

Potentially Preventable Hospitalizations Among Older Adults With Diabetes

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One in every 5 Americans 65 years or older has diabetes,¹ and its prevalence has increased by 62% over the last 10 years. Healthcare use and mortality rates are much higher for individuals with diabetes.² Suboptimal diabetes care (eg, failure to achieve recommended levels of glycemic control) has been consistently reported,³ particularly in ethnic minority groups,⁴ and is associated with serious complications³ and avoidable healthcare use, including potentially preventable hospitalizations (PPHs).⁴⁻⁶

Potentially preventable hospitalizations are hospital admissions for ambulatory care-sensitive conditions (ACSCs) that should not require in-hospital treatment if timely and appropriate ambulatory care is provided.⁷ Among older adults with diabetes, ACSCs include both acute conditions (eg, dehydration, urinary tract infection) and chronic conditions (eg, hypertension, congestive heart failure) that are prevalent in the population.⁴ Hospitalizations for these conditions can potentially be avoided with quality primary care “either preventing the onset of an illness or condition, controlling an acute episodic illness or condition, or managing a chronic disease or condition.”⁸ In this way, PPHs are thought to be associated with ineffective primary care and a lack of access to or coordination of care.

Potentially preventable hospitalizations are common, are often repeated,⁹ and represent serious clinical and economic burdens to patients, families, and healthcare providers.^{7,10} Nearly 36% of all hospitalizations with diabetes as the primary diagnosis were PPHs for short-term complications of diabetes or for uncontrolled diabetes, costing more than \$1.3 billion in 2004.⁵ The PPH rates for long-term diabetes complications increased by 11.7% (from 111.8 to 124.9 per 100,000 people) and the costs of PPHs for diabetes-related lower-extremity amputations rose by 29.5% between 1997 and 2004.⁷

Existing literature has reported on the prevalent occurrence of PPHs and disparities by sociodemographic characteristics, but a relatively small number of studies have focused on PPHs in older adults, a well-known high-risk group for PPHs. Niefeld and colleagues reported about 7% PPHs among all hospitalizations of older Medicare beneficiaries with type 2 diabetes in 1999 and a higher risk for PPHs in blacks than whites.⁴

However, their analysis used data from the 1990s and did not examine either minority groups other than blacks or the cost of PPHs. In addition, risk factors

Objectives: To examine prevalence of and factors associated with different types of potentially preventable hospitalizations (PPHs) among older adults with diabetes.

Study Design: Population-based secondary analysis.

Methods: We analyzed the California State Inpatient Databases, 2005 to 2006. PPHs for 3 acute and 5 chronic ambulatory care-sensitive conditions relevant for older adults were defined by applying the Prevention Quality Indicator algorithm developed by the Agency for Health Research and Quality. Prevalence and costs of PPHs for acute conditions (acute PPHs) and chronic conditions (chronic PPHs) were examined. Associations of sociodemographic and health-related factors as well as hospitalization history with both types of PPH were estimated.

Results: One-fifth of 555,538 hospitalizations of adults 65 years and older with diabetes were PPHs. Of these, 43.7% were acute PPHs and 56.3% were chronic PPHs. The total hospital cost associated with these PPHs was more than \$1.1 billion. Having Medi-Cal as the primary payer and hospitalization through the emergency department were positively associated with both types of PPH. Acute PPH rates were lower, but chronic PPH rates were higher, among blacks, patients with multiple chronic conditions, and those with previous admission(s) in the same year.

Conclusions: PPHs for common medical conditions are costly and prevalent among older patients with diabetes, suggesting a need for more comprehensive primary care, beyond glycemic control. The groups at risk for acute and chronic PPHs may differ, which suggests that more targeted and tailored approaches are necessary to reduce the rates of each type of PPH.

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Take-Away Points

This study used a population-based data set to examine prevalence of and factors associated with potentially preventable hospitalizations (PPHs) among older adults with diabetes.

- A substantial percentage (20.2%) of hospitalizations were classified as PPHs, at a cost of more than \$1.1 billion.
- Congestive heart failure, respiratory and urinary infections, and chronic obstructive pulmonary disease accounted for 89.1% of PPHs, suggesting need for better primary care of these conditions.
- Older diabetes patients with fewer chronic conditions were more likely to have acute PPHs, whereas those with black race, more chronic conditions, and greater hospital use were more likely to have chronic PPHs.

Measures

The main variable of interest was PPH (yes or no), which, as defined by the AHRQ's PQI algorithm, refers to a hospitalization with an ACSC as the principal diagnosis.¹⁵ The PQIs have been widely used to assess quality of and access to primary care.^{6,7,9} For this study, we selected 3 acute ACSCs—bacterial pneumonia, dehydration, and urinary tract infections—and 5 chronic

ACSCs—chronic obstructive pulmonary disease, congestive heart failure, hypertension, short-term complications of diabetes, and uncontrolled diabetes—that are relevant for older adults.¹⁶

for PPHs for acute ACSCs (acute PPHs) or chronic ACSCs (chronic PPHs) have not been examined separately, though these may reflect different attributes of primary care—in particular, preventive care services.¹¹

The purpose of this population-based secondary data analysis study was to describe the prevalence and cost burden of PPHs in older adults with diabetes and to examine risk factors for acute and chronic PPHs separately. We hypothesized that risk factors for these 2 types of PPH would be different, which would inform the development of targeted management to decrease PPHs.

METHODS

Data Set and Sample

This is a secondary analysis of 2 years of pooled data (2005-2006) from the Health Care Utilization Project State Inpatient Databases (SIDs) of California.¹² The SIDs include de-identified hospital discharge abstract data on inpatient stays at short-term, nonfederal, general, and specialty hospitals and contain a core set of clinical and nonclinical information (eg, patient demographics, diagnoses, payer source, total charges). More information about the Health Care Utilization Project SIDs can be obtained at <http://www.hcup-us.ahrq.gov/>.

The unit of analysis is a hospitalization. Our sample included acute hospital admissions (stays) of patients 65 years or older from the community with a diagnosis of diabetes (*International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM] code 250.XX*).^{13,14} Excluded were hospitalizations of patients at psychiatric, rehabilitation, and long-term hospitals, and patients transferred from other institutions and/or discharged against medical advice, as defined by the Agency for Healthcare Research and Quality (AHRQ) Prevention Quality Indicator (PQI) algorithm, adopted to identify PPHs in this study.¹⁵ The final analytic sample of this study included a total of 555,538 hospitalizations of older adults with diabetes at acute hospitals in California from 2005 to 2006.

Guided by Andersen's Behavioral Model of Health Services Use,¹⁷ we hypothesized that PPHs in older adults with diabetes were associated with certain predisposing, enabling, and need characteristics of individuals and also the communities in which they reside. We selected the predisposing factors of age, sex, and race as characteristics existing prior to illness that influence the likelihood of seeking healthcare. These are supported by the literature, which shows that advanced age and being female are risk factors for PPH in older adults with diabetes,⁴ but not in adults 18 years or older.⁵ Race/ethnicity has been found to be a determinant of PPH.^{4,6} Kim found PPH rates were 2.25 times higher in blacks than whites.¹⁰ In the current study, age (65-74, 75-84, and 85+) and sex (female or male) were coded categorically. Race/ethnicity was coded using 3 dichotomous variables (black, Hispanic, and Asian), with white as the reference group.

Enabling factors, including both patient- and community-level factors, refer to healthcare access factors.¹⁷ Insurance type, neighborhood income, patient location, and route of hospitalization were the factors selected for this study. These are supported by the literature, which shows that the PPH rate is higher in people with public insurance—Medicare and Medicaid—than in people with private insurance.^{6,8} Chang et al⁶ found the rates of both acute and chronic PPHs, as defined by the AHRQ's PQI, were higher in counties with higher poverty levels. In the current study, the primary payer for a hospitalization was categorized as Medicare, Medi-Cal, or private insurance (which refers to payment covered by private, non-profit, or commercial health plans).¹⁸ Neighborhood income level was measured using the quartile of median income in the neighborhood at the zip code level. To examine the influence of population density and travel time on PPH, patient location (rural vs urban) was measured, defined by the Rural-Urban Commuting Area codes.¹² We also measured the route of hospitalization—emergency department (ED) versus non-

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ED (admissions from home or other healthcare facilities)—an indicator of process and coordination of care.^{19,20}

Finally, the need for healthcare is determined by perceived and actual health status.^{6,17} To approximate health status, we accounted for the number of chronic conditions as a marker of disease burden.²¹ Studies have reported higher rates of PPH in people with a higher burden of disease.^{6,9} We calculated the number of chronic conditions in a manner similar to that of Wolff et al²¹: by categorizing the ICD-9-CM diagnosis codes into chronic and nonchronic conditions using the chronic conditions index algorithm²² and grouping them into 18 specific body systems in accordance with 18 major diagnostic categories.^{5,12} Using the major diagnostic categories as a unit of comorbidity, we counted only 1 chronic condition for each specific body system.

Data Analysis

We summarized the characteristics of the hospitalizations of older diabetes patients and overall rates of acute, chronic, and total PPH using descriptive statistics. We computed PPH-related resource use—length of stay (LOS) and inpatient costs—in the same way as other studies using Health Care Utilization Project databases.^{13,23,24} The total hospital cost for a PPH was calculated by multiplying the total charges incurred during a PPH by the hospital-level cost-charge ratio provided by AHRQ. The mean cost for PPHs for each of the 8 selected conditions was calculated by summing the total hospital cost for each type of PPH and dividing the sum by the total number of hospitalizations for that condition. The grand total hospital cost for all PPHs was calculated by summing up the total costs for all 8 conditions. Applying the same logic, the mean LOS for PPHs for each of the 8 selected conditions and the grand total LOS were also calculated.

The associations between sociodemographic and health-related factors and the likelihood of acute, chronic, and combined (total) PPHs were estimated using multivariate logistic regression models. To examine the effects of hospitalization history on PPH risk, we then included 2 additional variables in the model, created using a scrambled patient identifier: (1) whether a hospitalization was the first hospitalization for a patient and (2) whether a hospitalization was one of multiple hospitalizations in the same year for a patient. The risk-adjusted odds ratios and statistical significance were consistent after adding the 2 hospitalization history variables, so we reported the final models only.

RESULTS

The sample included 555,538 hospitalizations of 361,858 older patients with diabetes in California in 2005 and 2006

(**Table 1**). In 96.7% of the total, diabetes was a secondary diagnosis. The majority of hospitalizations were of white (58.1%), female (54.4%), and Medicare patients (88.7%). Hospitalized patients mostly resided in urban areas (93.4%), and nearly three-fourths of the hospitalizations were through the ED (74.6%). About half (55.3%) of the hospitalizations were for a patient with more than 1 hospitalization in 1 year.

Among the total hospitalizations, 20.2% (112,031) were attributable to 1 of the 8 ACSCs examined in this study; 43.7% (n = 48,994) were acute PPHs, and 56.3% (n = 63,037) were chronic PPHs (**Table 2**). Among acute PPHs, PPHs for bacterial pneumonia (58.6%) were the most common, followed by those for urinary tract infection (28.2%). Among chronic PPHs, PPHs for congestive heart failure (77.0%) were most common, followed by those for chronic obstructive pulmonary disease (14.1%). Congestive heart failure, respiratory and urinary infections, and chronic obstructive pulmonary disease accounted for 89.1% of all PPHs. The overall mean LOS for all 8 conditions was 5.1 days, and the mean cost was \$9894.80. The PPHs for all 8 conditions accounted for almost 570,000 days of hospital stays and cost more than \$1.11 billion.

Table 3 shows factors associated with acute, chronic, and combined (total) PPHs. The risk for all 3 types of PPH increased with age. Being female, living in a rural area, living in a lower income neighborhood, and being hospitalized through the ED were all positively associated with total PPHs. Total PPH risk was higher among patients with multiple hospitalizations during the same year. When we examined the risk factors for acute and chronic PPHs separately, most factors had a consistent relationship with both types of PPH. Ethnicity and comorbidity, however, were associated with the 2 types of PPH in opposite directions. The risk of chronic PPH was higher, but the risk of acute PPH was lower, among blacks than whites. Similarly, the risk of acute PPH was consistently lower, but the risk of chronic PPH was consistently higher, among patients with multiple chronic comorbidities (MCCs) compared with those who had diabetes only. The risk for acute PPH was higher when a hospitalization was the first hospitalization of a patient, but the relationship was opposite for chronic PPH.

DISCUSSION

The findings from this population-based study using California's inpatient discharge data show that one-fifth (20.2%) of hospitalizations of older diabetes patients during 2005 and 2006 were potentially preventable. The PPHs accounted for nearly 570,000 days of hospital stays and cost more than \$1.1 billion. The fact that 1 of the 8 selected ACSCs was the principal diagnosis for 1 in 5 hospitalizations

Table 1. Descriptive Statistics for Hospitalizations of Older Diabetes Patients: California State Inpatient Databases, 2005-2006 (n = 555,538)

Characteristic	No.	Percentage
Predisposing factor		
Age, y		
65-69	111,051	20
70-74	118,035	21.3
75-79	126,379	22.8
80-84	109,515	19.7
85+	90,558	16.3
Race		
White	322,855	58.1
Black	48,344	8.7
Hispanic	126,849	22.8
Asian/Pacific Islander	57,490	10.4
Sex		
Female	301,913	54.4
Male	253,625	45.7
Enabling factor		
Insurance		
Medicare	492,570	88.7
Medi-Cal	28,412	5.1
Private	34,556	6.2
Income^a		
Low	155,952	28.1
Medium	284,986	51.3
High	114,600	20.6
Residence		
Urban	518,726	93.4
Rural	36,812	6.6
ED admission		
Yes	414,114	74.6
No	141,394	25.5
Need factor		
Comorbidity		
1	4087	0.7
2	79,442	14.3
3	136,178	24.5
4	138,169	24.9
5	100,828	18.2
6	58,224	10.5
7+	38,610	7.0
Multiple hospitalizations^{b,c}		
Yes	307,035	55.3
No	248,503	44.7
First hospitalization^{b,d}		
Yes	361,858	65.1
No	193,680	34.9

ED indicates emergency department.

^aIncome refers to median family income of zip code area; income categories correspond to below the 25th percentile (low), 25th to 75th percentile (medium), and above the 75th percentile (high).

^bThis variable was created using the scrambled patient identifier in the California State Inpatient Databases, which does not allow the following of a patient across years.

^cThe variable refers to whether a hospitalization was for a patient with more than 1 hospitalization in a given year.

^dThe variable refers to whether an admission was the first hospitalization of a patient in a year.

for older diabetes patients suggests a significant missed opportunity to improve the primary care of patients with diabetes.

The PPH rate among older diabetes patients in this study was higher than the 15% in the study by Chang et al,⁶ which used AHRQ's PQI definitions and Tennessee state inpatient discharge data (2002-2004). However, that study was specific to neither an older population nor diabetes patients. The study by Niefeld and colleagues⁴ analyzing 1999 Medicare claims data reported 7% of all hospitalizations were PPHs. This study is not comparable with ours in several ways. The study by Niefeld et al focused on type 2 diabetes patients only and examined a set of ACSCs defined by panels of physicians. The study focused on white and black Medicare patients only, while ours included a more diverse population in terms of ethnicity and insurance. The wide range of estimates in the literature suggests that more population-based studies that report PPH rates specific to older diabetes patients using consistent PPH definitions are necessary.

Among predisposing factors, being older and being female were risk factors for acute and chronic PPHs, which is consistent with findings from previous studies.⁴ Unlike most existing studies reporting higher risks of total PPHs in blacks than whites in the general population,^{6,25} we found such a relationship only in chronic PPHs; the risk of acute PPHs was lower for blacks than whites. To our best knowledge, this is the first study reporting such an inverse relationship among older diabetes patients, and only the study by Chang et al⁶ reported the same opposite relationships between being black and the 2 types of PPH in the general population. The higher risk of chronic PPHs in blacks may be due to a higher prevalence of chronic health problems among the patients, or more limited access to primary or care coordination services to manage chronic

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Table 2. Number of Hospitalizations, Average Length of Stay, and Average Total Cost of Potentially Preventable Hospitalizations^a (n = 112,031)

Type of PPH	No.	% of Total	% of Subtotal	Mean LOS (days)	Total LOS (days, in thousands)	Mean Cost (\$)	Total Hospital Cost (in millions)
PPHs for acute conditions							
Bacterial pneumonia	28,731	25.6	58.6	5.6	162.3	11,037.10	317.1
Dehydration	6,467	5.8	13.2	3.9	25.1	6,535.40	42.3
Urinary tract infections	13,796	12.3	28.2	4.5	62.3	7,471.80	103.1
Subtotal	48,994	43.7	100.0	5.1	249.7	9,438.90	462.5
PPHs for chronic conditions							
Chronic obstructive pulmonary disease	8,887	7.9	14.1	5.0	44.7	10,303.70	91.6
Congestive heart failure	48,539	43.3	77.0	5.2	250.4	10,470.70	508.2
Diabetes, short-term complications	2,456	2.2	3.9	5.4	13.2	11,301.60	27.8
Hypertension	1,486	1.3	2.4	3.1	4.6	6,168.10	9.2
Uncontrolled diabetes	1,669	1.5	2.6	3.9	6.5	5,598.40	9.3
Subtotal	63,037	56.3	100.0	5.1	319.4	10,249.10	646.1
PPHs, combined conditions (total)	112,031	100.0	—	5.1	569.2	9,894.80	1,108.5

LOS indicates length of stay; PPH, potentially preventable hospitalization.

^aAcute and chronic conditions for PPHs among older adults with diabetes were defined according to Agency for Health Research and Quality's Prevention Quality Indicator criteria.¹⁵

conditions.^{9,25} Further studies are needed on the relationships between being an ethnic minority and risks for the 2 types of PPH.

Insurance type is a critical enabling factor associated with PPHs. Regardless of the type of PPH, compared with hospitalizations for which Medicare is the primary payer, hospitalizations with private insurance as the primary payer were less likely to be PPHs, but Medi-Cal (Medicaid) hospitalizations were more likely to be PPHs. The higher risks could be attributed to lower Medicaid reimbursement levels for primary care as well as more complex health conditions or psychosocial factors of Medicaid beneficiaries.²⁶ This finding is consistent with evidence from existing studies on the disparities in diabetes care (eg, glycosylated hemoglobin control, eye exams, readmissions) by insurance type.^{26,27} We also found geographic disparities in diabetes care. Hospitalizations of rural residents and patients living in low-income neighborhoods were more likely to be PPHs, which could be related to less access to care.^{6,14} These findings indicate the need to close gaps in diabetes care.

Care needs measured by MCCs and hospitalization history had the strongest associations with PPH: The risk for acute PPHs was higher, but the risk for chronic PPHs was lower, among patients with no MCCs and without 1 or more previous hospitalizations. Compared with chronic PPH, acute PPH was also more likely to be a patient's first PPH (odds ratio [OR]

= 1.24; 95% confidence interval [CI] = 1.19-1.30), and acute PPH was less likely to occur among patients with multiple PPHs (OR = 0.54; 95% CI = 0.52-0.56, not shown). The findings suggest that the populations at risk for the 2 PPHs may differ: relatively healthy older diabetes patients with limited inpatient service use are more likely at risk for acute PPHs, but those with serious and complex chronic conditions and high use of inpatient services are more likely at risk for chronic PPHs. This implies that acute PPH is difficult to prevent or that people with no MCCs may have less frequent encounters with primary care providers, which precludes early detection and treatment of acute illnesses.²⁸ People with MCCs are widely regarded as a high-risk group for healthcare services, and they are often considered a target group for care management to decrease PPHs. Our findings, however, suggest there may be a missed opportunity to decrease PPHs and increase patient safety by strengthening primary care for relatively healthy people to avoid acute PPHs through more targeted and tailored management for this group. Few studies have examined care needs in relation to PPH or acute and chronic PPHs separately. Further studies are necessary to explicate the reasons for and patterns of PPHs for acute conditions, as well as to replicate this study using other data sets.

This study addressed several gaps in the literature. We examined variables representing the major domains of Andersen's model that we hypothesized were associated with acute

■ **Table 3.** Multivariate Analysis of Factors Associated With Potentially Preventable Hospitalizations^a (n = 555,538)

Characteristic	PPHs for Total Conditions			PPHs for Acute Conditions			PPHs for Chronic Conditions		
	Rate	OR	95% CI	Rate	OR	95% CI	Rate	OR	95% CI
Predisposing factor									
Age, y									
65-74 (reference)	17.3	1		6.7	1		10.6	1	
75-84	20.9	1.213 ^b	1.195-1.231	9.3	1.362 ^b	1.333-1.392	11.6	1.073 ^b	1.053-1.093
85+	25.5	1.485 ^b	1.457-1.514	12.9	1.836 ^b	1.789-1.884	12.6	1.136 ^b	1.108-1.164
Race									
White (reference)	20.2	1		9.0	1		11.2	1	
Black	21.6	1.020	0.995-1.045	7.7	0.837 ^b	0.807-0.869	13.9	1.161 ^b	1.127-1.196
Hispanic	20.1	0.951 ^b	0.935-0.968	8.6	0.960 ^b	0.937-0.983	11.4	0.955 ^b	0.935-0.976
Asian/Pacific Islander	18.8	0.893 ^b	0.873-0.914	9.0	0.976	0.945-1.008	9.9	0.849 ^b	0.823-0.875
Sex									
Female	21.1	1.066 ^b	1.051-1.080	9.4	1.107 ^b	1.086-1.129	11.7	1.019 ^c	1.002-1.037
Male (reference)	19.1	1		8.1	1		11.0	1	
Enabling factor									
Insurance									
Medicare (reference)	20.2	1		8.9	1		11.4	1	
Medi-Cal	22.7	1.149 ^b	1.115-1.183	9.6	1.083 ^b	1.038-1.129	13.1	1.167 ^b	1.124-1.210
Private	17.0	0.893 ^b	0.867-0.919	7.1	0.870 ^b	0.833-0.908	9.9	0.931 ^b	0.897-0.966
Income									
Low	21.5	1.164 ^b	1.140-1.188	9.0	1.106 ^b	1.075-1.138	12.5	1.173 ^b	1.143-1.204
Medium	20.0	1.067 ^b	1.048-1.086	8.9	1.053 ^b	1.027-1.079	11.2	1.064 ^b	1.040-1.089
High (reference)	18.7	1		8.5	1		10.3	1	
Residence									
Urban (reference)	20.1	1		8.8	1		11.3	1	
Rural	21.2	1.110 ^b	1.080-1.140	9.5	1.128 ^b	1.086-1.171	11.7	1.070 ^b	1.034-1.107
ED admission									
Yes	23.3	2.326 ^b	2.284-2.369	10.4	2.446 ^b	2.379-2.515	12.9	1.968 ^b	1.923-2.014
No (reference)	11.0	1		4.3	1		6.7	1	
Need factor									
Comorbidity									
1 (reference)	18.8	1		15.2		1	3.6		1
2	18.0	0.929	0.856-1.008	8.1	0.493 ^b	0.450-0.539	9.9	2.827 ^b	2.394-3.339
3	19.9	1.015	0.936-1.100	8.7	0.523 ^b	0.479-0.571	11.2	3.107 ^b	2.633-3.666
4	21.0	1.038	0.958-1.125	9.1	0.534 ^b	0.489-0.583	11.9	3.162 ^b	2.680-3.731
5	21.1	1.011	0.932-1.096	9.1	0.526 ^b	0.481-0.575	12.0	3.072 ^b	2.603-3.626
6	20.4	0.939	0.865-1.019	8.8	0.495 ^b	0.452-0.543	11.7	2.865 ^b	2.425-3.385
7+	19.8	0.889 ^d	0.817-0.966	8.2	0.460 ^b	0.419-0.506	11.6	2.783 ^b	2.353-3.291
Multiple hospitalizations									
Yes	22.7	1.370 ^b	1.346-1.394	8.9	1.049 ^b	1.023-1.075	13.8	1.616 ^b	1.580-1.652
No (reference)	17.0	1		8.8	1		8.3	1	
First hospitalization									
Yes	18.7	0.988	0.971-1.006	8.9	1.109 ^b	1.080-1.138	9.8	0.916 ^b	0.896-0.93
No (reference)	22.9	1		8.6	1		14.3	1	

CI indicates confidence interval; ED, emergency department; OR, odds ratio; PPH, potentially preventable hospitalization.
^aData are for patients 65 years or older with diabetes who were discharged from community hospitals in California between 2005 and 2006.
^bP < .001.
^cP < .05.
^dP < .01.

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and chronic PPHs in older patients with diabetes.¹⁷ Using an entire hospitalized patient population, we also examined PPHs in older Asian and Hispanic adults with diabetes as well as their white counterparts, and those with insurance other than Medicare as the primary payer. In addition, the relationships between community-level enabling factors (eg, neighborhood income and a rural/urban location) and PPHs in older adults with diabetes were examined. The study findings showed PPHs among older patients with diabetes are prevalent, and they are due not only to diabetes-related conditions, but also to a broad range of medical conditions commonly treated by general medicine. This finding implies a need for more comprehensive and patient-centered primary care to prevent PPHs and ultimately reduce hospitalization in this vulnerable population. For example, because we found that many PPHs for patients with diabetes are caused by pneumonia and heart failure, clinical and health service improvement efforts in this population should be directed as much toward these conditions (eg, by raising flu and pneumococcal vaccination rates to prevent pneumonia) as toward improving blood sugar control.

The potential for reporting errors and a lack of detailed clinical information should be acknowledged. Selection and misclassification bias may exist in identifying hospitalizations of diabetes patients and their PPHs based on ICD-9-CM codes. Hospitalizations of undiagnosed diabetes patients may not be included in the analyses, and the coding could be affected by reimbursement policy. We could not differentiate type 1 diabetes from type 2 diabetes, and their differing disease processes may have impacted self-care and primary care management for each group of patients differently. Because no patient's zip code or county was available in the SIDs, we could not develop hierarchical models with the community as the second level. The hospitalization-route variable may not fully capture complex decision making or coordination of care process. In spite of these limitations, this study provides empirical evidence that PPHs among older adults with diabetes are common and costly, and also that the high-risk groups for acute and chronic PPHs may not be the same. These findings suggest that comprehensive primary care for sick as well as relatively healthy patients, covering a broad range of acute and chronic ACSCs, is necessary to meet the missed opportunities of promoting high-quality care for older diabetes patients at higher risk of PPHs.

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