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Risk Factors for Hospitalization in a National Sample of Medicare Home Health Care Patients

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Abstract

Acute care hospitalization during or immediately following a Medicare home health care (HHC) episode is a major adverse outcome, but little has been published about HHC patient-level risk factors for hospitalization. We determined risk factors at HHC admission associated with subsequent acute care hospitalization in a nationally representative Medicare patient sample (n=374,123). Hospitalization was measured using Medicare claims data; risk factors were measured using Outcome Assessment and Information Set data. Seventeen percent of sample members were hospitalized. Multivariate logistic regression analysis found that the most influential risk factors (all $p < .001$) were: skin wound as primary HHC diagnosis; clinician-judged guarded rehabilitation prognosis; congestive heart failure as primary HHC diagnosis; presence of depressive symptoms; dyspnea severity; and Black, compared to White. HHC initiatives that minimize chronic condition exacerbations, and that actively treat depressive symptoms, might help reduce Medicare patient hospitalizations. Unmeasured reasons for higher hospitalization rates among Black HHC patients deserve further investigation.

Introduction

Acute care hospitalization is a major focus of increasingly urgent challenges to control Medicare costs and improve the quality of health care for a growing older American population. A recent national study of rehospitalizations in the Medicare population found that nearly 20 percent of beneficiaries discharged from an acute care hospital were rehospitalized within 30 days, and that one-half of all rehospitalized patients had not seen an office-based physician since their prior hospital discharge (Jencks, Williams, & Coleman, 2009). Based on evidence from this and other published studies, consensus has generally been reached among researchers, practitioners, and policymakers that preventing hospitalizations in the Medicare population is tied to improving care continuity and patient transitions across acute and post-acute care settings (Coleman & Berenson, 2004; Coleman

& Boulton, 2003; Coleman, Min, Chomiak, & Kramer, 2004; Mor & Besdine, 2011; Peikes, Chen, Schore, & Brown, 2009; Wolff, Meadow, Weiss, Boyd, & Leff, 2008).

The primary focus to date of efforts to reduce Medicare hospitalizations has been preventing repeated hospital episodes through improved discharge planning and post-discharge care coordination. Another important but less-studied approach is to focus on hospitalizations of beneficiaries in Medicare post-acute settings—Skilled Nursing Facilities (SNFs), and home health care (HHC). In the case of SNF care, rehospitalization may reflect poor quality of care by either the SNF or the hospital from which the patient was discharged to SNF care; a recent study found that nearly 25% of Medicare beneficiaries discharged from hospitals to SNFs were readmitted to the hospital within 30 days (Mor, Intrator, Feng, & Grabowski, 2010). Medicare HHC is available to patients requiring skilled care at home with or without a prior hospitalization, but any hospitalization after starting Medicare HHC is viewed as a potential signal of poor quality of care (Schlenker, Powell, & Goodrich, 2005). Wolff and colleagues found that 29% of Medicare HHC patients were transferred or admitted to acute care hospitals within 30 days of discharge from HHC (Wolff, et al., 2008).

Of these two Medicare post-acute services, HHC serves nearly twice as many beneficiaries as SNFs each year, and Medicare HHC has grown much more quickly in recent years. Between 2002 and 2009, the number of persons served annually by Medicare HHC agencies increased by 29.1% from 2.54 million to 3.28 million; by comparison, the number of persons served annually for Medicare-covered SNFs stays rose 10.3% from 1.56 million to 1.71 million (Centers for Medicare and Medicaid Services, 2004, 2010). In Medicare HHC, acute care hospitalization is often a consequence of a sudden serious decline in patient health status while in the care of an agency, and its avoidance is thought to reflect effective decision making and communication among HHC agency staff (Shaughnessy, et al., 2002). The Outcome Based Quality Initiative (OBQI) for HHC includes reducing hospitalizations through HHC agency initiatives and collaborations with Quality Improvement Organizations (Rollow, et al., 2006).

Despite the importance of hospitalization as negative outcome in the rapidly-growing Medicare HHC arena, there are no known published studies using national data with well-defined patient cohorts to identify clinically and policy-relevant factors that increase risk for hospitalization after starting a Medicare HHC episode. Published studies of hospitalization risk in this patient population have either involved patients with single clinical conditions, or clinically heterogeneous patients in local or state-level settings (Fortinsky, Madigan, Sheehan, Tullai-McGuinness, & Fenster, 2006; Madigan, 2008; Madigan, Schott, & Matthews, 2001; Rosati & Huang, 2007; Rosati, Huang, Navaie-Waliser, & Feldman, 2003). Murtaugh and colleagues (2009) have portrayed the clinical heterogeneity and complexity in the older HHC population nationally. Studies designed to ascertain risk factors for hospitalization in this heterogeneous national Medicare HHC population could inform practice, policy, and further research in several important ways: identified risk factors could be prioritized according to degree of risk and serve as the basis for designing HHC interventions that might lead to reductions in hospitalizations; groups of identified risk factors could be combined to develop future risk adjustment models to compare and reward HHC provider performance; and subgroups found to be at higher or lower risk for

hospitalization could serve as the springboard for more in-depth studies to deepen our understanding of underlying mechanisms operating at the patient, family, or home health agency level of analysis.

To help fill this knowledge gap, the purpose of this study was to determine factors observed at HHC admission associated with greater likelihood of experiencing a hospitalization after starting that Medicare HHC episode, in a nationally representative sample of Medicare HHC patients. Risk factors were classified as predisposing, enabling, need, and environmental variables, following Andersen's Behavioral Model of Health Service Use to portray factors associated with health service utilization and patient outcomes (Andersen, 1995). According to this model's conceptualization, predisposing variables are immutable individual attributes that exist prior to the onset of illness but may influence service use in a variety of direct and indirect ways. Enabling variables may facilitate or inhibit service use once illness has begun. Need variables refer to illness-related variables that may influence service use; typically, need factors are found to explain the most variation in health service use. The Andersen model has undergone several revisions since its original conception, including the addition of "environmental" variables which are considered extra-individual level factors that might influence an individual's use of health services (Andersen, 1995). The classification approach guided by the Andersen model also helps distinguish predictors of hospitalization that are more or less directly modifiable through HHC patient-level, organizational-level, and policy-level interventions. Using the Andersen model as an organizing framework, the single guiding research question for this study was: What are the most important predisposing, enabling, need, and environmental risk factors associated with hospitalization after starting an episode of Medicare HHC in a national sample of patients?

Methods

Design

This study employed a retrospective cohort design and involved linking several national data sources to construct the cohort and link HHC-related data to hospitalization data. The Institutional Review Board at the University of Connecticut Health Center approved the study protocol; a Data Use Agreement with the Centers for Medicare & Medicaid Services enabled acquisition of data files.

Data Sources and Study Cohort Construction

A nationally-representative sample of Medicare fee-for-service HHC patients was constructed using linked data from the Outcome and Assessment Information Set (OASIS), the Medicare Provider of Services (POS) file, and the Area Resource File (ARF) for 2002, the first full calendar year in which all Medicare-certified HHC agencies were paid under the current HHC Prospective Payment System. Medicare standard analytic files containing inpatient hospital claims were used as a data source to measure hospitalization.

Three steps were accomplished to construct the study cohort. First, all Medicare-certified HHC agencies from the Medicare POS file were grouped into 16 strata based on: geographic region of the agency's location (Northeast, Midwest, South, and West); metropolitan or non-

metropolitan location of agency; and free-standing or hospital-affiliation. These stratification variables were chosen because they were found to influence variations in Medicare HHC access and utilization rates (Kane, Lin, & Blewett, 2002; Kenney, 1993; Kenney & Dubay, 1992; Schlenker, Powell, & Goodrich, 2002; Swan & Benjamin, 1990).

Second, an algorithm was developed to exclude ineligible OASIS forms and then to aggregate all eligible OASIS forms into unique patients and unique patient-level HHC episodes. Ineligible OASIS forms included those coded with non-Medicare payment sources, those with start of care dates before 2002, and those with start of care dates in 2002 but without another form appearing in the full OASIS file. The complete algorithm was reviewed and approved by a CMS staff member with extensive OASIS data experience; details are available from the corresponding author. This step yielded 1,870,615 unduplicated Medicare patients with 1 complete episodes of HHC. For patients with >1 episode, the first episode of the calendar year was selected for study inclusion.

Finally, unduplicated patients were grouped into the 16 strata, then 20% of patients within each stratum were randomly selected, yielding a self-weighted, nationally-representative 20% stratified random sample of Medicare HHC patients with a complete episode of care in 2002 (n=374,123).

Independent Variable Selection and Measurement

Most independent variables selected as predisposing, enabling, and need variables for this study were found in one or more published studies to predict hospitalization or rehospitalization in Medicare HHC patients or in adult HHC patients of all payor types (Fortinsky, et al., 2006; Madigan, 2008; Madigan, et al., 2001; Rosati, et al., 2003; Rosati & Huang, 2007).

In this study, the Start of Care (SOC) OASIS form was the data source for all patient-level predisposing, enabling, and need variables; trained clinicians, 95% of whom are nurses and the remainder of whom are nearly all rehabilitation therapists, complete the SOC OASIS form during the initial home visit. Adequate reliability has been reported for OASIS items contributing to most need (health-related) variables used in this study (Madigan & Fortinsky, 2004); functional disability and cognitive status OASIS items were found to have acceptable validity when compared with well-established measures of these constructs (Tullai-McGuinness, Madigan, & Fortinsky, 2009).

Predisposing variables included gender, age, and ethnicity or racial group membership, the latter which was based on patient-reported self-identification. An important limitation of the OASIS form is that race (e.g., African-American) and ethnicity (e.g., Hispanic) are response options for a single question, not for two separate questions about race and ethnicity. Racial/ethnic groups with adequate sample sizes for study inclusion were White, Black or African-American, Hispanic or Latino, and Asian. Patients with other racial/ethnic group responses (American Indian or Alaska native; and Native Hawaiian or Pacific Islander; <1% combined) were excluded.

Enabling variables included whether patients had Medicaid insurance in addition to their Medicare coverage (dual eligible), denoted by having a Medicaid number listed on the OASIS form; and whether patients lived alone or lived with others, denoted by a living arrangements variable on the OASIS form. Dual eligible status was selected as the best available proxy measure of patients' socioeconomic status, as more direct measures such as educational attainment and income level are not recorded on OASIS forms. Living alone or with others was selected as a dichotomous proxy variable for availability of an informal caregiver, because OASIS data denoting type of informal caregiving situation have not been tested for reliability.

Several *need variables* were selected as predictors of hospitalization. *Recent history of an inpatient stay* was chosen because patients with a recent inpatient stay might have greater health care needs upon starting an episode of HHC than patients without such a recent inpatient stay. The OASIS form contains information on whether patients began their Medicare HHC episode within 14 days after a hospitalization, a rehabilitation facility stay, a skilled nursing facility stay, or without an inpatient stay within 14 days of HHC admission

Selected primary HHC diagnoses were based on International Classification of Diseases, Ninth Revision (ICD-9) codes, as recorded in the OASIS primary diagnosis code field. The six most common primary HHC diagnoses were: skin ulcer (707 thru 708; 454.0; 459.11; 459.13; 459.33; 998.32) or wound (879; 881; 891; 894; 895); type 2 diabetes (250.00, 250.02); heart failure (420 thru 429); chronic obstructive pulmonary disease (491; 496); stroke (430 thru 438); and osteoarthritis (721 thru 722 and 715 thru 716). Each of these diagnoses was coded as present or absent for each patient. Our rationale for selecting these six individual diagnosis-based medical conditions as separate independent variables was to isolate and feature the risk of hospitalization associated with having one of the most common and clinically relevant acute and chronic conditions seen in the Medicare HHC population (Murtaugh, et al, 2009), after controlling for other factors. We chose to study only the primary HHC diagnosis, rather than all listed diagnoses (up to five diagnoses are listed per patient), because OASIS guidelines specify that the primary diagnosis should be the medical condition most directly related to the patient's current plan of care, the most acute diagnosis, and the chief reason for providing home care. OASIS coding instructions further specify that home care diagnoses should be listed in the order that best reflect the seriousness of each medical condition and support the services provided, starting with the primary diagnosis.

Severity of primary diagnosis ratings ranged from 0 (asymptomatic) to 4 (poorly controlled symptoms); each patient was assigned the severity rating code corresponding to whatever ICD-9 code was listed as the primary HHC diagnosis. *Total number of medical conditions* was measured by summing the number of ICD-9 diagnostic codes (up to five) listed as home care diagnoses, for a measure of comorbidity burden. *Pain frequency* ratings ranged from 0 (no pain or pain does not interfere with activity or movement) to 3 (pain all the time). *Dyspnea severity* ranged from 0 (never short of breath) to 4 (noticeably short of breath at rest, day or night). *Functional disability* was measured based on degree of independence conducting 8 activities of daily living (ADL)—grooming, dressing upper body, dressing lower body, bathing, toileting, transferring, ambulation, and eating—and 7 instrumental

ADL (IADL)—preparing light meals, using personal transportation, laundry, housekeeping, shopping, use telephone, take oral medications. A functional disability scale was created based on patterns of responses to these 15 ADL and IADL using Rasch analysis, as reported and used elsewhere as a disability measure for Medicare HHC patients (Fortinsky, Garcia, Joseph Sheehan, Madigan, & Tullai-McGuinness, 2003; Fortinsky, et al., 2006). *Cognitive functioning* was measured on a rating scale ranging from 0 (alert/oriented) to 4 (totally dependent due to constant disorientation). *Depressive symptoms* were determined to be present based on whether or not the OASIS item “depressed mood; feeling sad or tearful” was checked. *Rehabilitation prognosis* was coded as either guarded (minimal improvement in functional status expected; decline is possible) or good (marked improvement in functional status is expected).

Environmental variables included the three variables used to stratify the study population: free-standing or hospital-affiliated HHC agencies; metropolitan or non-metropolitan area location of agency; and geographic region of agency location.

Dependent Variable

Acute care hospitalization was operationally defined with the goal of identifying hospitalizations that were most likely attributable to patients’ clinical and functional conditions observed at HHC admission and associated clinical care provided during the episode of care under study. Therefore, evidence of hospitalization occurring after the start of the HHC episode and before a patient was discharged from the HHC episode was considered a hospitalization for purposes of this study. Additionally, evidence of a hospital admission occurring within three (3) days of HHC discharge was considered a hospitalization for study purposes. This 3-day post-HHC discharge limit for hospital admission following HHC discharge is considerably shorter than 30 day post-HHC discharge window reported by others (Wolff, et al., 2008); however, this brief time window represents a conservative estimate of how long after HHC discharge a clinical situation attributable to factors associated with the Medicare HHC episode might exacerbate, leading to hospitalization.

Evidence of hospitalization was determined by matching and linking Medicare inpatient hospitalization claims with other data assembled for the study cohort. Dates of inpatient Medicare claims were compared to OASIS start of care and discharge dates to determine whether or not a patient fit the operational definition of hospitalization. Patients were coded “1” if hospitalized, and “0” if not hospitalized.

Analyses

Multivariate logistic regression analyses were conducted to determine the extent to which each independent variable was associated with the likelihood or not of being admitted to an acute care hospital. Because our interest was identifying risk factors with the most independent influence on hospitalization while controlling for other variables, we entered all independent variables simultaneously into the logistic regression model. Dummy variables were used for all categorical independent variables; reference groups for variables with more than two categories are shown in the results table. Due to the large sample size, we expected

most observed relationships to be statistically significant; therefore, to enhance practical significance of results, we focused attention and interpretations on results showing adjusted odds ratios (AOR) that affected the likelihood of hospitalization by 10% or more. In other words, independent variables found to have an AOR ≥ 1.10 were considered risk factors for hospitalization in the study cohort. Predictors with AOR < 0.90 were considered protective against hospitalization. Level of statistical significance associated with all such AORs in this study sample was $p < 0.001$. The Hosmer and Lemeshow chi square test, Cox and Snell's R-square, and Nagelkerke R-square, were all reported as goodness-of-fit model summary statistics. The latter two tests were both reported to provide a range of the percentage of hospitalizations correctly predicted by the model. SPSS Version 19 was used for all analyses reported in this paper.

Results

Study Cohort Characteristics

Table 1 summarizes characteristics of the national study cohort ($n=374,123$), organized according to the Anderson framework. Mean age was 76.5 (± 10.8) years; nearly two-thirds were females (63.9%); 82.4% were White, 10.6% Black or African American, 4.2% Hispanic, and 1.2% Asian. Nearly one in eight study patients (11.6%) were dually eligible, and nearly 30% lived alone. More than half (56.2%) had a hospital discharge within 14 days of starting the HHC episode; 26.4% had no recorded recent inpatient stay; and the remainder had a recorded discharge from a rehabilitation facility or a SNF within 14 days of starting HHC. The most common primary HHC diagnoses accounted for no more than 7% of the entire cohort, with osteoarthritis most common, followed by heart failure and stroke. Study patients had an average of 2.4 medical conditions. Dyspnea severity, pain frequency, severity of primary HHC diagnosis, and disability level varied widely at HHC admission. One-third of the cohort had at least a minimal level of cognitive impairment, 20% exhibited depressive symptoms, and 20% were judged to have guarded rehabilitation prognosis. Among environmental variables, 40% of study patients were from the South region, 14.5% from the West, and equal proportions from the Northeast and Midwest. More than 80% were from metropolitan areas, and 64% were provided HHC by a freestanding agency.

Risk Factors Associated with Acute Care Hospitalization

We found that 17.1% of sample patients were hospitalized after their HHC episode began. Table 2 summarizes results of the multivariate logistic regression analysis determining the likelihood of experiencing hospitalization for each independent variable; adjusted odds ratios (AOR) and 95% confidence intervals (CI) are shown.

In descending order of magnitude, the following variables at HHC admission were associated with at least a 10% greater likelihood of being hospitalized (adjusted odds ratio, or AOR ≥ 1.10): skin ulcer or wound as primary HHC diagnosis (AOR=1.52, 95% CI=1.45-1.59); clinician-judged guarded rehabilitation prognosis at HHC admission (compared to good prognosis; AOR=1.45, 95% CI=1.42-1.48); congestive heart failure as primary HHC diagnosis (AOR=1.42, 95% CI=1.37-1.48); depressed mood (AOR=1.19, 95% CI=1.170-1.22); dyspnea severity (AOR=1.18 for each point increase in severity, 95%

CI=1.17-1.19); Black racial/ethnic group (compared to White; AOR=1.16; 95% CI=1.13-1.20); severity of primary HHC diagnosis symptoms (AOR=1.12 for each point increase in severity; 95% CI=1.11-1.14); functional disability level (AOR=1.12 for each point increase on the Rasch scale, 95% CI=1.12-1.13); Male (AOR=1.12, 95% CI=1.10-1.14); and number of medical conditions (AOR=1.11 for each additional medical conditions, 95% CI=1.11-1.12).

Table 2 also shows that several variables were associated with a 10% or lower likelihood of hospitalization (AOR = 0.90): Osteoarthritis as primary HHC diagnosis (AOR=0.42, 95% CI=0.40-0.45); Asian racial/ethnic group (compared to White; AOR=0.72, 95% CI=0.65-0.79); home health agency located in the West U.S. Census region (compared to the South region; AOR=0.82, 95% CI=0.80-0.85); inpatient rehabilitation stay within 14 days of admission (compared to inpatient hospital stay within 14 days of HHC admission, AOR=0.82, 95% CI=0.80-0.85); no inpatient stay within 14 days of HHC admission (compared to inpatient hospital stay within 14 days of HHC admission, AOR=0.86, 95% CI=0.84-0.88); and home health agency located in metropolitan area (compared to in a non-metropolitan area; AOR=0.89, 95% CI=0.87-0.91). Statistics summarizing overall model fit revealed a very modest goodness of fit; while the chi square value was highly statistically significant (Hosmer and Lemeshow chi square=81.48, $p<0.01$), R square values ranged from 0.05 to 0.08.

Discussion

The purpose of this study was to determine the most important risk factors for hospitalization during or immediately after an episode of Medicare HHC in a nationally representative sample of patients. The Andersen model was used to classify potential risk factors for hospitalization into predisposing, enabling, need, and environmental variables. Several findings are noteworthy, especially in the context of current efforts to improve care transitions for Medicare beneficiaries with multiple chronic conditions.

First, need variables predominated among identified risk factors, led by the presence of skin ulcers or wounds as the primary HHC diagnosis at admission, and by heart failure as the primary HHC admission diagnosis, increasing the likelihood of hospitalization by 52% and 42%, respectively. Symptoms associated with heart failure, including dyspnea and depressive symptoms, were found to be independent risk factors, increasing hospitalization likelihood by nearly 20% each. Dyspnea symptoms were especially noteworthy because each level of increase on the 5-point dyspnea severity scale conferred an additional 18% greater likelihood of hospitalization. These results, based on a national sample, highlight the most challenging clinical conditions encountered in Medicare HHC, and they are similar to previously identified risk factors for hospitalization in single-state and single-site samples of Medicare HHC patients (Fortinsky, et al., 2006; Madigan, 2008; Rosati & Huang, 2007).

Another important finding was that patients judged by HHC clinicians on the first home visit as having expected minimal improvement in functional status were nearly 50% more likely to be subsequently hospitalized than patients judged to have expected marked improvement in functional status. This relationship was also found in a previous study (Fortinsky, et al.,

2006), and provides greater evidence of the remarkable prognostic capacity of HHC clinicians. At the same time, there appears to be considerable room for improvement in reducing hospitalizations among patients deemed with poorer rehabilitation potential at the start of a Medicare HHC episode. Clinically, these patients might be identified as high-risk and subject to tailored HHC interventions, such as frontloaded nurse or rehabilitation therapist visit patterns or telehealth (Rollow, et al., 2006).

Based on this evidence, efforts by HHC service providers to reduce hospitalizations of Medicare patients might benefit from having greater access to well-trained clinical specialists such as advanced practice nurses and consultant physicians in skin and wound care, cardiac care, and geriatric mental health/geropsychiatry. These expert clinicians could participate on quality improvement teams within HHC agencies as well as across health care providers who regularly share Medicare patients in care transitions, including local hospitals and primary care practices. Attention to these risk factors and reducing hospitalizations would be especially useful for HHC agencies that might wish to partner with other local health care providers to form Accountable Care Organizations (ACOs), a Medicare shared savings initiative created by the 2010 Affordable Care Act (Lieberman & Bertko, 2011; Mor & Besdine, 2011). Recognizing the expense of hiring clinical specialists such as those suggested here, provider partners responsible for Medicare patients should carefully balance the economic costs of hiring or retaining these specialists against the potential cost savings of avoided hospitalizations due to specialty care. For example, providers could simulate the expenses of retaining a wound care nurse specialist against potential cost savings associated with reductions of excess hospitalization risks due to skin and wound problems from 50% (as found in this study) to 30% or lower. While under traditional Medicare financing arrangements the HHC agency would bear the cost of such clinical specialists and cost savings due to reduced hospitalizations would be realized by the Medicare program, it is important to note that under novel financing arrangements such as ACOs, HHC agencies and their partner providers would be able to share any derived costs savings with the Medicare program.

Higher hospitalization rates were found among Black Medicare HHC patients, 16% greater than Whites after controlling for all need-related variables as well as for dually eligible status. This higher hospitalization rate for Black Medicare HHC patients compared to their White counterparts after adjusting for numerous covariates is in direct contrast to hospitalization studies of relatively healthy community-dwelling older adults in the general Medicare population, where Blacks have been found to have a lower hospitalization rate than Whites (Clay, Roth, Safford, Sawyer, & Allman, 2011). In the context of Medicare HHC, because hospitalization is considered an indicator of potentially poorer quality of care, one explanation for this finding is that Blacks may receive inferior quality of HHC. A recent national study of HHC patients with a primary diagnosis of type 2 diabetes mellitus found that Blacks received less skilled care from nurses and from rehabilitation therapists during their HHC episodes than did their White counterparts (Yeboah-Korang, Kleppinger, & Fortinsky, 2011). An equally plausible alternative explanation is that Black Medicare HHC patients are more likely than their White counterparts to lack access to primary care, and to have fewer resources to manage their chronic conditions despite receiving HHC, both of which may lead to greater risk for hospitalization. Finally, it is possible that race might serve

as a proxy for aspects of clinical severity that are unmeasured by the OASIS instrument. Further studies employing qualitative as well as quantitative data and analytic methods are needed to help determine the extent to which, and how, clinically significant racial and ethnic group disparities might exist in the Medicare HHC population.

Finally, noteworthy predisposing and environmental variables were found to be “protective” factors against hospitalization; Asians and patients in the Western U.S. region experienced lower hospitalization rates than Whites and patients from the South region, respectively. Studies involving primary data collection and qualitative methods might be useful in exploring further why patients with these characteristics were less likely to be hospitalized, with potential lessons for other groups of Medicare HHC patients.

Despite the importance of identified risk factors, it is equally important to point out that the overall model performed quite poorly in predicting hospitalization risk. No single predictor increased the likelihood of hospitalization by more than 50%, and the amount of unexplained influence on hospitalization after accounting for all model variables exceeded 90%. Future research will clearly have to consider other OASIS items than those used in this study, an opportunity afforded by the introduction in January 2010 of a new version of the OASIS, known as OASIS-C, which contains additional items not available in the OASIS version used in this study. Future studies may also have to pursue data from sources other than the OASIS to capture many of the unmeasured reasons for hospitalization in the Medicare HHC population. Moreover, it is important to note that some degree of hospitalization in the Medicare HHC population will remain unavoidable and unattributable to care provided by home health agencies.

The major limitation of this study is that results are based on data from 2002, and it is unclear whether similar or different risk factors for hospitalization would be found in more recent national cohorts of Medicare HHC beneficiaries. Numerous initiatives during the past several years designed to reduce hospitalizations of Medicare HHC patients have been carried out, but there are no known published results of effects of these quality improvement efforts on more recent national patient-level hospitalization rates. However, despite the age of study data, results can be viewed as establishing important national benchmark patient-level hospitalization risk factors before widespread implementation of Medicare HHC quality improvement efforts.

Another important study limitation is the unavailability of direct measures of enabling characteristics reflecting socioeconomic status, especially level of educational attainment. Lower levels of educational attainment might lead patients to have higher risks for hospitalization due to incomplete understanding of treatment and care instructions communicated by HHC staff, leading to acute exacerbations of chronic conditions, acute illnesses, or injuries, necessitating hospitalization. Other potentially important variables that might be important for predicting hospitalization are not available from OASIS data, including prescription and over-the-counter medications taken by patients, and access to primary care or other outpatient care, the latter which has been shown to be lacking in Medicare patients rehospitalized within 30 days of a previous hospitalization (Jencks, et al, 2009).

Despite these important study limitations, this is the first known study to comprehensively examine risk factors for hospitalization in a nationally representative sample of Medicare HHC patients. The use of Medicare claims to measure hospitalizations yields a more objective measure than studies that rely of self-reports from study subjects about their hospitalization experience. Therefore, internal and external validity are maximized. Much more research is needed to improve our understanding of the dynamics of Medicare HHC, which is an understudied yet quite commonly used Medicare benefit for millions of Americans who wish to remain at home and avoid hospitalizations.

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Table 1

Characteristics of Study Patients at Home Health Care Admission (n=374,123)

Characteristic	% or Mean (s.d.)
<i>Predisposing variables</i>	
Age (years)	76.5 (10.8)
Females	63.9
<i>Race/Ethnicity</i>	
Asian	1.2
Black	10.6
Hispanic	4.2
White	82.4
<i>Enabling variables</i>	
Lives alone	29.8
Has Medicaid (dually eligible)	11.6
<i>Need variables</i>	
Inpatient stay within 14 days before start of HHC episode	
No inpatient stay within previous 14 days	26.4
Hospital discharge within previous 14 days	56.2
Rehabilitation facility discharge within previous 14 days	9.8
SNF discharge within previous 14 days	7.1
Shortness of breath/dyspnea severity	
Never short of breath	36.5
Walking > 20 ft, stairs	25.3
Moderate exertion	22.2
Minimal exertion	12.7
At Rest (day or night)	3.2
Pain frequency	
No Pain	37.6
Less often than Daily	11.4
Daily, but not constantly	42.6
All the Time	8.4
Functional disability severity	-0.67 (1.89)
Cognitive function severity	
Alert/Oriented, focused	66.9
Requires prompting	21.0
Requires assistance	7.8
Requires considerable assistance	3.1
Totally dependent	1.2
Depressed	20.4
Guarded rehabilitation prognosis	20.2

Characteristic	% or Mean (s.d.)
Primary HHC diagnosis	
Osteoarthritis	6.9
Congestive heart failure	5.2
Stroke	5.1
Chronic obstructive pulmonary disease	3.1
Skin ulcer or wound	3.1
Type 2 diabetes mellitus	2.7
Primary HHC diagnosis severity	2.3 (0.64)
Total number of medical conditions	2.4 (1.5)
<i>Environmental variables</i>	
U.S. Census Region	
West	14.5
Northeast	23.0
Midwest	22.7
South	39.8
Metropolitan area location	82.2
Freestanding HHC agency	64.0

Table 2

Multivariate Logistic Regression Results: Risk Factors for Hospitalization

Risk Factor	Adjusted Odds Ratio	95% Confidence Interval
<i>Predisposing variables</i>		
Age	0.996	(0.995-0.997)
Males	1.12	(1.10-1.14)
<i>Females are the reference group</i>		
<i>Race/Ethnicity</i>		
Asian	0.72	(0.65-0.79)
Black	1.16	(1.13-1.20)
Hispanic	0.99	(0.95-1.04)
<i>White is reference group</i>		
<i>Enabling variables</i>		
Lives alone	1.04	(1.02-1.06)
Has Medicaid (dually eligible)	1.08	(1.05-1.11)
<i>Need variables</i>		
<i>Inpatient stay within 14 days before start of HHC episode</i>		
No inpatient stay in previous 14 days	0.86	(0.84-0.88)
Rehabilitation hospital discharge in previous 14 days	0.82	(0.80-0.85)
SNF discharge in previous 14 days	0.90	(0.87-0.94)
<i>Hospital discharge in previous 14 days is reference group</i>		
Shortness of breath/dyspnea severity	1.18	(1.17-1.19)
Pain frequency	1.02	(1.01-1.03)
Functional disability severity	1.12	(1.12-1.13)
Cognitive function severity	0.95	(0.94-0.96)
Depressed	1.19	(1.17-1.22)
Guarded prognosis	1.45	(1.42-1.48)
<i>Primary HHC diagnosis</i>		
Osteoarthritis	0.42	(0.40-0.45)
Congestive heart failure	1.42	(1.37-1.48)
Stroke	0.90	(0.86-0.94)
Chronic obstructive pulmonary disease	1.11	(1.06-1.17)
Skin ulcer or wound	1.52	(1.45-1.59)
Type 2 diabetes mellitus	1.08	(1.02-1.14)
Primary HHC diagnosis severity	1.12	(1.11-1.14)
Total number of medical conditions	1.11	(1.11-1.12)
<i>Environmental variables</i>		
<i>U.S. Census Region</i>		
West	0.82	(0.80-0.85)
Northeast	1.02	(1.00-1.05)

Risk Factor	Adjusted Odds Ratio	95% Confidence Interval
Midwest	0.99	(0.97-1.02)
<i>South is reference group</i>		
Metropolitan location	0.89	(0.87-0.91)
<i>Non-metropolitan location is reference group</i>		
Free standing HHC agency	1.02	(1.00-1.04)
<i>Hospital-affiliated HHC agency is reference group</i>		

Model goodness of fit statistics:

Hosmer and Lemeshow Chi-square=81.48; $p < 0.001$

Cox & Snell R square=0.05; Nagelkerke R square=0.08