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Original Study

Determinants of Post-acute Care Costs in Acutely Hospitalized Older Adults: The Hospital-ADL Study

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A B S T R A C T

Objectives: After hospitalization, many older adults need post-acute care, including rehabilitation or home care. However, post-acute care expenses can be as high as the costs for the initial hospitalization. Detailed information on monthly post-acute health care expenditures and the characteristics of patients that make up for a large share of these expenditures is scarce. We aimed to calculate costs in acutely hospitalized older patients and identify patient characteristics that are associated with high post-acute care costs.
Design: Prospective multicenter cohort study (between October 2015 and June 2017).
Setting and participants: 401 acutely hospitalized older persons from internal medicine, cardiology, and geriatric wards.
Measurements: Our primary outcome was mean post-acute care costs within 90 days postdischarge. Post-acute care costs included costs for unplanned readmissions, home care, nursing home care, general practice, and rehabilitation care. Three costs categories were defined: low [0-50th percentile (p0-50)], moderate (p50-75), and high (p75-100). Multinomial logistic regression analyses were conducted to assess the associations between costs and frailty, functional impairment, health-related quality of life, cognitive impairment, and depressive symptoms.
Results: Costs were distributed unevenly in the population, with the top 10.0% (n = 40) accounting for 52.1% of total post-acute care costs. Mean post-acute care costs were €4035 [standard deviation (SD) 4346] or $4560 (SD 4911). Frailty [odds ratio (OR) 3.44, 95% confidence interval (CI) 1.78-6.63], functional impairment (OR 1.80, 95% CI 1.03-3.16), and poor health-related quality of life (OR 1.89, 95% CI 1.09-3.28) at admission were associated with classification in the high-cost group, compared with the low-cost group.
Conclusions/Implications: Post-acute care costs are substantial in a small portion of hospitalized older adults. Frailty, functional impairment, and poor health-related quality of life are associated with higher post-acute care costs and may be used as an indicator of such costs in practice.

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In many Western countries, including the Netherlands, the overall demand for health care is increasing because of aging populations. Acute hospitalizations in older persons are an important driver of increasing health care expenditures. Moreover, post-acute care expenses can be high in these patients. For example, the cost of readmission along with postdischarge care like rehabilitation care and nursing care can be just as costly, if not more, than the initial index admission.[1] The high demand for post-acute care in older persons is often caused by the presence of multiple medical and functional problems.[2] Older patients develop impairments in performing activities of daily living, and after hospitalization often do not regain their previous level of functioning.[3–5] Moreover, such functional loss is associated with the need for home care or rehabilitation, which might result in a long-term stay in a nursing care facility.[6–8] Furthermore, more than 20% of older patients require rehospitalization within 30 days postdischarge.[2]

Insights into post-acute care spending and characteristics of high-cost patients are of interest to policy makers and care managers alike, as such information may reveal opportunities for care improvement or cost reduction.[1,9–11] When studying overall health care costs, it is often found that a small population of patients with multiple chronic conditions consume most care.[12–14] Furthermore, previous studies have identified frailty as a risk factor associated with increased health care utilization.[15] Although the association between frailty and costs might overlap with the association between costs and functional status or comorbidity, frailty has been described as a distinct entity.[16,17] Most preventable costs, such as for preventable hospital admissions, can be attributed to patients with frailty.[18] Other determinants such as depressive symptoms and cognitive impairment are associated with poorer outcomes, and can also be related to increased health care utilization.[19,20] Although high health care costs are thus often caused by multiple underlying factors, the problems that are associated with high care costs in older patients are often studied individually, describing only 1 determinant of increased overall health care or hospital care utilization.[15,21]

Previous research in health care costing has focused on large cohorts of patients, often derived from insurance or, in the United States, Medicare databases.[1,11,22] These studies have shed light on the distribution of health care costs in various populations. They indicate that health care utilization and associated costs are typically unevenly spread; high-cost groups, top 10%, or even top 1%, often make up for 20% to 50% of the total health care budget.[10,11,22] Targeting particular high-cost patient groups who have high inpatient and post-acute care costs may help to reduce costs more effectively.[9,23,24]

However, currently there are few studies that provide a detailed description of post-acute health care expenditures in older patients and the characteristics of patients that make up for a large share of these expenditures. Insight into the characteristics of these patients can help to identify targets for cost-reduction strategies and care improvement.[23] Therefore, the objectives of this study were to (1) calculate costs that are associated with post-acute care in acutely hospitalized older patients and (2) identify and analyze patient characteristics and clinical measurements (ie, determinants) that are associated with high post-acute care costs in the 90 days following hospitalization.

Methods

Study Design and Setting

The Hospital-Associated Disability and impact on daily Life (Hospital-ADL-study) is a multicenter prospective cohort study. The study was conducted between October 2015 and June 2017, including a 3-month follow-up period. Further details of the study can be found in the study protocol, which was published elsewhere.[25] Participants were recruited from internal medicine, cardiology, or geriatric wards at 6 hospitals in the Netherlands.

Study Population

Patients aged 70 years and older requiring an acute admission to the hospital were eligible for inclusion. The following inclusion criteria were applied: (1) approval of the attending medical doctor, (2) sufficient Dutch language proficiency to complete questionnaires, and (3) Mini-Mental State Examination[26] score $\geq$15 or the presence of delirium, because in the latter case an MMSE could not be performed. The researcher asked the attending medical doctor for approval, for example, to confirm that the patient was not delirious or terminally ill and could be approached. Also, patients were excluded if they had a life expectancy of less than 3 months or were disabled in all basic activities of daily living.[27] Besides community dwellers, individuals who did not live independently, but, for example, in a nursing home, were also eligible for inclusion. Two trained researchers (R.S. and L.R.) visited the participating wards on Mondays, Wednesdays, and Fridays and contacted eligible patients within 48 hours after hospital admission. After informed consent was obtained, patients were enrolled in the study.

Definition of Health Care Utilization and Costs

Data on postdischarge health care utilization were collected through reviewing patient files, that is, medical records, and questionnaires that were conducted either by interviewing patients over telephone (at 2 months postdischarge) or during home visits (at 1 month and 3 months postdischarge). Interviews were conducted by trained research personnel. Costs were determined according to the Dutch Manual for Costing studies, and standard costs were obtained and set for the year 2017.[28] We included costs that are funded through the Dutch health care system.[28] We assessed the following units of care during the 90 days after discharge: (1) number and duration of acute (unplanned) readmissions within the last month; (2) number of general practice visits, both during office hours and outside of office hours; (3) number and duration of admissions and returns to a home for older adults, nursing home (including palliative care), or rehabilitation facility, (4) number of hours of home care per week, both medical and nonmedical home care; and (5) rehabilitation care, namely, the number of outpatient physiotherapist consultations and occupational therapy sessions. We did not collect data on emergency room visits and therefore could not calculate costs for these visits. Also omitted were elective readmissions, such as admissions for cataract surgery, pacemaker insertion, chemotherapy, or other procedures, because describing these types of care costs lies beyond the scope of this study. Observation days were included because, in the Netherlands, there is no difference in the standardized cost rate for an observation day vs an inpatient day.[28] Costs of patients living in a nursing home, senior residence, or in a rehabilitation facility were assessed using the per diem cost tariff in the Dutch Costing Manual; this tariff includes rent, nursing, home care, and daily activities.[28]

Primary Outcome Measure

We first calculated the mean and median costs, which was the sum of post-acute care costs over 3 months. For the primary outcome in the multinomial regression model, we made a categorical variable based on the sum of 3-month post-acute care costs. Patients who had below-median costs (p0-50) were labeled as the low-cost group. The third quartile of costs (p50-75) was labeled as the moderate-cost group and above that (p75-100) was labeled as the high-cost group.

Table 1
Patient Characteristics and Cost Groups (N = 401)

Patient Characteristics	Low-Cost Group (n = 201)	Moderate-Cost Group (n = 100)	High-Cost Group (n = 100)
Age, y, mean (SD*)	78.9 (6.7)	80.6 (8.1)	80.2 (7.2)
Male, n (%)	114 (56.7)	48 (48.0)	45 (45.0)
Living arrangements before admission, n (%)			
Independent	181 (90.0)	83 (83.0)	73 (73.0)
Nursing home	1 (0.5)	—	7 (7.0)
Senior residence/assisted living	19 (9.5)	17 (17.0)	20 (20.0)
Marital status, n (%)			
Married or living together	118 (58.7)	51 (51.0)	40 (40.0)
Single or divorced	26 (12.9)	12 (12.0)	26 (26.0)
Widow/widower	57 (28.4)	37 (37.0)	34 (34.0)
Born in the Netherlands, n (%)	179 (89.1)	90 (90.0)	90 (90.0)
Education, n (%)			
Primary school	46 (22.9)	24 (16.0)	31 (31.0)
Elementary technical/domestic science school	43 (21.4)	28 (28.0)	18 (18.0)
Secondary vocational education	62 (30.8)	31 (31.0)	27 (27.0)
Higher level high school/third-level education	50 (24.9)	17 (17.0)	24 (24.0)
Charlson Comorbidity Index,* mean (SD)	2.04 (2.00)	2.21 (2.08)	2.27 (2.11)
Polypharmacy, † n (%)	120 (59.7)	71 (71.0)	71 (71.0)
Mean MMSE‡ score, mean (SD)	26.20 (3.15)	25.48 (4.16)	25.19 (3.82)
Hospitalization in past 6 months, n (%)	61 (30.3)	46 (46.0)	27 (27.0)
Primary admission diagnosis, n (%)			
Infection	24 (11.9)	18 (18.0)	16 (16.0)
Gastrointestinal	23 (11.4)	11 (11.0)	11 (11.0)
Cardiac	74 (36.8)	18 (18.0)	30 (30.0)
Respiratory	37 (18.4)	21 (21.0)	18 (18.0)
Cancer (including hematology)	8 (4.0)	4 (4.0)	1 (1.0)
Electrolyte disturbance	5 (2.5)	4 (4.0)	1 (1.0)
Renal	7 (3.5)	4 (4.0)	4 (4.0)
Other	23 (11.4)	20 (20.0)	19 (19.0)
Length of hospital stay, mean (SD)	6.96 (6.15)	7.47 (7.94)	10.48 (10.75)
Discharge destination, n (%)			
Home	168 (83.6)	83 (83.0)	66 (66.0)
Nursing home	2 (1.0)	—	4 (4.0)
Rehabilitation center	3 (1.5)	4 (4.0)	13 (13.0)
Assisted living	1 (0.5)	—	5 (4.0)
Other (eg, other hospital)	7 (3.5)	4 (4.0)	6 (6.0)
Unknown	20 (10)	9 (9.0)	6 (6.0)
Functional impairment	104 (51.7)	72 (72.0)	73 (73.0)
Depressive symptoms	38 (18.9)	25 (25.0)	28 (28.0)
Cognitive impairment	36 (17.9)	28 (28.0)	23 (23.0)
Poor health-related quality of life	90 (44.8)	57 (57.0)	65 (65.0)
Frailty ≥3 factors	85 (42.3)	58 (58.0)	74 (74.0)

*Range of 0-31, with a higher score indicating more or more severe comorbidity.[29]
†Use of 5 or more different medications.
‡Range 0-30, ≤23 is cognitive impairment.[26]

Measurements and Determinants in Relation to Costs

All measurements, including baseline demographic characteristics, length of hospital stay, hospitalization in the past 6 months, and score on the Charlson Comorbidity Index, were assessed at admission.[29] The Charlson Comorbidity Index is a common parameter that can be used to correct for any overlap between comorbidity, disability, and frailty.[16] Baseline characteristics included age, sex, living arrangements before admission, marital status, whether participants were born in the Netherlands, level of education (primary, elementary/domestic, secondary, higher level education), and admission diagnosis (see Table 1 for a complete overview).

Functional impairment was defined as a score of 1 or higher on the Katz-6 ADL index.[27] Depressive symptoms were classified as a score of 6 or higher on the 15-item, Geriatric Depression Scale (GDS-15).[30] Cognitive impairment was defined as an MMSE of 23 points or lower.[26] Health-related quality of life (HRQOL) was measured using the EQ-5D questionnaire. Based on the answers to the EQ-5D, utility scores were calculated using the Dutch EQ-5D tariff.[31] The EQ-5D is widely used to measure HRQOL and is validated in many countries. The questions concern mobility, self-care, usual activities, pain and discomfort, anxiety, and depression.[32] HRQOL is expressed as a utility score between 0 and 1, where 0 equals death and 1 equals perfect health. Poor HRQOL was defined as a utility score below the median value.[33]

Frailty was assessed according to the criteria described by Fried et al,[34] including weight loss, fatigue, low physical activity, slowness, and muscle weakness. A person was considered frail when 3 or more criteria were present. Weight loss was dichotomized as determined by the SNAQ-score: having lost 6 kg or more in the last 6 months, or 3 kg or more in the past month.[35] Fatigue was defined by a numerical rating scale score of 4 or more on the question "On a scale of 0-10 how would you score your sense of fatigue at this time?"[36] Low physical activity was scored as present when patients reported that they did not do any physical exercise, walking, cycling, or swimming for 30 minutes at least monthly in the past 6 months. Slowness was defined with a cut-off point of walking slower than 6.42 seconds on a 4-m walking test.[34] We measured muscle weakness using maximum handgrip strength (Jamar). Cut-off points were <18 kg for women and <30 kg for men.[34]

Statistical Analysis

Missing values for cost and effect data were imputed using multiple imputation by chained equations with predictive mean

matching.[37] We reported missingness and used chi-square or Kruskal-Wallis test to evaluate differences between the group with complete and missing cost data. Individual subcosts per category were imputed instead of total costs to maximize the accuracy of the imputation.[38] We created 25 data sets where the analysis results were pooled using Rubin's rules.[39] Cost groups (low, moderate, and high) were calculated per imputed data set and pooled in further analyses.

We used multinomial logistic regression models to calculate Odds Ratios (OR) to estimate the association between variables and the 3 cost-groups.[40] The low cost group was the reference group in all analyses. Besides crude analysis, we adjusted for the following demographic characteristics: age (continuous), sex, educational level, marital status, and/or living situation in all adjusted multivariable multinomial logistic regression analyses. We ran a further adjusted analysis, including length of stay, hospitalization in the past 6 months, and score on the Charlson Comorbidity Index.[29] For sensitivity analyses, we performed a complete case analysis, including only complete cases and patients who died within 3 months postdischarge. Moreover, we performed additional sensitivity analyses to see if post-discharge costs and associations would be different if participants who originated from a nursing home or senior residence would be excluded from the analysis. Data were analyzed using SPSS, version 25.00.

Results

Participants and Study Sample

In total, 1024 consecutive patients were determined eligible for participation, of whom 505 did not meet inclusion criteria, could not be approached, or were too ill to participate. Of the 519 remaining patients, 401 were enrolled in the study. Forty patients (10.0%) died within the first 3 months postdischarge, of whom 28 died during admission or within the first month postdischarge. For these 28 patients, post-acute care costs were zero. Overall, we had 296 complete (including those who died and whose costs were set to zero) and 105 incomplete cases, missing partial or all cost data. Overall cost data missingness was 25%. Baseline missingness was very low (range 94.51%-99.75% complete), except for the frailty variable, which was low (84.5% complete). Participants who were single or widow(er), or had a lower education, were more likely to have missing data.

Mean Care Costs and Distribution of Costs

In the imputed data set we found that mean costs, that is, the average per-person value, for index admission were €4121 [standard deviation (SD) €7597, or $4657. (SD $5846)].[41] Mean costs for post-acute care were €4035 [SD €4346; $4560 (SD $4911)]. Post-acute care costs were distributed unevenly in the population, with the top 10.0% (n = 40) of participants accounting for 52.1% of total post-acute care costs. Mean health care costs were highest in the first month postdischarge, €1689 ($1909), and were €1161 ($1312) and €1186 ($1340) in the second and third month, respectively. Of total costs, 40.9% were attributed to unplanned readmissions (Figure 1). Additional analysis showed that in patients who originated from the community, the average costs for post-acute care were €3366 (SD 7018), equal to $3804 (SD 7930).

Costs Groups and Patient Characteristics by Cost Group

Total post-acute care costs for the 401 cases were €1.6 million ($1.8 million). The low-, moderate- and high-cost groups accounted for 4.3%, 16.3%, and 79.4% of total post-acute care costs, respectively. In Figure 2, we present the mean costs for index admission and the mean associated post-acute care costs per cost group based on index admission. Table 1 presents the baseline table per cost group based on post-acute care costs: participants in the high cost group tended to be older, had a higher length of stay, were often previously hospitalized, and tended to be nursing home residents more often than patients in the low- and moderate-cost groups.

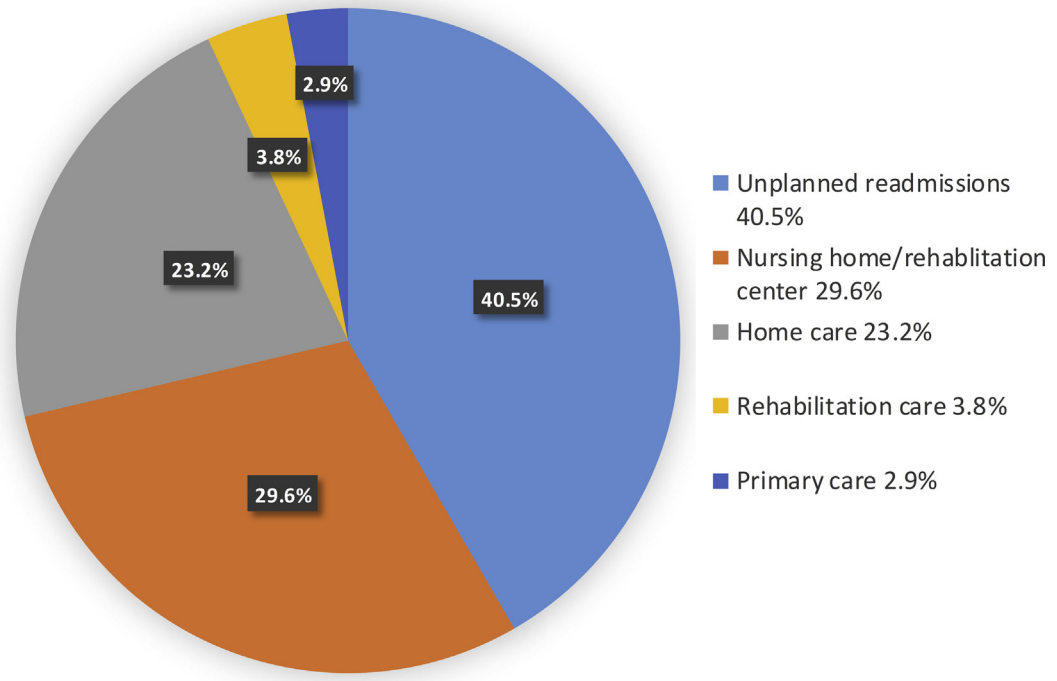

Fig. 1. Distribution of post-acute care costs, by type of care.

Multinomial Logistic Regression Analyses

In Table 2, we show that participants who had functional impairment, poor HRQOL, or were frail at admission had higher odds of being categorized in the high-cost group compared to the lowest-cost group. These associations were still present in the adjusted analyses. Cognitive impairment and depressive symptoms at admission were not associated with higher odds of categorization in the moderate- or high-cost group compared to the low-cost group in any of our models (Table 2). In the complete case analysis (n = 296) results were similar except for frailty; the found associations were much stronger in the complete case analysis (Appendix 1). The observed results from the main analysis were also similar to the analysis that only included participants (n = 377) who originated from home, though functional impairment was not as strongly associated with a risk of being categorized in the high-cost group (Appendix 2).

Discussion

This is 1 of the first studies to describe post-acute care costs in older hospitalized persons, clinically relevant patient characteristics, and determinants that are associated with higher costs. Our results demonstrated that for the total study population, the mean costs of post-acute care were as high as the costs of the index admission. As mean costs of the index admission increased, post-acute care costs increased as well. The top 10.0% (n = 40) of patients with highest post-acute care cost accounted for 52.1% of total post-acute care costs. Hence, whereas most patients had none to minimal costs, costs were substantial in a small part of the population. Costs were highest in the first month postdischarge, and the costliest types of care were unplanned readmissions, nursing home/rehabilitation care, and home care. Frailty, functional impairment, and poor HRQOL at admission were strongly associated with higher post-acute care costs.

Our findings on the ratio between post-acute care costs and the costs of index admission are consistent with a report by Mechanic et al.[1] This study stated that the average post-acute care payments by Medicare were almost as high as the costs for the initial index admission.[1] Our findings on the pattern of spending, with highest costs occurring in the first month postdischarge, coincide with the postdischarge literature that describes that most readmissions occur within 30 days after discharge.[42,43] General practice care was only a small proportion of overall costs, which is in a accordance with the small percentage (3.9%) of the total health care budget that is allocated to general practice in the Netherlands.[44]

Although frailty can be measured using various scales,[34,45,46] the finding that frailty is associated with increased post-acute care costs corresponds with previous literature that has described frailty as an independent determinant of high health care costs in both the inpatient and outpatient setting.[15,17,46] Building on these findings, our study indicates that frailty measured during the hospitalization period is also associated with increased postdischarge costs. Moreover, our findings are consistent with Murray et al, who studied mean costs in the inpatient setting and found that hospital expenses were higher in older patients with functional impairment.[21] Finally, our analyses suggest there is a relationship between poor HRQOL scores and costs.

The fact that post-acute care costs are substantial underlines the importance of adequate follow-up care to prevent unnecessary post-acute care expenditures. Our findings show that several measures that are often included in Comprehensive Geriatric Assessment (CGA), such as screening on frailty, are associated with increased

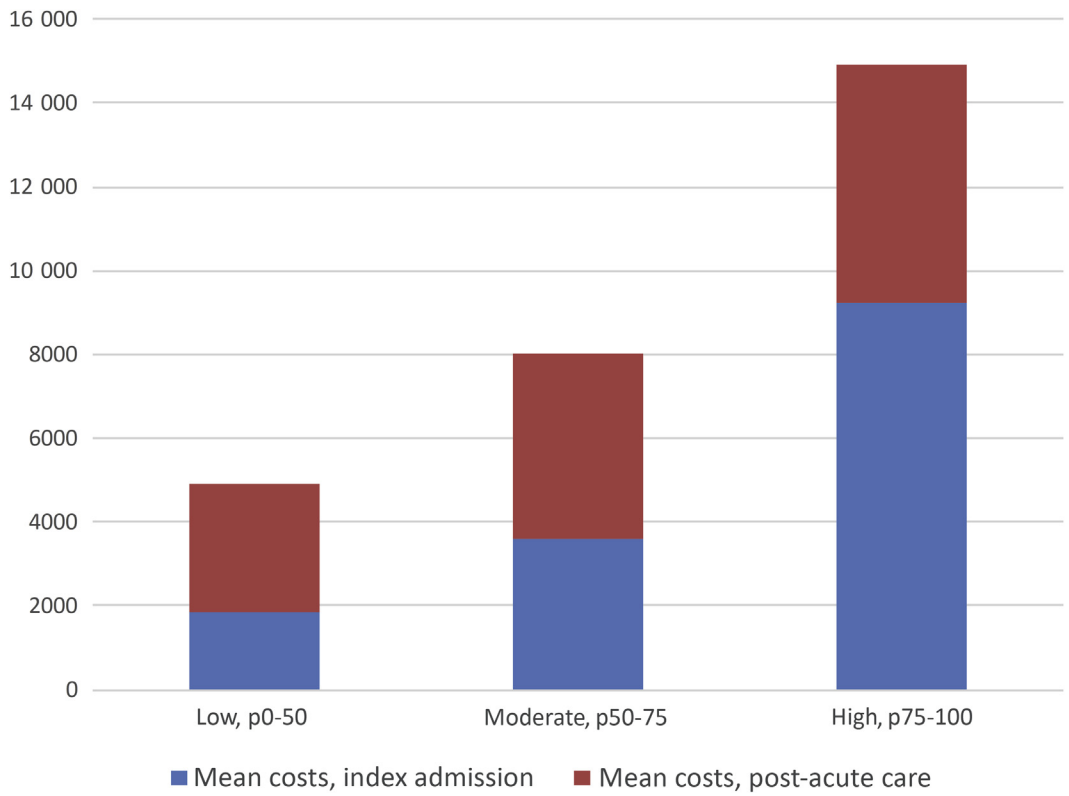

Fig. 2. Displaying the mean costs of the index admission and associated post-acute care costs, in euro, per cost group defined as low [0-50th percentile (p0-50)], moderate (p50-75), and high (p75-100). In the lowest cost group (p0-50), the mean index admission cost and associated mean post-acute care costs in euros were 1852 (SD 2746) and 3062 (SD 7797). In the group p50-75, these costs were 3581 (SD 2181) and 4416 (SD 6948) and for the highest quartile (p75-100) this was 9146 (SD 6289) and 5556 (SD 10 114). In USD, these costs would be 2093 (SD 3103) and 3460 (SD 8811) in the lowest cost group (p0-50). In the group p50-75, these costs were 4047 (SD 2465) and 4 990 (SD7 851) and for the highest quartile (p75-100), this was 10 335 (SD 7107) and 6278 (SD 11 429).

Table 2
Multinomial Logistic Regression on Cost Groups, With the Low-Cost Group as Reference Group at Admission (N = 401)

Outcome Variables at Admission	Moderate-Cost Group						High-Cost Group					
	OR (CI), Unadjusted	*P* Value	OR (CI), Adjusted*	*P* Value	OR (CI), Adjusted†	*P* Value	OR (CI), Unadjusted	*P* Value	OR (CI), Adjusted*	*P* Value	OR (CI), Adjusted†	*P* Value
Functional impairment	2.36 (1.34-4.16)	.003	2.03 (1.11-3.73)	.22	1.84 (0.98-3.46)	.06	2.58 (1.45-4.61)	.001	2.19 (1.17-4.10)	.015	1.80 (1.03-3.16)	.04
Depressive symptoms	1.44 (0.74-2.81)	.28	1.38 (0.70-2.73)	.35	1.43 (0.71-2.86)	.32	1.68 (0.89-3.19)	.11	1.52 (0.79-2.94)	.21	1.49 (0.75-2.95)	.25
Cognitive impairment	1.75 (0.86-3.52)	.12	1.50 (0.71-3.15)	.29	1.68 (0.78-3.61)	.18	1.38 (0.71-2.69)	.34	1.20 (0.59-2.45)	.62	1.17 (0.57-2.44)	.66
Poor health-related quality of life	1.62 (0.96-2.74)	.07	1.49 (0.87-2.53)	.15	1.50 (0.87-2.58)	.14	2.29 (1.36-3.88)	.002	2.10 (1.23-3.59)	.007	1.89 (1.09-3.28)	.02
Frailty	1.86 (1.03-3.35)	.04	1.70 (0.91-3.15)	.10	1.60 (0.83-3.06)	.16	3.93 (2.15-7.18)	<.001	3.69 (1.98-6.88)	<.001	3.44 (1.78-6.63)	<.001

Moderate-Cost Group, third quartile of costs (p50-75) compared to Low-Cost Group, below median costs (p0-50); High-Cost Group, highest quartile of costs (p75-100) compared to Low-Cost Group, below median costs (p0-50).
CI, confidence interval; OR, odds ratio.
*Multivariable regression with the low-cost group as reference group, correction for demographic characteristics: age, marital status, education level, sex, and living arrangements at admission.
†Multivariable regression with the low-cost group as reference group, correction for demographic characteristics, length of stay, previous hospitalization in the past 6 months, and Charlson Comorbidity Index.[29]

health care expenditure. Although there is no definitive evidence that CGA has a cost-reducing effect on overall post-acute care costs,[47,48] using recommendations provided in the CGA treatment for discharge planning and initiation of appropriate follow-up care may reduce costs from preventable readmissions and institutionalization.[47,48] It should be noted, however, that frailty may also be a sign that an older patient is entering the final phase of life, which may not warrant a sole focus on early treatment of recurrent illness but also on advance care planning.[34,49]

There is no decisive evidence on the effects of advance care planning on post-acute care costs.[50] This study is limited to the extent to which hospice care costs and planning can be described precisely. Further research on this topic is warranted, especially on how advance care planning could aid in preventing unnecessary readmissions or hospital interventions and thereby reduce costs. This has been studied more extensively in patients suffering from malignant diseases, but not in older patients with frailty who were recently hospitalized.[50]

Limitations

This study has some limitations. First, how post-acute care should be defined is contentious. For instance, because it is difficult to distinguish between post-acute care and “care as usual” in participants who were already nursing home residents, we decided to account all costs for home care and nursing home/rehabilitation care as post-acute care. However, we corrected for this in our analyses and performed a sensitivity analysis including only community-dwelling participants, which showed similar costs and associations. Furthermore, we did not include costs for emergency department visits that did not result in a hospitalization, which in other research has been studied as a source of preventable costs.[11,18] Second, patients with an MMSE score lower than 15 were excluded from this study, which fundamentally alters our study population from the populations that have been studied with respect to the relation between dementia and costs.[20] This could explain why we did not find an association between cognitive impairment and costs. Moreover, missing data may have decreased the accuracy of the absolute cost data per participant. After performing multiple imputation, we found similar results in our multinomial regression analysis, so this missingness may not have changed our results and conclusions. However, it is possible that we were underpowered for drawing conclusions on some of the relations between determinants and costs, as the number of participants in the study was powered to draw conclusions on differences in ADL functioning.

Conclusions and Implications

Post-acute care costs are substantial, but only in a small portion of acutely hospitalized older adults. The presence of frailty, functional impairment, and poor HRQOL at time of admission are associated with an increased risk of high post-acute care costs. These measures may provide means to be studied as a predictor of post-acute costs in future research. Moreover, our findings suggest that adequate follow-up care planning in patients who score positive on these measures may help in making cost-reduction strategies more effective in practice.

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Appendix

Appendix 1

Complete Case Analysis: Multinomial Logistic Regression on Cost Groups, With the Low-Cost Group as Reference Group at Admission (n = 296)

Outcome Variables at Admission	Moderate-Cost Group						High-Cost Group					
	OR (CI), Unadjusted	*P* Value	OR (CI), Adjusted*	*P* Value	OR (CI), Adjusted†	*P* Value	OR (CI), Unadjusted	*P* Value	OR (CI), Adjusted*	*P* Value	OR (CI), Adjusted†	*P* Value
Functional impairment	2.10 (1.16-3.78)	.01	1.62 (0.85-3.07)	.14	1.58 (0.81-3.08)	.18	2.69 (1.46- 4.98)	.002	2.19 (1.14-4.21)	.02	2.16 (1.10-4.20)	.02
Depressive symptoms	1.44 (0.72-2.88)	.3	1.36 (0.66-2.80)	.4	1.62 (0.76-3.43)	.2	1.91 (0.99-3.73)	.06	1.75 (0.89-3.45)	.1	1.69 (0.85-3.41)	.14
Cognitive impairment	2.83 (1.40-5.76)	.004	1.90 (0.87-4.12)	.11	2.28 (1.03-5.10)	.043	1.69 (0.77-3.69)	.19	1.57 (0.68-3.61)	.29	1.64 (0.70-3.86)	.25
Poor health-related quality of life	1.46 (0.83-2.56)	.19	1.32 (0.74-2.35)	.35	1.39 (0.77-2.53)	.28	1.93 (1.09-3.41)	.02	1.80 (1.01-3.21)	.047	1.72 (0.96-3.10)	.07
Frailty	1.41 (0.77-2.59)	.27	1.07 (0.55-2.10)	.84	1.04 (0.51-2.15)	.91	6.93 (3.03-14.54)	<.001	6.87 (3.16-14.92)	<.001	6.93 (3.09-15.54)	<.001

Moderate-Cost Group, third quartile of costs (p50-75) compared to Low-Cost Group, below median costs (p0-50); High-Cost Group, highest quartile of costs (p75-100) compared to Low-Cost Group, below median costs (p0-50).
CI, confidence interval; OR, odds ratio.

*Multivariable regression with the low-cost group as reference group, correction for demographic characteristics: age, marital status, education level, sex, and living arrangements at admission.

†Multivariable regression with the low-cost group as reference group, correction for demographic characteristics, length of stay, previous hospitalization in the past 6 months, and Charlson Comorbidity index.[29]

Appendix 2

Analysis in Community-Dwelling Older Adults: Multinomial Logistic Regression on Cost Groups, With the Low-Cost Group as Reference Group at Admission (n = 377)

Outcome Variables at Admission	Moderate-Cost Group						High-Cost Group					
	OR (CI), Unadjusted	*P* Value	OR (CI), Adjusted*	*P* Value	OR (CI), Adjusted†	*P* Value	OR (CI), Unadjusted	*P* Value	OR (CI), Adjusted*	*P* Value	OR (CI), Adjusted†	*P* Value
Functional impairment	2.30 (1.28-4.16)	.006	1.85 (0.99-3.46)	.052	1.65 (0.87-3.14)	.13	2.28 (1.28-4.04)	.005	1.93 (1.04-3.58)	.04	1.80 (0.94-3.44)	.08
Depressive symptoms	1.73 (0.89-3.37)	.11	1.63 (0.83 -3.21)	.16	1.74 (0.87-3.47)	.12	1.71 (0.86-3.35)	.12	1.54 (0.77-3.06)	.16	1.53 (0.74-3.15)	.25
Cognitive impairment	1.94 (0.95-3.95)	.07	1.55 (0.72-3.34)	.26	1.81 (0.81-4.04)	.15	1.74 (0.88-3.44)	.11	1.49 (0.73-3.06)	.28	1.56 (0.74-3.29)	.24
Poor health-related quality of life	1.55 (0.88-2.74)	.23	1.44 (0.80-2.57)	.22	1.44 (0.80-2.58)	.23	2.15 (1.24-3.73)	.006	2.08 (1.19-3.64)	.01	1.86 (1.04-3.32)	.036
Frailty	1.64 (0.85-3.17)	.15	1.45 (0.71-2.97)	.31	1.32 (0.63-2.75)	.46	3.32 (1.83-6.02)	<.001	3.13 (1.70-5.79)	<.001	2.84 (1.48-5.42)	.002

Moderate-Cost Group, third quartile of costs (p50-75) compared to Low-Cost Group, below median costs (p0-50); High-Cost Group, highest quartile of costs (p75-100) compared to Low-Cost Group, below median costs (p0-50).
CI, confidence interval; OR, odds ratio.

*Multivariable regression with the low-cost group as reference group, correction for demographic characteristics: age, marital status, education level, sex, and living arrangements at admission.

†Multivariable regression with the low-cost group as reference group, correction for demographic characteristics, length of stay, previous hospitalization in the past 6 months, and Charlson Comorbidity Index.[29]