

Improving Diabetic Patient Transition to Home Healthcare: Leading Risk Factors for 30-Day Readmission

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There is a rising demand for post acute home healthcare among Medicare beneficiaries. This demand is associated with an unprecedented growth in the number of Medicare home healthcare episodes preceded by a hospitalization or skilled nursing home stay, increasing from 1.9 million episodes in 2001 to 2.3 million episodes in 2011.¹ The transition of care is required when Medicare home healthcare beneficiaries are discharged from hospitals. This transition involves multiple levels and types of healthcare professionals. Previous studies have shown transitional care programs and discharge planning to be cost-effective in reducing 30-day readmissions for the elderly and Medicaid patients²⁻⁵; however, none of these studies specifically focused on Medicare home healthcare beneficiaries who are discharged from hospitals.

Medicare home healthcare beneficiaries are homebound due to physical or psychiatric limitations and require intermittent skilled care. On average, Medicare home healthcare beneficiaries have 4.2 diagnosed conditions, and 84% of them have at least 1 limitation in the activities of daily living (ADL).⁶ Conducting a smooth and safe care transition is typically challenging for healthcare professionals coordinating care for home healthcare beneficiaries with complex clinical conditions. Currently, there are no guidelines regarding what information should be exchanged during the coordinated care transition; consequently, gaps in care transition due to poor or insufficient communication between hospital coordinators, physicians, and home healthcare professionals, as well as poor documentation of discharge planning, have been found.⁷⁻¹⁰ This poor communication causes discontinuities in care and may result in potential harm to patients.

Previous studies reveal that identifying patients at high risk of a 30-day readmission can be useful for coordinating care and make transitional care more effective.^{11,12} In a study of Medicare home healthcare patients with heart failure, Madigan and colleagues identified risk factors for 30-day

ABSTRACT

Objectives: To identify risk factors of 30-day readmissions due to ambulatory care-sensitive conditions (ACSCs) for diabetic Medicare home healthcare beneficiaries in order to improve transition from hospital-based care to home healthcare.

Study Design: We analyzed diabetic Medicare beneficiaries who received home healthcare within 14 days of hospital discharges in 2009. The unit of analysis is the home health episode for post acute care.

Methods: The conceptual framework was guided by Andersen's Behavioral Model of Health Services. Data sources included: Medicare Beneficiary Summary File, Medicare Provider Analysis Review, Outcome Assessment Information Set, Home Health Agency Research Identifiable File, Hospital Readmissions Reduction Program Supplemental Data File, Provider of Services File, and Area Health Resources File. The dependent variable was time to first 30-day ACSC-related readmission. Proportional hazards regression was used for the statistical analyses.

Results: The 30-day ACSC-related readmission rate was approximately 6% in our study sample, costing the Medicare program about \$62 million. Predictors of readmissions due to ACSCs within 30 days of hospital discharge were: being aged 75 to 84 years, being an African American, requiring assistance in medication management, and having 1 or more of the following clinical conditions: congestive heart failure, peripheral vascular disease, chronic obstructive pulmonary disease, renal failure, deficiency anemia, fluid and electrolyte diseases, depression and/or anxiety, and pressure or stasis ulcer. Patients with chronic obstructive pulmonary disease or renal failure had a 40% higher risk of 30-day ACSC-related readmissions than their counterparts.

Conclusions: Knowing the risk factors identified above, hospital providers can improve care planning and transition of care to the home healthcare providers.

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readmissions due to ambulatory care-sensitive conditions (ACSCs).¹³ The authors included several risk factors such as severity of dyspnea and ADL functions from the Outcome Assessment Information Set (OASIS) that provides clinical conditions for home healthcare patients. They also included a risk factor—the number of previous hospitalizations before the index hospitalization—from the Medicare Provider Analysis Review (MedPAR) that provides clinical conditions during hospitalization.

The study found that the number of previous hospitalizations was the strongest predictor among all other predictors for 30-day readmissions due to ACSCs.

Dharmarajan and colleagues examined the timing of 30-day readmission for heart failure, pneumonia, and acute myocardial infarction (AMI) for Medicare patients. They found that among patients with 30-day readmissions, approximately 13% to 19%, and 61% to 68% of them were readmitted within 3 days and 15 days of hospital discharge, respectively.¹⁴ The evidence discussed above suggests that patients' clinical conditions during hospitalizations affect the risk of 30-day readmissions for home healthcare patients who are transferred from hospitals. However, studies that evaluate specific patient risk factors during hospitalizations for home healthcare patients are limited, which is a critical gap in the field of home healthcare knowledge.

The purpose of this study is to identify the risk factors for 30-day readmissions due to ACSCs for diabetic Medicare home healthcare beneficiaries. We focused on diabetes because nearly a third (31%) of Medicare home healthcare patients have diabetes, making this the most common diagnosis.⁶ Additionally, diabetes is one of the major chronic diseases driving the overall healthcare expenditure growth in the Medicare program, thus causing a significant economic burden in the United States.^{15,16} This study focuses on 30-day readmissions due to ACSCs, such as urinary tract infection and ketoacidosis, as these conditions are potentially avoidable if patients receive timely and effective interventions,^{17,18} which can be affected by the quality of coordinated care among hospital coordinators, physicians, and home healthcare professionals.

METHODS

Study Design and Data Sources

We analyzed Medicare beneficiaries with diabetes who received home healthcare within 14 days of hospi-

Take-Away Points

Identifying risk factors for 30-day readmissions due to ambulatory care-sensitive conditions (ACSCs) among patients with diabetes can inform healthcare providers about opportunities to improve home healthcare transition.

- Thirty-one percent of 30-day readmissions were due to ACSCs, costing the Medicare program about \$62 million in 2009.
- Patients with the following conditions were at high risk for readmission: heart failure, peripheral vascular disease, chronic obstructive pulmonary disease, renal failure, deficiency anemia, fluid and electrolyte diseases, depression/anxiety, pressure/stasis ulcer, and incapability of managing medication.
- Identified risk factors could be used to prioritize care in the transition from hospital-based care to home healthcare.

tal discharge in 2009. The unit of analysis is the home health episode for post acute care. Andersen's Behavioral Model of Health Services was used as a framework for determining and estimating the key predictors of 30-day readmission, while adjusting for empirically determined predictor variables identified in our review of the literature.^{13,14,19-21} Andersen posited that healthcare utilizations, such as 30-day readmissions due to ACSCs, are affected by predisposing factors (age and gender), enabling conditions (whether patients live alone), healthcare needs (comorbid conditions and ADL), and the external environment (quality of hospital care and the number of primary care physicians per 1000 population), as well as the intensity of home healthcare visits that home healthcare patients receive.^{13,20}

We conducted analyses of national data, fitting proportional hazard regression models to home healthcare episodes after hospital discharge in 2009. The Medicare Beneficiary Summary File was used to identify Medicare beneficiaries who were enrolled in the fee-for-services (FFS) program. The 100% MedPAR file provided inpatient data, such as dates for admission and discharge, as well as the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* codes for primary and secondary diagnoses. The 100% OASIS B1 version provided patients' conditions at the time patients were admitted to home healthcare. The 2013 Hospital Readmissions Reduction Program (HRRP) Supplemental Data File provided the readmission adjustment factor that determines the percentage of Medicare payment reduction that hospitals received in 2013 due to excess 30-day readmissions between July 1, 2008, and June 30, 2011.²² The Provider of Services (POS) file provided the characteristics of home health agencies. The Home Health Agency Research Identifiable File provided the number of home healthcare visits. Finally, the Area Health Resource File (AHRF) provided community characteristics at the county level.

Study Sample

We used the date of discharge from MedPAR and the date of the start of home healthcare from OASIS to identify home healthcare episodes within 14 days of hospital discharges, relative to diabetes conditions for our study sample. This 14-day criterion is commonly used in OASIS assessment and previous studies.^{1,13,23} The study sample also needed to meet the following criteria: being 65 years or older, enrolling in the FFS program in 2009, and being discharged from a hospital before December 1, 2009, in order to have a full 30 days of follow-up in 2009. Patients whose admission and discharge dates were the same were also excluded because these records are likely to be incorrect.

Medicare home healthcare patients, on average, had 4.2 diagnoses, and diabetes is a significant contributor to several chronic diseases, such as heart disease and renal disease.^{6,24} We used the series of ICD-9-CM codes for the primary and secondary diagnoses used by Jiang and colleagues for identifying diabetic hospital admissions as our index admission (refer to Jiang et al 2005 for the detailed ICD-9-CM codes).²⁵ Using CMS measures,²⁶ additional readmissions within 30 days of hospital discharge were not counted as 30-day readmissions or used as an index admission. However, the readmissions that occurred after 30 days from the index hospitalization were used as the index admission if their diagnoses codes met the ICD-9-CM codes discussed above.

Variables

The outcome variable of interest was the time-to-first readmission due to ACSCs within 30 days of hospital discharge. The ACSCs were extracted from MedPAR, by applying the Prevention Quality Indicator (PQI) software version 4.5 from the Agency for Healthcare Research and Quality (AHRQ).²⁷ The ACSCs were diabetes with short-term complications, diabetes with long-term complications, chronic obstructive pulmonary disease (COPD) or asthma in older adults, hypertension, heart failure, dehydration, bacterial pneumonia, urinary tract infection, angina without procedure, uncontrolled diabetes, and lower-extremity amputation among patients with diabetes. Although perforated appendix is included in ACSCs, the incidence was low (fewer than 3 individual patients) and was therefore excluded from the analysis.

The risk factors were grouped into the Andersen Model categories of predisposing, enabling, and need for healthcare. Predisposing factors included age (75-84 years and 85 years or older, with 65-74 years as the reference category), gender (male as the reference category), and race/

ethnicity (black, Hispanic, and other race, with white as the reference category). The enabling factors included whether patients were eligible for Medicare and Medicaid benefits (with non-dual eligible patients as the reference group) and whether patients lived alone (with "not living alone" as the reference category). The need for healthcare was measured by the clinical and functional conditions of the patient.

We included comorbid conditions defined by Elixhauser and colleagues²⁸ (the reference category for each comorbidity is "no condition"). The comorbid conditions were extracted from MedPAR, by using the Comorbidity Software from AHRQ. Only comorbid conditions that at least 1% of study sample had as risk factors were included. A total of 20 comorbid conditions were thus selected: congestive heart failure, hypertension, pulmonary circulation disease, peripheral vascular disease, coagulopathy, COPD, renal failure, deficiency anemia, paralysis, other neurological disorders, hypothyroidism, metastatic cancer, solid tumor without metastasis, rheumatoid arthritis, obesity, weight loss, fluid and electrolyte disorders, psychoses, and depression.

In addition to comorbid conditions, several variables related to the needs for healthcare from OASIS were also included. We created indicator variables for whether the patient had pressure or stasis ulcers, felt anxious, or required assistance in medication management, and 4 categories of patient ADL functioning (need for assistance in: 1 to 3 ADL functions, 4 to 6 ADL functions, at least 7 ADL functions, or complete dependence in ADL functions, with patients who could independently perform all ADL functions in the reference group). Because about 57% of patients who had depression also had anxiety, we created an indicator variable to represent whether patients had depression and/or anxiety, instead of using depression and anxiety individually.

Based on the conceptual framework discussed previously, the intensity of home healthcare visits and external environment are also related to 30-day readmissions due to ACSCs. The intensity of home healthcare visits was defined as the log-transformed number of home healthcare visits per week.^{13,20} The external environment included the quality of care from hospitals and home health agencies, and the characteristics of counties where patients resided. An indicator variable was created as a proxy variable for poor quality of hospital care if a readmission adjustment factor for a hospital from the 2013 HRRP file was less than 1; namely, a hospital received a financial penalty due to having excess 30-day readmissions for heart failure, pneumonia, and AMI.²² Previous studies

Table 1. Outcome and Predictor Variables Related to 30-Day Readmissions Due to Ambulatory Care–Sensitive Conditions

Variables	Operational Definition	Data Source(s)
Outcome variable		
30-day readmissions due to ACSC	Time to first readmission due to ACSC within 30 days of hospital discharge	MedPAR and OASIS
Predictor variables		
Predisposing factors		
Age	2 indicator variables identifying patients as aged 75-84 years or 85+ years, with patients aged 65-74 years as the reference group	MedPAR
Race/ethnicity	3 indicator variables identifying patients as African American, Hispanic, or other races, with white as the reference group	
Female	1 if gender is female, with male in the reference group	
Enabling factors		
Live alone	1 if patients live alone; 0 otherwise.	OASIS
Dual eligible	1 if patients are eligible for both Medicare and Medicaid; 0 otherwise	
Need factors (health conditions and functions)		
Congestive heart failure	1 if patients have the comorbidity; 0 otherwise	MedPAR
Valvular disease	1 if patients have the comorbidity; 0 otherwise	
Hypertension	1 if patients have the comorbidity; 0 otherwise	
Pulmonary circulation disease	1 if patients have the comorbidity; 0 otherwise	
Peripheral vascular disease	1 if patients have the comorbidity; 0 otherwise	
Coagulopathy	1 if patients have the comorbidity; 0 otherwise	
Chronic obstructive pulmonary disease	1 if patients have the comorbidity; 0 otherwise	
Renal failure	1 if patients have the comorbidity; 0 otherwise	
Deficiency anemia	1 if patients have the comorbidity; 0 otherwise	
Paralysis	1 if patients have the comorbidity; 0 otherwise	
Other neurological disorders	1 if patients have the comorbidity; 0 otherwise	
Hypothyroidism	1 if patients have the comorbidity; 0 otherwise	
Metastatic cancer	1 if patients have the comorbidity; 0 otherwise	
Solid tumor without metastasis	1 if patients have the comorbidity; 0 otherwise	
Rheumatoid arthritis	1 if patients have the comorbidity; 0 otherwise	
Obesity	1 if patients have the comorbidity; 0 otherwise	
Weight loss	1 if patients have the comorbidity; 0 otherwise	
Fluid and electrolyte disorders	1 if patients have the comorbidity; 0 otherwise	
Psychoses	1 if patients have the comorbidity; 0 otherwise	
Depression and/or anxiety	1 if patients felt depressed and/or anxious; 0 otherwise	
Requirement of assistance in medication management	The assessment for the abilities in managing oral medication (M0780), inhalant medication (M0790), and injectable medication (M0800) in the OASIS were used; 1 if patients required any assistance (codes for "01" and "02" in the OASIS) in managing their oral, inhalant, or injectable medications; 0 otherwise (code "00" in the OASIS)	OASIS
Activities of daily living (ADL)	ADL functions include grooming, toileting, bathing, dressing upper body, dressing lower body, transferring, ambulating, and eating. 3 dummy variables represent patients with different levels of ADL functions: patient required assistance in 1 to 3 ADL functions; patient required assistance in 4 to 6 ADL functions; and patient required assistance in at least 7 ADL functions or were completely dependent on someone to perform ADL functions. The reference group is the patients who could independently perform all ADL functions.	OASIS
Pressure or stasis ulcer	1 if patient has pressure and/or stasis ulcer; 0 otherwise	OASIS

(continued)

Table 1. Outcome and Predictor Variables Related to 30-Day Readmissions Due to Ambulatory Care–Sensitive Conditions (continued)

Intensity of home healthcare visits		
Intensity of visit	Number of visits divided by the number of days during the home healthcare episode, then multiplied by 7 Number of visits include the visits from any of 6 home healthcare professionals: nurses, physical therapists, occupational therapists, speech therapists, home health aides, and medical social workers	HHA RIF
Environmental factors		
Quality of hospital care	1 if hospital received Medicare payment reduction due to excess 30-day readmissions; 0 otherwise	HRRP
Hospital-based home health agency	1 if home health agency is hospital-based; 0 otherwise	POS
Primary care resources	Number of primary care physicians/1000 population	AHRF
Acute care hospital beds	Number of hospital beds/1000 population	
Income	Annual per capita income	
Rural	1 if rural/urban continuum code for the county is from 4 to 9. Counties with a rural/urban continuum code between 1 and 3 are the reference group.	
ACSC indicates ambulatory care–sensitive condition; AHRF, Area Health Resources File; HHA RIF, Home Health Agency Research Identifiable File; HRRP, Hospital Readmissions Reduction Program Supplemental Data File; MedPAR, Medicare Provider Analysis Review; OASIS, Outcome Assessment Information Set; POS, Provider of Services File.		

have found that hospital-based agencies have better-quality performance than non-hospital-based home health agencies.^{13,29} An indicator variable was created from POS if home health agencies were hospital-based.

The characteristics at the county level extracted from AHRF included the number of primary care physicians per 1000 population, the number of acute care hospital beds per 1000 population, per capita income at the county level, and whether or not a county is rural. **Table 1** provides the operational definition of variables and data sources.

Statistical Analysis

We assessed multicollinearity among the independent variables. The variance inflation factor ranged from 1.00 to 3.26, indicating that multicollinearity was not problematic. Readmission times were censored at 30 days when readmission did not occur in the 30-day window. A Cox proportional hazards regression model was used to model time-to-readmission. Estimated adjusted hazard ratios (HRs) and 95% CIs are reported.

RESULTS

Table 2 presents the descriptive analysis for the study variables. The study sample consisted of 120,208 home healthcare episodes within 14 days of hospital discharge. The 30-day ACSC-related readmission rate is approximately 6% in our study sample. Approximately 20% of

home healthcare episodes (23,743 of 120,208) had 30-day readmissions. Among these readmissions, 7441 admissions were ACSCs, accounting for approximately \$62 million in Medicare payments; they consumed about 43,000 inpatient days (**Table 3**). Heart failure alone accounted for about 48% of ACSC hospitalizations and \$28 million of the Medicare expenses. ACSCs related to diabetes, including short-term and long-term diabetes complications, uncontrolled diabetes, and lower-extremity amputation among patients with diabetes, were observed in about 22% of all ACSC hospitalizations. Readmission rates due to urinary tract infection, bacteria pneumonia, and COPD or asthma in older adults were about 8%, 7%, and 7% of ACSC hospitalizations, respectively.

Table 4 presents the HRs and 95% CIs from the Cox regression model. Several factors were positively associated with 30-day readmissions due to ACSCs ($P < .05$). Statistically significant factors included age (75-84 years), race (African American), health conditions (congestive heart failure, peripheral vascular disease, COPD, renal failure, deficiency anemia, fluid and electrolyte diseases, depression and/or anxiety), requirement of assistance in medication management, and the presence of a pressure or stasis ulcer. Patients were less likely to experience 30-day readmissions due to ACSCs if they had comorbid conditions of valvular disease, hypertension, obesity, and psychosis. The following factors were not statistically associated with 30-day readmissions due to ACSCs: age (85

■ **Table 2.** Descriptive Analysis for Study Variables (N = 120,208)

Variables	Proportion or Mean	SD
Dependent variables		
ACSC	0.06	0.24
Predisposing factors		
Patient aged 75-84 years	0.41	0.49
Patient 85 years or older	0.22	0.42
African American	0.16	0.37
Hispanic	0.03	0.18
Other race	0.04	0.19
Female	0.57	0.50
Enabling factors		
Lives alone	0.26	0.44
Dual eligible for Medicare and Medicaid	0.06	0.23
Need factors (health conditions and functional status)		
Congestive heart failure	0.10	0.30
Valvular disease	0.02	0.13
Hypertension	0.58	0.49
Pulmonary circulation disease	0.01	0.10
Peripheral vascular disease	0.08	0.27
Coagulopathy	0.02	0.15
Chronic obstructive pulmonary disease	0.16	0.37
Renal failure	0.19	0.39
Deficiency anemia	0.12	0.33
Paralysis	0.02	0.14
Other neurological disorders	0.05	0.22
Hypothyroidism	0.08	0.27
Metastatic cancer	0.01	0.11
Solid tumor without metastasis	0.02	0.13
Rheumatoid arthritis	0.01	0.12
Obesity	0.07	0.25
Weight loss	0.02	0.14
Fluid and electrolyte diseases	0.19	0.39
Psychoses	0.02	0.12
Depression or anxiety	0.43	0.50
Required assistance in 1 to 3 ADL functions	0.28	0.45
Required assistance in 4 to 6 ADL functions	0.29	0.45
Required assistance in at least 7 ADL functions or complete dependence in ADL function	0.35	0.48
Pressure or stasis ulcer	0.08	0.28
Required assistance in medication management	0.75	0.44
Intensity of home healthcare visits		
Number of home healthcare visits per week	3.37	2.46
Environmental factors		
Hospital received penalty due to excess 30-day readmissions	0.76	0.43
Hospital-based home health agency	0.23	0.42

(continued)

Table 2. Descriptive Analysis for Study Variables (N = 120,208) (continued)

Number of primary care physicians per 1000 population	0.73	0.29
Number of acute hospital beds per 1000 population	2.81	1.88
Income per capita (\$1000)	39.15	11.56
Rural	0.19	0.40

ACSC indicates ambulatory care-sensitive condition; ADL, activities of daily living.

Table 3. Preventable Hospitalizations and Utilizations (N = 7441)

Preventable Quality Indicators (PQIs)	N (%)	Average Length of Stay (days)	Total Inpatient Days	Average Medicare Payment	Total Medicare Payment
Diabetes short-term complications (PQI 01)	101 (1.36)	5.82	588	\$8899	\$898,754
Diabetes long-term complications (PQI 03)	1098 (14.76)	5.77	6332	\$9036	\$9,858,512
Chronic obstructive pulmonary disease or asthma in older adults (PQI 05)	499 (6.71)	5.85	2917	\$8050	\$3,992,869
Hypertension (PQI 07)	140 (1.88)	4.21	590	\$6137	\$846,880
Heart failure (PQI 08)	3562 (47.87)	5.72	20,378	\$7949	\$28,138,105
Dehydration (PQI 10)	458 (6.16)	4.74	2169	\$6564	\$2,960,252
Bacterial pneumonia (PQI 11)	519 (6.97)	6.66	3457	\$8797	\$4,530,368
Urinary tract infection (PQI 12)	625 (8.40)	5.29	3305	\$6248	\$3,867,438
Angina without procedure (PQI 13)	26 (0.35)	3.38	88	\$3271	\$85,045
Uncontrolled diabetes (PQI 14)	126 (1.69)	4.56	575	\$6787	\$855,223
Lower-extremity amputation among patients with diabetes (PQI 16)	287 (3.86)	10.46	3001	\$20,150	\$5,742,723
Total	7441		43,400		\$61,776,169

years or older), race (Hispanic or other race), being a female, being dual eligible, living alone, ADL functions, and other health conditions (pulmonary circulation disease, coagulopathy, paralysis, other neurological disorders, hypothyroidism, metastatic cancer, solid tumor without metastasis, rheumatoid arthritis, and weight loss).

Increases in intensity of home healthcare visits were associated with high 30-day readmissions due to ACSCs. Expectedly, patients who were discharged from the hospitals that received Medicare payment reduction had higher odds of being readmitted due to ACSCs than their counterparts. Hospital-based home health agencies and county characteristics were not significantly associated with

ACSC admissions within 30 days of hospital discharge.

DISCUSSION

One in 5 (20%) diabetic Medicare home healthcare episodes had 30-day readmission in our study—a rate comparable to the national 30-day readmission rate among all Medicare hospital stays.³⁰ Approximately 1 in 3 (7441/23,743) readmissions is preventable. Reduction in preventable 30-day readmissions requires care collaboration among hospital coordinators, physicians, home healthcare professionals, patients, and their families and caregivers. Awareness of the leading readmission risk fac-

■ **Table 4.** Predictors of Time-to-Readmissions Due to ACSCs for Diabetic Medicare Home Healthcare Beneficiaries (N = 110,161)

Variables	Estimated Hazard Ratio	95% CI
Predisposing factors		
Aged 75 to 84 years	1.10 ^a	1.04-1.16
Aged 85 years and older	1.07	1.00-1.14
African American	1.11 ^b	1.04-1.18
Hispanic	0.89	0.77-1.02
Other race	0.91	0.79-1.04
Female	0.99	0.94-1.04
Enabling factors		
Live alone	0.97	0.91-1.02
Dual eligible for Medicare and Medicaid	0.98	0.88-1.09
Need factors (health conditions and functional status)		
Congestive heart failure	1.09 ^c	1.01-1.18
Valvular disease	0.74 ^b	0.59-0.92
Hypertension	0.82 ^a	0.78-0.86
Pulmonary circulation disease	0.87	0.69-1.10
Peripheral vascular disease	1.12 ^b	1.03-1.22
Coagulopathy	0.89	0.75-1.05
Chronic obstructive pulmonary disease	1.60 ^a	1.51-1.70
Renal failure	1.44 ^a	1.36-1.53
Deficiency anemia	1.11 ^b	1.04-1.19
Paralysis	0.97	0.82-1.15
Other neurological disorders	0.92	0.82-1.03
Hypothyroidism	0.91	0.83-1.00
Metastatic cancer	1.13	0.91-1.41
Solid tumor without metastasis	1.10	0.92-1.31
Rheumatoid arthritis	0.84	0.67-1.05
Obesity	0.75 ^a	0.66-0.84
Weight loss	0.93	0.78-1.10
Fluid and electrolyte diseases	1.10 ^a	1.04-1.17
Psychoses	0.74 ^b	0.59-0.93
Depression or anxiety	1.09 ^a	1.04-1.14
Required assistance in 1 to 3 ADL functions	1.03	0.94-1.13
Required assistance in 4 to 6 ADL functions	0.99	0.90-1.08
Required assistance in at least 7 ADL functions or complete dependence in ADL function	0.96	0.88-1.05
Pressure or stasis ulcer	1.25 ^a	1.16-1.35
Required assistance in medication management	1.16 ^a	1.09-1.23
Intensity of home healthcare visits		
Intensity of home healthcare visits (log-transformed)	1.84 ^a	1.77-1.91
Environmental factors		
Hospitals received penalty due to excess 30-day readmissions	1.21 ^a	1.14-1.28
Hospital-based home health agencies	1.06	1.00-1.12

(continued)

Table 4. Predictors of Time-to-Readmissions Due to ACSCs for Diabetic Medicare Home Healthcare Beneficiaries (N = 110,161) (continued)

Number of primary care physicians per 1000 population	1.06	0.93-1.20
Number of acute hospital beds per 1000 population	1.00	0.99-1.02
Income per capita (log-transformed)	0.94	0.81-1.08
Rural	1.05	0.98-1.13

ADL indicates activities of daily living; ACSC, ambulatory care-sensitive condition.

^aP < .001.

^bP < .01.

^cP < .05.

tors can inform the decisions and type of care provided by the collaborating clinicians and home healthcare providers.

The risk factors identified in our study serve as sentinel conditions in the care transition for our study population. Among all risk factors, COPD and renal failure are the strongest predictors for 30-day ACSC-related readmission. The findings in our study aid physicians and home healthcare professionals with prioritizing care and providing timely and effective interventions to reduce potentially avoidable readmissions. Additionally, for patients and their families and caregivers, engagement is a critical part of chronic disease management. Rather than solely focusing on diabetes treatment, education, and support, home health nurses can utilize the findings in our study to develop a multi-comorbidity approach for teaching patients and their families and caregivers to manage their comorbid conditions.

Healthcare professionals currently rely on their professional judgments to decide what messages should be communicated during the coordinated care transition. As a result, variations in communication occur across different levels of providers, which may harm patients. Being informed about key risk factors for readmission can reduce the variations in information exchange among clinicians and home healthcare providers. This is especially critical under the CMS Electronic Health Records Incentive Programs, which requires providers to deliver an electronic summary care record for each transition of care and referral.³¹ Our research model yields a “checklist” of significant risk factors that can be used to enhance the meaningful use of the electronic health record.

Our study findings indicated that increases in intensity of home healthcare visits were associated with high 30-day readmissions due to ACSCs. This finding is consistent with a previous study of Medicare home healthcare patients with heart failure.¹³ The intensity of visits is dependent on patients’ clinical conditions; thus, it is likely that patients who are at high risk of 30-day readmis-

sions due to ACSCs are likely to receive high intensity of visits. One study based on the data from 1 home health agency found that early home healthcare visits reduced rehospitalization for heart failure patients, although the generalizability of the findings is limited.³² CMS requires home healthcare professionals to visit patients within 48 hours after receiving physicians’ referrals; however, some patients may require home healthcare visits on the same date of hospital discharge or high-intensive visits in the first few days after hospital discharge. Future studies based on large data that focus on the association between 30-day readmissions and the timing of the first home healthcare visit or the intensity of the home healthcare visit at different time periods within the first 30 days after hospital discharge are recommended.

We also estimated the risk associated with several community factors at the county level, (eg, per capita income). None of these factors were statistically significant. Previous studies found that ACSCs were associated with socioeconomic status and community characteristics when using data at the individual or zip code level,^{17,18,33,34} but found insignificance when using data at the county level.^{35,36} It is likely that the measures for the community factors at the county level may not be as sensitive as the ones at the individual level or small geographic areas. Future studies based on individual level or small geographic areas for the community characteristic measures are suggested.

Limitations

There are data constraints and study limitations. First, measures of patients’ vital signs and laboratory results, and the quality of home healthcare visits, which all likely affect 30-day readmissions due to ACSCs, were not available in the database. Second, because the study was based on Medicare FFS beneficiaries, generalizability is limited to this population. Third, previous studies found that the number of hospitalizations in the previous 6 months of the index admission was critical.^{1,18} The present study

only used data for 1 year, which did not allow us to track the number of previous hospitalizations for our study sample. Fourth, one should be cautious about the variable of hospital penalty extracted from the HRRP in our study. Evidence has shown that community factors and patients' socioeconomic status affect the risk of 30-day readmission, which are not taken into account in the HRRP.^{37,38} Finally, a clinical decision rule has been used to quantify the probability of a patient's outcome.³⁹ Future studies applying clinical decision rules to quantify a risk score that flags high-risk patients are imperative.

CONCLUSIONS

Despite these limitations, our findings have important policy implications. The Medicare Payment Advisory Commission has reported the high variation in quality of care among home health agencies.¹ Instead of solely targeting hospitals under the HRRP, a policy that addresses the excess preventable 30-day readmissions among home health agencies after taking community factors and patients' socioeconomic status into account is imperative and could be effective in reducing overall 30-day readmissions. Patients with chronic obstructive pulmonary disease or renal failure had a 40% higher risk of 30-day ACSC-related readmissions than their counterparts. Knowing the risk factors identified above, hospital providers can improve care planning and transition of care to the home health-care providers.

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