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The effects of acute care hospitalization on health and cost trajectories for nursing home residents

A matched cohort study

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Abstract

Thirty five percent to sixty seven percent of admissions to acute care hospitals from nursing homes are potentially preventable. Limited data exist regarding clinical and cost trajectories post an acute care hospitalization. To describe clinical impact and post-hospitalization costs associated with acute care admissions for nursing home residents. Analysis of population-based data. The 65,996 nursing home residents from a total of 645 nursing homes. Clinical outcomes assessed with the Changes in Health, End-stage disease and Symptoms and Signs (CHESS) scores, and monthly costs. Post-index date, hospitalized residents worsened their clinical conditions, with increases in CHESS scores (CHESS 3 + 24.5% vs 7.6%, SD 0.46), more limitations in activities of daily living (ADL) (86.1% vs 76.0%, SD 0.23), more prescriptions (+1.64 95% CI 1.43-1.86, $P < .001$), falls (30.9% vs 18.1%, SD 0.16), pressure ulcers (16.4% vs 8.6%, SD 0.37), and bowel incontinence (47.3% vs 39.3%, SD 0.35). Acute care hospitalizations for nursing home residents had a significant impact on their clinical and cost trajectories upon return to the nursing home. Investments in preventive strategies at the nursing home level, and to mitigate functional decline of hospitalized frail elderly residents may lead to improved quality of care and reduced costs for this population. Pre-hospitalization costs were not different between the hospitalized and control groups but showed an immediate increase post-hospitalization (CAD 1882.60 per month, $P < .001$).

Abbreviations: ABS = aggressive behaviour scale, ADL = activities of daily living, CCRS = Continuing Care Reporting System, CHESS = Changes in Health, End-stage disease and Symptoms and Signs, CIHI = Canadian Institutes for Health Information, CPS = cognitive performance scale, DAD = Discharge Abstract Database, DRS = depression rating scale, NACRS = National Ambulatory Care Reporting System, NRS = National Rehabilitation Reporting System, ODB = Ontario Drug Database, OHIP = Ontario Health Insurance Program Database, RAI-MDS 2.0 = Resident Assessment Instrument Minimal Dataset, RPDB = Registered Persons Database, SD = standard deviation.

Keywords: acute care hospitalization, ageing, frailty, health economics, nursing home residents

1. Introduction

Up to 12% of those aged 75 and older currently reside in nursing homes.[1] This population is frail and requires extensive medical and allied healthcare support,[2,3] with 89% requiring extensive assistance for their activities of daily living (ADL).[4] The high prevalence of cognitive impairment and polypharmacy, both present in more than 60% of nursing home residents, contributes to this scenario. In Canada, 11% of health expenditures are spent in nursing homes and residential care facilities, for a total of 26 billion dollars per year.[5]

There is large variation in admissions to acute care facilities, likely due to heterogeneity in both preventing admissions and avoiding admissions at the end-of-life that may not be compatible with resident's wishes. Previous studies suggest that between 35% and 67%[6–8] of acute care admissions from nursing homes are potentially preventable. Typical examples of modifiable conditions that increase risk of admission to acute care hospitals include falls, admissions due to deterioration of chronic diseases, such as heart failure and COPD, and admissions due to infections, where infection prevention control and vaccination may decrease the number of events. Reducing the rate of admissions due to potentially preventable factors is important since seniors often do not return to their previous quality of life after admission to an acute care facility. This appears to be due to worsening cognitive and physical functions, which are either

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The data that support the findings of this study are available from a third party, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are available from the authors upon reasonable request and with permission of the third party.

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related to the acute illness or iatrogenic complications developing during hospitalization.[9]

Unfortunately, limited data exist on clinical and cost trajectories prior to and post an acute care hospitalization. Since complexity of care also drives elevated costs, we hypothesize that both healthcare needs and costs increase for nursing home residents after an acute care admission.

2. Methods

2.1. Design and setting

We performed a population-based observational matched-cohort study of nursing home residents in the Province of Ontario, Canada. Sunnybrook Health Sciences Centre's Research Ethics Board approved this study under number 104-2017, as did the University of Waterloo Office of Research Ethics (ORE# 18228).

We created a research dataset for this project using data derived from the Canadian Institutes for Health Information (CIHI) Discharge Abstract Database (DAD), which includes clinical and demographic data on discharges from all acute care hospitals in Ontario, and the Continuing Care Reporting System (CCRS) for nursing homes, which includes data on clinical characteristics of residents during their nursing home stay, based on the Resident Assessment Instrument Minimal Dataset (RAI-MDS 2.0). The RAI-MDS 2.0 is a standardized comprehensive clinical and functional assessment designed for nursing homes, with demonstrated reliability and validity.[10–14] It has been in use in Ontario since 2005 and it is administered within the first 14 days of a resident's stay, and every three months thereafter, or sooner in case of significant changes. To obtain data on costs we linked this dataset with other healthcare services datasets including the Ontario Health Insurance Program Database (OHIP), Ontario Drug Database (ODB), National Ambulatory Care Reporting System (NACRS), and National Rehabilitation Reporting System (NRS).

In Ontario, these datasets are housed at ICES and are routinely linked with a high degree of validity to other administrative datasets including the Registered Persons Database (RPDB) containing vital statistics on all persons ever issued a Provincial Health Card. These datasets were linked using unique encoded identifiers and analyzed at ICES.

2.2. Resident population

We used the CCRS to define a cohort of adults aged 65 years or older, residing long-term (defined as at least 6 months of stay) in a nursing home in Ontario between 2009 and 2015. This cohort was followed until March 31, 2015 or death. Residents were included if they had at least 2 RAI-MDS assessments.

We defined our exposed cohort as residents surviving an acute care hospitalization following long-term nursing home admission. To account for time as a determinant of costs we matched each hospitalized resident to a nursing home resident that did not have an acute care hospitalization on their total length-of-stay in the nursing home (±15 days).

2.3. Outcomes

Our primary clinical outcome was the Changes in Health, End-stage disease and Symptoms and Signs (CHESS), a validated measure of frailty-related health instability, which is associated with the use of diagnostic and therapeutic measures, such as new physician visits, use of parenteral medications, abnormal laboratory investigations, and oxygen and suctioning needs. CHESS scores range from 0 (no instability in health) to 5 (highly unstable health).[15–18] Secondary clinical outcomes included relevant clinical variables such as ADL, depression rating scale (DRS), cognitive performance scale (CPS), aggressive behavior scale (ABS), falls, pressure ulcers, bowel and urinary continence, and number of prescription medications. RAI-MDS 2.0 was the source for clinical variables.[19]

Our primary cost outcome was the total monthly cost of healthcare expenditures per resident. We used a previously developed and validated algorithm to derive person-level costing from administrative databases.[20] Briefly, the algorithm uses data routinely available in Ontario databases to derive person-level costing for a variety of healthcare settings, including inpatient, outpatient, and home care settings. It uses two components, utilization data (such as length-of-stay and intensity of resource usage) and cost information (such as cost per stay or per day). In acute care, utilization data is measured as resource intensity weights, representing the average resource utilization by individuals with a particular condition relative to other persons. Similarly, other case-mix methodologies are used for the other healthcare settings. This is possible in Ontario as[1] the expenditures are primarily paid from public funds, and[2] each Ontario resident has a unique health card number, allowing linkage of utilization from all care providers. All costs are adjusted to 2015 Canadian dollars.

2.4. Statistical analysis

For baseline group comparisons (hospitalized versus non-hospitalized nursing-home cohorts) we used the Chi-square test to compare categorical data and the Student *t* test or Wilcoxon Rank Sum test to compare continuous data, as appropriate. To decrease the possibility of selection bias, we used inverse probability weighting (IPW) to create a pseudopopulation where hospitalization status is independent of baseline covariates. Briefly, we generated a propensity score using baseline covariates to generate the conditional probability of hospitalization. Non-hospitalized residents are assigned weights inverse to the probability of not being hospitalized, while hospitalized residents are assigned a weight of 1. The subsequent re-weighted samples were analyzed for each clinical outcome of interest using linear, logistic, or ordinal logistic regression models as appropriate for the variable of interest.[21] We report the adjusted odds ratio (OR) for categorical variables and adjusted linear coefficient for continuous variables.

For the cost analysis we used the IPW-generated pseudopopulation, applying linear regression with an interrupted time series methodology to measure changes in monthly costs post admission to an acute care hospital.[22] To compare changes in costs post hospitalization we included a matched control group, where we assigned an index date for the non-hospitalized individuals as the date of index hospital admission for his or her matched case. Since residents were matched on total length-of-stay in the nursing home, this step creates a matched number of month's pre and post-hospitalization and allows for interpretation of the data without adjustments for person-time variables.

In interrupted time series 3 parameters are estimated: the trends in costs before the hospitalization, the immediate change in costs associated with the hospitalization, and the change in trends post hospitalization. Because our analysis includes a control group of non-hospitalized residents, we estimated the following parameters from the model: group (hospitalized vs non-hospitalized), interaction between group and pre-exposure time interaction between group and exposure, and interaction between group and post-exposure time. The latter 2 parameters are interpreted as the immediate change in costs after hospitalization and trends in costs post-hospitalization. We removed all inpatient costs at the time of acute care hospitalization to avoid inflating post-hospitalization costs.

To better understand the clinical and cost impact of preventable admissions we further defined three subgroups of potentially preventable admissions: falls, acute decompensation of chronic illness (e.g., heart failure and COPD), and infections. All analysis was repeated for these subgroups of interest after rematching on length of stay.

Data are reported as counts and percentages or medians and interquartile ranges for categorical and continuous data, respectively. Due to the large number of residents in this cohort we also report standardized differences. Standardized differences represent the mean difference as a percentage of the standard deviation (SD). They provide a more meaningful representation of the differences because they are insensitive to sample size. Standardized differences greater than 0.1 are considered meaningful.[23] For the post index date results only report standardized differences for variables with a baseline standardized difference less than 0.1.

All analyses are performed using SAS Enterprise Guide 7.15 (SAS Institute Inc.), using a significance level of $P < .05$.

3. Results

Between 2009 and 2015, there were 119,215 residents newly admitted to 645 nursing home in Ontario. Of these, 59,245 residents were admitted to an acute care facility. From this group, 32,398 residents fulfilled criteria to enter the study and were subsequently matched to 32,398 residents that were never hospitalized from the remainder of the cohort (Fig. 1). Residents were observed for a median of 817 (IQR 471-1292) days, of which 409 (159-792) were in the post-index day period. Compared to non-hospitalized residents, hospitalized residents were less likely to be female (65.6% vs 70.6%, SD 0.16), more likely to have been admitted to an intensive care unit in the preceding 3 years (13.5% vs 8.1%, SD 0.17), and had more visits to an emergency department in the year preceding nursing home admission (0 IQR 0-1 vs 1 IQR 0-2, SD 0.51). Hospitalized residents were sicker, with a larger number of residents with 2 or more Charlson co-morbidities (49.3% vs 37.7%, SD 0.24), and used more medications at baseline (number of prescriptions prior to index date: 24 IQR 14-36 vs 21 IQR 11-32, SD 0.20) (Table 1).

Most hospitalizations were non-elective (95.5%), with femur fractures (12.8%), pneumonia (9.3%), urinary system disorders (7.2%), chronic obstructive pulmonary disease (5.1%), and congestive heart failure (4.5%) as the leading causes. Residents were seen by a median of 2 (2-4) physicians and stayed in hospital for a median of 5 (3-8) days. 6.4% of hospitalized residents required an intensive care unit (ICU) admission for a median of 4 (2-6) days. Upon returning to the nursing home after the index hospitalization, a greater proportion of residents had CHESS scores greater or equal to 3, more limitations in ADL, more falls, more pressure ulcers, and more bowel incontinence compared to controls (Table 2). The number of monthly prescriptions increased more in the hospitalized group (+1.64 95% CI 1.43-1.86, $P < .001$), as well as their case-mix index (CMI) (+0.14, 95% CI 0.14-0.14, $P < .001$).

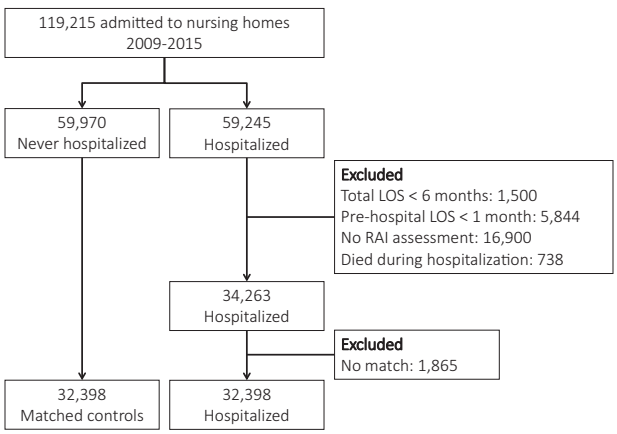

Figure 1. Cohort inception.

Total costs were higher for hospitalized residents (CAD 157,807 IQR 105,096-229,515 vs CAD 122,015 IQR 73,972-187,138, $P < .001$). The interrupted time-series analysis demonstrates that the pre-hospitalization costs were only slightly different between the hospitalized and control groups (Hospitalized trend CAD -38.7/month pre-hospitalization, $P < .001$), but showed an immediate increase in post-hospitalization costs (CAD 1882.60, $P < .001$), with slightly different trends post hospitalization (Hospitalized trend CAD 5.3/month, $P < .001$) (Fig. 2). The largest component of immediate post-hospitalization costs was due to repeated hospitalizations (CAD 605.20/month, $P < .0001$), followed by increases in long-term care costs (CAD 347.00/month, $P < .0001$), complex-continuing care costs (CAD 95.36/month, $P < .0001$), and physician costs (CAD 81.43/month, $P < .0001$).

3.1. Subgroups of potentially preventable admissions

There were 16,158 (49.8%) admissions due to potentially preventable conditions (4559 residents admitted with a diagnosis of fall, 8475 with an infection and 3124 with exacerbation of a chronic disease). Their clinical trajectories mostly mirrored the overall population in all aspects, demonstrating increases in subsequent falls, pressure ulcers, worsening ADLs, worsening bowel and urinary function and worsening health instability. Their cost trajectory also showed increases compared to their baseline and the control population (Tables S1-S3, Supplemental Digital Content, http://links.lww.com/MD/H556).

4. Discussion

Among nursing home residents surviving an acute care hospitalization, we observed increases in CHESS scores, ADL limitations, pressure ulcers, falls and bowel incontinence upon return to a nursing home, suggesting that an acute hospitalization is associated with declining health and quality of life. Findings were consistent across the 3 subgroups of residents admitted with a potentially preventable condition. These complications associated with an acute care admission led to an immediate increase in total costs. Our findings translate into an excess of CAD 15,600 per nursing home resident per year, not including costs associated with the acute care hospitalization. Importantly, most of these hospitalizations were due to potentially preventable and modifiable conditions, such as falls, infections and decompensation of chronic diseases.

Given the variation in utilization of acute care resources for nursing home residents, our data suggests that there is an opportunity to improve care and reduce healthcare costs by preventing common causes of hospitalization. Policies and strategies to improve the quality of care in nursing homes and prevent hospitalizations could lead to important healthcare savings, while providing a better quality of life for this frail population.

As this study does not have data to measure the quality of care provided in nursing homes or in the acute care setting, it is not possible to predict the potential cost-savings of further investing in the quality of care. Furthermore, further work is necessary to identify strategies to decrease hospitalizations and evaluate their cost-effectiveness. Another important limitation is the difference in pre-hospitalization baseline characteristics of these residents. However, despite important clinical differences, pre-hospitalization costs and case-mix index were similar between hospitalized and non-hospitalized, suggesting that resource utilization was not affected until the hospitalization event. Our sensitivity analysis confirms that pre-hospitalization clinical differences did not affect costs. Finally, about 50% of cost increases post-hospitalization are due to re-hospitalizations. While this seemingly creates an unfair comparison with the residents who were never hospitalized, we cannot exclude the possibility that worsening health instability post-hospitalizations can also lead to further re-hospitalizations,

Table 1

Baseline characteristics of residents.

	Non-hospitalized 32,398	Hospitalized 32,398	*P*-value	Standardized difference
Age, median (IQR)	85 (80-90)	84 (79-89)	<.001	0.16
Gender, Female	22,862 (70.6%)	21,237 (65.6%)	<.001	0.11
Co-morbidities				
Diabetes mellitus	7027 (21.7%)	9534 (29.4%)	<.001	0.18
Coronary artery disease	3755 (11.6%)	4189 (12.9%)	<.001	0.04
Congestive heart failure	3380 (10.4%)	4599 (14.2%)	<.001	0.11
Hypertension	20,317 (62.7%)	21,164 (65.3%)	<.001	0.05
Chronic obstructive pulmonary disease	4080 (12.6%)	5515 (17.0%)	<.001	0.12
Stroke	5999 (18.5%)	6683 (20.6%)	<.001	0.05
Chronic renal failure	2407 (7.4%)	3415 (10.5%)	<.001	0.11
Dementia, non-Alzheimer's	16,045 (49.5%)	14,180 (43.8%)	<.001	0.12
Dementia, Alzheimer's	5963 (18.4%)	4465 (13.8%)	<.001	0.13
Previous acute medical conditions				
Hip fracture	2172 (6.7%)	2127 (6.6%)	.478	0.01
Pneumonia	383 (1.2%)	528 (1.6%)	<.001	0.04
Urinary tract infection	2608 (8.0%)	2743 (8.5%)	.054	0.02
Charlson, 2 or more co-morbidities	11,379 (37.7%)	15,239 (49.3%)	<.001	0.24
Falls (previous 6 months)	10,840 (33.5%)	11,048 (34.1%)	.085	0.01
Pressure ulcer	2525 (7.8%)	2692 (8.3%)	.016	0.02
Bowel incontinence	11,527 (35.6%)	10,237 (31.6%)	<.001	0.08
Bladder incontinence	18,527 (57.2%)	16,884 (52.1%)	<.001	0.1
Changes in Health, End-Stage Disease and Symptoms and Signs (CHESS)			.18	
0	14,600 (45.9%)	14,720 (46.3%)		0.01
1-2	15,524 (48.8%)	15,485 (48.7%)		0
3+	1706 (5.4%)	1608 (5.1%)		0.01
Activities of daily living ≥ 3	23,424 (73.6%)	22,943 (72.1%)	<.001	0.03
Depression rating scale ≥ 3	10,633 (33.4%)	9849 (31.0%)	<.001	0.05
Cognitive performance scale ≥ 3	18,929 (59.5%)	15,747 (49.5%)	<.001	0.2
Aggressive behaviour scale ≥ 5	3185 (10.0%)	2539 (8.0%)	<.001	0.07
Status prior to nursing home admission				
Living alone	6005 (18.5%)	6663 (20.6%)	<.001	0.05
Admitted from acute care service	9291 (28.7%)	10,616 (32.8%)	<.001	0.09
ICU admission in the 3 years prior to cohort entry	2634 (8.1%)	4376 (13.5%)	<.001	0.17
Healthcare utilization prior to index date (hospital admission or matching date)				
Number of prescriptions per month	21 (11-32)	24 (14-36)	<.001	0.2
Emergency department visits 1 year before hospitalization, median (IQR)	0 (0-1)	1 (0-2)	<.001	0.51

Table 2

Post hospitalization clinical outcomes.

	Non-hospitalized, 32,398	Hospitalized, 32,398	Adjusted OR (95% CI)	*P*-value	Standardized difference
Falls, past 30 days	5850 (18.0%)	9997 (30.9%)	1.97 (1.89-2.05)	<.001	0.16
Pressure ulcer	2776 (8.6%)	5311 (16.4%)	2.43 (2.28-2.58)	<.001	0.37
Bowel incontinence	12,747 (39.3%)	15,316 (47.3%)	2.48 (2.36-2.60)	<.001	0.35
Bladder incontinence	19,610 (60.5%)	20,206 (62.4%)	1.73 (1.65-1.82)	<.001	NR
Changes in Health, End-Stage			3.20 (3.10-3.31)*	<.001	-
Disease and Symptoms and Signs					
0	14,075 (43.5%)	7766 (24.0%)	-		0.41
1-2	15,863 (49.0%)	16,683 (51.5%)	-		0.05
3+	2451 (7.6%)	7940 (24.5%)	-		0.46
Limitations in activities of daily living ≥ 3	24,615 (76.0%)	27,876 (86.1%)	3.96 (3.71-4.22)	<.001	0.23
Depression rating scale ≥ 3	11,281 (34.8%)	11,613 (35.9%)	1.16 (1.11-1.22)	<.001	0.24
Cognitive performance scale ≥ 3	20,125 (62.1%)	18,743 (57.9%)	1.92 (1.80-2.06)	<.001	NR
Aggressive behaviour scale ≥ 5	3463 (10.7%)	2634 (8.1%)	0.85 (0.79-0.91)	<.001	0.07

Adjusted for baseline status on each clinical outcome.

NR = not reported due to large (≥0.1) baseline differences, * = ordinal logistic regression.

creating a vicious cycle of worsening health and increasing costs. Residents come out of hospital with higher health instability and may thus require re-hospitalization due to problems acquired in hospital, such as increases in falls and pressure ulcers as observed in our study, and increases in infections due to organisms acquired in-hospital, such as *Clostridium difficile*[24] and multi-resistant organisms.[25] While not all re-hospitalization costs are potentially preventable, a significant portion may be, assuming acute care hospitals use strategies to avoid further clinical deterioration. A recent randomized trial demonstrated improvements in functional capacity, strength, and quality of life in elderly acute care residents, suggesting that functional decline can be mitigated during an acute care hospitalization.[26]

Further understanding and addressing the large variation in acute care hospitalizations from nursing homes presents an opportunity to improve quality of care and limit costs. Potential

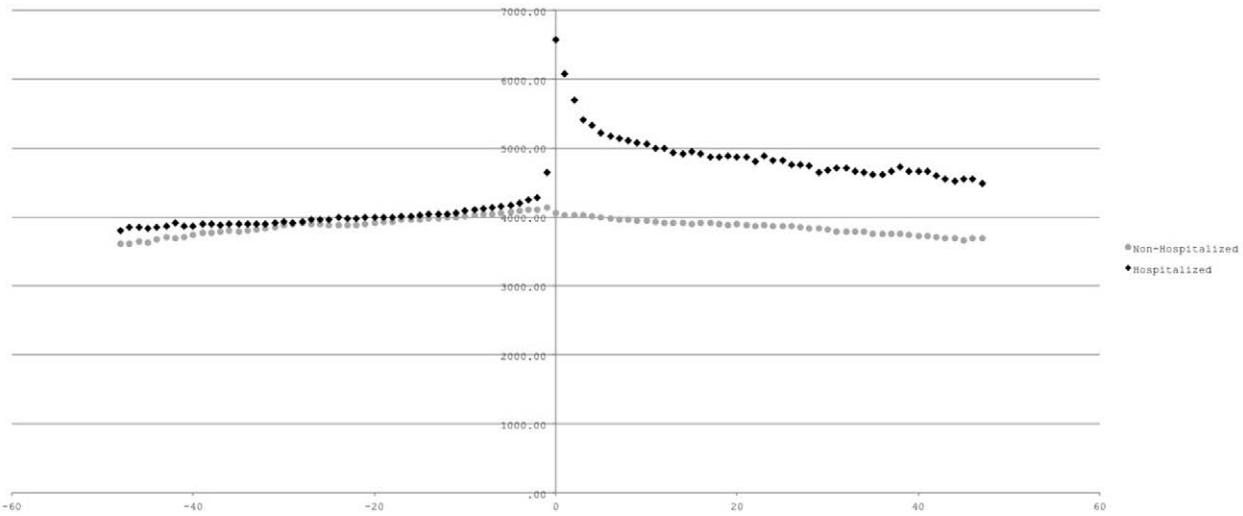

Figure 2. Monthly costs of hospitalized and matched control residents.

reasons for variation in acute care admission rates relate to prevention of complications, such as falls and infections, treatment of infections and decompensating chronic diseases in the nursing home, and variation in how advance care planning discussions are approached. A recent study of a systematic discussion regarding treatment preferences at the end-of-life led to a greater than 30% reduction in acute care admissions.[27]

Acute care hospitalizations for nursing home residents have a significant impact on their health state and post-hospitalization costs. Increased medical complexity and health instability post-hospitalization drives costs, primarily due to further re-hospitalizations, but also from increases in utilization of other resources, such as medical assessments, long-term care costs and complex continuing care. Policymakers should consider investments in preventive strategies at the nursing home level and on interventions to mitigate functional decline for hospitalized elderly residents.

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