cohort, ED visits as the first post-discharge event remained steady in the first three study years before rising in 2010, while censoring within this cohort fluctuated during the study period. Among CAP patients, the growth in follow-up visits as the first post-discharge event was associated with a general decline in censoring, but no substantial change in ED use or readmission as the first-occurring post-discharge event.

It is important to note that the readmission trends in Exhibit 3 do not include readmissions that were preceded by a follow-up or ED visit. In contrast, Exhibit 4 shows trends in 30-day rates of all readmissions regardless of whether the readmission was the first utilization event or a

Exhibit 2. Cumulative Incidence Function for Follow-up Visits among HF Patients, 2007–2010



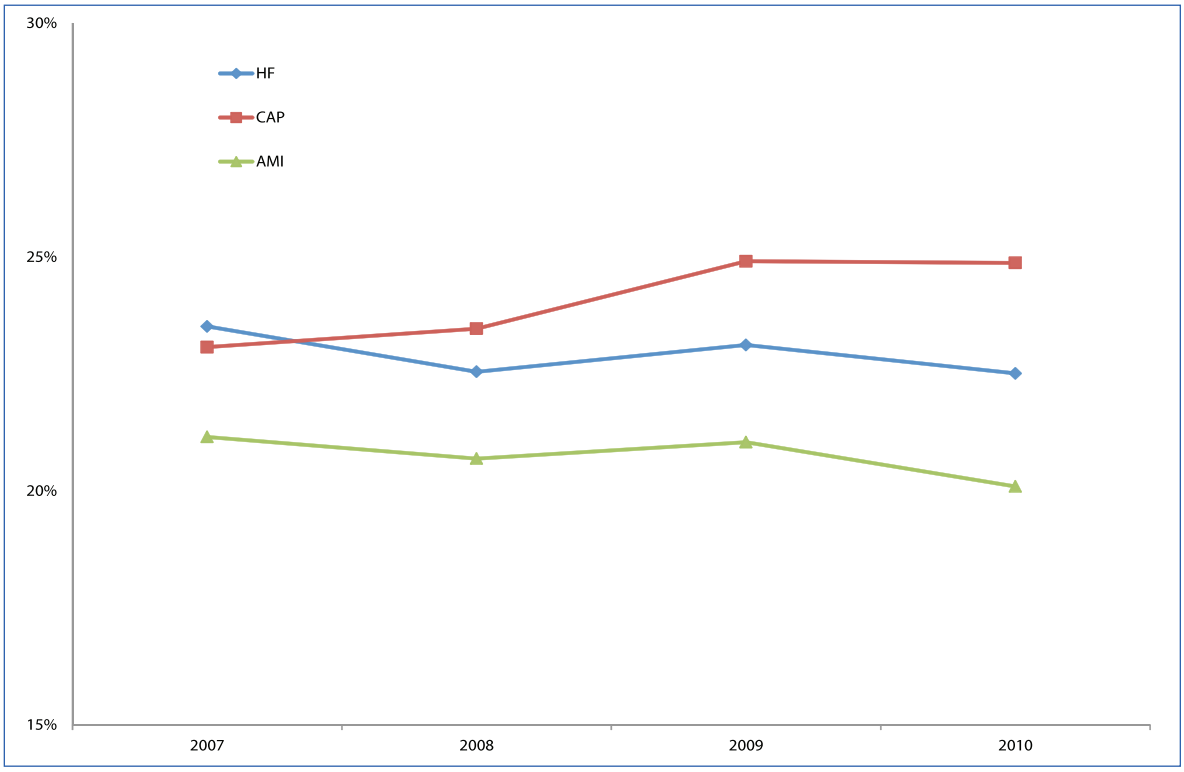
SOURCE: Multi-Payer Claims Data (MPCD), 2007–2010.

Exhibit 3. First Event within 30 Days of Index Discharge

	First Event within 30 Days			
	Follow-up Visit	ED Visit	Readmission	No Event
HF[1]				
2007	71.1	3.5	10.1	15.3
2008	71.4	3.4	9.8	15.4
2009	75.6	3.7	9.6	11.2
2010	75.4	3.5	9.2	12.0
AMI[1]				
2007	70.6	4.0	11.0	14.4
2008	70.6	4.0	10.6	14.9
2009	73.3	3.9	10.9	11.9
2010	72.1	4.4	10.3	13.2
CAP[1]				
2007	70.9	3.5	10.7	14.9
2008	71.3	3.6	11.0	14.2
2009	73.9	3.8	11.2	11.1
2010	73.9	3.7	11.0	11.4

NOTE: [1]Differences over time are statistically significant according to a Chi-square test ($p<0.001$).
SOURCE: Multi-Payer Claims Data (MPCD), 2007–2010.

Exhibit 4. 30-Day Readmission Rates for HF, AMI, and CAP



SOURCE: Multi-Payer Claims Data (MPCD), 2007–2010.

later utilization event within 30 days of the index discharge. These rates fluctuated in the HF and AMI cohorts and rose slightly for the CAP cohort between 2007 and 2010.

Exhibits 5, 6, and 7 show the estimated marginal effects from the multinomial probit models for the HF, AMI, and CAP cohorts, respectively. For example, Exhibit 5 shows that relative to HF patients with an index admission in 2008, those with an index admission in 2009 were 1.8 percentage points more likely to have a follow-up visit as their first post-discharge event and 1.6 percentage points less likely to have no event within 30 days of index discharge (holding all other independent variables fixed). HF patients in 2009 were also 0.4 percentage points less likely to have a readmission and 0.2 percentage points more likely to have a treat-and-release ED visit. Differences in first event probabilities are similar for 2010 relative to 2008.

The effects of most independent variables were very similar across all three study cohorts. Patients with more comorbidities and prior procedures were much more likely to have one of the three first-occurring post-discharge utilization events and much less likely to have no event within 30 days of their index discharge.

Major difference in utilization events occurred among patients with different forms of supplemental coverage. Patients with coverage through Medicare Advantage or Medicaid were much less likely to have a follow-up visit and much more likely to have no post-discharge event. Patients with Medicare Advantage were also consistently more likely to have a readmission as the first-occurring post-discharge event across the three cohorts. In contrast, patients with either form of commercial coverage (capitated or non-capitated) were much more likely to have a follow-up visit as the first post-discharge event and much less likely to experience the other possible events including censoring at 30 days.

Substantial differences also emerged by patient race and ethnicity. In each of the three cohorts, Black and Hispanic patients were much less likely to have a follow-up visit and much more likely to have no post-discharge event relative to White patients. Hispanic HF and AMI patients were also more likely to have a readmission as their first post-discharge event. Black patients were consistently more likely to have a readmission or an ED visit as their first post-discharge event.

Finally, among older patients and women, follow-up visits were consistently more likely to occur as the first post-discharge utilization event and censoring was much less likely to occur. Differences in first-occurring utilization events also appeared across broadly defined regions.

Our findings are not sensitive to how prior conditions and procedures were entered into the models and are very similar when restricted to patients who were discharged home after the index admission. Details from these supplementary analyses appear in the Appendix.

Discussion

In this study, we focused on Medicare patients over age 65 who were admitted to the hospital for HF, AMI, or CAP. We found that from 2007–2010, there was a small increase in the likelihood that these patients received a community-based follow-up visit within 30 days of discharge and a slight decrease in the number of days before such visits took place. Within each cohort, the largest increase in the cumulative incidence of follow-up visits took place between 2008 and 2009. This increase may have been a response to the publication of hospital-level readmission rates on-line through Medicare.gov, which began in 2009. Hospitals seeking to avoid negative publicity or reduced patient volume from poor readmission rankings may have put extra effort into arranging

Exhibit 5. Predictors of First Post-Discharge Event within 30 Days for Patients with Index Admission for HF[1]

	First Event within 30 Days			
Variable	Follow-up Visit	ED Visit	Readmission	Censored (No Event)
Year of index admission				
Reference: 2008	—	—	—	—
2009	1.8*	0.2	–0.4	–1.6*
2010	1.7*	0.0	–0.8*	–0.9*
Number of comorbidities/ prior procedures				
Reference: Bottom tercile	—	—	—	—
Middle tercile	5.6*	0.3*	0.6*	–6.5*
Top tercile	5.8*	1.2*	2.8*	–9.8*
Age				
Reference: 66–70	—	—	—	—
71–75	1.8*	–0.2	0.2	–1.8*
76–80	1.9*	–0.3	0.6	–2.3*
81–85	2.2*	–0.1	0.0	–2.1*
Sex				
Reference: Female	—	—	—	—
Male	–0.9*	–0.1	0.0	1.0*
Race				
Reference: White	—	—	—	—
Black	–5.5*	0.9*	1.4*	3.2*
Hispanic	–7.4*	0.2	2.5*	4.7*
Other/Unknown	–2.3*	–0.2	0.3	2.2*
Region				
Reference: South	—	—	—	—
Northeast	4.0*	–0.8*	–1.0*	–2.3*
Midwest	2.0*	–0.1	–1.0*	–0.9*
West	–3.7*	–0.3*	0.2	3.9*
Unknown	–10.4*	0.8	1.3	8.3*
Other insurance coverage[2]				
Medicare Advantage	–16.8*	0.5	2.7*	13.6*
Commercial/capitated	10.8*	–2.2*	–2.9*	–5.7*
Commercial/non-capitated	13.7*	–0.8*	–3.1*	–9.9*
Medicaid	–17.8*	0.4	0.3	17.0*

NOTES: [1]Marginal effects (holding other variables constant) expressed as percentage points derived from multinomial probit regression.

[2]Based on all sources of coverage during the index admission.

*Marginal effect is statistically significant at $p<0.016$ (derived from a multiplicity adjustment using 5% level test for 3 outcomes, 0.05/3 = 0.016).

SOURCE: Multi-Payer Claims Data (MPCD), 2007–2010.

Exhibit 6. Predictors of First Post-Discharge Event within 30 Days for Patients with Index Admission for AMI[1]

	First Event within 30 Days			
Variable	Follow-up Visit	ED Visit	Readmission	Censored (No Event)
Year of index admission				
Reference: 2008	—	—	—	—
2009	1.3*	–0.1	0.2	–1.4*
2010	0.2	0.3	–0.3	–0.3
Number of comorbidities/ prior procedures				
Reference: Bottom tercile	—	—	—	—
Middle tercile	5.6*	0.3	2.1*	–8.0*
Top tercile	5.8*	0.8*	5.6*	–12.3*
Age				
Reference: 66–70	—	—	—	—
71–75	1.7*	–0.1	0.8	–2.4*
76–80	1.4*	0.0	1.5*	–2.9*
81–85	1.4*	–0.2	1.4*	–2.6*
Sex				
Reference: Female	—	—	—	—
Male	–1.6*	–0.2	–0.5	2.2*
Race				
Reference: White	—	—	—	—
Black	–5.3*	0.7*	2.4*	2.2*
Hispanic	–7.0*	–0.4	2.9*	4.6*
Other/Unknown	–1.9*	0.0	0.4	1.4*
Region				
Reference: South	—	—	—	—
Northeast	5.8*	–1.0*	–1.0*	–3.8*
Midwest	2.7*	0.4*	–1.5*	–1.6*
West	–2.3*	0.0	–0.3	2.6*
Unknown	–17.0*	1.0	4.4*	11.6*
Other insurance coverage[2]				
Medicare Advantage	–16.3*	0.0	1.4*	14.9*
Commercial/capitated	11.4*	–2.5*	–2.0*	–6.9*
Commercial/non-capitated	14.6*	–0.1	–2.8*	–11.6*
Medicaid	–15.3*	–0.6	–0.7	16.7*

NOTES: [1]Marginal effects (holding other variables constant) expressed as percentage points derived from multinomial probit regression.

[2]Based on all sources of coverage during the index admission.

*Marginal effect is statistically significant at $p<0.016$ (derived from a multiplicity adjustment using 5% level test for 3 outcomes, 0.05/3 = 0.016).

SOURCE: Multi-Payer Claims Data (MPCD), 2007–2010.

Exhibit 7. Predictors of First Post-Discharge Event within 30 Days for Patients with Index Admission for CAP[1]

	First Event within 30 Days			
Variable	Follow-up Visit	ED Visit	Readmission	Censored (No Event)
Year of index admission				
Reference: 2008	—	—	—	—
2009	1.0*	1.6	0.1	–1.2*
2010	1.1*	0.0	–0.1	–0.9*
Number of comorbidities/ prior procedures				
Reference: Bottom tercile	—	—	—	—
Middle tercile	4.5*	0.9*	0.5	–5.9*
Top tercile	5.1*	1.6*	3.0*	–9.6*
Age				
Reference: 66–70	—	—	—	—
71–75	0.9	0.0	0.2	–1.0*
76–80	1.5*	–0.5	0.1	–1.1*
81–85	0.9	–0.4	–0.5	0.0
Sex				
Reference: Female	—	—	—	—
Male	–0.6	0.0	0.6*	0.0
Race				
Reference: White	—	—	—	—
Black	–5.7*	1.1*	2.5*	2.1*
Hispanic	–5.0*	–0.2	1.2	4.0*
Other/Unknown	–0.6	–0.9*	–0.6	2.3*
Region				
Reference: South	—	—	—	—
Northeast	4.5*	–0.7*	–1.3*	–2.5*
Midwest	2.7*	–0.2	–1.8*	–0.8*
West	–2.3*	0.0	–0.7	3.0*
Unknown	–10.9*	0.8	1.1	9.0*
Other insurance coverage[2]				
Medicare Advantage	–15.7*	0.7*	2.0*	13.0*
Commercial/capitated	11.7*	–2.7*	–2.7*	–6.3*
Commercial/non-capitated	10.8*	–0.5	–1.6*	–8.6*
Medicaid	–15.8*	0.9	0.6	14.3*

NOTES: [1]Marginal effects (holding other variables constant) expressed as percentage points derived from multinomial probit regression.

[2]Based on all sources of coverage during the index admission.

*Marginal effect is statistically significant at $p<0.016$ (derived from a multiplicity adjustment using 5% level test for 3 outcomes, 0.05/3 = 0.016).

SOURCE: Multi-Payer Claims Data (MPCD), 2007–2010.

follow-up visits for their patients, specifically those initially admitted for HF, AMI, or CAP, which are the conditions appearing in Medicare's on-line readmission reports.

The incentive to avoid negative reports continued after 2009 and intensified in 2010 with the inclusion of the HRRP in the ACA. Nevertheless, the increase in post-discharge follow-up visits did not continue into 2010 for any of our study cohorts. This lack of a sustained increase may have been the result of constraints on primary care supply as mentioned above. Moreover, as the ACA's coverage expansions are phased in, discharged Medicare patients may find themselves in competition with newly insured individuals for primary care appointments that will be difficult to expand in the near term. Thus, even with the incentives to avoid readmissions, hospitals may find it difficult to ensure that their patients receive timely follow-up care in the community.

The general increase in community-based follow-up visits from 2007–2010 did not coincide with reductions in 30-day readmission rates among any of the cohorts we examined. Moreover, we found that when discharged patients returned to the hospital within 30 days, their first post-discharge hospital episode was much more likely to be a readmission than a treat-and-release ED visit. This greater likelihood of inpatient care likely reflects a variety of factors, including the underlying burden of illness, diminished health status associated with the lack of community-based follow-up care, and reimbursement incentives that have historically favored inpatient admission. This pattern may change, however, in the years after the implementation of the HRRP, which will provide hospitals with incentives to avoid admitting borderline cases within 30 days of an index admission for HF, AMI, or CAP. Nevertheless, even though hospitals would not be penalized for a treat-and-release ED visit within 30 days of discharge, these return visits to the hospital would represent problems in the coordination of post-discharge care that are not explicitly measured in the HRRP. Moreover, although the incentive to avoid readmission depends on whether the index admission occurred at the same hospital, broader reforms under the ACA, such as the Medicare Shared Savings Program (MSSP) provide additional incentives for hospitals to avoid readmissions whenever there is flexibility in the admitting decision.

Within each of the patient cohorts, a number of groups stood out for having a much lower than average probability of a follow-up visit as the first post-discharge event. These groups included Black and Hispanic patients as well as those with coverage through Medicare Advantage and Medicaid. In many cases, these patients returned to the hospital as inpatients or visited the ED before having a follow-up visit, while others went 30 days with no post-discharge medical episode. Nevertheless, even if patients do not return to the hospital, lack of follow-up care can be detrimental to patients' longer term health status if issues related to the initial hospital episode are neglected or unresolved. Lack of follow-up care may also result in readmissions that occur soon after the 30-day post-discharge observation window.

Our findings for Black and Hispanic patients as well as patients with Medicaid coverage are consistent with prior literature on disparities in healthcare access and readmission rates by race, ethnicity, and socioeconomic status (Arbaje *et al.,* 2008; Ayanian, Weissman, Chasan-Taber, & Epstein, 1999; Institute of Medicine, 2002). They also underscore concerns that have been raised about the disadvantages that safety net hospitals can face under the HRRP (Joynt & Jha, 2013). Specifically, if minority and low-income patients have greater difficulty obtaining post-discharge follow-up care, then hospitals serving

a disproportionate number of these individuals will be at greater risk for paying reimbursement penalties from excess readmissions.

The dramatically lower probability of follow-up visits among patients in Medicare Advantage might be a reflection of unmeasured income disparities. Lower-income beneficiaries often enroll in Medicare Advantage plans, which typically offer lower premiums and cost-sharing in exchange for a more restricted provider network and tighter drug formularies (America's Health Insurance Plans, 2012). Low premiums in particular may be very attractive to lower-income beneficiaries, as 55% of all Medicare Advantage enrollees in 2013 were in a plan that required no additional premium beyond the regular Part B premium (Kaiser Family Foundation, 2013). Moreover, if plan networks are very restrictive or in-network physicians are responsible for large patient panels, patients could have a difficult time scheduling timely appointments for follow-up care. Also, all the Medicare Advantage plans in our database are classified as capitation plans. As a result, some may not generate a billing record for follow-up visits that are covered under the capitation arrangement. In addition, some plans may have implemented a bundled payment scheme for hospital episodes that include follow-up care in the service bundle. Thus, it is possible that our analysis would fail to capture some early follow-up visits that took place for Medicare Advantage patients.

However, it is important to note that similar issues did not appear among patients with commercial/capitated coverage. To the contrary, Medicare patients with commercial coverage, regardless of capitation arrangements, were much more likely to have a follow-up visit as the first post-discharge utilization event. They were also less likely to have a readmission or a treat-and-release ED visit as their first post-discharge utilization event; in addition, they were much less likely to have no event within 30 days. Medicare patients with additional commercial coverage may have an easier time arranging follow-up visits to the extent that this coverage offers greater physician reimbursement and physician choice. Also, Medicare beneficiaries with individually purchased or employer-based supplemental coverage have a higher income on average, which could further enable the arrangement of timely follow-up visits (America's Health Insurance Plans, 2012). This issue requires further monitoring as the number of Medicare beneficiaries enrolled in Medicare Advantage has recently grown from 11.1 million in 2010 to 14.4 million in 2013 (Kaiser Family Foundation, 2013).

Finally, we found that follow-up visits were more likely among patients with more comorbidities and prior procedures. As noted earlier, patients with a greater burden of illness are likely to receive greater attention from clinicians seeking to ensure that follow-up visits are scheduled soon after discharge. Nevertheless, our analysis showed that these patients were also more likely than others to have a readmission or a treat-and-release ED visit as their first post-discharge utilization event, suggesting that many of the sickest patients did not receive a follow-up visit in time to potentially avert a subsequent acute care episode in the hospital.

Our analysis is subject to some limitations. Due to restrictions placed on the data that we obtained from the MPCD, we did not have access to provider or area level identifiers, which precluded us from analyzing continuity of follow-up care with a usual physician, provider characteristics, or local-area practice patterns in determining study outcomes. Similarly, we had to exclude some individuals where it could not be determined whether the individual died or was censored within 30 days of the index discharge. As a result, we could not include mortality as a competing event in our analysis. Nevertheless, the number of excluded

cases for this reason was fairly small (less than 1% for each cohort). Thus, the impact of these exclusions on our findings is likely to be small.

Although follow-up visits, as measured in this study, represent a key component of recovery from a hospital episode, they do not capture all potential efforts made by hospitals and other providers to avert readmissions. Additional efforts may include intensive discharge planning before patients leave the hospital, provider follow-up by phone or electronic communication, and other forms of informal follow-up care that are not captured in claims data. Moreover, although follow-up visits were captured, we were not able to evaluate the quality of these visits and whether patients had the needed cognitive and social resources to fully execute the care plans developed during these visits.

Despite these limitations, our analysis provides a detailed description of the experiences of Medicare patients during a 30-day window after hospital discharge. These experiences were consistent across three patient cohorts who are currently the focus of the HRRP, which is a major Medicare payment and delivery reform. Our findings also uncover areas for potential improvement in post-discharge care coordination and document baseline conditions in patterns of post-discharge utilization in the years leading up to the HRRP.

Disclaimer

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Post-Discharge Follow-Up Visits and Hospital Utilization by Medicare Patients, 2007–2010

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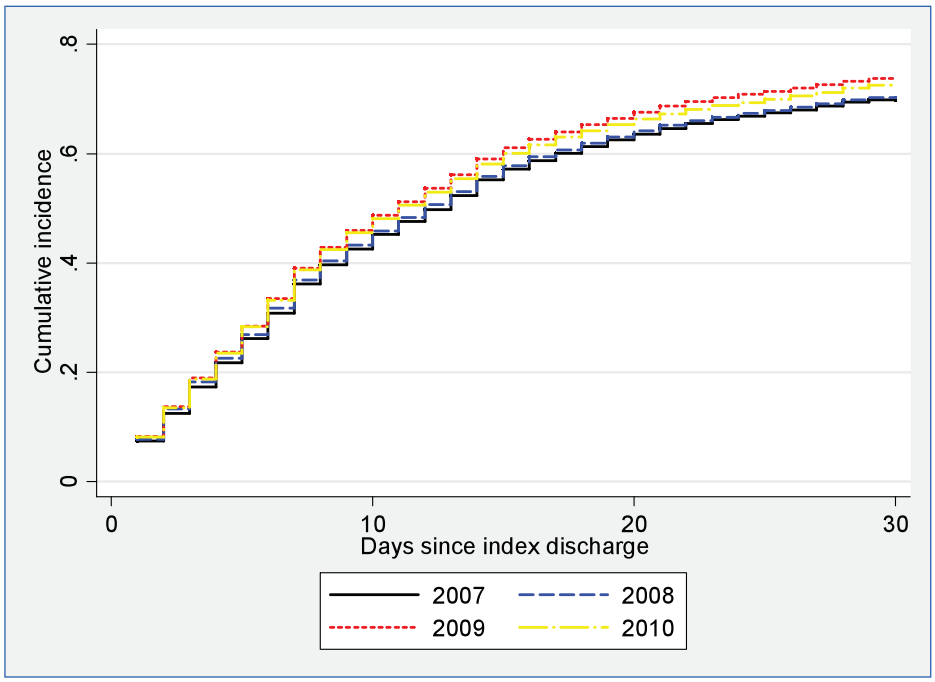
Appendix

This appendix provides additional details to support the material in the main paper. Exhibits A1 and A2 show that the changes in cumulative incidences of post-discharge follow-up visits for AMI and CAP patients are similar to the corresponding change for HF patients, which is shown in Exhibit 2 of the main paper. Specifically, there was an increase in the cumulative incidences of follow-up visits during the study period with the greatest increases occurring between 2008 and 2009 (AMI: Chi-square=223.61, $p<0.001$; CAP: Chi-square=399.28, $p<0.001$). For AMI patients, the cumulative incidence of post-discharge follow-up visits was slightly reduced between 2009 and 2010, but still remained higher than in 2007 and 2008.

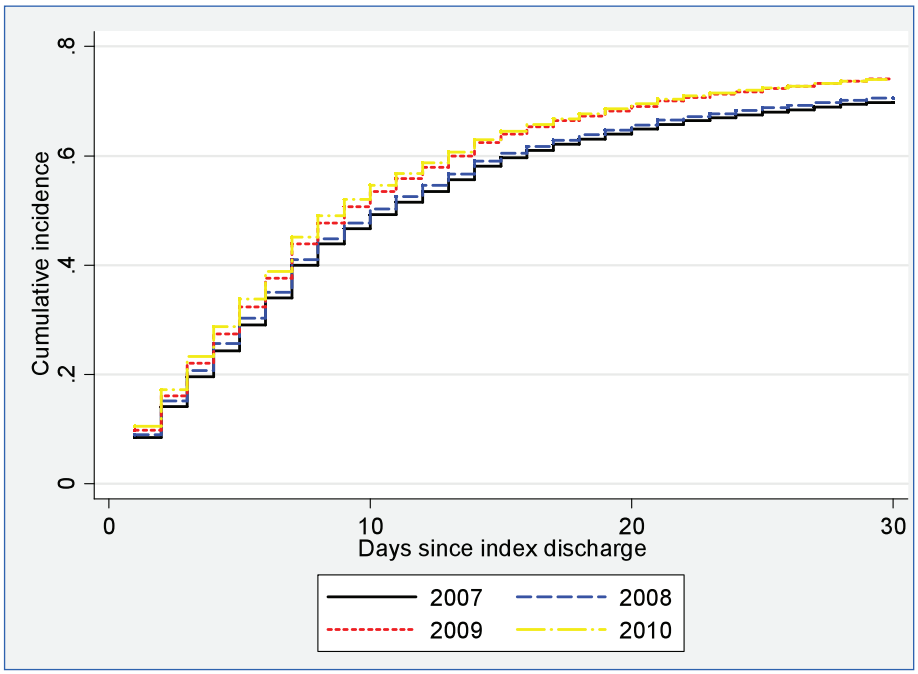
Within all three cohorts, the majority of patients were discharged to their homes after the index admission (HF: 74.6%, AMI: 75.5%, PN: 63.8%). Although patients discharged to a destination other than home were slightly less likely to have a follow-up visit, the differences were quantitatively very small (Exhibit A3). As shown in Exhibits A4–A6, the marginal effects from the multinomial probit models were very similar in size and statistical significance between the full sample models and models that were restricted to individuals who were discharged home. Also, when prior conditions and procedures were measured individually instead of within terciles, the marginal effects of the other variables were very similar to those reported in the main paper (Exhibits A4–A6).

Exhibit A1. Cumulative Incidence Function for Follow-up Visits Among AMI Patients, 2007–2010



SOURCE: Multi-Payer Claims Data (MPCD), 2007–2010.

Exhibit A2. Cumulative Incidence Function for Follow-up Visits among CAP Patients, 2007–2010



SOURCE: Multi-Payer Claims Data (MPCD), 2007–2010.

Exhibit A3. First Occurring Post-Discharge Utilization Events by Index Discharge Status

	HF*		AMI*		CAP*	
	Home[1]	Other[2]	Home	Other	Home	Other
Follow-up	72.7%	71.5%	72.6%	66.4%	72.3%	70.4%
ED visit	3.9%	2.5%	4.5%	2.6%	3.9%	3.0%
Readmission	8.4%	13.0%	7.7%	19.4%	9.0%	14.1%
Censored	15.0%	13.0%	15.2%	11.6%	14.8%	12.5%

NOTES: * Differences between home and other groups are statistically significant at the 0.1% level. [1]Patient discharged home after index admission. [2]Patient discharged to a medical facility or other (non-home) destination after index admission.
SOURCE: Multi-Payer Claims Data (MPCD), 2007–2010.

Exhibit A4. Sensitivity Analysis for HF Models[1]

	Follow-up visit		Ed visit		Readmission		Censored	
	Full[2]	Home[3]	Full[2]	Home[3]	Full[2]	Home[3]	Full[2]	Home[3]
Year of index admission								
Reference: 2008	—	—	—	—	—	—	—	—
2009	1.6*	1.8*	0.2	0.2	–0.4	–0.6*	–1.4*	–1.4*
2010	1.6*	1.5*	0.0	0.0	–0.9*	–0.7*	–0.7*	–0.8*
Prior procedures and conditions								
History OF CABG	0.1	0.6	0.2	0.2	0.3	–0.1	–0.6*	–0.6*
History OF PCI	0.3	0.7	0.3	0.3	0.2	–0.2	–0.8*	–0.8*
Diabetes or DM complications	1.4*	1.7*	0.1	0.1	0.1	–0.1	–1.6*	–1.7*
Disorders of fluid, electrolyte, acid-base	–0.7*	–0.7	0.3*	0.5*	0.7*	0.7*	–0.3	–0.5
Iron deficiency or other anemias and blood disease	1.3*	1.6*	–0.3*	–0.3	0.2	0.0	–1.3*	–1.3*
Cardio-respiratory failure or shock	0.6	0.9*	0.0	0.0	0.6*	0.3	–1.3*	–1.1*
Congestive heart failure	12.7*	13.4*	0.4	0.4	–3.8*	–3.6*	–9.3*	–10.2*
Vascular or circulatory disease	2.5*	2.8*	0.1	0.1	0.1	0.1	–2.7*	–3.0*
COPD	–1.3*	–1.5*	0.1	0.1	1.0*	1.0*	0.3	0.4
Pneumonia	0.0	0.2	0.0	0.0	0.8*	0.6*	–0.8*	–0.8*
Renal failure	–0.5	–0.6	0.0	0.1	1.0*	1.0*	–0.6*	–0.6*
Other urinary tract disorders	2.3*	2.8*	0.1	0.1	–0.2	–0.5*	–2.1*	–2.4*
Decubitus ulcer or chronic skin ulcer	–0.4	–1.3*	–0.1	0.0	0.9*	1.0*	–0.4	0.3
Other gastrointestinal disorders	2.3*	2.4*	0.5*	0.6*	–0.7*	–0.3	–2.1*	–2.6*
Acute coronary syndrome	–1.2*	–1.5*	0.1	0.2	1.0*	1.1*	0.0	0.2
Valvular or rheumatic heart disease	2.6*	3.2*	–0.3*	–0.4*	–0.4*	–0.3	–2.0*	–2.4*
Specified arrhythmias	3.6*	3.7*	0.0	0.0	–0.7*	–0.6*	–3.0*	–3.1*
Asthma	2.2*	2.4*	–0.1	–0.1	–0.5	–0.5	–1.6*	–1.9*

(Continued)

Exhibit A4 Continued. Sensitivity Analysis for HF Models[1]

	Follow-up visit		Ed visit		Readmission		Censored	
	Full[2]	Home[3]	Full[2]	Home[3]	Full[2]	Home[3]	Full[2]	Home[3]
Peptic ulcer, hemorrhage, other specified	–1.7*	–1.9*	0.0	0.0	0.7*	0.5	1.0*	1.4*
Cancer	3.5*	4.3*	–0.2	–0.4*	–0.3	–0.4	–3.0*	–3.5*
Drug/alcohol abuse/dependence/ psychosis	–1.4*	–1.3*	0.4	0.3	0.7*	0.7*	0.3	0.3
Major psychiatric disorders	0.2	–0.5	0.0	0.2	0.3	0.2	–0.5	0.1
End stage renal disease or dialysis	–10.9*	–13.5*	1.7	1.8*	2.0*	2.7*	7.2*	8.9*
Severe hematological disorders	1.5*	2.3*	0.5	0.5	–0.1	–0.2	–2.0*	–2.6*
Nephritis	0.1	0.7	0.2	0.0	0.8	0.6	–1.1	–1.3
Liver or biliary disease	0.7	1.0	–0.1	–0.2	0.2	0.0	–0.8*	–0.8
Metastatic cancer or acute leukemia	1.9*	1.8	–0.3	–0.4	0.2	0.7	–1.8*	–2.1*
Stroke	–0.4	–0.4	0.0	0.1	0.4	0.3	0.0	–0.1
Dementia or other specified brain disorders	–1.8*	–2.9*	0.6*	1.0*	0.1	0.7*	1.1*	1.3*
Coronary atherosclerosis or angina	0.0	–0.2	0.0	0.0	0.0	0.2	0.1	0.1
Other or unspecified heart disease	1.0*	1.1*	0.3*	0.3*	–0.2	–0.2	–1.1*	–1.2*
Other psychiatric disorders	0.8*	0.7	0.5*	0.6*	0.0	0.2	–1.4*	–1.5*
Fibrosis of lung or other chronic lung disorders	0.3	0.3	0.2	0.3	0.3	0.2	–0.8*	–0.9*
Protein-calorie malnutrition	–3.4*	–4.1*	–0.1	0.3	3.0*	2.2*	0.5	1.6*
Hemiplegia, paraplegia, paralysis, functional disability	–1.5*	–1.4*	0.1	0.1	1.1*	0.5	0.3	0.9
Depression	–0.2	–0.8	0.2	0.5*	–0.1	0.5	0.1	–0.3
Age								
Reference: 66–70	—	—	—	—	—	—	—	—
71–75	1.1*	1.4*	–0.1	0.0	0.3	0.1	–1.3*	–1.4*
76–80	0.8	1.0	–0.2	–0.1	0.9*	0.9*	–1.5*	–1.8*
81–85	0.9*	0.1	0.0	0.3	0.4	0.9*	–1.3*	–1.3*
Sex								
Reference: Female	—	—	—	—	—	—	—	—
Male	–0.8*	–0.5	–0.1	–0.3	0.0	–0.1	0.8*	0.9*
Race								
Reference: White	—	—	—	—	—	—	—	—
Black	–4.4*	–5.4*	0.8*	1.0*	1.0*	1.2*	2.5*	3.2*
Hispanic	–6.3*	–5.4*	0.1	0.1	2.3*	1.6*	3.9*	3.7*
Other/ Unknown	–1.5*	–1.5*	–0.2	–0.2	0.1	–0.2	1.6*	1.9*

(Continued)

Exhibit A4 Continued. Sensitivity Analysis for HF Models[1]

	Follow-up visit		Ed visit		Readmission		Censored	
	Full[2]	Home[3]	Full[2]	Home[3]	Full[2]	Home[3]	Full[2]	Home[3]
Region								
Reference: South	—	—	—	—	—	—	—	—
Northeast	3.7*	1.6*	–0.7*	–0.5*	–0.9*	0.0	–2.1*	–1.1*
Midwest	1.7*	1.1*	–0.1	0.0	–1.0*	–0.2	–0.7*	–0.9*
West	–2.8*	–3.2*	–0.3	–0.3	0.0	0.5	3.1*	3.0*
Unknown	–7.1*	–8.5*	1.0	0.7	0.8	2.3	5.4*	5.58
Other insurance coverage[4]								
Medicare Advantage	–14.5*	–15.1*	0.6*	0.2	2.4*	2.9*	11.4*	12.1*
Commercial/capitated	8.9*	8.6*	–2.3*	–2.1*	–2.8*	–2.1*	–3.9*	–4.4*
Commercial/non- capitated	11.1*	11.7*	–0.8*	–0.8*	–2.8*	–2.7*	–7.5*	–8.2*
Medicaid	–15.2*	–16.2*	0.4	0.3	–0.1	0.5	14.9*	15.3*

NOTES: * Marginal effect is statistically significant at p<0.016 (derived from a multiplicity adjustment using 5% level test for 3 outcomes, 0.05/3 = 0.016). [1]Marginal effects (holding other variables constant) expressed as percentage points derived from multinomial probit regression. [2]Estimation using full sample. [3]Estimation restricting sample to individuals discharged from index admission to home. [4]Based on all sources of coverage during the index admission.

SOURCE: Multi-Payer Claims Data (MPCD), 2007–2010.

Exhibit A5. Sensitivity Analysis for AMI Models[1]

	Follow-up visit		Ed visit		Readmission		Censored	
	Full[2]	Home[3]	Full[1]	Home[2]	Full[1]	Home[2]	Full[1]	Home[2]
Year of index admission								
Reference: 2008	—	—	—	—	—	—	—	—
2009	1.1*	1.8*	–0.1	–0.3	0.2	0.0	–1.1*	–1.4*
2010	0.1	0.2	0.3	0.2	–0.2	–0.2	–0.1	–0.1
Prior procedures and conditions	—	—	—	—	—	—	—	—
Anterior myocardial infarction	0.0	0.7	–0.2	–0.1	2.4*	1.6*	–2.2*	–2.2*
Other location of myocardial infraction	–1.2*	–0.4	–0.1	0.0	1.7*	0.7	–0.4	–0.2
History OF CABG	–4.5*	–2.9*	0.6*	1.0*	4.1*	1.0*	–0.1	0.9*
History OF PCI	3.2*	2.8*	0.9*	0.8*	–2.1*	–1.1*	–2.0*	–2.5*
Diabetes or DM complications	0.9*	1.4*	–0.2	–0.2	1.1*	0.7*	–1.7*	–1.9*
Iron deficiency or other anemias and blood disease	1.1*	1.2*	0.0	0.2	0.9*	0.8*	–2.1*	–2.2*
Congestive heart failure	–0.2	0.2	0.1	0.0	1.5*	1.5*	–1.4*	–1.7*
Valvular or rheumatic heart disease	1.8*	2.1*	0.3	0.2	0.2	0.5	–2.3*	–2.8*
COPD	–0.8*	–1.1*	0.1	0.2	0.9*	1.1*	–0.3	–0.2

(Continued)

Exhibit A5 Continued. Sensitivity Analysis for AMI Models[1]

	Follow-up visit		Ed visit		Readmission		Censored	
	Full[2]	Home[3]	Full[1]	Home[2]	Full[1]	Home[2]	Full[1]	Home[2]
End stage renal disease or dialysis	−11.3*	−14.7*	2.3*	2.6*	2.4*	2.7*	6.6*	9.3*
Other urinary tract disorders	1.9*	2.2*	0.1	0.0	0.0	0.0	−2.0*	−2.3*
Specified arrhythmias	2.1*	2.7*	0.0	0.0	0.3	0.3	−2.5*	−2.9*
Pneumonia	−0.4	−0.2	−0.2	−0.2	2.1*	1.7*	−1.5*	−1.4*
Renal failure	0.2	0.4	0.0	0.1	0.9*	0.9*	−1.2*	−1.5*
Vascular or circulatory disease	2.0*	2.5*	−0.2	−0.2	0.4	0.2	−2.2*	−2.6*
Disorders of fluid, electrolyte, acid-base	0.1	0.2	0.3	0.5	0.5	0.4	−0.9*	−1.1*
Coronary atherosclerosis	1.5*	1.2	0.3	0.1	−1.3*	0.0	−0.5	−1.4*
History of infection	3.8*	4.0*	0.0	0.0	−0.5	0.2	−3.3*	−4.1*
Cerebrovascular disease	1.7*	2.1*	0.3	0.4	0.5	−0.2	−2.4*	−2.3*
Metastatic cancer or acute leukemia	2.3	3.8*	0.5	0.1	−1.0	−0.4	−1.8	−3.4*
Cancer	4.0*	4.6*	−0.2	−0.2	−0.4	−0.3	−3.4*	−4.2*
Decubitus ulcer or chronic skin ulcer	0.0	−1.2	−0.3	0.1	0.3	0.6	0.0	0.6
Dementia or other specified brain disorders	−1.0*	−2.9*	0.5*	0.9*	−0.7*	0.8*	1.2*	1.3*
Angina pectoris, old MI	0.9*	0.8	−0.1	−0.4	−0.8*	−0.2	0.0	−0.2
Stroke	−1.3*	−0.4	−0.5	−0.5	1.9*	0.3	−0.1	0.6
Asthma	1.3*	1.8*	0.4	0.4	0.0	−0.2	−1.7*	−2.0*
Acute coronary syndrome	8.4*	9.8*	0.6*	0.6*	−1.6*	−1.8*	−7.3*	−8.6*
Hemiplegia, paraplegia, paralysis, functional disability	−1.3	−1.4	0.4	0.6	1.0*	0.4	−0.1	0.4
Protein–calorie malnutrition	−5.2*	−6.5*	0.3	0.9	4.1*	2.8*	0.8	2.9*
Age								
Reference: 66–70	—	—	—	—	—	—	—	—
71–75	1.5*	1.9*	−0.1	0.0	0.7	0.1	−2.1*	−2.0*
76–80	1.2*	1.6*	0.0	0.3	1.4*	0.7	−2.5*	−2.5*
81–85	1.4*	0.4	0.0	0.5	1.0*	1.7*	−2.5*	−2.5*
Sex								
Reference: Female	—	—	—	—	—	—	—	—
Male	−1.2*	−0.9*	−0.3	−0.6*	−0.5*	−0.8*	2.0*	2.3*
Race								
Reference: White	—	—	—	—	—	—	—	—
Black	−4.3*	−4.7*	0.8*	0.9*	1.7*	1.1*	1.8*	2.7*

(Continued)

Exhibit A5 Continued. Sensitivity Analysis for AMI Models[1]

	Follow-up visit		Ed visit		Readmission		Censored	
	Full[2]	Home[3]	Full[1]	Home[2]	Full[1]	Home[2]	Full[1]	Home[2]
Hispanic	–6.2*	–5.2*	–0.4	–0.7	2.5*	1.5*	4.0*	4.4*
Other/ Unknown	–1.3	–1.7	0.1	0.3	0.1	0.2	1.1*	1.1
Region								
Reference: South	—	—	—	—	—	—	—	—
Northeast	5.0*	4.2*	–0.9*	–0.7*	–0.8*	–0.7*	–3.3*	–2.8*
Midwest	2.4*	1.6*	0.3	0.6*	–1.4*	–0.7*	–1.3*	–1.5*
West	–1.9*	–2.1*	0.1	0.2	–0.3	0.2	2.1*	1.7*
Unknown	–14.6*	–16.9*	1.4	1.8	4.1*	5.3*	9.1*	9.8*
Other insurance coverage[4]								
Medicare Advantage	–14.6*	–15.4*	0.2	0.0	1.2*	1.9*	13.2*	13.6*
Commercial/capitated	9.9*	9.3*	–2.5*	–2.8*	–1.9*	–0.7	–5.5*	–5.8*
Commercial/non-capitated	12.2*	12.9*	–0.3	–0.3	–2.4*	–2.3*	–9.5*	–10.3*
Medicaid	–13.5*	–15.5*	–0.5	–0.3	–1.3	0.1	15.3*	15.7*

NOTES: * Marginal effect less than 0.1 in absolute value and statistically insignificant. [1]Marginal effects (holding other variables constant) expressed as percentage points derived from multinomial probit regression. [2]Estimation using full sample. [3]Estimation restricting sample to individuals discharged from index admission to home. [4]Based on all sources of coverage during the index admission. [5]Marginal effect is statistically significant at p<0.016 (derived from a multiplicity adjustment using 5% level test for 3 outcomes, 0.05/3 = 0.016).
SOURCE: Multi-Payer Claims Data (MPCD), 2007–2010.

Exhibit A6. Sensitivity Analysis for CAP Models[1]

	Follow-up visit		Ed visit		Readmission		Censored	
	Full[2]	Home[3]	Full[1]	Home[2]	Full[1]	Home[2]	Full[1]	Home[2]
Year of index admission								
Reference: 2008	—	—	—	—	—	—	—	—
2009	0.9*	1.4*	0.1	0.1	0.0	–0.4	–1.0*	–1.1*
2010	1.2*	1.1*	0.0	–0.1	–0.4	–0.2	–0.8*	–0.7
Prior procedures and conditions	—	—	—	—	—	—	—	—
History OF CABG	1.3*	1.0	0.0	–0.1	–1.1*	–0.4	–0.3	–0.6
History of infection	2.0*	1.9*	0.1	0.2	–0.4	0.2	–1.8*	–2.3*
Septicemia/shock	–1.3*	–1.5	–0.6*	–0.5	1.1*	0.0	0.8	2.0*
Metastatic cancer or acute leukemia	1.6	1.1	–0.3	0.1	0.7	1.1	–1.9*	–2.3*
Lung or other severe cancers	1.2	2.2*	–0.1	–0.3	0.8	1.9*	–2.0*	–3.9*
Other major cancers	3.0*	3.6*	–0.3	–0.3	–0.5	–0.8	–2.2*	–2.4*
Diabetes or DM complications	1.0*	1.3*	0.0	0.0	0.1	0.0	–1.2*	–1.3*
Protein-calorie malnutrition	–3.9*	–5.0*	0.5*	1.0*	2.9*	1.5*	0.5	2.5*

(Continued)

Exhibit A6 Continued. Sensitivity Analysis for CAP Models[1]

	Follow-up visit		Ed visit		Readmission		Censored	
	Full[2]	Home[3]	Full[1]	Home[2]	Full[1]	Home[2]	Full[1]	Home[2]
Disorders of fluid, electrolyte, acid-base	–0.6	–0.9*	0.3	0.4*	0.6	0.6	–0.3	–0.2
Other gastrointestinal disorders	1.6*	1.8*	0.1	0.1	–0.4	–0.1	–1.3*	–1.8*
Severe hematological disorders	2.1*	3.0*	0.4	0.6	–0.1	–0.4	–2.4*	–3.2*
Iron deficiency or other anemias and blood disease	0.8*	1.1*	0.0	–0.1	0.5	0.5	–1.2*	–1.5*
Dementia or other specified brain disorders	–2.3*	–4.8*	0.4*	0.8*	0.0	1.1*	1.9*	3.0*
Drug/alcohol abuse/dependence/ psychosis	–1.5*	–2.1*	0.6*	0.7*	0.4	0.6	0.5	0.8
Major psychiatric disorders	0.4	–1.2	0.2	0.5	0.5	0.9	–1.0*	–0.3
Other psychiatric disorders	0.2	–0.5	0.7*	1.0*	0.1	0.4	–1.0*	–0.9
Hemiplegia, paraplegia, paralysis, functional disability	–1.5*	–2.7*	0.4	0.5	0.7	1.0*	0.4	1.2
Cardio-respiratory failure or shock	–0.2	0.5	–0.3	–0.3	1.2*	0.3	–0.7*	–0.6
Congestive heart failure	0.3	0.1	0.0	0.1	–0.8*	–0.6	0.6*	0.4
Acute coronary syndrome	–1.5*	–1.7*	0.6*	0.5	0.7	0.8*	0.3	0.3
Coronary atherosclerosis or angina	0.5	0.5	0.1	0.1	–0.2	0.0	–0.4	–0.5
Valvular or rheumatic heart disease	2.3*	2.8*	–0.1	–0.2	0.0	–0.4	–2.2*	–2.2*
Specified arrhythmias	1.8*	2.1*	0.1	0.3	0.3	0.1	–2.2*	–2.5*
Stroke	–0.4	–1.1*	–0.2	–0.1	0.9*	0.6	–0.3	0.6
Vascular or circulatory disease	2.3*	2.4*	0.1	0.1	0.0	0.3	–2.3*	–2.9*
copd	–0.9	–1.2*	0.0	0.1	0.7*	0.9*	0.2	0.1
Fibrosis of lung or other chronic lung disorders	0.4	0.9	–0.1	0.0	0.6	0.2	–0.9*	–1.1*
asthma	2.4*	3.0*	0.1	0.0	–0.5	–0.7*	–2.1*	–2.3*
pneumonia	7.6*	8.1*	0.3	0.2	–2.3*	–1.7*	–5.5*	–6.6*
Pleural effusion/pneumothorax	–0.9*	–1.0	–0.2	–0.1	1.7*	1.4*	–0.5	–0.3
Other lung disorders	3.2*	4.2*	0.0	–0.1	–0.6	–1.1*	–2.7*	–3.0*
End stage renal disease or dialysis	–10.2*	–12.2*	1.7*	1.8*	2.1*	2.4*	6.4*	7.9*
Renal failure	–0.4	–0.3	0.3	0.2	1.3*	1.4*	–1.1*	–1.4*
Urinary tract infection	–0.8*	–1.5*	0.4*	0.7*	0.2	0.7*	0.2	0.1
Other urinary tract disorders	2.1*	2.5*	0.1	0.1	–0.6	–0.4	–1.6*	–2.2*
Decubitus ulcer or chronic skin ulcer	–0.2	–1.8*	–0.2	0.1	0.2	0.3	0.2	1.4*
Vertebral fractures	–0.1	–0.2	–0.6	–0.6	0.9	1.4*	–0.3	–0.5

(Continued)

Exhibit A6 Continued. Sensitivity Analysis for CAP Models[1]

	Follow-up visit		Ed visit		Readmission		Censored	
	Full[2]	Home[3]	Full[1]	Home[2]	Full[1]	Home[2]	Full[1]	Home[2]
Other injuries	1.0*	1.4*	0.6*	0.7*	0.1	0.1	–1.7*	–2.2*
Age								
Reference: 66–70	—	—	—	—	—	—	—	—
71–75	0.7	0.9	–0.1	0.0	0.3	–0.1	–0.9	–0.8
76–80	0.9*	0.6	–0.4	–0.2	0.4	0.3	–0.8	–0.7
81–85	0.6*	–1.1	–0.3	0.0	–0.1	0.8	–0.1	0.3
Sex								
Reference: Female	—	—	—	—	—	—	—	—
Male	–0.7	–0.2	0.1	0.0	0.6	–0.1	0.0	0.3
Race								
Reference: White	—	—	—	—	—	—	—	—
Black	–4.1*	–4.9*	1.0*	1.2*	1.9*	1.7*	1.3*	2.0*
Hispanic	–4.0*	–4.0*	–0.3	0.0	0.9	0.1	3.3*	3.9*
Other/ Unknown	0.0	0.1	–1.0*	–1.0	–0.9	–1.2	1.8*	2.0*
Region								
Reference: South	—	—	—	—	—	—	—	—
Northeast	3.8*	0.1	–0.7*	0.0	–1.1*	0.5	–2.0*	–0.5
Midwest	2.4*	1.4*	–0.1	0.1	–1.7*	–0.3	–0.5	–1.2*
West	–1.8*	–2.7*	0.0	0.2	–0.8*	0.1	2.7*	2.4*
Unknown	–8.9*	–10.2*	0.9	1.3	1.0	1.5	7.0*	7.4*
Other insurance coverage[4]								
Medicare Advantage	–14.1*	–14.6*	0.8*	0.8	1.9*	2.6*	11.4*	11.2*
Commercial/capitated	10.2*	9.1*	–2.7*	–3.0*	–2.6*	–2.0*	–4.8*	–4.1*
Commercial/non-capitated	8.8*	10.4*	–0.6	–0.7	–1.5*	–2.1*	–6.8*	–7.6*
Medicaid	–14.3*	–15.4*	0.9	0.9	0.5	1.2	13.0*	13.3*

NOTES: * Marginal effect less than 0.1 in absolute value and statistically insignificant. [1]Marginal effects (holding other variables constant) expressed as percentage points derived from multinomial probit regression. [2]Estimation using full sample. [3]Estimation restricting sample to individuals discharged from index admission to home. [4]Based on all sources of coverage during the index admission. [5]Marginal effect is statistically significant at $p<0.016$ (derived from a multiplicity adjustment using 5% level test for 3 outcomes, 0.05/3 = 0.016).
SOURCE: Multi-Payer Claims Data (MPCD), 2007–2010.