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30-Day Readmission Among Elderly Medicare Beneficiaries with Type 2 Diabetes

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Abstract

This study retrospectively assessed rates and risk factors for all-cause hospital readmission among elderly Medicare beneficiaries with type 2 diabetes mellitus (T2DM) aged ≥65 years. Associations between 30-day readmission and patients' demographic, insurance, index hospital, and clinical characteristics; patient complexities specific to the elderly; and health care utilization were examined using multivariable logistic regressions. Of 202,496 elderly Medicare beneficiaries, 52% were female, 76% were white, the mean age was 75.8 years, and 13.2% had all-cause 30-day readmissions. Elderly patients with cognitive impairment (adjusted odds ratio [aOR] = 1.06, 95% confidence interval [CI] = 1.01–1.12), falls and falls risk (aOR = 1.15, 95% CI = 1.08–1.22), polypharmacy (aOR = 1.20, 95% CI = 1.14–1.27), and urinary incontinence (aOR = 1.08, 95% CI = 1.01–1.15) were at higher risk for all-cause 30-day readmission than their counterparts without these complexities. As elderly-specific complexities are associated with greater risk for readmission, intervention programs to reduce readmission risk among elderly patients with T2DM should be tailored to suit the needs of elderly patients with extensive complexities. (*Population Health Management* 2015;18:256–264)

Introduction

Readmission to hospitals within 30 days after discharge is commonplace among elderly patients. Reducing preventable readmissions by 10% can result in a Medicare savings of $1 billion.[1] Systematic reviews have reported that 30-day readmission rates range from 11% to 23% among elderly Medicare beneficiaries.[2,3] The Medicare Payment Advisory Commission (MedPAC), which regularly monitors readmissions among Medicare beneficiaries, found that three quarters of such readmissions might be avoidable. These 30-day readmissions are very expensive for both payers and patients; MedPAC has estimated that they accounted for $15 billion in annual health care spending.[4] In addition, 30-day readmission rates were higher among elderly Medicare beneficiaries with chronic conditions (22.5%) than among those with acute conditions (19.3%).[5] Between 2004 and 2006, readmission rates among elderly Medicare beneficiaries hospitalized with heart failure remained virtually constant at 23.0%.[6]

Hospitalizations among individuals with diabetes are frequent. Using Healthcare Cost and Utilization Project (HCUP) data, the Agency for Healthcare Research and Quality (AHRQ) reported that nearly 1 in 5 hospitalizations was related to patients with diabetes, totaling >7.7 million stays and $83 billion in hospital expenditures in 2008.[7] When compared with elderly people without type 2 diabetes mellitus (T2DM), those with T2DM might be at greater risk for readmissions because of a high prevalence of comorbid conditions.[8] There are a few studies on readmission rates among individuals with diabetes[9–12]; however, only one of these studies focused on elderly Medicare beneficiaries.[12] Using 1999 HCUP State Inpatient Databases for 5 states in the United States (California, Missouri, New York, Tennessee, and Virginia), one study reported significant racial/ethnic disparities in the likelihood of 30-day readmission among individuals hospitalized for diabetes-related conditions.[9] Using hospital data on enrollees in Philadelphia Health Care Centers, it was shown that 22% of individuals with diabetes were readmitted within 30 days.[10] Another state-specific (California) study of individuals with diabetes aged ≥50 years indicated that 26.3% of patients were readmitted within 3 months of their index hospitalization.[11] A study using fee-for-service (FFS) claims data from the 5% Medicare sample from the Chronic Conditions

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Warehouse (CCW) analyzed readmission rates among Medicare beneficiaries with diabetes. This study reported that 14.4% of Medicare beneficiaries with diabetes had 30-day readmission.[12]

It is important to understand the factors associated with the risk of hospital readmissions among elderly patients with T2DM, which is a highly manageable chronic condition. In the United States, 10.9 million elderly individuals aged ≥65 years suffer from T2DM,[13] and this aging population presents challenges to health care management. The identification of specific characteristics of elderly patients with T2DM who are at high risk for 30-day hospital readmission will help develop tailored surveillance efforts and intervention programs to reduce the risk of readmission. The primary objectives of the present study are to estimate the rates of all-cause 30-day readmission among elderly patients with T2DM using a nationwide database of Medicare beneficiaries and to examine the relationship between 30-day readmission and patient complexities specific to the elderly, while controlling for demographic, clinical, insurance, and index hospitalization characteristics, and for health care utilization.

Methods

Study design

A retrospective, longitudinal cohort study design was used. Baseline period was defined as the 6 months prior to the admission date of the index hospitalizations (ie, first observed hospitalization) between January 2007 and August 2011, and patients were followed for 30 days after discharge from the index hospitalization.

Data source and study population

The data source comprised information on elderly individuals who were enrolled in the Humana Medicare Advantage with Prescription Drug (MAPD) plan database between January 2007 and April 2012. This database includes claims for >12 million current and previous Humana members (Medicare, commercial, and Medicaid), with enrollment, medical, pharmacy, and laboratory claims data, including monthly updates to these claims. Nearly 1.9 million individuals were MAPD plan members. An encrypted identity number was used to link the different claims files and patient enrollment files, which had information on the patients' year of birth, race, sex, and monthly enrollment status. The medical conditions files provided information on: disease conditions, hospitalization, cost, plan type, length of stay (LOS) during hospitalization, and diagnosis codes (using *International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM]) and procedural codes (using Current Procedural Terminology). In addition, pharmacy claims files contained information on prescription fill date, days of supply, formulary status, the national drug codes for each dispensed medication, the net amount paid by Humana, and member out-of-pocket expenditure for each prescription claim. Laboratory data were available for 30% of the enrolled Medicare beneficiaries.

The study population was restricted to elderly Medicare beneficiaries aged ≥65 years who were diagnosed with T2DM and identified using the ICD-9-CM diagnosis codes 250.x0 or 250.x2 available in inpatient and outpatient files. Elderly patients were considered to have a diagnosis of T2DM if they had ≥1 inpatient or 2 outpatient visits (a minimum of 30 days apart) with a primary or secondary diagnosis of T2DM. Additional inclusion criteria were having an index hospitalization event (ie, first observed hospitalization) during the period of July 1, 2007, through September 31, 2011, and continuous enrollment in the plan during the baseline period (6 months prior to the admission date of index hospitalization) and 120 days after index hospitalization.

Dependent variable

Readmission days were calculated as the number of days from the discharge date of an index hospitalization to the admission date of the subsequent hospitalization. For the purposes of this study, individuals were classified into 2 groups: those with all-cause 30-day readmission and those with no readmission within 30 days. Patient transfers from a different unit within the same hospital and from different hospitals were not considered to be readmissions.

Independent variables

Demographic and insurance characteristics. Variables included: age (65–74 years and ≥75 years); sex; race (white, African American, Hispanic, and other); ''donut hole'' (ie, the Medicare prescription drug coverage gap [those who had a coverage gap in the baseline period versus those who were in the pre- or post-donut hole phase]); and insurance type (FFS, health maintenance organization, preferred provider organization, and other insurance).

Index hospitalization characteristics. The characteristics associated with index hospitalizations were: LOS; reasons for admission (diabetes- and cardiovascular-related); and month of index hospitalization (included to control for potential seasonal effects).

Clinical characteristics. The severity of diabetes was measured using the modified Diabetes Complications Severity Index (mDCSI) using the algorithm defined by Chang and colleagues.[14,15] mDCSI was subdivided into 4 categories based on quartiles. Dominant comorbid conditions (cancers) also were included following the framework developed by Piette and Kerr[16] because these are so complex or serious that they eclipse the management of other health problems. In addition, the presence of baseline hypoglycemia was identified using ICD-9-CM codes based on an algorithm published by Ginde and colleagues.[17]

Patient complexities specific to the elderly. These were measured during the baseline period based on the guidelines from the American Geriatric Society (AGS), which recommend individualized treatment for elderly patients with the following specific presentations: cognitive impairment; depression; falls and falls risk; polypharmacy; and urinary incontinence.[18] Cognitive impairment related to physical illnesses was defined as the presence or absence of Huntington's disease, Parkinson's disease, delirium, dementia, amnesia, and other cognitive disorders. Cognitive impairment related to mental illnesses was defined as the presence

or absence of bipolar disorder, schizophrenia, and other psychotic disorders. Any cognitive impairment was defined as the presence or absence of mental and/or physical cognitive impairment and diagnosed using codes provided by AHRQ.[19] Risk for injurious falls was captured using E-codes from E880 to E888 and V-code V15.88.[20,21] The cutoff point used to define polypharmacy was mean plus 1 standard deviation of the number of prescribed medications.[22] Urinary incontinence and depression were defined using ICD-9-CM codes from existing studies.[23] Details of the ICD-9-CM codes for disease conditions are available from the authors upon request.

Health care utilization. Health care utilization included the number of office visits and any emergency department visits during the baseline period.

Statistical analyses

Chi-square tests were used to determine differences between patient characteristics and the presence or absence of all-cause 30-day readmission. Multivariable logistic regressions were used to examine the association between all-cause 30-day readmission and patient complexities specific to the elderly, after controlling for clinical characteristics, index hospitalization characteristics, health care utilization, and demographic and insurance characteristics. The reference group for the dependent variable was ''no readmission during 30 days.'' Secondary analyses were conducted by restricting the study population to those with glycated hemoglobin (A1c) values available during the baseline period ($N = 58{,}098$).

Results

Table 1 presents the number and percentage of elderly Medicare beneficiaries with T2DM by all-cause 30-day readmission and no readmissions within 30 days. A total of 202,496 patients were hospitalized during the study period (52% female, 76% white, and mean age 75.8 years), 13.2% ($n = 26{,}710$) of whom had readmissions within 30 days of index hospitalization.

Demographic and insurance characteristics and 30-day readmission

As shown in Table 1, those characteristics associated with higher rates of 30-day readmission were female sex (0.4% higher than men), age ≥ 75 years (3.8% higher than adults aged 65–74 years), Other race (including Native American and Asian; 3.3% higher than whites), those living in the Midwest region of the United States (1.8% higher than those living in the Northeast), and those not reaching the donut hole (3.1% higher than those having the index hospitalization while experiencing a coverage gap).

Index hospital characteristics and 30-day readmission

As shown in Table 1, readmission rates varied by LOS—8.2% greater rates of readmission were observed among those in the highest LOS (≥ 8 days) category, compared with those in the lowest LOS (1 day) category. A higher proportion (1.6%) of elderly patients with cardiovascular-related index hospitalization had 30-day readmission compared to those without cardiovascular conditions. However, 0.7% fewer elderly patients with diabetes-related index hospitalization had 30-day readmission compared with those with non-diabetes-related index hospitalization.

Clinical characteristics, health care utilization, and 30-day readmission

Table 1 shows that 4.1% more elderly patients in the highest category of mDCSI had 30-day readmission compared with those in the lowest category of mDCSI. A 3.8% greater proportion of elderly patients with dominant conditions (cancer) had 30-day readmission compared with those without dominant conditions. A total of 28.7% of elderly patients had A1c data available. Elderly patients with A1c values $< 7.0\%$ had 0.6% lower 30-day readmission rates compared with those with A1c values $\geq 9.0\%$. A higher proportion of elderly patients with hypoglycemia and emergency department visits during the baseline period had 30-day readmission, compared with those without hypoglycemia and without emergency department visits during the baseline period.

Patient complexities specific to the elderly and 30-day readmission

As shown in Table 1, those complexities associated with 30-day readmission of elderly Medicare beneficiaries were cognitive impairment (3.6% higher than for those without cognitive impairment), depression (2.6% higher than for those without depression), falls and falls risk (5.7% higher than for those without falls/falls risk), polypharmacy (4.7% higher than for those without polypharmacy), and urinary incontinence (2.7% higher than for those without urinary incontinence).

Multivariable logistic regression on 30-day readmission

Findings from the multivariate logistic regression were consistent with those found in the bivariate analyses (Table 2). The regression adjusted for: patient complexities specific to the elderly (cognitive impairment, depression, falls and falls risk, polypharmacy, and urinary incontinence), clinical and index hospitalization characteristics, health care utilization, and demographic and insurance characteristics. Statistically significant associations were found between patient complexities specific to the elderly and risk of 30-day readmission. Elderly Medicare beneficiaries with cognitive impairment, falls and falls risk, polypharmacy, and urinary incontinence were more likely to have 30-day readmission compared with those without cognitive impairment, falls and falls risk, polypharmacy, and urinary incontinence, respectively. However, elderly individuals with depression did not have a significantly higher likelihood of 30-day readmission compared with those without depression.

Subgroup analysis: elderly with available A1c values

A total of 58,121 elderly individuals with T2DM had A1c values available at baseline; however, 23 individuals who resided in the Other region had to be excluded because of too few patients. Of the remaining 58,098 individuals, 12.7% ($n = 7399$) had all-cause 30-day readmission. In adjusted regression analysis, not all of the patient complexities

Table 1. Baseline Characteristics of Elderly Medicare Beneficiaries with T2DM by All-Cause 30-Day Readmission

	All						*Subgroup With A1c Values*[a]				
	Total	*30-Day Readmission*		*No 30-Day Readmission*			*30-Day Readmission*		*No 30-Day Readmission*		
	N	N	%	N	%		N	%	N	%	
	202,496	*26,710*	*13.2*	*175,786*	*86.8*	*Sig.*	*7399*	*12.7*	*50,699*	*87.3*	*Sig.*
Demographic and Insurance Characteristics											
Age group						***					***
65–74 years	97,849	10,981	11.2	86,868	88.8		2993	10.9	24,392	89.1	
≥75 years	104,647	15,729	15.0	88,918	85.0		4406	14.3	26,307	85.7	
Sex						**					*
Female	104,461	14,013	13.4	90,448	86.6		3959	13.0	26,386	87.0	
Male	98,035	12,697	13.0	85,338	87.0		3440	12.4	24,313	87.6	
Race						***					***
White	153,931	19,878	12.9	134,053	87.1		5415	12.6	37,459	87.4	
African American	28,225	3687	13.1	24,538	86.9		1014	11.4	7858	88.6	
Hispanic	4770	619	13.0	4151	87.0		257	12.9	1738	87.1	
Other	15,570	2526	16.2	13,044	83.8		713	16.4	3644	83.6	
Region						***					***
Midwest	53,743	7616	14.2	46,127	85.8		987	14.1	6034	85.9	
South	126,225	16,312	12.9	109,913	87.1		5778	12.6	39,955	87.4	
Other region	2276	279	12.3	1997	87.7				NA		
Northeast/West	20,252	2503	12.4	17,749	87.6		634	11.9	4710	88.1	
Insurance type						***					*
HMO	80,638	10,657	13.2	69,981	86.8		5027	13.0	33,778	87.0	
PPO	52,843	7012	13.3	45,831	86.7		1334	12.8	9119	87.2	
FFS	66,622	8857	13.3	57,765	86.7		977	11.8	7313	88.2	
Other	2393	184	7.7	2209	92.3		61	11.1	489	88.9	
Prescription drug coverage gap						***					***
Before index hospitalization	174,716	22,719	13.0	151,997	87.0		6195	12.5	43,301	87.5	
After index hospitalization	4165	707	17.0	3458	83.0		219	17.6	1023	82.4	
During index hospitalization	23,615	3284	13.9	20,331	86.1		985	13.4	6375	86.6	
Index Hospitalization Characteristics											
Due to cardiovascular disease						***					***
Yes	71,721	10,172	14.2	61,549	85.8		2672	13.7	16,873	86.3	
No	130,775	16,538	12.6	114,237	87.4		4727	12.3	33,826	87.7	
Due to diabetes						***					
Yes	144,738	18,808	13.0	125,930	87.0		5675	12.8	38,682	87.2	
No	57,758	7902	13.7	49,856	86.3		1724	12.5	12,017	87.5	
Length of stay at index hospitalization, days						***					***
≤1	63,208	5653	8.9	57,555	91.1		1704	8.5	18,268	91.5	
2	30,542	3626	11.9	26,916	88.1		1031	11.5	7901	88.5	
3–7	59,604	9009	15.1	50,595	84.9		2507	15.5	13,714	84.5	
≥8	49,142	8422	17.1	40,720	82.9		2157	16.6	10,816	83.4	
Season											
April–June	42,057	5638	13.4	36,419	86.6		1656	13.2	10,899	86.8	
July–October	81,219	10,626	13.1	70,593	86.9		2870	12.6	19,997	87.4	
November–March	79,220	10,446	13.2	68,774	86.8		2873	12.7	19,803	87.3	
Clinical Characteristics											
Hypoglycemia						***					**
Yes	8141	1283	15.8	6858	84.2		406	14.6	2378	85.4	
No	194,355	25,427	13.1	168,928	86.9		6993	12.6	48,321	87.4	
Dominant conditions						***					
Yes	49,326	7927	16.1	41,399	83.9		2147	14.8	12,353	85.2	
No	153,170	18,783	12.3	134,387	87.7		5252	12.0	38,346	88.0	

(*continued*)

Table 1. (Continued)

	All						*Subgroup With A1c Values*[a]				
	Total	*30-Day Readmission*		*No 30-Day Readmission*			*30-Day Readmission*		*No 30-Day Readmission*		
	N *202,496*	N *26,710*	% *13.2*	N *175,786*	% *86.8*	*Sig.*	N *7399*	% *12.7*	N *50,699*	% *87.3*	*Sig.*
mDCSI category						***					***
0	58,733	6807	11.6	51,926	88.4		1215	10.5	10,326	89.5	
1	29,067	3325	11.4	25,742	88.6		904	11.7	6806	88.3	
2–3	67,188	9097	13.5	58,091	86.5		2531	12.5	17,692	87.5	
4–13	47,508	7481	15.7	40,027	84.3		2749	14.8	15,875	85.2	
A1c categories											
<7.0%	3521	4553	12.5	31,968	87.6		4551[a]	12.5	31,954[a]	87.5	
7.0%–7.9%	12,304	1610	13.1	10,694	87.0		1610	13.1	10,690[a]	86.9	
8.0%–8.9%	4897	660	13.5	4237	86.5		660	13.5	4237	86.5	
≥9.0%	4125	578	13.1	3821	86.9		578	13.1	3818[a]	86.8	
NA	144,375	19,309	13.4	125,066	86.6						
Patient Complexities Specific to the Elderly											
Cognitive impairment						***					***
Yes	32,522	5284	16.2	27,238	83.8		1507	15.6	8154	84.4	
No	169,974	21,426	12.6	148,548	87.4		5892	12.2	42,545	87.8	
Depression						***					***
Yes	17,819	2785	15.6	15,034	84.4		884	15.1	4987	84.9	
No	184,677	23,925	13.0	160,752	87.0		6515	12.5	45,712	87.5	
Falls and falls risk						***					***
Yes	7492	1398	18.7	6094	81.3		353	18.7	1535	81.3	
No	195,004	25,312	13.0	169,692	87.0		7046	12.5	49,164	87.5	
Polypharmacy						***					***
>13 drugs	12,653	2222	17.6	10,431	82.4		737	17.4	3508	82.6	
≤13 drugs	189,843	24,488	12.9	165,355	87.1		6662	12.4	47,191	87.6	
Urinary incontinence						***					**
Yes	7287	1154	15.8	6133	84.2		300	15.1	1689	84.9	
No	195,209	25,556	13.1	169,653	86.9		7099	12.7	49,010	87.3	
Health Care Utilization											
Emergency department visit						***					***
Yes	73,369	11,639	15.9	61,730	84.1		2789	15.1	15,721	84.9	
No	129,127	15,071	11.7	114,056	88.3		4610	11.6	34,978	88.4	
Office visits						***					***
0–4	46,405	5686	12.3	40,719	87.7		1276	11.3	10,001	88.7	
5–9	59,814	7164	12.0	52,650	88.0		2226	11.8	16,689	88.2	
10–15	47,606	6104	12.8	41,502	87.2		1884	12.9	12,739	87.1	
≥16	48,671	7756	15.9	40,915	84.1		2013	15.2	11,270	84.8	

Based on data from the Humana Medicare Advantage Prescription Drug plan of 202,496 elderly Medicare beneficiaries with T2DM hospitalized during the period of January 2007 through September 2011. A subgroup of 58,121 elderly Medicare beneficiaries with T2DM who had A1c values available at the baseline period were hospitalized during the period of January 2007 through September 2011; however, this analysis excluded 23 individuals who were from ''Other'' region because of too few patients. Therefore, 58,098 patients were analyzed in this subgroup.

[a]Numbers do not match to those of A1c categories presented in the ''All'' columns because 23 individuals who were residing in ''Other'' region were excluded because of too few patients.

Asterisks represent significant group differences between the ''30-day readmission'' and ''No 30-day readmission'' groups: ***$P < 0.001$; **$0.001 \le P < 0.01$; *$0.01 \le P < 0.05$.

A1c, glycated hemoglobin; FFS, fee for service; HMO, health maintenance organization; mDCSI, modified Diabetes Complications Severity Index; NA, not applicable; PPO, preferred provider organization; Sig., significance; T2DM, type 2 diabetes mellitus.

specific to the elderly were associated with increased risk of 30-day readmission. For example, significant statistical associations were not observed between urinary incontinence and risk of 30-day readmission. Similarly, there was no statistically significant association between cardiovascular disease-related index hospitalization and 30-day readmission risk.

Discussion

This study aimed to estimate the prevalence of 30-day readmission among elderly Medicare beneficiaries with T2DM enrolled in a nationwide Humana MAPD plan. Nearly 1 in 8 (13.2%) elderly beneficiaries had 30-day readmission. The findings of this study are consistent with the overall

Table 2. Adjusted Odds Ratios from Logistic Regression for All-Cause 30-Day Readmission Among Elderly Medicare Beneficiaries With T2DM

	Overall			*Subgroup With A1c Values*		
	aOR	*95% CI*	*Sig.*	*aOR*	*95% CI*	*Sig.*
Demographic and Insurance Characteristics						
Age group						
65–74 years	Ref.			Ref.		
≥75 years	1.30	(1.27–1.34)	***	1.28	(1.22–1.35)	***
Sex						
Female	1.01	(0.99–1.04)		1.05	(1.00–1.11)	*
Male	Ref.			Ref.		
Race						
White	Ref.			Ref.		
African American	1.03	(0.99–1.07)		0.92	(0.86–0.99)	*
Hispanic	0.99	(0.90–1.08)		0.97	(0.85–1.11)	
Other	1.28	(1.22–1.34)	***	1.31	(1.20–1.43)	***
Region						
Midwest	1.14	(1.09–1.20)	***	1.23	(1.10–1.37)	***
South	1.02	(0.98–1.07)		1.06	(0.97–1.16)	
Other region	0.85	(0.74–0.97)	*	NA	NA	
Northeast/West	Ref.			Ref.		
Insurance type						
HMO	1.00	(0.97–1.03)		1.11	(1.03–1.20)	**
PPO	1.00	(0.97–1.03)		1.10	(1.01–1.21)	*
FFS	Ref.			Ref.		
Other	0.52	(0.45–0.61)	***	0.93	(0.70–1.23)	
Prescription drug coverage gap						
Before index hospitalization	1.01	(0.97–1.05)		1.01	(0.94–1.09)	
After index hospitalization	1.14	(1.04–1.25)		1.27	(1.08–1.50)	**
During index hospitalization	Ref.			Ref.		
Index Hospitalization Characteristics						
Due to cardiovascular disease						
Yes	1.06	(1.03–1.09)	***	1.05	(1.00–1.11)	
No	Ref.			Ref.		
Due to diabetes						
Yes	0.95	(0.92–0.98)	***	1.03	(0.97–1.09)	
No	Ref.			Ref.		
Length of stay at index hospitalization, days						
≤1	Ref.			Ref.		
2	1.38	(1.32–1.45)	***	1.41	(1.30–1.53)	***
3–7	1.77	(1.71–1.83)	***	1.92	(1.80–2.05)	***
≥8	1.98	(1.91–2.05)	***	2.02	(1.89–2.16)	***
Season						
April–June	1.03	(1.00–1.07)		1.06	(0.99–1.13)	
July–October	0.98	(0.95–1.01)		0.98	(0.93–1.04)	
November–March	Ref.			Ref.		
Clinical Characteristics						
Baseline hypoglycemia						
Yes	1.04	(0.96–1.14)		1.00	(0.85–1.18)	
No	Ref.			Ref.		
Dominant conditions						
Yes	1.18	(1.14–1.22)	***	1.07	(1.01–1.14)	*
No	Ref.			Ref.		
mDCSI category						
0	Ref.			Ref.		
1	0.96	(0.92–1.01)		1.09	(0.99–1.19)	
2–3	1.08	(1.04–1.12)	***	1.10	(1.02–1.19)	*
4–13	1.16	(1.12–1.21)	***	1.21	(1.12–1.31)	***

(*continued*)

Table 2. (Continued)

	Overall			Subgroup With A1c Values		
	aOR	*95% CI*	*Sig.*	*aOR*	*95% CI*	*Sig.*
Baseline A1c categories						
<7.0%				1.05	(0.99–1.12)	
7.0%–7.9%				1.09	(1.00–1.19)	
8.0%–8.9%				1.08	(0.98–1.19)	
≥9.0%	Ref.			Ref.		
Patient Complexities Specific to the Elderly						
Cognitive impairment						
Yes	1.06	(1.01–1.12)	*	1.17	(1.06–1.30)	**
No	Ref.			Ref.		
Depression						
Yes	1.06	(0.99–1.13)		0.98	(0.87–1.11)	
No	Ref.			Ref.		
Falls and falls risk						
Yes	1.15	(1.08–1.22)	***	1.21	(1.07–1.37)	**
No	Ref.			Ref.		
Polypharmacy						
>13 drugs	1.20	(1.14–1.27)	***	1.24	(1.14–1.36)	***
≤13 drugs	Ref.			Ref.		
Urinary incontinence						
Yes	1.08	(1.01–1.15)	*	1.10	(0.96–1.25)	
No	Ref.			Ref.		
Health Care Utilization						
Baseline emergency department visit						
Yes	1.31	(1.27–1.35)	***	1.24	(1.17–1.31)	***
No	Ref.			Ref.		
Baseline office visits						
0–4	Ref.			Ref.		
5–9	0.95	(0.91–0.98)	**	1.01	(0.93–1.08)	
10–15	0.97	(0.93–1.01)		1.07	(0.99–1.16)	
≥16	1.11	(1.07–1.16)	***	1.16	(1.07–1.26)	***

Based on data from the Humana Medicare Advantage Prescription Drug plan of 202,496 elderly Medicare beneficiaries with T2DM hospitalized during the period of January 2007 through September 2011. A subgroup of 58,121 elderly Medicare beneficiaries with T2DM who had A1c values available at the baseline period were hospitalized during the period of January 2007 through September 2011; however, this analysis excluded 23 individuals who were from ''Other'' region because of too few patients. Therefore, 58,098 patients were analyzed in this subgroup.

Asterisks represent significant group differences between the ''30-day readmission'' and ''No 30-day readmission'' groups using logistic regression: ***$P < 0.0001$; **$0.001 \le P < 0.01$; *$0.01 \le P < 0.05$.

A1c, glycated hemoglobin; aOR, adjusted odds ratio; CI, confidence interval; FFS, fee for service; HMO, health maintenance organization; mDCSI, modified Diabetes Complications Severity Index; NA, not applicable; PPO, preferred provider organization; Ref., reference; Sig., significance; T2DM, type 2 diabetes mellitus.

30-day readmission rate of 14% that was reported in the only other comparable study on elderly Medicare beneficiaries with diabetes (5% Medicare sample from the CCW), which used FFS claims data from 2005.[12] Although not specific to elderly patients with diabetes, one study that included patients enrolled in Medicare Advantage plans estimated the all-cause 30-day readmission rate as 14.5%. This study also reported readmission rates that were 13%–20% lower in Medicare Advantage plans than in Medicare's traditional FFS program.[24] Based on these published reports, one can speculate that, even with T2DM, the readmission rates reported therein are lower than those previously observed in the elderly, perhaps because of the coordinated and managed care that is typical of Medicare Advantage plans.

The findings of this study emphasize the role of patient complexities specific to the elderly (as identified by the AGS guidelines) in increasing the risk for all-cause 30-day readmission among Medicare beneficiaries with T2DM. These findings are also consistent with a systematic review of results from 37 studies on determinants of readmissions, in which patient-level indicators of general ill health or complexity were shown to be the most commonly identified risk factors for readmissions.[2] In this study, after controlling for demographic, clinical, index hospitalization, and health insurance characteristics, as well as health care utilization, readmission rates were higher among those with complexities compared to those without complexities.

The findings of this study have implications for effective discharge planning efforts. Some of the variables that were associated with high risk of readmissions, such as polypharmacy, presence of chronic conditions (urinary incontinence and falls and falls risk), functional status (cognitive

impairment), severity of diabetes, and whether the index hospitalization was related to cardiovascular disease, can be incorporated into the checklist for discharge planning for elderly patients with diabetes. This checklist could be used to guide the organization of post-discharge services, for coordination of care with physicians, for medication reconciliation, to review follow-up care with physicians, and for appropriate self-management for chronic conditions.

Indeed, a randomized controlled trial that incorporated these elements in discharge planning reduced 30-day readmissions.[25] In the present study, elderly patients with polypharmacy prior to index hospitalization were more likely to have 30-day readmission than those without polypharmacy. These findings emphasize the role of medication reconciliation efforts in preventing 30-day readmissions.[25] The present study also found that urinary incontinence and falls can increase the risk for readmission. For community-dwelling elderly, the case manager can suggest evidence-based strategies to manage urinary incontinence and evidence-based strategies for fall prevention.[26] Nursing interventions for urinary incontinence have been reported to improve the care of urinary incontinence and reduce the risk of readmission.[27] Referral to supportive services can be made for patients with cognitive impairment who are discharged to home. In this context, the Community-based Care Transitions Program, created under the Affordable Care Act to reduce readmissions, can help. Under this program, community-based organizations provide transition care services particularly to those with multiple chronic conditions, depression, and cognitive impairments.[28]

The present study found that elderly patients with a greater degree of diabetes complications were more likely to have 30-day readmissions compared with patients without any diabetes complications. The case managers can coordinate post-discharge visits not only with the primary care physician but also with endocrinologists and cardiologists. Although the findings of the present study have highlighted variables that were associated with high risk of 30-day readmission, comprehensive discharge planning that includes these variables may be important in reducing 30-day readmissions.[29]

Previous research has indicated differences in readmission rates between African American and Hispanic groups.[9,30,31] However, the present study did not find these racial differences. Again, one could speculate that in a managed care environment with an integrated approach, such as that provided by Medicare Advantage plans, improved care for racial minorities could result. There is some evidence that managed care plans improve access to care for racial minorities and improve the quality of care for elderly Medicare beneficiaries. A study that examined racial disparities in the quality of care for elderly Medicare beneficiaries in managed care plans reported that, between 1997 and 2003, such disparities declined for many diabetes-related measures.[32]

The present study found significantly higher rates of 30-day readmission among patients residing in the Midwest when compared with patients living in the Northeast/West. There are many possible reasons for geographic variations in readmission rates, but these reasons are not known from the current data set available to the researchers. However, based on the literature, the researchers speculate that the higher readmission rates in Midwest region may be because of differences in health profiles of individuals, quality of care during index hospitalization, discharge planning, and care coordination prior to discharge.[33]

The findings from the current study need to be interpreted in the context of its strengths and limitations. Strengths of the present study include that it was a nationwide analysis of elderly individuals with T2DM and that the analysis was adjusted for a comprehensive list of clinical and other risk factors at the patient level. Some of the limitations include lack of adjustment for variables related to hospital discharge planning and care coordination. These factors might influence the readmission risk of patients with complexities. Previous studies have suggested that effective discharge planning and coordinated care after discharge can reduce the risk of readmissions among the elderly.[34] Similarly, some relevant index hospitalization characteristics (eg, surgical procedures, trauma status) and information on whether readmission was planned or unplanned could not be included. Again, such variables could affect the magnitude of the association between patient complexities specific to the elderly and risk of readmissions.

Despite the limitations of this study, its findings represent an important contribution toward understanding the association between patient-level complexity specific to the elderly and the risk of readmission among elderly individuals with T2DM. The study findings suggest that intervention programs to reduce the risk of readmissions among elderly patients with T2DM might need to be tailored to suit the needs of elderly patients with extensive complexities.

Author Disclosure Statment

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References

1. Medicare Payment Advisory Commission (MedPAC). Report to the Congress: Medicare and the Health Care Delivery System. Chapter 4: Refining the hospital readmissions reduction program. June 2013. http://www.medpac.gov/documents/reports/jun13_entirereport.pdf. Accessed October 27, 2014.
2. Kansagara D, Englander H, Salanitro A, et al. Risk prediction models for hospital readmission: a systematic review. JAMA. 2011;306:1688–1698.
3. Jencks SF. Defragmenting care. Ann Intern Med. 2010;153:757–758.
4. Medicare Payment Advisory Commission (MedPAC). Report to the Congress: Promoting Greater Efficiency in Medicare. June 17, 2007. http://www.medpac.gov/reports/Jun07_EntireReport.pdf. Accessed December 20, 2014.
5. Podulka J, Barrett M, Jiang HJ, Steiner C. 30-Day Readmissions following Hospitalizations for Chronic vs. Acute Conditions, 2008. HCUP Statistical Brief #127. February 2012. http://www.hcup-us.ahrq.gov/reports/statbriefs/sb127.pdf. Accessed May 14, 2014.

6. Ross JS, Chen J, Lin Z, et al. Recent national trends in readmission rates after heart failure hospitalization. Circ Heart Fail. 2010;3:97–103.
7. Fraze TK, Jiang HJ, Burgess J. Hospital Stays for Patients with Diabetes, 2008. HCUP Statistical Brief #93. August 2010. http://www.hcup-us.ahrq.gov/reports/statbriefs/sb93.pdf. Accessed May 14, 2014.
8. Niefeld MR, Braunstein JB, Wu AW, Saudek CD, Weller WE, Anderson GF. Preventable hospitalization among elderly Medicare beneficiaries with type 2 diabetes. Diabetes Care. 2003;26:1344–1349.
9. Jiang HJ, Andrews R, Stryer D, Friedman B. Racial/ethnic disparities in potentially preventable readmissions: the case of diabetes. Am J Public Health. 2005;95:1561–1567.
10. Robbins JM, Valdmanis VG, Webb DA. Do public health clinics reduce rehospitalizations?: the urban diabetes study. J Health Care Poor Underserved. 2008;19:562–573.
11. Kim H, Ross JS, Melkus GD, Zhao Z, Boockvar K. Scheduled and unscheduled hospital readmissions among patients with diabetes. Am J Manag Care. 2010;16:760–767.
12. Bennett KJ, Probst JC, Vyavaharkar M, Glover SH. Lower rehospitalization rates among rural Medicare beneficiaries with diabetes. J Rural Health. 2012;28:227–234.
13. American Diabetes Association. Fast Facts: Data and Statistics about Diabetes. http://professional.diabetes.org/admin/UserFiles/0%20-%20Sean/Documents/Fast_Facts_9-2014.pdf. Accessed October 27, 2014.
14. Young BA, Lin E, Von Korff M, et al. Diabetes complications severity index and risk of mortality, hospitalization, and healthcare utilization. Am J Manag Care. 2008;14:15–23.
15. Chang HY, Weiner JP, Richards TM, Bleich SN, Segal JB. Validating the adapted Diabetes Complications Severity Index in claims data. Am J Manag Care. 2012;18:721–726.
16. Piette JD, Kerr EA. The impact of comorbid chronic conditions on diabetes care. Diabetes Care. 2006;29:725–731.
17. Ginde AA, Blanc PG, Lieberman RM, Camargo CA Jr. Validation of ICD-9-CM coding algorithm for improved identification of hypoglycemia visits. BMC Endocr Disord. 2008;8:4.
18. Sue Kirkman M, Briscoe VJ, Clark N, et al. Diabetes in older adults: a consensus report. J Am Geriatr Soc. 2012;60:2342–2356.
19. Agency for Healthcare Research and Quality Center for Financing, Access, and Cost Trends. MEPS HC-129 2009 Full Year Consolidated Data File, November 2011. http://meps.ahrq.gov/mepsweb/data_stats/download_data/pufs/h129/h129doc.pdf. Accessed May 14, 2014.
20. Mehta S, Chen H, Johnson ML, Aparasu RR. Risk of falls and fractures in older adults using antipsychotic agents: a propensity-matched retrospective cohort study. Drugs Aging. 2010;27:815–829.
21. Tinetti ME, Gordon C, Sogolow E, Lapin P, Bradley EH. Fall-risk evaluation and management: challenges in adopting geriatric care practices. Gerontologist. 2006;46:717–725.
22. Goldberg JF, Brooks JO 3rd, Kurita K, et al. Depressive illness burden associated with complex polypharmacy in patients with bipolar disorder: findings from the STEP-BD. J Clin Psychiatry. 2009;70:155–162.
23. Anger JT, Saigal CS, Madison R, Joyce G, Litwin MS; Urologic Diseases of America Project. Increasing costs of urinary incontinence among female Medicare beneficiaries. J Urol. 2006;176:247–251.
24. Lemieux J, Sennett C, Wang R, Mulligan T, Bumbaugh J. Hospital readmission rates in Medicare Advantage plans. Am J Manag Care. 2012;18:96–104.
25. Jack BW, Chetty VK, Anthony D, et al. A reengineered hospital discharge program to decrease rehospitalization: a randomized trial. Ann Intern Med. 2009;150:178–187.
26. Department of Health and Human Services; Centers for Disease Control and Prevention. Preventing Falls: How to Develop Community-based Fall Prevention Programs for Older Adults. 2008. http://www.cdc.gov/homeandrecreationalsafety/images/cdc_guide-a.pdf. Accessed October 13, 2014.
27. Da Silva VA, D'Elboux MJ. Nurses' interventions in the management of urinary incontinence in the elderly: an integrative review. Rev Esc Enferm USP. 2012;46:1221–1226.
28. Centers for Medicare and Medicaid Services. Community-based Care Transitions Program. 2008. http://innovation.cms.gov/initiatives/CCTP/?itemID=CMS1239313. Accessed October 13, 2014.
29. Hunter T, Nelson JR, Birmingham J. Preventing readmissions through comprehensive discharge planning. Prof Case Manag. 2013;18:56–63.
30. Joynt KE, Orav EJ, Jha AK. Thirty-day readmission rates for Medicare beneficiaries by race and site of care. JAMA. 2011;305:675–681.
31. Laditka JN, Laditka SB. Race, ethnicity and hospitalization for six chronic ambulatory care sensitive conditions in the USA. Ethn Health. 2006;11:247–263.
32. Trivedi AN, Zaslavsky AM, Schneider EC, Ayanian JZ. Trends in the quality of care and racial disparities in Medicare managed care. N Engl J Med. 2005;353:692–700.
33. Robert Wood Johnson Foundation. The Revolving Door: A Report on U.S. Hospital Readmissions. 2013. http://www.rwjf.org/content/dam/farm/reports/reports/2013/rwjf404178. Accessed October 13, 2014.
34. Tilson S, Hoffman GJ. Addressing Medicare Hospital Readmissions. May 2012. http://op.bna.com/hl.nsf/id/bbrk-8url4c/$File/CRSMedicareReadmission.pdf. Accessed October 13, 2014.

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