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Major Article

Urinary tract infection-related hospitalization among older adults receiving home health care

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Background: Urinary tract infection (UTI)- related hospitalizations are a poor patient outcome in the rapidly growing home health care (HHC) arena that serves a predominantly elderly population. We examined the association between activities of daily living (ADL) and risk of UTI-related hospitalization among this population.

Methods: Using a retrospective cohort design, we conducted a secondary data analysis of a 5% random sample of a national HHC dataset, the Outcome and Assessment Information Set for the year 2013. Andersen's Behavioral Model of Health Service Utilization was used as a guiding framework for statistical modeling. We used logistic regression to examine the association between UTI-related hospitalization and predisposing, enabling, or need factors.

Results: Among beneficiaries (n = 24,887) hospitalized in 2013, 1,133 had UTI-related hospitalizations. HHC patients with a UTI-related hospitalization were more likely to have severe ADL dependency, impaired decision making, and lower Charlson Comorbidity Index, than those with a non UTI-related hospitalization ($P < .001$). Risk factors for UTI-related hospitalization included female sex, (adjusted odds ratio [AOR], 1.44; 95% confidence interval [CI], 1.25-1.66), Medicaid recipient (AOR, 1.99; 95% CI, 1.09-3.64), severe ADL dependency (AOR, 1.50; 95% CI, 1.16-1.94), the presence of a caregiver to assist with supervision and safety (AOR, 1.26; 95% CI, 1.06-1.49), treatment for UTI in the previous 14 days (AOR, 2.85; 95% CI, 2.46-3.29), presence of a urinary catheter (AOR, 3.77; 95% CI, 2.98-4.77), and prior history of indwelling or suprapubic catheter (AOR, 1.44; 95% CI, 1.06-1.94).

Conclusions: ADL dependency levels are a potentially modifiable risk factor for UTI-related hospitalization on admission to HHC. ADL dependency levels can inform clinical interventions to ameliorate ADL dependency in HHC settings and identify groups of patients at high risk for UTI-related hospitalization.

The need for home health care (HHC) is common among the elderly and has grown substantially over the past 2 decades in the United States. Medicare is the dominant public payer of postacute care HHC services,[1] The Medicare program provides health insurance to Americans ≥65 years, and the nonelderly disabled.[2] In 2013, 3.5 million Medicare beneficiaries received HHC services from approximately 12,613 HHC agencies[1], and HHC accounted for 50% of all patient discharges to postacute care settings settings.[3] On average, HHC patients have 4.2 diagnoses, and 84% have at least 1 limitation in their activities of daily living (ADL).[4] The acuity of illness among the HHC population has increased, at least partially as a result of shorter lengths of hospital stay under the current health system that emphasizes community-based health services.[5] Given this background, the impetus to examine quality of care provided in the HHC setting has become critical. One outcome used to determine quality of care in this setting is the development of a urinary tract infection (UTI) requiring hospitalization while receiving HHC services.[6]

UTIs are one of the most common bacterial infections[7,8] the third leading cause for infection-related hospitalizations in the elderly,[9] and may lead to more severe infections such as sepsis.[10,11] A 2016 study from the Centers for Disease Control and Prevention Emerging Infections Program estimated that nearly 80% of sepsis cases started

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outside of the hospital, in which 42% were community associated, and among adults hospitalized for sepsis 25% had a UTI.[12] In a large retrospective analysis of sepsis hospitalizations in US academic medical centers between 2012 and 2014, 61.8 % (689, 189) of the patients had community-acquired sepsis.[13]

Little research has examined UTIs and the risks for acute care hospitalization among the HHC population. Using a nationally representative sample of 4,394 HHC patients, Dwyer et al[14] found that 11.6% of HHC patients had an infection, 3.6% of which were UTIs. Further, 9.2% of HHC patients had an indwelling urinary catheter, which is a known risk factor for UTIs. However, this study did not identify if the UTI diagnosis was present on admission to HHC or acquired during the HHC stay.

Difficulty in the ability to perform ADLs has been identified as a predictor for UTI-related hospitalization among residents of skilled nursing facilities (SNFs). In previous research focusing on SNFs, improvement of walking ability or maintenance of the ability to walk observed in 29% of SNF residents was associated with a 53% reduction in the risk of UTI-related hospitalizations.[15] This suggests that a patient's ability to perform ADLs may affect risk for UTI-related hospitalization at least in the SNF population. To our knowledge, the association between ADLs and UTI-related hospitalizations among elderly HHC patients has not been explored. Using a 5% random sample of a national HHC dataset, the Outcome and Assessment Information Set (OASIS), this study was conducted to assess the risk factors for UTI-related hospitalization among elderly HHC patients. In particular, the specific aim was to examine the relationship between UTI-related hospitalization and ADLs. We hypothesized that low ADL ability is associated with increased risk for UTI-related hospitalizations among elderly patients receiving HHC.

METHODS

This was a secondary data analysis of a 5% random sample of HHC recipients, ≥65 years of age who had a hospitalization while receiving HHC services in the year of 2013. Only a patients' first HHC episode was used in these analyses. The institutional review board of Columbia University Medical Center approved this study.

OASIS data

OASIS was first released in 1999 by the Centers for Medicare and Medicaid Services as the mandated patient assessment tool for collecting administrative and clinical data on all patients receiving HHC from Medicare certified HHC programs. The OASIS items were designed to measure HHC patient outcomes, with appropriate adjustment for patient risk factors affecting those outcomes. The OASIS contains data regarding patients' socio-demographic status, environment, support systems, health status, functional status, and behavioral status data.[16] Multiple versions of the OASIS have been developed and validated since its inception in 1999; the OASIS-C was implemented in 2010[17] and used in this study.

The OASIS provides longitudinal data during a patient stay in HHC collected at specific times during the receipt of HHC services: on admission, transfer to the acute care hospital, discharge from a facility back to the HHC agency, change in medical status, discharge from the agency, death, or every 60 days if HHC services continue.[16] The most comprehensive time points for OASIS data collection are admission and discharge, whereas other time points have abbreviated versions.

Inter-rater reliability on most OASIS items has been reported as Cohen's kappa of .60 or higher.[18] Madigan and colleagues (2004)[19] tested inter-rater reliability of items using OASIS-B, the previous version of the OASIS, and found that all ADL items had kappa values >0.70, except the feeding or eating item that had a score of 0.67. Evidence for the validity of the OASIS-B items has shown that the functional status items are sufficiently valid.[20] Compared to the OASIS-B, the OASIS-C expands on the ADL item of toileting ability, with the addition of an item to assess toilet transferring.[21] We found no studies that have reported the reliability and validity of the OASIS-C items.

Conceptual framework

The initial Andersen's Behavioral Model of Health Service Utilization[22] was used as a framework for determining the key predictor of UTI-related hospitalization, and estimating the relationship between ADLs and UTI-related hospitalization while adjusting for other empirically determined predictor variables identified from previous HHC literature.[23–25] According to the model, health care use, such as UTI-related hospitalization, is affected by predisposing factors (age, race, sex), enabling conditions (whether patients live alone, level of caregiver ability), and need factors (comorbid conditions and ADLs).

The primary outcome measure was a dichotomous variable indicating UTI-related hospitalization that was identified by 2 OASIS-C items: 1) Item M2410, "To which inpatient facility has the patient been admitted?" This item lists 5 answers including "hospital"; 2) Item M2430, "What reason(s) did the patient require hospitalization?" This item includes 18 medical conditions as reasons for acute care hospitalization, 1 of which is UTI.[21] Although more than 1 reason may be checked for each hospitalization, the OASIS does not indicate which 1 is the primary reason. Both M2410 & M2430 are collected when a patient is transferred to an inpatient facility.

The risk factors were grouped into the Andersen Model categories of predisposing, enabling, and need for health care. The admission OASIS assessment conducted during admission to HHC was the data source for these risk factors. Predisposing factors included sex, age, and ethnicity or racial group membership. Age was classified as a continuous variable. Race was categorized as black/African American, Hispanic, white, and Other.

Enabling factors included whether patients were (1) dual eligible, denoted by whether patients had Medicaid insurance in addition to their Medicare coverage. Dual eligibility was used as a proxy for socioeconomic status because Medicaid coverage is offered to patients below the federal poverty level,[26] (2) whether patients lived alone or with others indicated by a living arrangement variable on the OASIS-C, and (3) presence of a caregiver. This was identified by a series of OASIS-C variables that ask the ability and willingness of non-agency caregivers to provide assistance in 7 tasks, with responses that characterize the presence and ability of a caregiver to provide assistance on a scale of 0-5. All 7 tasks were dichotomized into presence or absence of caregiver(s).

Need factors were measured by clinical and functional characteristics of the HHC patients including (1) ADL, (2) having a prior inpatient stay, (3) comorbidities, (4) impaired decision making, (5) history of a urinary catheter within the past 14 days, (6) current urinary catheter, (7) urinary incontinence, and (8) history of UTI treatment within the past 14 days.

ADL dependency levels were measured from 9 items in the OASIS-C. Items varied in their range of scores: grooming, dressing upper body, dressing lower body, and toileting hygiene were each scored 0-3; toilet transferring has a score ranging from 0-4; transferring, feeding or eating, and ambulation/locomotion scored 0-5 each; and bathing was scored 0-6. For all ADLs, a value of 0 indicates independence and a higher score is indicative of greater difficulty in managing the task independently. Following the approach of Chen et al,[27] each respective ADL was dichotomized into 0 or 1, with 0 indicating total independence, and 1 indicating some level of dependence in managing the task.[27] Second, the total number of functions in which an individual required assistance was summed to create a categorical variable with 4 levels: (1) independent in all functions; (2) required

assistance in 1 to 3 ADL functions (mild); (3) required assistance in 4 to 6 ADL functions (moderate); and (4) required assistance in 7 and more ADL functions (severe), indicating complete dependence on someone to perform ADL functions.

Prior inpatient stay was included as a covariate using the OASIS item that identifies whether the patient had been discharged from an inpatient facility within 14 days prior to admission for HHC services; including in an SNF, acute care hospital, or other inpatient unit such as long term acute care hospital, intensive rehabilitation facility, long term nursing facility, or psychiatric hospital unit. The weighted Charlson Comorbidity Index (CCI) was used to identify co-morbidities at HHC admission.[28] This score was based on ICD-9-CM codes within the OASIS assessments. The ICD-9-CM codes used to compute the CCI from the OASIS were generated from the following 18 OASIS fields: primary diagnosis (n = 1), secondary diagnoses (n = 5), reasons for inpatient treatment (n = 2), reasons for treatment change (n = 4), and payment diagnoses for Medicare patients (n = 2). Impaired decision making was defined based on the OASIS item M1740, which asks if a patient displays cognitive, behavioral, and psychiatric symptoms at least once a week. Dichotomous variables were created to identify whether a patient had a urinary catheter present (M1610), history of urinary catheter within the past 14 days (M1018), history of UTI treatment within the 14 days (M1600), and history of urinary incontinence (M1018**).**

Statistical analysis

Baseline patient demographics were summarized using descriptive statistics (means and standard deviation for continuous variables and counts or percentages for categorical variables). To identify independent risk factors for UTI-related hospitalization during an HHC episode, baseline characteristics between patients with UTI-related hospitalization and without a UTI-related hospitalization were compared using bivariate analyses (χ^2 tests for categorical variables and t tests for continuous variables). In addition, continuous variables (age and CCI) of the ADL categories were analyzed with analysis of variance.

Variables that were significantly different between the groups ($P < .05$) were entered in the multivariable regression model as covariates. Prior to this, multicollinearity was assessed among independent variables that appeared related (history of urinary catheter within the past 14 days and current urinary catheter; impaired decision making and the respective ADL variables) by calculating the variance inflation factor. A variance inflation factor value of ≥5 was considered to indicate the presence of multicollinearity. Because the associated variance inflation factor we obtained was 1, we retained both variables in the model. Adjusted odds ratios (AOR) and 95% confidence intervals (CI) are reported. Statistical significance was set at $P < 0.05$. All analyses were conducted using IBM SPSS Statistics software version 24.0 (IBM Corporation, Armonk, NY).

RESULTS

Sample characteristics

Table 1 summarizes characteristics of the sample of 24,887 hospitalized HHC patients and bivariate associations between sample characteristics and UTI-related hospitalizations. Approximately 4.6% (1,133 of 24,887) of the patients had UTI-related hospitalizations, and 95.4% (23,754 of 24,887) were non-UTI-related hospitalization. The average age for the entire sample was 77 (SD = 11.6) years. Overall, patients were predominantly women (60.4%) and white (79.5%). Most were insured by Medicare (96.1%) and almost a quarter lived alone (24.4%). About 3 quarters (74.5%) had an inpatient facility stay, primarily in an acute care hospital (48.0%), within 14 days prior to the HHC admission. The CCI for this sample was 0.89 (SD = 1.2).

Compared with patients hospitalized for other reasons, HHC patients with a UTI-related hospitalization were older (mean age = 79.7 years vs 76.6 years), more likely to be women (68.4% vs 60%), white (85.3% vs 79.3%), and have had an SNF stay 14 days prior to HHC admission (23.0% vs 16.2%). Patients with a UTI-related hospitalization were less likely to live alone (19.1% vs 24.6%) and more likely to have a caregiver present for assistance with ADLs (95.2% vs 92.5%), medication administration (86.8% vs 80%), supervision and safety (78.1% vs 66.9%), and advocacy or facilitation (95.9% vs 94.4%).

Overall, approximately 70% of the patients had severe dependence on ADL requiring assistance in all 7 or more ADL functions. Patients with a UTI-related hospitalization were more likely to have severe ADL dependency (81.8% vs 70.1%) than those with a non UTI-related hospitalization. Compared with HHC patients hospitalized for other reasons, HHC patients with a UTI-related hospitalization had fewer comorbidities indicated by a higher percentage of patients with CCI = 0 (44.04% vs 37.48%) and lower percentage with CCI ≥2 (28.7% vs 35.30%), and were less likely to have a history of urinary incontinence (50.1% vs 62.1), however, they were more likely to have impaired decision making (30.9% vs 21.7%), to currently have a urinary catheter (17.7% vs 4.3%), a history of urinary catheter within the past 14 days (9.4% vs 2.1%), and a history of being treated for a UTI in the previous 14 days (29.3 vs 9.8%).

Table 2 compares sample characteristics among patients with 4 ADL dependency levels. Compared with patients with other ADL dependency levels, patients with mild ADL dependency, namely those requiring assistance in 1 to 3 ADLs, were more likely to live alone (46.9%), be discharged from an acute care hospital (56.3%) prior to HHC admission, and have a history of urinary incontinence (71.9%). Compared with other ADL dependency levels, patient with mild ADL dependency were also less likely to have a caregiver to assist in most tasks, and less likely to have impaired decision making ($P < .001$).

Table 3 shows the results of regression analyses to determine the risk factors for UTI-related hospitalizations. Statistically significant variables included in the regression model were age, sex, race, living condition, insurance, ADL levels, CCI, impaired decision making, prior inpatient stay, treatment for UTI in the past 14 days, urinary catheter within the past 14 days, current urinary catheter, and the presence of a primary caregiver to provide assistance with: (1) ADL, (2) medication administration, (3) supervision and safety, and (4) advocacy or facilitation.

Female sex was an independent risk factor for UTI-related hospitalization (AOR, 1.44; 95% CI, 1.25-1.66). Compared to patients with Medicare, having Medicaid as the primary payer increased the risk for UTI-related hospitalization (AOR, 1.99; 95% CI, 1.09-3.64), and compared to patients who were independent in ADLs, patients with severe ADL dependency levels had significantly increased the risk for UTI-related hospitalization (AOR, 1.50; 95% CI, 1.16-1.94). Other significant predictors included: the presence of a caregiver to assist with supervision and safety (AOR, 1.26; 95% CI, 1.06-1.49), treatment for UTI in the past 14 days (AOR, 2.85; 95% CI, 2.46-3.29), presence of a urinary catheter (AOR, 3.77; 95% CI, 2.98-4.77), and history of urinary catheter within the past 14 days (AOR, 1.44; 95% CI, 1.06-1.94).

The risk of UTI-related hospitalization decreased by 21% for patients who lived alone (AOR, 0.79; 95% CI, 0.67-0.92), and by 36% for patients who had a prior stay in an acute care hospital (AOR, 0.64; 95% CI, 0.54-0.74). Compared to white patients, racial and ethnic minorities had a decreased risk of UTI-related hospitalization ([black patients] AOR, 0.72; 95% CI, 0.58-0.89; [Hispanic patients] AOR, 0.68; 95% CI, 0.50-0.92). Compared to patients who were independent in ADLs, the odds of UTI-related hospitalization also decreased by 38% for patients with mild ADL dependency (AOR, 0.62; 95% CI,

Table 1
Sample characteristics and risk factors for urinary tract infection-related hospitalization

Variable	Total N = 24,887 (%)	UTI-hospitalization n = 1,133 (%)	Non-UTI hospitalization n = 23,754 (%)	*P* value
Predisposing factors				
Age years, mean (SD)	77.12 (11.6)	79.66 (10.9)	76.60 (12.2)	<.001
Sex (reference, male)				
Male	9,851 (39.6)	358 (31.6)	9,493 (40.0)	<.001
Female	15,036 (60.4)	775 (68.4)	14,261 (60.0)	
Race (reference, white)				
White	19,793 (79.5)	967 (85.3)	18,826 (79.3)	<.001
Black	3,096 (12.4)	101 (8.9)	2,995 (12.6)	
Hispanic/Latino	1,479 (5.9)	1,430 (4.3)	49 (6.0)	
Other	3,425 (2.1)	503 (1.4)	16 (2.1)	
Enabling factors				
Lives alone	6,071 (24.4)	216 (19.1)	5,855 (24.6)	<.001
Insurance (reference, Medicare)				
Medicare	23,923 (96.1)	1,086 (95.9)	22,837 (96.1)	.685
Medicaid	207 (0.8)	12 (1.1)	195 (0.8)	
Dual eligible	757 (3.0)	35 (3.1)	722 (3.0)	
Presence of a caregiver				
ADL assistance	23,042 (92.6)	1,079 (95.2)	21,963 (92.5)	<.001
IADL assistance	24,287 (97.6)	1,111 (98.1)	23,176 (97.6)	.292
Medication administration	19,989 (80.3)	984 (86.8)	19,005 (80.0)	<.001
Medical procedures/treatments	10,453 (42.0)	497 (43.9)	9,956 (41.9)	.193
Management of equipment	8,946 (35.9)	393 (34.7)	8,553 (36.0)	.366
Supervision and safety	16,784 (67.4)	885 (78.1)	15,899 (66.9)	<.001
Advocacy or facilitation	23,498 (94.4)	1,086 (95.9)	22,412 (94.4)	.032
Need factors (health condition and functions)				
ADL (reference, independent)				
Independent	2,529 (10.2)	71 (6.3)	2,458 (10.3)	<.001
Mild dependence	1,738 (7.0)	32 (2.8)	1,706 (7.2)	
Moderate dependence	3,048 (12.2)	103 (9.1)	2,945 (12.4)	
Severe dependence	17,572 (70.6)	927 (81.8)	16,645 (70.1)	
Charlson Comorbidity Index, mean (SD)				
0	9,402 (37.8)	499 (44.0)	8,903 (37.5)	<.001
1	6,782 (27.3)	316 (27.9)	6,466 (27.2)	
2	8,703 (35.0)	318 (28.1)	8,385 (35.3)	
Prior inpatient stay (reference, no prior inpatient stay)				
No prior inpatient stay	6,353 (25.5)	325 (28.7)	6,028 (25.4)	<.001
Skilled nursing facility	4,119 (16.6)	261 (23.0)	3,858 (16.2)	<.001
Acute care hospital	11,948 (48.0)	410 (36.2)	11,538 (48.6)	<.001
Other	2,467 (9.9)	137 (12.1)	2,330 (9.8)	<.001
Impaired decision making	5,495 (22.1)	350 (30.9)	5,145 (21.7)	<.001
History of UTI treatment	2,668 (10.7)	332 (29.3)	2,336 (9.8)	<.001
History of urinary catheter	606 (2.4)	107 (9.4)	499 (2.1)	<.001
Current urinary catheter	1,230 (4.9)	200 (17.7)	1,030 (4.3)	<.001
Urinary incontinence	15,308 (61.5)	568 (50.1)	14,740 (62.1)	<.001

ADL, activities of daily living; *IADL*, instrumental activities of daily living, independent; *SD*, standard deviation; *UTI*, urinary tract infection.

0.40-0.97). The risk of UTI-related hospitalization decreased by 29% for patients who had a caregiver to assist with ADLs (AOR, 0.71; 95% CI, 0.51-0.99) and 24% for patients with a history of urinary incontinence (AOR, 0.76; 95% CI, 0.67-0.87).

DISCUSSION

To our knowledge, this is the first study to examine factors associated with UTI-related hospitalizations using the nationwide OASIS-C dataset. Based on the assessment by registered nurses or therapists, we found that approximately 4.6% (1,133 of 24,887) of the patients had UTI-related hospitalizations during the home health stay. None of the patients with UTI-related hospitalizations had a diagnosis of UTI documented on their start of care (admission) assessment. Significant associations of predisposing factors (sex, race), enabling factors (presence of a caregiver for supervision and safety, Medicaid insurance), need-related factors (impaired decision making, history of UTI treatment within 14 days, history of urinary catheter within 14 days, and the current use of a urinary catheter), and UTI-related hospitalizations were identified.

Women in this study had a higher risk for UTI-related hospitalization than men, which is consistent with well-established evidence of higher risk for UTIs among female sex.[29,30] However, and inconsistent with previous reports,[31–33] black patients and Hispanic patients in this study had a reduced risk of UTI-related hospitalizations. Because black patients in our sample had higher all-cause hospitalization rates than white patients (15.1% and 17.2%, respectively), it suggests that black patients were more likely to be hospitalized for reasons other than UTI (Appendix A). The finding that medical comorbidity (using CCI) was inversely related to UTI-related hospitalization is unsurprising because in the present study, we compared HHC patients who were hospitalized for UTI to patients hospitalized for other reasons, such as congestive heart failure patients who may be sicker.[34]

We also found that having Medicaid, the insurance source for low-income individuals as a payer source, was associated with an increased risk of UTI-related hospitalizations. This is consistent with findings from other studies that have found poorer outcomes, such as increased health care use and a higher risk of being hospitalized among the Medicaid population.[35-37] Other risk factors identified (history of urinary catheter within 14 days, history of treatment for a

Table 2
Sample characteristics by activities of daily living dependency level

Variable	Total	Independent	Mild dependence	Moderate dependence	Severe dependence	*P* value
	100	n (%)	n (%)	n (%)	n (%)	
	1,133	71 (6.3)	32 (2.8)	103 (9.1)	927 (81.8)	
Predisposing factors						
Age years, mean (SD)	79.66 (10.8)	77.63 (9.9)	75.84 (14.8)	79.63 (10.3)	79.95 (10.8)	.069
Sex (reference, male)						
Male	358 (31.6)	23 (32.4)	10 (31.3)	33 (32)	292 (31.5)	.998
Female	775 (68.4)	48 (67.6)	22 (68.8)	70 (68)	635 (68.5)	
Race (reference, white)						
White	967 (85.3)	67 (94.4)	27 (84.4)	89 (86.4)	784 (84.6)	.272
Black	101 (8.9)	3 (4.2)	2 (6.3)	7 (6.8)	89 (9.6)	
Hispanic/Latino	49 (4.3)	0	3 (9.4)	4 (3.9)	42 (4.5)	
Other	16 (1.4)	1 (1.4)	0	3 (2.9)	12 (1.3)	
Enabling factors						
Lives alone	216 (19.1)	22 (31)	15 (46.9)	39 (37.9)	140 (15.1)	<.001
Insurance (reference, Medicare)						
Medicare	1,087 (95.9)	70 (98.6)	30 (93.8)	94 (91.3)	892 (96.2)	.004
Medicaid	12 (1.1)	1 (1.4)	2 (6.3)	3 (2.9)	56 (0.6)	
Dual eligible	35 (3.1)	0	0	6 (5.8)	29 (3.1)	
Presence of a caregiver						
ADL assistance	1,079 (95.2)	58 (81.7)	14 (43.8)	88 (85.4)	919 (99.1)	<.001
IADL assistance	1,112 (98.1)	64 (90.1)	27 (84.4)	98 (95.1)	922 (99.5)	<.001
Medication administration	983 (86.8)	51 (71.8)	14 (43.8)	70 (68)	849 (91.6)	<.001
Medical procedures/treatments	497 (43.9)	26 (36.6)	13 (40.6)	30 (29.1)	428 (46.2)	.005
Management of equipment	393 (34.7)	16 (22.5)	8 (25)	25 (24.3)	344 (37.1)	.004
Supervision and safety	885 (78.1)	47 (66.2)	7 (21.9)	52 (50.5)	779 (84)	<.001
Advocacy or facilitation	1,087 (95.9)	64 (90.1)	25 (78.1)	96 (93.2)	901 (97.2)	<.001
Need factors (health condition and functions)						
Charlson Comorbidity Index						.079
0	499 (44.04)	37 (52.11)	14 (43.75)	39 (37.86)	409 (44.12)	
1	316 (27.9)	11 (15.5)	6 (18.8)	28 (27.2)	271 (29.2)	
2	318 (28.1)	23 (32.4)	12 (37.5)	36 (35.0)	247 (26.7)	
Prior inpatient stay (reference, no prior inpatient stay)						
No prior inpatient stay	325 (28.7)	15 (21.1)	7 (21.9)	26 (25.2)	277 (29.9)	<.001
Skilled nursing facility	261 (23)	14 (19.7)	6 (18.8)	22 (21.4)	219 (23.6)	<.001
Acute care hospital	410 (36.2)	37 (52.1)	18 (56.3)	44 (42.7)	311 (33.5)	<.001
Other	137 (12.1)	5 (7)	1 (3.1)	11 (10.7)	120 (12.9)	<.001
Impaired decision making	350 (30.9)	1,001 (14.1)	1(3.1)	18 (17.5)	321 (34.6)	<.001
History of UTI treatment						
No	763 (67.3)	50 (70.4)	19 (59.4)	73 (70.9)	621 (67)	.804
Yes	332 (29.3)	18 (25.4)	11 (34.4)	28 (27.2)	275 (29.7)	
History of urinary catheter	107 (9.4)	6 (8.5)	2 (6.3)	9 (8.7)	90 (9.7)	.897
Current urinary catheter	201 (17.7)	13 (18.3)	6 (18.8)	18 (17.5)	163 (17.6)	.997
Urinary incontinence	568 (50.1)	46 (64.8)	23 (71.9)	62 (60.2)	437 (47.1)	<.001

ADL, activities of daily living; *IADL*, instrumental activities of daily living, independent; *SD*, standard deviation; *UTI*, urinary tract infection.

UTI, and presence of a urinary catheter) have been previously reported.[29,38]

HHC patients who had a caregiver present for supervision and safety were at an increased risk for UTI-related hospitalization. In general, patients with caregivers assisting with supervision and safety were more complex and had higher ADL dependent levels that may increase their risk for UTI-related hospitalizations. Patients living alone were less likely to have a UTI-related hospitalization possibly because they were less dependent for ADL compared to patients living with others.[39]

The results of our study suggest that severe ADL dependence is an independent risk factor for UTI-related hospitalizations. Notably, for patients at the highest level of ADL dependence, the risk of UTI-related hospitalization increased by nearly 50% compared to patients who were ADL independent. However, we found that patients with mild ADL dependence (in 1-3 ADLs) had a 38% reduction in the risk for UTI-related hospitalization compared to patients independent in ADLs. Using the same ADL levels in national OASIS data, another study reported similar findings.[27] This finding was surprising, given that dependence in ADL is a known risk factor for UTIs and UTI[8] hospitalizations.[15] A possible explanation, is that in our study on univariable analysis, we found that HHC patients who are independent in ADL were more likely to have impaired decision making and a urinary catheter– both have previously been shown to be related to UTIs.[29,40,41]

Implications

This study provides evidence of risk factors on admission to HHC that could put HHC patients at greatest risk for UTI-related hospitalizations. Registered nurses and physical therapists working in HHC settings can identify high-risk patients on admission to HHC who may benefit from monitoring and interventions to mitigate these risk factors earlier in the HHC episode. Two of these risk factors identified are potentially modifiable: severe ADL dependency[42] and the current use of a urinary catheter. Knowledge of the level of ADL dependence can be used to identify patients who are similar in the severity of ADL dependence.[43] Patients with severe ADL dependence are a high cost-use population.[44] An important contribution of our study to HHC literature is use of well-defined ADL levels to identify the stage of ADL dependence associated with UTI-related hospitalization. This may provide valuable information that can be combined with cost information to help with policy development, planning, and designing interventions targeted at ADL ability to mitigate the risk for

Table 3
Multivariate regression analysis for predictors of urinary tract infection-related hospitalization

Variable	Odds ratio	CI lower	CI upper
Predisposing factors			
Age years, mean (SD)	1.01	1.00	1.02
Sex (reference, male)			
Male			
Female	1.44	1.25	1.66
Race (reference, white)			
White			
Black	0.72	0.58	0.89
Hispanic/Latino	0.68	0.50	0.92
Other	0.65	0.39	1.08
Enabling factors			
Lives alone	0.79	0.67	0.92
Insurance (reference, Medicare)			
Medicare			
Medicaid	1.99	1.09	3.64
Dual eligible	1.30	0.90	1.86
Presence of a caregiver			
ADL assistance	0.71	0.51	0.99
IADL assistance			
Medication administration	0.99	0.80	1.21
Medical procedures/treatments			
Management of equipment			
Supervision and safety	1.26	1.06	1.49
Advocacy or facilitation	0.87	0.64	1.20
Need factors (health condition and functions)			
ADL (reference, independent)			
Independent			
Mildly dependent	0.62	0.40	0.97
Moderately dependent	1.31	0.96	1.79
Severe dependent	1.50	1.16	1.94
Charlson Comorbidity Index, mean (SD)	0.95	0.91	1.00
Prior inpatient stay (reference, no prior inpatient stay)			
No prior inpatient stay			
Skilled nursing facility	1.10	0.93	1.31
Acute care hospital	0.64	0.54	0.74
Other	0.97	0.78	1.20
Impaired decision making	1.20	1.04	1.38
History of UTI Treatment	2.85	2.46	3.29
History of urinary catheter	1.44	1.06	1.94
Current urinary catheter	3.77	2.98	4.77
Urinary incontinence	0.76	0.67	0.87

ADL, activities of daily living; *CI*, confidence interval; *IADL*, instrumental activities of daily living, independent; *SD*, standard deviation; *UTI*, urinary tract infection.

UTI-related hospitalizations. Such interventions could be the focus of home physical therapy and other coordinated rehabilitative services in the outpatient setting.

The development of a UTI during an HHC episode and acute care hospitalization during an HHC episode are both home health quality measures monitored by the Centers for Medicare and Medicaid Services described as potentially avoidable events.[6] There is growing evidence that infections in the community, including UTIs, are risk factors for sepsis on admission to the hospital setting,[12] and future efforts toward UTI-related hospitalization risk prediction modeling and the development of targeted interventions for high-risk patients on admission to HHC would be important endeavors. Reducing inappropriate use of urinary catheters could also be an important strategy for HHC clinicians to adapt to reduce the risk of UTI among HHC. Managing these at-risk patients more aggressively in the HHC setting may prevent unnecessary hospitalizations and reduce associated health care costs.

Strengths and limitations

Our study had several strengths and limitations. By using data from the nationwide OASIS database, we were able to study a large population of patients in HHC. Another strength of this study is that we used the Andersen's Model of Healthcare Utilization, that has been widely used in health service research, including HHC to classify potential risk factors and distinguish modifiable risk factors of UTI-related hospitalization. In addition, we investigated ADL dependence as an independent risk factor for UTI-related hospitalization using carefully defined categories that identify the level of ADL dependence and predicts a UTI-related hospitalization. We also examined individual care management variables in the OASIS-C and their contribution to the risk for UTI -related hospitalization that very few HHC studies have examined.

Some of the limitations of this study are inherent to the OASIS data set. The study only captured a snap shot of ADL dependence level on admission to HHC and did not include changes in ADL that may occur on transfer to the hospital. This is because the OASIS does not assess ADLs on transfer to inpatient setting during an HHC episode. Next, the rigor and accuracy of OASIS data are dependent on the clinician who completes the form, but we had no information on those completing the form or information on other important variables, such as patient medications, nursing or therapy visits per episode, and physician coordination or visits.

Like other researchers who have examined Anderson's model in HHC studies,[23,31] we used secondary data, which limits the variables available for our study.[45] We found Medicaid insurance, as a proxy of low socio-economic status, a risk factor to UTI-related hospitalization. However, we were not able to disentangle exactly which socio-economic factors cause the adverse outcome. Future research may

incorporate direct measures of socio-economic status, such as level of education, that was found to influence patients understanding of treatment instructions communicated by the HHC clinicians. The identification of the sample with UTI-related hospitalization was also restricted to the assessment by the registered nurse during the transfer OASIS and not necessarily a confirmed medical diagnosis for hospitalization. Future studies should consider linking OASIS data to claims data to get a clear picture of hospitalization diagnosis and services received prior to hospitalization.

CONCLUSIONS

Using a nationwide sample of HHC OASIS we found that sex, Medicaid insurance, the presence of a caregiver for supervision and safety, severe ADL dependence level, history of UTI treatment within 14 days, history of a urinary catheter, current use of a urinary catheter, and impaired decision making on admission to HHC services are risk factors for UTI-related hospitalizations. Importantly, we also observed that ADL dependency levels may serve as an additional predictor of adverse health outcomes, such as UTI-related hospitalization, on admission to HHC. These findings highlight the importance of managing patients with the identified risk factors more closely in the HHC to prevent hospitalizations and reduce associated health care cost.

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APPENDIX A

Hospitalizations by race

Variable	Total n = 154,801	No Hospitalization n = 131,170(%)	Hospitalization n = 23,631(%)	*P* value
Race				<.001
White	123,590	104,919 (84.9)	18,671 (15.1)	
Black	17,612	14,583 (82.8)	3,029 (17.2)	
Hispanic/Latino	10,164	8,742 (85.9)	1,432 (14.1)	
Other	3,425	2,926 (85.4)	499 (14.6)	