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# Vulnerable populations at risk of potentially avoidable hospitalizations: The case of nursing home residents with Alzheimer's disease

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## Abstract

*This study explores whether nursing home residents with Alzheimer's disease and related dementias (ADRD) are affected differently by facility-level risk factors of ambulatory care-sensitive (ACS) conditions, a measure of timely access to medical care. Three years of quarterly Medicaid reimbursement data from over 525 Massachusetts nursing homes were linked with four years of Medical Provider Analysis and Review hospital claims data and facility-level attribute data to investigate whether facility effects differed by resident ADRD status. The findings suggest that nursing home residents with ADRD are more likely to be hospitalized for certain ACS conditions, including gastroenteritis and kidney/urinary tract infections. Availability of increased registered nurse staffing levels and on-site nurse practitioners appears to attenuate this risk. Although findings suggest that ACS hospitalization measures may represent a useful approach to monitoring nursing home care, additional effort is needed to understand the extent to which severity of illness and/or comorbidities affect the measurement of these hospitalizations.*

*Key words: nursing homes, hospitalizations, ambulatory care, dementia, Alzheimer's disease*

## Introduction

### Hospitalizations stemming from medical conditions

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thought to be largely avoidable or manageable with timely access to outpatient physician and other medical support services have been termed ambulatory care-sensitive hospitalizations (ACSH).<sup>1</sup> Without medical supervision, undiagnosed problems, and/or chronic conditions, which might have been successfully treated and/or managed by outpatient care services, may worsen to the point of eventually necessitating admission to an acute-care hospital for successful treatment. Because these hospitalizations are thought to be largely preventable, community rates of ACSH have been used to monitor accessibility to healthcare services, evaluate medical outcomes, and gauge healthcare system performance.<sup>2,3</sup> Despite clinicians, researchers, and policymakers' expressed concern about the frequency with which residents of nursing homes are transferred to hospitals for acute care, few studies have examined factors contributing to ACSH among residents of nursing home facilities. Findings suggest that, among nursing home residents, low registered nurse (RN) staffing levels and poor quality-of-care practices significantly increase resident risk of experiencing ACSH.<sup>4</sup> However, because of the paucity of work in this area, little is known about the extent to which vulnerable subpopulations in the nursing home, such as residents with Alzheimer's disease, may be differentially affected by these and other risk factors of ACSH.

Accounting for at least 50 percent of the nursing home population,<sup>5</sup> residents with Alzheimer's disease and related dementias (ADRD) represent a particularly vulnerable subpopulation. Research indicates that nursing home residents with ADRD are more likely to experience malnutrition and dehydration<sup>6</sup> and injurious falls<sup>7</sup> and be physically restrained,<sup>8</sup> and also less likely to receive analgesics to relieve pain symptoms.<sup>9</sup> Moreover,

because of the clinical nature of their disease, nursing home residents with ADRD may be especially reliant on staff and other providers to identify medical problems early enough to avoid unnecessary health complications.<sup>10</sup> However, recent research suggests that residents with ADRD receive fewer physician visits, both before and after a diagnosis of infection, than do otherwise similar residents without ADRD.<sup>11</sup> Although the authors suggest that these findings may reflect an implicit decision to withhold aggressive medical care from residents near the end of life, further work is needed to understand the extent to which delays in prompt medical treatment may be hindering attempts to avoid worsening of symptoms that subsequently contribute to potentially avoidable hospitalizations. In response, this study examines the extent to which residents of nursing facilities with ADRD may be differentially affected by certain facility-level structural and organizational risk factors of ACSH and quality-of-care practices.

## Methods

### *Data sources*

Five data sources were used to construct a three-year panel data set of resident nursing home histories. Data from the Management Minutes Questionnaire (MMQ) served as the core data file to which the other three data sources were linked. The MMQ, which is submitted quarterly on behalf of all Medicaid nursing home residents in the state of Massachusetts, is completed by trained nursing staff who use a variety of record sources, including clinical notes, medication-tracking records, care-team planning sessions, doctors' orders and progress sheets, and daily professional nursing summaries to collect resident information. Thus, the MMQ provides a rich and detailed longitudinal source of resident-level sociodemographic data, such as age, gender, nursing home length of stay, degree of functional impairment, and nursing home diagnosis.<sup>12</sup> Hospital claims data from the Medicare Provider Analysis and Review (MEDPAR) (1990-1993) were merged to the MMQ analytical file to identify ACSH admission rates and to identify prior hospital use patterns. Also, Medicare Provider of Service files and cost reports from the Massachusetts Rate Setting Commission (1991-1993) were merged to specify nursing home organizational and structural attributes. Finally, data from the Massachusetts death registry file (1991-1993) were used to identify residents with censored periods of hospitalization risk due to death.

### *Sample populations*

The study population consisted of two samples: one

comprised of nursing home residents with ADRD and one comprised of residents without, selected from the same nursing home. The ADRD sample included all dually eligible (Medicaid/Medicare) nursing home residents in Massachusetts who 1) had at least one MMQ record between April 1991 and December 1993, 2) were aged 65 years or older on the completion date of their index MMQ record, 3) were never enrolled in an HMO within a year (before and after) of their initial MMQ record, and 4) met the sample selection criteria for ADRD status. A resident was defined as having ADRD when a diagnosis of Alzheimer's disease [International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) 331] or related dementia (ICD-9-CM 290) was consistently recorded as a nursing home diagnosis over his/her history of quarterly MMQ records. The ADRD sample consisted of 131,395 quarterly observations contributed from 19,802 nursing home residents.

The second sample, comprised of nursing home residents without any recorded diagnosis of ADRD, was identified using the same selection criteria as the ADRD sample, with the added constraint that the nursing facility distribution of residents without ADRD matched approximately that of the ADRD resident sample. These selection criteria produced a non-ADRD study sample of 124,539 quarterly observations drawn from 19,958 nursing home residents.

## Measures

### *Outcome measures*

Five outcome variables of interest were specified to model the event of ACSH among nursing home residents, including 1) hospitalization for any ambulatory care-sensitive condition (Table 1<sup>13</sup>), 2) hospitalization for an infectious ACSH, 3) hospitalization for bacterial pneumonia, 4) hospitalization for gastroenteritis, and 5) hospitalization for kidney and/or urinary tract infection (UTI). Infectious ACSH were examined separately because previous studies have identified infections as a primary reason for hospitalization among nursing home residents.<sup>14</sup> Hospitalizations were classified as ambulatory care-sensitive using the principal discharge diagnosis recorded in ICD-9-CM format on MEDPAR records. All five variables were specified as dichotomous variables set to unity if the event occurred at any time during the next 90 days of observation ( $q + 1$ ), and 0 otherwise.

### *Resident attribute measures*

Several resident-level variables measured (at quarter  $q$ )

**Table 1. Ambulatory care-sensitive conditions**

Medical condition	ICD-9-CM
Grand mal seizure disorders	780.3; 345
Severe ear, nose, and throat infections	382; 462; 463; 465; 472.1
Tuberculosis	011-018
Chronic obstructive pulmonary disease	491; 492; 494; 496; 466
Bacterial pneumonia	481; 482.2; 482.3; 482.9; 483; 468
Asthma	493
Congestive heart failure	428; 518.4
Hypertension	401.0; 401.9; 402.0; 402.1; 402.9
Angina	411.1; 411.8; 413
Cellulitis	681; 682; 683; 686
Diabetes with ketoacidosis or hyperosmolar coma	250.1-250.3
Diabetes with specified complications	250.8-250.9
Diabetes without specified complications	250.0
Hypoglycemia	251.2
Gastroenteritis	558.9
Kidney/urinary tract infection	590; 599.0; 599.9
Dehydration	276.5
Iron-deficiency anemia	280.1; 280.8; 280.9
Nutritional deficiency	260-262; 268.0-268.1
Dental conditions	521-523; 525; 528

Source: Adapted from Millman M (Ed.): *Access to Health Care in America. Committee on Monitoring Access to Personal Health Care Services*. Institute of Medicine. Washington, DC: National Academy Press, 1993.

were specified to control for case-mix differences between samples and across nursing homes, including a set of resident attributes (age, gender, nursing home length of stay, newly admitted status, and a Medicaid case-mix reimbursement score to proxy for illness severity), a set of clinical diagnostic dummy variables (to control for the 15 most-frequently occurring diagnoses associated with nursing home residency), a set of residual diagnostic dummy variables grouped by bodily system according to ICD-9 classification (to control for illnesses not represented among the most-frequently

occurring nursing home diagnoses), and a set of prior hospital use variables based on diagnostic cost groupings (to control for differences in illness severity levels).<sup>15</sup>

#### *Individual-level quality-of-care measures*

Because past research suggests that nursing home quality of care may influence resident risk of hospitalization in general<sup>16</sup> and risk of ACSH in particular,<sup>4</sup> five dichotomous measures of nursing home quality as potential determinants of ACSH were explored, including the

presence of a stage 2 or higher decubitus ulcer, the application of physical restraints, an unplanned weight/gain or loss in the past 90 days, a reported accident in the past 90 days, and frequent behavioral outbursts.

### *Facility structural and organizational attribute measures*

Much interest has surrounded the question of whether variations in hospitalization rates among nursing home residents reflect differences in the structural and organizational attributes across facilities,<sup>17</sup> with research findings suggesting that certain facility characteristics associated with an increased resident risk of hospitalization.<sup>18,19</sup> To examine the extent to which operating differences between facilities also may contribute to differential risk of ACSH among residents with and without ADRD, the following facility attributes of interest were specified: facility size (measured by number of licensed beds), nonprofit status, chain membership status, presence of on-site special care units (Alzheimer's unit, rehabilitation beds, other designated special-care beds), presence of on-site diagnostic capabilities (blood chemistry, clinical lab, and radiograph ability), and staffing patterns (number of full-time employee RNs per occupied resident beds, number of full-time employee licensed nurse practitioners (LPNs) per occupied resident beds, facility use of an on-site full-time nurse practitioner, and the percentage of nursing hours staffed by pool agencies). Additionally, three variables were included to capture differences in population reimbursement mix, including the percentage of resident days reimbursed privately, paid by Medicare, and paid by Medicaid. Finally, a Herfindal index of nursing home market concentration<sup>20</sup> was included to adjust for the effect that market competition may have on hospital admission patterns.<sup>21</sup>

### *Estimation procedures*

For the purposes of this study, resident quarters served as the unit of analysis. Logistic regression using general estimating equations methods to adjust for clustering arising from multiple observations per resident and multiple residents per facility was used to estimate the risk of ACSH in the next quarter (at quarter  $q + 1$ ) as a function of a set of facility-level structural and organizational attributes and a set of individual-level quality of care measures, both measured (at quarter  $q$ ) after adjusting for differences in resident attributes, clinical diagnoses, illness severity levels, and market competition levels. To explore whether nursing home residents with ADRD were differently affected by facility characteristics, separate models by ADRD status were estimated.

## Results

Table 2 presents a comparison of mean resident characteristics and facility structural and operating attributes for each study population. For both samples, the typical resident was female, approximately 83 years of age, and had lived in the same nursing home for a little more than two years. Bivariate comparisons indicate that residents in the ADRD sample were somewhat older, more likely to be male, had a slightly shorter length of stay in the facility, and were less likely to have been recently admitted. Approximately 26 percent of the facilities operated as a nonprofit, while nearly half held chain membership status. Typically, facilities had an average of 124 licensed beds, and roughly 75 percent of all resident days were reimbursed by Medicaid, although comparisons suggest that the ADRD sample was somewhat more likely to be located in a facility with a lower Medicare census and a higher Medicaid census.

Among all ADRD observations, 9 percent contained at least one hospitalization, of which nearly 41 percent were classified as ACSH; of these, nearly 15 percent were for bacterial pneumonia, 11 percent were for gastroenteritis, and 7 percent were for kidney infection/UTI. In contrast, among the non-ADRD sample, 11 percent contained at least one hospitalization, and nearly 43 percent of these were classified as ACSH. Approximately 13 percent resulted from bacterial pneumonia, 7 percent were for gastroenteritis, and 5 percent were for kidney infection/UTI (data not shown).

Table 3 compares the percentage of ACSH among nursing home residents with and without ADRD with high or low overall rates of hospitalization. Nursing homes were classified as having high (low) overall hospitalization rates if the transfer rate was more (less) than one standard deviation away from the sample mean. Findings suggest that nursing homes with higher hospitalization rates have a greater proportion of ACSH residents. For example, while 26 percent of all hospitalizations among residents with ADRD residing in a nursing home with a low overall transfer rate were identified as ACSH, 46 percent of hospitalizations occurring among ADRD residents located in facilities with high transfer rates were identified as ACSH. Moreover, it appears that among residents with ADRD, hospitalizations for ambulatory care-sensitive conditions result disproportionately from two of the following three infectious diseases: gastroenteritis and kidney infection/UTI. Moreover, the study data (not shown) reveal that while these three conditions account for approximately 55 percent of all ACSH among residents without ADRD, the same three conditions account for more than 70 percent of all ACSH among residents with ADRD.

**Table 2. Sample characteristics**

	<b>ADRD (n = 19,802) Mean/Percent</b>	<b>Non-ADRD (n = 19,958) Mean/Percent</b>
Resident characteristics		
Age (yr)	84.109*	82.431
Male gender	0.212*	0.245
Length of stay in facility (yr)	2.183*	2.383
Newly admitted status	0.233*	0.239
Individual-level quality of care indicators		
Reported accident in past 90 days	0.123*	0.093
Decubitus ulcer, stage 2 or higher present	0.112	0.116
Regularly exhibits behavior outbursts	0.275*	0.126
Physical restraints applied	0.409*	0.212
Unplanned weight gain/loss past 90 days	0.062	0.058
Facility structural and organizational attributes		
Number of beds in facility	124.493	123.910
Operates as a nonprofit facility	0.256	0.258
Chain membership	0.499	0.498
Percent of privately paid resident days	18.995	18.873
Percent of resident days paid by Medicare	2.702*	3.020
Percent of resident days paid by Medicaid	74.817*	74.439
Facility uses a fulltime onsite LPN	0.013	0.013
Number of RNs per occupied resident beds	7.967	8.034
Number of LPNs per occupied resident beds	10.173	10.102
Percentage of nursing hours staffed from pools	4.367	4.359
On-site Alzheimer's unit	0.114	0.108
On-site special-care beds	0.068	0.065
On-site rehabilitation beds	0.008*	0.009
On-site blood chemistry ability	0.197	0.200
On-site clinical laboratory	0.017	0.017
On-site radiograph ability	0.022	0.021
LPN, licensed nurse practitioner; RN, registered nurse; * p < 0.05.		

**Table 3. ACSHs as a percentage of all hospitalizations among residents in nursing homes with high and low transfer rates**

Hospitalization rate	Any ACSH		Bacterial pneumonia		Gastroenteritis		Kidney/urinary tract infection	
	ADRD	Other	ADRD	Other	ADRD	Other	ADRD	Other
Low	26*	30	10*	8	5	5	2	4
High	46	48	17	15	14*	11	8*	5

ACSH, acute care-sensitive hospitalizations; ADRD, Alzheimer's disease and related dementias; \* p < 0.05; Numbers given are percentages.

Table 4 presents study findings, including adjusted odds ratios and corresponding p-values for significant coefficients. A cursory review of the results reveals a fairly stable set of risk factors for ACSH and indicates that nurse staffing patterns, payer case-mix, and unexpected patient weight gain/loss are important determinants of potentially preventable hospitalizations among all residents of nursing homes. Comparing results across models also reveals important differences between samples and between specific conditions, providing empirical support for the study hypothesis that risk of ACSH among residents with ADRD is differentially affected by facility organizational and structural attributes and quality-of-care practices in the nursing home. Because of the large number of coefficients estimated in multiple models, however, only select findings are discussed here.

#### *Individual-level quality-of-care indicators*

Regardless of ADRD status, nursing home residents who experience unplanned weight loss/gain are at increased risk of experiencing an ACSH of any type in the next quarter. Estimates suggest that the odds of ACSH are increased 33 percent among residents with ADRD, and 23 percent among residents without ADRD. Similar findings are observed for both populations with respect to weight loss/gain and increased risk of infectious ACSH. When the three infectious conditions are examined individually, however, it appears that weight loss/gain is an important determinant of hospitalizations for bacterial pneumonia among non-ADRD residents, with findings indicating 26 percent greater odds. Conversely, among residents with ADRD, weight loss/gain appears to be associated with 35 percent greater odds of experiencing a hospitalization for gastroenteritis. Although weight loss/gain may be an indicator of illness severity, and thus associated with higher hospitalization risk among residents without ADRD, in residents with ADRD, the

association of weight loss/gain may reflect difficulty in communicating discomfort, thus delaying staff's attention to a change in health. Unplanned weight loss/gain appears to place both populations at increased risk of being hospitalized for a kidney infection/UTI, although the effect is observed to be larger for residents without ADRD. Whereas the odds of hospitalization are increased 41 percent among residents with ADRD, the odds are increased 65 percent among residents without ADRD.

Findings suggest that the presence of a stage 2 or higher decubitus ulcer increased resident risk of experiencing an ACSH of any type regardless of ADRD status, with odds ratios indicating 10 percent greater odds of hospitalization for both study populations. However, no further effect was observed across models, suggesting that the association between decubiti and ACSH reflects hospitalizations occurring from other than the three infectious conditions. Lastly, having sustained an accident in the past 90 days was associated with 20 percent greater odds of hospitalization for bacterial pneumonia among residents without ADRD, as well as a 53 percent greater odds of hospitalization for kidney infection/UTI among residents with ADRD.

#### *Facility structural and organizational attributes*

Researchers have long been interested in whether proprietary status affects resident outcomes, with recent work suggesting that residents of nursing homes operating as nonprofit organizations are less likely to be hospitalized than their otherwise similar counterparts.<sup>22</sup> Findings from this study offer new insight into this correlation, suggesting that reductions in hospitalizations may be achieved, in part, by lowering transfer rates for infectious ambulatory care-sensitive conditions. For example, although no effect was observed when examining all ACSH, nonprofit status was found to significantly lower the odds of hospitalization for such infectious conditions

**Table 4. Significant odds ratios from multivariate logistic regressions:  
Comparing resident risk of experiencing an ACSH by ADRD status**

	All ACSHs				Infectious ACSHs only			
	ADRD		Non-ADRD		ADRD		Non-ADRD	
	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value
Individual-level quality of care indicators								
Accident in past 90 days	–	–	–	–	–	–	–	–
Decubitus ulcer present, stage 2 or higher	1.10	0.033	1.10	0.029	–	–	–	–
Regularly exhibits behavior outbursts	–	–	–	–	–	–	–	–
Physical restraints applied	–	–	–	–	1.04	0.023	–	–
Unplanned weight gain/loss in past 90 days	1.33	0.000	1.23	0.000	1.27	0.000	1.27	0.000
Facility structural and organizational attributes								
Number of beds	–	–	–	–	–	–	–	–
Operates as a nonprofit	–	–	–	–	0.90	0.028	–	–
Chain membership	–	–	–	–	–	–	–	–
Percent of privately paid resident days	0.98	0.000	0.99	0.000	0.98	0.000	0.98	0.000
Percent of Medicare-paid resident days	0.97	0.000	0.98	0.032	0.97	0.000	0.98	0.021
Percent of Medicaid-paid resident days	–	–	–	–	–	–	–	–
Facility uses a nurse practitioner	0.38	0.000	0.57	0.001	0.29	0.000	0.63	0.024
Number of registered nurses per occupied beds	0.97	0.000	0.98	0.000	0.97	0.000	0.98	0.001
Number of licensed nurse practitioners per occupied resident beds	1.01	0.001	1.01	0.000	1.01	0.023	1.01	0.018
Percent of nursing hours staffed from pools	1.01	0.000	1.01	0.000	1.01	0.000	1.01	0.000
On-site Alzheimer's unit	–	–	1.26	0.000	1.15	0.048	1.26	0.000
On-site special-care beds	–	–	–	–	–	–	–	–
On-site rehabilitation beds	0.28	0.014	–	–	0.27	0.020	0.31	0.015
On-site blood chemistry ability	–	–	–	–	–	–	–	–
On-site clinical laboratory	–	–	–	–	–	–	–	–
On-site radiograph ability	1.36	0.002	1.55	0.000	–	–	1.54	0.000
ACSH, acute care-sensitive hospitalization; ADRD, Alzheimer's disease and related dementias. Odds ratios adjusted by resident characteristics (age, male gender, nursing home length of stay), coexisting medical conditions based on ICD-9 classification, severity of illness measures (number of nursing minutes needed each day, prior diagnosis-related group scores), and market concentration levels.								

(odds ratio, 0.90;  $p = 0.028$ ) among residents with ADRD. Individual examination of the three infectious conditions suggests that the effect is primarily related to reductions in transfers among residents with ADRD for bacterial pneumonia; findings suggest that the odds of hospitalization for bacterial pneumonia are reduced by 14 percent among residents with ADRD located in facilities

holding nonprofit status. It is unclear, however, whether this finding stems from fewer infections among residents with ADRD residing in nonprofit homes, more timely in-house response among nonprofits to residents with infections (thus preventing exacerbation of symptoms), or a greater propensity for nonprofits to provide in-house care for residents with ADRD.

**Table 4. Significant odds ratios from multivariate logistic regressions: Comparing resident risk of experiencing an ACSH by ADRD status (continued)**

Bacterial pneumonia				Gastroenteritis				Kidney/urinary tract infection			
ADRD		Non-ADRD		ADRD		Non-ADRD		ADRD		Non-ADRD	
Odds ratio	p value	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value
–	–	1.20	0.008	–	–	–	–	1.53	0.000	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	1.26	0.006	1.35	0.002	–	–	1.41	0.005	1.65	0.000
–	–	–	–	–	–	–	–	–	–	–	–
0.86	0.028	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
0.98	0.000	–	–	0.97	0.000	0.97	0.000	0.98	0.005	–	–
0.95	0.000	0.98	0.029	0.97	0.009	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
0.35	0.010	–	–	0.33	0.033	–	–	–	–	–	–
0.97	0.001	0.98	0.019	0.97	0.004	–	–	0.95	0.000	0.96	0.001
–	–	1.02	0.001	–	–	–	–	–	–	–	–
1.01	0.047	1.01	0.000	1.02	0.000	1.02	0.000	1.01	0.013	–	–
–	–	–	–	–	–	1.73	0.000	–	–	1.40	0.025
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	1.42	0.016	1.46	0.021	1.62	0.007	–	–	–	–

ACSH, acute care-sensitive hospitalization; ADRD, Alzheimer's disease and related dementias. Odds ratios adjusted by resident characteristics (age, male gender, nursing home length of stay), coexisting medical conditions based on ICD-9 classification, severity of illness measures (number of nursing minutes needed each day, prior diagnosis-related group scores), and market concentration levels.

Similarly, the relationship between nursing home staffing patterns and resident outcomes has been a key area of study interest, with several studies demonstrating a link between staffing levels and risk of hospitalization.<sup>18,19</sup> Findings from this study suggest that an on-site nurse practitioner significantly reduces the odds of resident ACSH. Moreover, the reduction in odds appears to be larger for residents with

ADRD. For example, while the odds of experiencing an ACSH of any type is reduced by 43 percent among residents without ADRD located in a facility with an on-site nurse practitioner, the reduction in odds is nearly 50 percent greater among residents with ADRD. Odds ratios indicate a 62 percent reduction in the odds of experiencing an ACSH of any type among residents with ADRD located in facilities



with an on-site nurse practitioner. Much of the reduction in odds associated with an on-site nurse practitioner appears to stem from the lower odds of hospitalization for infectious acute care-sensitive conditions, and again, the effect appears particularly important for residents with ADRD. For example, while the odds of experiencing an infectious ACSH are reduced by 37 percent among residents without ADRD, the odds of experiencing an infectious ACSH are reduced by 71 percent among residents with ADRD. Interestingly, when comparing odds ratios across the three infectious ACSH models, the effect is unobserved among residents without ADRD, but remains strong for residents with ADRD in two of the three models. Specifically, odds of hospitalization for bacterial pneumonia and gastroenteritis were reduced by 65 and 67 percent, respectively, among residents with ADRD residing in facilities with an on-site nurse practitioner.

The effect of increased RN staffing on risk of ACSH was consistent across all models, with findings suggesting that higher RN staffing levels decrease the odds of experiencing an ACSH among both populations. Findings suggest that for residents with ADRD, the addition of one FTE RN per 100 residents is associated with 3 percent lesser odds of ACSH, and 5 percent lesser odds of a hospitalization for a kidney/UTI infection. Use of nursing personnel from staffing pools demonstrated similar results across all models as well, with results indicating that with each percentage point increase in staffing hours from pooled services, the odds of ACSH and infectious ACSH are increased by 1 percent among both study populations. Additionally, findings indicate that increased LPN staffing patterns are associated with greater risk of ACSH, but a consistent pattern of results across all models was not observed. Although findings suggest that odds of ACSH and infectious ACSH are increased among all residents located in homes with a higher number of LPNs per bed, only one significant effect across the three separate models of infectious ACSH was observed. Results suggest that residents without ADRD and located in facilities with a higher intensity of LPN staffing levels experience increased odds of being hospitalized for bacterial pneumonia (OR = 1.02,  $p = 0.001$ ).

## Discussion

This is the first study to explore differential ACSH rates among nursing home residents by ADRD status, with key findings suggesting that increased use of nurse practitioners and RNs, as well as overall quality-of-care practices, are particularly important in preventing unnecessary hospitalizations among residents with ADRD. Because residents with ADRD are less able to alert facility personnel to changes in their healthcare needs, availability of highly trained nursing staff most likely increases timely identification of subtle

changes in resident symptoms, allowing for prompt medical intervention. Additionally, because the gains in preventing unnecessary hospitalizations were found to be the strongest for those hospitalizations occurring from infectious conditions, the presence of more highly trained nursing personnel may help to ensure better adherence to daily infectious control policies in the facility. Alternatively, facilities with a greater intensity of RN staffing levels and/or an on-site nurse practitioner may encourage in-house management of complex medical treatments, resulting in fewer hospitalizations.

At the same time, the finding that weight loss/gain is not only an important determinant of ACSH in general, but bacterial pneumonia and gastroenteritis in particular among residents with ADRD, suggests that residents with ADRD may be more likely to experience delays in receiving timely medical intervention that potentially could prevent the need for hospitalized care. Moreover, given that infectious conditions such as gastroenteritis rarely affect just one resident, coupled with the additional findings associated with increased RN staffing levels, lower LPN staffing levels, and resident weight loss/gain, the finding that residents with ADRD are at increased risk of being hospitalized for certain infectious conditions may suggest that poor quality of care is in part responsible. Additionally, the finding that for-profit nursing homes have higher rates of hospitalizations for bacterial pneumonia most likely echoes the long history of research linking nursing home quality to facility propriety status.<sup>23</sup> Finally, although differences in case-mix among populations may account for some of the variation in ACSH, the extensive list of adjusters included in the estimation procedures, coupled with the much higher proportion of ACSH among facilities with high hospitalization rates compared with those facilities with low transfer rates, further suggests that poor quality of care may be contributing to the problem.

Overall, our findings suggest that using ACSH measures to monitor nursing home quality of care provides important insight into the extent to which residents are being transferred for conditions that potentially could have been prevented. Besides being costly, hospitalization for preventable conditions places residents at increased risk of experiencing iatrogenic complications. For example, a recent study reported that nursing home residents hospitalized for infectious diseases experience higher mortality rates, increased pressure ulcer development, and greater physical decline in comparison with residents treated in-house or transferred only after initial efforts at providing in-house care proved insufficient.<sup>23</sup> Moreover, because residents with ADRD appear to be at greater risk of experiencing certain ACS conditions, understanding what factors contribute to high/low ACSH rates may assist in identifying best-practice guidelines specific to the needs of residents with ADRD.

For example, findings from this study suggest that efforts to minimize reliance on unfamiliar caregivers, implementation of early intervention strategies, and increased use of licensed nursing personnel should lower the rate of ACSH among residents with ADRD.

Although our findings provide strong empirical support for the use of ACSH measures to examine timely access to care among nursing home residents, future studies are needed to understand the extent to which severity of illness and comorbidities affect rates of ACSH among these residents. Because medical management of certain conditions (e.g., congestive heart failure, diabetes) may be more complicated when additional comorbid conditions exist, and because the severity of such conditions generally worsen over time, even with access to proper medical treatment, additional work is needed to explore the appropriateness of including/excluding certain acute care-sensitive conditions as well as strategies for case-mix adjustment. For example, although past researchers have frequently combined all measures of ACSH, as was done in one of the models presented here to monitor rates among broadly defined populations, our findings suggest that factors contributing to potentially unnecessary hospitalizations appear to vary across subpopulations as well as by the type of ACSH studied, thus suggesting that measure refinement is needed. Continued effort to understand factors associated with hospitalization of nursing home residents with ADRD will provide valuable insight regarding the system-level factors that lead to inappropriate hospitalizations, as well as assist in future efforts to identify appropriate hospitalization practices affecting vulnerable populations.

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