Clinical and functional patient characteristics predict medical needs in older patients at risk of functional decline

Anne-Carina Scharf (anne-carina.scharf@uk-essen.de)
University Hospital Essen  https://orcid.org/0000-0001-7541-7503

Janine Gronewold
Universitätsklinikum Essen

Christian Dahlmann
Universitätsklinikum Essen

Jeanina Schlitzer
Alfred Krupp Hospital, Essen, Germany

Andreas Kribben
Universitätsklinikum Essen

Guido Gerken
Universitätsklinikum Essen

Helmut Frohnhofen
Alfred Krupp Hospital Essen

Richard Dodel
Universitätsklinikum Essen

Dirk M Hermann
Universitätsklinikum Essen

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Abstract

Background: The rising number of older multimorbid in-patients has implications for medical care. There is a growing need for the identification of factors predicting the needs of older patients in hospital environments. Our aim was to evaluate the use of clinical and functional patient characteristics for the prediction of medical needs in older hospitalized patients.

Methods: 242 in-patients (57.4% male) aged 78.4±6.4 years, who were consecutively admitted to internal medicine departments of the University Hospital Essen between July 2015 and February 2017, were prospectively enrolled. Patients were assessed upon admission using Identification of Seniors at Risk (ISAR) screening followed by comprehensive geriatric assessment (CGA). CGA included standardized instruments for the assessment of activities of daily living (ADL), cognition, mobility, and signs of depression upon admission. In multivariable regressions we evaluated the association of clinical patient characteristics, ISAR score and CGA results with length of hospital stay and number of nursing hours and receiving physiotherapy as indicators for medical needs. We identified clinical characteristics and risk factors associated with higher medical needs.

Results: The 242 patients spent [median(Q1;Q3)]:9.0(4.0;16.0) days in the hospital, needed 2.0(1.5;2.7) hours of nursing each day, and 34.3% received physiotherapy. In multivariable regression analyses including clinical patient characteristics, ISAR and CGA domains, the factors age (β=-0.19, 95% confidence interval (CI)=-0.66;-0.13), number of admission diagnoses (β=0.28, 95%CI=0.16;0.41), ADL impairment (B=6.66, 95%CI=3.31;10.01), signs of depression (B=6.69, 95%CI=1.43;11.94) independently predicted length of hospital stay. ADL impairment (B=1.14, 95%CI=0.67;1.61) cognition impairment (B=0.57, 95%CI=0.07;1.07) and ISAR score (β =0.26, 95%CI=0.01;0.28) independently predicted nursing hours. The number of admission diagnoses (risk ratio (RR)=1.06, 95%CI=1.04;1.08), ADL impairment (RR=3.54, 95%CI=2.29;5.47), cognition impairment (RR=1.77, 95%CI=1.20;2.62) and signs of depression (RR=1.99, 95%CI=1.39;2.85) predicted receiving physiotherapy.

Conclusion: Among older in-patients at risk for functional decline, the number of comorbidities, reduced ADL, cognition impairment and signs of depression are important predictors of length of hospital stay, nursing hours, and receiving physiotherapy during hospital stay.

Introduction

With the ongoing demographic changes, hospitals face a constantly rising number of older, often multimorbid patients. This has profound implications for patients care [1–4]. Older patients with multimorbidity are characterized by multidimensional impairments including physiological, emotional, social, and cognitive deficits, which are associated with higher risk of functional decline [3, 5, 6]. Older patients with chronic and complex conditions are more vulnerable and likely to fall, and have more risk factors which could extend and complicate their hospital stay and increase complications [1, 7]. Since the number of these patients at risk is expected to increase due to demographic changes, attempts have
been made to identify these patients using screenings and assessments [8]. By now the ISAR screening tool is one of the most commonly used tools to predict the risk of functional decline in older patients [6, 9, 10]. In case of high-risk patients with positive ISAR screening, a comprehensive geriatric assessment (CGA) is recommended as second diagnostic step. ISAR screening in combination with CGA has recently been validated for acute medical departments by Scharf et al. [11]. Since CGA is a time- and resource consuming assessment it is not efficient to perform CGA in all patients [12, 13]. In patients at risk for functional decline, CGA enables to collect further information about patients’ clinical and functional characteristics and offers a possibility to gain a better understanding of mechanisms underlying needs for intensified in-hospital medical care [14].

Needs of intensified medical care in older patients reflected by prolonged length of hospital stay, more nursing hours and receiving physiotherapy challenges personnel and financial resources [7, 15, 16]. Previous studies showed that prolonged length of hospital stay is predicted by factors including female sex and polypharmacy in patients aged ≥65 years admitted to acute internal and geriatric wards [7] and by age ≥60 and higher number of comorbidities in colon cancer patients with an age <60 to >80 years [17]. By now, it is unknown which patient characteristics predict prolonged length of hospital stay in older internal medicine in-patients who are at risk for functional decline defined by positive ISAR.

An association between nursing hours and patients’ functional status seems obvious but systematic evidence-based analyses are still scarce [18]. A study conducted by Sousa et al. found that nursing hours in intensive care patients was predicted by higher age and severity of illness and it was higher in surgical patients than in internal medicine wards [19]. In patients admitted to surgery wards, comorbidities, ISAR score, and mobility impairment, ADL impairment and cognition impairment were predictors for nursing hours [6]. By now, evidence for the prediction of nursing hours in internal medicine in-patients is still missing as is evidence for the prediction of physiotherapy, which reflects mobility impairment and contributes to functional recovery, in internal medicine in-patients. Previous studies evaluated how physiotherapy influenced patients’ medical needs [20, 21]. The association of physiotherapy with preexisting impairment was much less studied [22, 23].

There have hitherto been very few studies exploring higher medical needs in older patients at risk for functional decline. To further improve the attribution of medical care, we need to understand which patient characteristics are associated with patient needs for intensified medical care in hospital environments. In our last manuscript, we evaluated the diagnostic validity of ISAR score and CGA conducting cutoff- and sensitivity/specificity analyses [11]. We now focus on clinical application of these tools and study how patient characteristics, ISAR score and CGA results are associated with length of hospital stay, nursing hours, and receiving physiotherapy in older internal medicine patients.

**Methods**

**Study cohort**
The sample used for the present analyses included 242 hospitalized patients (57.2% male, mean± standard deviation (SD) age 78.4±6.4 years old) who were admitted to the internal medicine departments of the University Hospital Essen between July 2015 and February 2017 and who received ISAR screening by the nursing staff upon admission. Patients were included into this present study if they fulfilled an age criterion (see below), and had a positive ISAR screening (score ≥2) followed by CGA. The age criterion was a) ≥75 years in the Department of Gastroenterology and Hepatology and in the Department of Cardiology and Angiology or b) ≥65 years in the Department of Nephrology since nephrological patients exhibit premature aging [24, 25]. The CGA was performed within three days after admission by a geriatric liaison service (consisting of a geriatrician, a psychologist and an occupational therapist). The available data were prospectively obtained. More detailed information about study cohort characteristics and methodology have previously been reported (see [11]). The study was approved by the ethics committee of the University Duisburg-Essen and need for consent was waived.

**Clinical and functional characteristics of patients**

*Clinical characteristics*

It has been proposed that admission diagnoses represent the best predictor for length of hospital stay [26]. Since we had a broad spectrum of different internal medicine diseases, we analyzed the number of admission diagnoses as indicator for illness severity. Patients’ demographic data, diagnoses and medical histories were taken from the electronic Hospital Information System (HIS).

*Functional characteristics: ISAR screening*

We utilized a modified version of the original ISAR by McCusker [27]. This ISAR screening comprises six yes/no items about the following domains: Premorbid functional dependence, acute change in functional dependence within the last 24 hours, hospitalization within the last six months, impaired vision, impaired memory and polypharmacy (≥6 medications). These items are summed up resulting in an ISAR score ranging from 0–6. An ISAR score ≥2 was interpreted as positive implying that patients with positive ISAR are at risk for functional decline.

*Functional characteristics: CGA*

The CGA included six commonly used geriatric tests. The Barthel Index was used for the assessment of ADL with a score ≤90 defined as impaired [28–30]. Timed Up and Go [31] and Tinetti Mobility Test [32] were used for the assessment of mobility. Mobility was rated as impaired if Timed Up & Go was ≥20 seconds and/or the patients had scores <20 in the Tinetti Mobility Test [33, 34]. Cognition was assessed using the 30 item Mini-Mental State Examination (MMSE) [35] and the Clock-Drawing Test [36]. Cognition was interpreted as impaired if MMSE was ≤27 and/or the clock-Drawing Test score was ≥3 [37, 38]. For the assessment of signs of depression, we applied the Geriatric Depression Scale (GDS). A GDS score ≥6 was interpreted as present signs of depression [39].
In-hospital medical needs

Measures of in-hospital medical needs comprised length of hospital stay in days, nursing hours per day and received physiotherapy (yes/no), which were obtained by the electronical HIS. Length of hospital stay was defined as the number of days from admission to discharge from the ward. Prolonged length of hospital stay was defined as ≥7 days, which is the minimum duration of geriatric rehabilitation in Germany.

Nursing hours were documented using the “Leistungserfassung in der Pflege” catalogue, a set of approximately 180 items covering all features of nursing in-patient care which is widely used in German-speaking countries [18]. Each item includes a time value, which is coded as the default value or adapted based on nursing effort (for further details see [6]). More nursing hours were defined as ≥2 hours per day since this was the median in our cohort. Receiving physiotherapy was again operationalized using HIS data. Since 159 (65.7%) patients did not receive physiotherapy, the variable was dichotomized into receiving physiotherapy and not receiving physiotherapy.

Statistical analyses

Continuous variables were presented as mean± SD for normally distributed data (age) or as median and interquartile range (Q1;Q3) when data was not normally distributed (all other variables). Categorical variables were shown as numbers and percentages (%).

We dichotomized patients’ outcome variables in

(a) length of hospital stay <7 days vs ≥7 days,

(b) nursing hours above median (≥2 hours) vs below median (<2 hours), and

(c) receiving physiotherapy vs not receiving physiotherapy

To compare these characteristics between patients low and high medical needs, we used t-tests for normally distributed continuous data, Mann-Whitney-U-tests for not normally distributed data and χ² tests for categorical data. For this comparison,

To evaluate the predictors for length of hospital stay in days and nursing hours per day, uni- and multivariable linear regressions (forced entry method) were calculated. Since only about one third of patients (34.3%) received physiotherapy during hospital stay, we used the dichotomized variable of receiving physiotherapy (yes vs no) in uni- and multivariable Poisson regressions with robust error variance. The factors age, sex, number of admission diagnoses, ISAR score, ADL, mobility impairment and cognition impairment as well as signs of depression were first inserted unadjusted into these regressions. In a next step we analyzed the effects of the following models on in-hospital medical needs (length of hospital stay, nursing hours, and receiving physiotherapy).
(a) Model 1 including age, sex, and ISAR score,

(b) model 2 including age, sex, ADL impairment, mobility impairment, cognition impairment, and signs of depression,

(c) model 3 including age, sex, ISAR score, ADL impairment, mobility impairment, cognition impairment, and signs of depression and

(d) model 4 including age, sex, number of admission diagnoses, ISAR score, ADL impairment, mobility impairment, cognition impairment, and signs of depression

In regression analyses, missing data were excluded list-wise, in the other calculations cases were only excluded if outcome variables were missing. All analyses were performed using Statistical Packing for Social Science 22 (SPSS 22) for Windows (SPSS, Chicago, IL, U.S. A.).

Results

Study cohort

The 242 patients of the total cohort (78.4±6.4 years and 57.2% male) spent 9.0(4.0; 16.0) (median(Q1;Q3)) days in hospital, and received 2.0(1.5;2.7) hours of nursing each day. Approximately one third (34.3%) received physiotherapy. Of the total cohort, 48.8% had chronic kidney disease, 38.8% had cancer, and 39.7% had coronary heart disease. ADL impairment was present in 47.1%, mobility impairment in 35.1%, cognition impairment in 53.7%, and signs of depression in 11.6% of the total cohort. Further demographic and medical data including comorbidities for the total cohort and split by high and low medical needs are shown in Table 1 and supplementary material S1.

Factors associated with needs for intensified medical care

Length of hospital stay

Comparison of patients staying <7 vs ≥7 days in hospital

142 (58.7%) of the patients stayed ≥7 days in hospital. Compared with patients staying < 7 days (n = 100), patients who stayed ≥7 days were significantly more often female (47.9% vs 35.0%, p = 0.046) had a higher number of diagnoses at admission (median(Q1;Q3) = 2.0(2.0;6.0) vs 1.0(1.0;6.0), p<0.001), received more nursing hours (2.1(1.6;2.9) vs 1.9(1.4;2.6), p<0.001), and more often received physiotherapy (53.5% vs 7.0%, p<0.001). They were also more often impaired in the CGA domains ADL (55.6% vs 47.1%, p = 0.002), mobility (41.5% vs 26.0%, p = 0.012), signs of depression (15.5% vs 6.0%, p = 0.022) with a tendency towards significance in cognition (58.5% vs 47.0%, p = 0.071). Age and ISAR score did not significantly differ between patients staying ≥7 days and patients staying <7 days (Table 1).
Predictors of length of hospital stay in multivariable regression models

In unadjusted regressions, younger age ($\beta = -0.19$, 95% CI = $-0.66;-0.13$), higher number of admission diagnoses ($\beta = 0.28$, 95% CI = $0.16;0.41$), ADL impairment ($B = 6.66$, 95% CI = $3.31;10.01$) and signs of depression ($B = 6.69$, 95% CI = $1.43;11.94$) were significantly associated with longer hospital stay in the total cohort. In a multivariable regression including ISAR score, age and sex, only younger age remained a significant predictor (model 1 in Table 2). Replacing ISAR by CGA results, ADL impairment and cognition impairment as well as signs of depression were associated with longer hospital stay in addition to younger age (model 2 in Table 2). The addition of ISAR score did not influence regression model characteristics to a relevant degree (model 3 in Table 2) whereas further adding the number of admission diagnoses (model 4 in Table 2) improved the regression model from $R^2 = 0.143$ to 0.197 because a higher number of admission diagnoses were a significant predictor of longer hospital stay in addition to ADL impairment and cognition impairment, signs of depression and younger age.

Nursing hours per day

Comparison of patients needing $<2$ vs $\geq 2$ hours nursing per day

108 (50.9%) of the patients received $\geq 2$ hours of nursing per day. Compared with patient with $<2$ hours nursing per day; patients with more nursing hours ($\geq 2$ hours per day) had more often a diagnosis of dementia (13.0% vs 3.8%, $p = 0.017$), diagnosis of depression (9.3% vs 1.0%, $p = 0.006$), and diagnosis of pressure ulcer (11.1% vs 3.8%, $p = 0.045$). They also received more often physiotherapy (44.4% vs 24.0%, $p = 0.002$), had a higher ISAR score (3.0(2.0;4.0) vs 2.0(2.0;3.0), $p = 0.002$), and more often ADL impairment (61.1% vs 33.7%, $p<0.001$) and mobility impairment (42.6% vs 29.8%, $p = 0.046$). These two groups did not differ in age, number of admission diagnoses, and the CGA domains mobility, cognition, and signs of depression (Table 1).
Predictors of nursing hours in multivariable regression models

In unadjusted regressions, a higher ISAR score (β = 0.26, 95% CI = –0.01; 0.28) and ADL impairment (B = 1.14, 95% CI = 0.67;1.61) and cognition impairment (B = 0.57, 95% CI = 0.07;1.07) were significant predictors of hours of nursing care received per day. In multivariable regression models, only ADL impairment remained a significant predictor (models 1–4 in Table 3).

Receiving physiotherapy

Comparison of patients receiving physiotherapy vs not receiving physiotherapy

83 patients (34.3%) received physiotherapy, whereas 159 patients did not. Compared with patients not receiving physiotherapy, clinical characteristics which were more common in patients receiving physiotherapy had more often pressure ulcers (12.0% vs 5.0%, p = 0.048). Patients who received physiotherapy stayed longer in hospital (20.0 vs 6.0 days, p<0.001), needed more hours of nursing (2.6(1.9;3.3) vs 1.8(1.4;2.5), p = 0.044), were more often female (47.0% vs 37.1%,p = 0.018) and had a higher ISAR score (3.0 (2.0;4.0), p = 0.040). Patients who received physiotherapy were also more often impaired in ADL (75.9% vs 32.1%, p<0.001), mobility (45.8% vs 29.6%, p = 0.009), cognition (66.3% vs 47.2%, p = 0.029), more often showed signs of depression (20.5% vs 6.9%, p = 0.045) and had a higher number of admission diagnoses (3.0 (1.0;7.0) vs 1.0(1.0;2.0), p<0.001). Age did not differ between these groups (Table 1).

Predictors of receiving physiotherapy in multivariable regression models

In unadjusted regressions, higher number of admission diagnoses (RR = 1.06, 95% CI = 1.04;1.08), ADL impairment (RR = 3.54, 95% CI = 2.29;5.47), cognition impairment (RR = 1.77, 95% CI = 1.20;2.62), and signs of depression (RR = 1.99, 95% CI = 1.39;2.85) were significant predictors of receiving physiotherapy (Table 4). In a multivariable regression including age, sex and ISAR score, only female sex remained a significant predictor (model 1 in Table 4). Replacing ISAR by CGA results, ADL impairment and signs of depression were significantly associated with receiving physiotherapy (model 2 in Table 5). The addition of ISAR score again did not influence regression model characteristics to a high degree (model 3 in Table 4). Further addition of the number of medical admission diagnoses (model 4 in Table 4) improved the regression model from $R^2 = 0.291$ to 0.336. A higher number of admission diagnoses were a significant predictor of receiving physiotherapy in addition to ADL impairment with now also impairment of
cognition reaching significance. In contrast, signs of depression stayed slightly below the statistical significance threshold (model 4 in Table 4) probably because of a significant intercorrelation between number of admission diagnoses and signs of depression.

**Discussion**

The present study identified predictors of medical needs represented by length of hospital stay, nursing hours and receiving physiotherapy in older hospitalized patients at risk for functional decline identified by a positive ISAR. In multivariable regressions, significant predictors of length of hospital stay were ADL impairment and cognition impairment as well as signs of depression, in addition to a higher number of admission diagnoses. Patients with more nursing hours (≥2 hours) had more often a diagnosis of dementia and depression and ADL impairment and mobility impairment than patients with <2 hours of nursing per day. Moreover, ADL impairment was a significant predictor of nursing hours per day in multivariable regression. Predictors for receiving physiotherapy in multivariable regressions were a higher number of admission diagnoses and ADL impairment with cognition impairment and signs of depression, being significant predictors in unadjusted univariate regression models.

**Comparison with literature**

**Length of hospital stay**

In our study, the median length of hospital stay in the total cohort was 9.0 (4.0;16.0) days which is comparable to other older patient cohorts. The medium stay in hospital was between 5–12 days in older patients admitted to geriatric and internal medicine wards [7, 15, 20, 40]. In a previous study analyzing 419 patients aged ≥70 years from geriatric wards [26], higher age, number of admission diagnoses, incontinence, and ADL impairment predicted the length of hospital stay. In a cohort of older orthopedics and trauma surgery patients (82.5±5.5 years) impairment of ADL, signs of depression, and higher number of admission diagnoses predicted prolonged hospital stay [6].

Available data concerning the predictive value of cognition impairment for length of hospital stay is ambiguous. Vetrano et al. showed that cognition impairment assessed by MMSE did not predict the length of hospital stay in older patients (≥65 years) electively admitted to acute geriatric and internal medicine wards in Italy [7]. However, other studies showed that cognitive impairment or the diagnosis of dementia predicted a longer stay in hospital [41, 42]. Binder and Robins showed that lower MMSE score was a significant predictor for a longer hospital stay. A decline in the MMSE score over one year in community-dwelling older persons was associated with an higher risk of hospitalization and prolonged hospital stay (>20 days) [43]. Cognitive impairment often remains undetected in hospitals. However, early identification of cognitive impairment during the hospital stay is crucial since patients with cognitive impairment are often malnourished, have a greater risk of falls, higher mortality, longer hospital stay, and higher short-term readmission risk [44]. Besides cognition impairment, signs of depression were associated with prolonged length of hospital stay in our study. In a meta-analysis, Jansen et al. described
that patients with comorbid depression spent more days in hospital (mean 13.8 days) than patients without comorbid depression (mean 10.5 days) and that comorbid depression was also related to increased medical costs which was not further analyzed in their meta-analysis due to limited data [45].

**Nursing**

In a study comparable to the results of our study, conducted by Mueller et al. analyzing 50 geriatric patients in multivariable analyses, impairment of ADL measured by the Barthel Index was a highly significant predictor of nursing hours [46]. In a Canadian Multicenter study of Hall et al., hospitalized patients of internal medicine, surgical and obstetric wards needed more nursing hours per day if their age was higher or if they suffer from more complex diseases which both were not associated with nursing hours in our cohort [47]. In our internal medicine patients, an impaired Barthel Index for the assessment of ADL was the only significant predictor for nursing workload and is therefore a useful tool for predicting older patients’ needs. One explanation for the influence of the Barthel Index in predicting nursing hours is that the Barthel Index is closely linked to the nursing anamnesis at the beginning of the nursing process, which includes planning of patients’ nursing needs and subsequent nursing hours.

**Physiotherapy**

Receiving physiotherapy was also predicted by impairment in ADL and signs of depression in our internal medicine patients at risk for functional decline. Physicians prescribe physiotherapy for patients with impairment in ADL because physiotherapy aims to restore the patients’ functional independence [48]. One explanation for the influence of depression could be that prescription of physiotherapy was also based on the idea that the patient would benefit from physiotherapy because of its influence on mood [49]. Another explanation could be that depressed patients better emphasize their neediness.

**Strengths and limitations**

A major strength of our study was the prospective design, which enabled to analyze associations between clinical patient characteristics and their medical needs. We included a broad spectrum of internal medicine diseases and merge patients from cardiological, gastroenterological, and nephrological departments. By merging patients from different wards we decreased the susceptibility of our data to specific singularity. Since we only included internal medicine patients, our results should carefully be transferred to other medical specialties. Our study evaluated medical needs in a university hospital environment. Further analyses are required to show if the identified risk factors can also predict medical needs in non-academic primary hospitals.

The combination of clinical and functional patient characteristics was an additional strength of our study. We performed an extensive CGA in every patient which we combined with clinical routine data. Of course, CGA itself can influence medical care and change patients’ outcome e.g. by rising awareness of
patients’ medical needs, and making the hospital staff more attentive to these patients during their stay. Using data of the HIS implies that data documentation is complete and adequate.

**Conclusion**

Among older in-patients at risk for functional decline, the number of comorbidities, ADL impairment, cognition impairment, and signs of depression are important predictors of medical needs during hospital stay. Patients with needs for intensified medical care should be identified soon after admission. Their early identification enables appropriate care and treatment allocation.

**Declarations**

**Ethics approval and consent to participate**

The study was approved by the ethics committee of the University Duisburg-Essen, need for consent was waived and the study was performed in accordance to the Declaration of Helsinki

**Consent to publish**

Since there are no details on individuals reported within the manuscript consent for publication was waived.

**Availability of data and materials**

All relevant data are within the paper. If additional data is needed it can be made available from the ethical committee of the University Duisburg-Essen (ethikkommission@uk-essen.de) for researchers who meet the criteria for access to confidential data by contacting the corresponding author.

**Competing interests**

All authors report no competing interests.

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**Authors Contributions**

All authors read and approved the final version of the manuscript
ACS Data curation, Formal analysis, Methodology, Project administration, Visualization, Writing-original draft

JG Data curation, Formal analysis, Methodology, Project administration, Supervision, Visualization, Writing-original draft

CD Conceptualization Software, Project administration, Writing-review & editing

JS Data curation, Writing-review & editing

AK Conceptualization, Project administration, Writing-review & editing

GG Conceptualization, Project administration, Writing-review & editing

HF Conceptualization, Project administration, Writing-review & editing

RD Conceptualization, Project administration, Writing-review & editing

DMH Conceptualization, Investigation, Methodology, Project administration, Supervision, Writing-original draft

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**List Of Abbreviations**

Identification of Seniors at Risk screening (ISAR)

Comprehensive geriatric assessment (CGA)

Geriatric Depression Scale (GDS)

Mini Mental State Examination (MMSE)

(ADL)

Standard deviation (SD)

Statistical Packing for Social Science 22 (SPSS 22)

Confidence interval (CI)
Hospital information system (HIS)

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### Table 1. Characteristics of the total cohort also split by low vs high medical needs

|                          | Total cohort (n=242) | Length of hospital stay | Nursing hours per day | Received physiotherapy |
|--------------------------|----------------------|-------------------------|-----------------------|------------------------|
|                          |                      | <7 days (n=100, 41.3%)  | ≥7 days (n=142, 58.7%)| <2 hours (n=104, 49.1%)| ≥2 hours (n=108, 50.9%)| No (n=159, 65.7%)| Yes (n=83, 34.3%)|
| Age (years), mean±SD     | 78.41±6.4            | 79.0±5.9                | 78.04±6.7             | 77.44±6.0              | 78.87±6.5              | 78.13±6.0              | 78.95±7.0              |
| Sex (male), n(%)         | 139 (57.2)           | 65 (65.0)*              | 74 (52.1)             | 67 (64.4)              | 56 (51.9)              | 100 (62.9)*            | 44 (53.0)              |
| Admission diagnoses     |                      |                         |                       |                        |                        |                        |                        |
| of stroke, (median[Q1;Q3])| 1.0 [1.0;3.25]       | 1.0                     | 2.0                   | 1.0                    | 2.0                    | 1.0                    | 3.0                    |
| of heart failure, (median[Q1;Q3])| 2.0 [2.0;4.0]   | 3.0                     | 2.0                   | 3.0                    | 2.0                    | 2.0                    | 3.0                    |
| of depression, n(%)      | 28 (11.6)            | 6 (6.0)*                | 22 (15.5)             | 12 (11.5)              | 13 (12.0)              | 11 (6.9)*              | 17 (20.5)              |
| of hypertension, n(%)    | 9 (40.0)             | 3.5                     | 14.0                  | 8.0                    | 11.0                   | 6.0                    | 20.0                   |
| of diabetes, n(%)        | 83 (34.3)            | 7 (7.0)*                | 76 (35.5)             | 25 (24.0)*             | 48 (44.4)              | 0.0 (0.0)              | 83 (100.0)             |
| of myocardial infarction | 193 (79.8)           | 77 (77.0)               | 116 (81.7)            | 85 (81.7)              | 88 (81.5)              | 124 (78.0)             | 69 (83.1)              |
| of kidney disease        | 134 (55.4)           | 51 (51.0)               | 83 (58.5)             | 63 (60.6)              | 59 (54.6)              | 89 (56.0)              | 45 (54.2)              |
| of obstructive pulmonary disease | 32 (13.2) | 12 (12.0)               | 20 (14.1)             | 18 (17.3)              | 10 (9.3)               | 17 (10.7)              | 15 (18.1)              |
| of diabetes             | 78 (32.2)            | 35 (35.0)               | 43 (30.3)             | 34 (32.7)              | 36 (33.3)              | 54 (34.0)              | 24 (28.9)              |
| History of stroke       | 31 (12.8)            | 11 (11.0)               | 20 (14.1)             | 9 (8.7)                | 15 (13.9)              | 16 (10.1)              | 15 (18.1)              |
| Dementia, n(%)          | 25 (10.3)            | 9 (9.0)                 | 16 (11.3)             | 4 (3.8)*               | 14 (13.0)              | 14 (8.8)               | 11 (13.3)              |
| Cancer, n(%)            | 94 (38.8)            | 50 (50.0)*              | 44 (31.0)             | 46 (44.2)              | 34 (31.5)              | 73 (45.9)*             | 21 (25.3)              |
| Depression, n(%)        | 12 (5.0)             | 5 (5.0)                 | 7 (4.9)               | 1 (1.0)*               | 10 (9.3)               | 8 (5.0)                | 4 (4.8)                |

**Note:** * refers to *p < 0.05*.
* p≤0.05 or †p≤0.001 compared to the corresponding low vs high medical needs; ADL, activities of daily living; ISAR, Identification of Seniors at Risk

Table 2. Predictors of length of hospital stay (in days)

|                      | Unadjusted | Model 1 Corrected R²=0.038 | Model 2 Corrected R²=0.147 |
|----------------------|------------|----------------------------|----------------------------|
|                      | β or B     | 95% CI         | p   | β or B     | 95% CI         | p  | β or B     | 95% CI         | p  |
| Age (years)          | -0.19      | -0.66;-0.13    | 0.004 | -0.22      | -0.34;-0.09    | 0.001 | -0.27      | -0.39;0.14     | <0.001 |
| Sex (male vs female) | 1.203      | -2.28;4.69     | 0.497 | 1.82       | -1.62;5.23     | 0.299 | 0.26       | -3.05;3.52     | 0.876          |
| Number of admission diagnoses | 0.28 | 0.16;0.41 | <0.001 |                          |                      |         |                          |      |
| ISAR score           | 0.06       | -0.26;0.72     | 0.363 | 0.104      | -0.02;0.23     | 0.108 |                          |      |
| ADL impairment (yes vs no) | 6.66 | 3.31;10.01 | <0.001 |                          |                      |         |                          |      |
| Mobility impairment (yes vs no) | 1.47 | -2.11;5.05 | 0.481 |                          |                      |         |                          |      |
| Cognition impairment (yes vs no) | 3.35 | -0.07;6.78 | 0.055 |                          |                      |         |                          |      |
| Signs of depression (yes vs no) | 6.69 | 1.43;11.94 | 0.013 |                          |                      |         |                          |      |

Table 3. Predictors of nursing hours per day during hospital stay

|                      | Model 3 Corrected R²=0.143 | Model 4 Corrected R²=0.197 |
|----------------------|---------------------------|---------------------------|
|                      | β or B     | 95% CI         | p  | β or B     | 95% CI         | p  |
| Age (years)          | -0.27      | -0.40;-0.14    | <0.001 | -0.26      | -0.38;0.14     | <0.001 |
| Sex (male vs female) | 0.25       | -3.05;3.56     | 0.880 | 0.04       | -3.19;3.21     | 0.982 |
| Number of admission diagnoses | 0.24 | 0.12;0.36 | <0.001 |                          |                      |         |                          |      |
| ISAR score           | 0.00       | -0.13;0.13     | 0.966 | 0.00       | -0.12;0.13     | 0.957 |
| ADL impairment (yes vs no) | 8.05 | 4.19;11.91 | <0.001 | 7.38       | 3.72;11.26     | <0.001 |
| Mobility impairment (yes vs no) | -2.03 | -5.97;1.91 | 0.312 | -2.44      | -6.46;1.19     | 0.210 |
| Cognition impairment (yes vs no) | 3.78 | 0.48;7.08 | 0.025 | 3.72       | 0.50;6.89      | 0.023 |
| Signs of depression (yes vs no) | 6.43 | 1.18;11.69 | 0.017 | 5.85       | 0.78;10.95     | 0.025 |

ADL, activities of daily living; ISAR, Identification of Seniors at Risk; beta, standardized regression coefficient; B, unstandardized regression coefficient; CI, confidence interval
### Table 4. Predictors of receiving physiotherapy during hospital stay

|                       | Unadjusted | Model 1 Corrected $R^2$=0.022 | Model 2 Corrected $R^2$=0.051 |
|-----------------------|------------|-------------------------------|-------------------------------|
|                       | $\beta$ or B | 95% CI | P     | $\beta$ or B | 95% CI | P     | $\beta$ or B | 95% CI | P     |
| Age (years)           | 0.09        | -0.05;0.23 | 0.196 | 0.05        | -0.09;0.19 | 0.493 | 0.49        | -1.95;0.22 | 0.578 |
| Sex (male vs female)  | 0.42        | -0.08;0.92 | 0.102 | 0.39        | -0.11;0.89 | 0.121 | 0.19        | -0.25;0.71 | 0.532 |
| Number of admission diagnoses | 0.03        | -0.11;0.16 | 0.693 |            |          |       |            |          |       |
| ISAR score            | 0.26        | 0.01;0.28 | 0.032 | 0.135       | -0.01;0.27 | 0.056 |            |          |       |
| ADL impairment (yes vs no) | 1.14        | 0.67;1.61 | $<0.001$ | 1.01      | 0.95;2.09 | 0.008 |            |          |       |
| Mobility impairment (yes vs no) | 0.31        | -0.34;0.96 | 0.345 |            |          |       | -0.35      | -1.59;-0.38 | 0.393 |
| Cognition impairment (yes vs no) | 0.57        | 0.07;1.07 | $0.026$ | 0.38       | -0.09;0.88 | 0.212 |            |          |       |
| Signs of depression (yes vs no) | 0.40        | -0.37;1.17 | 0.311 |            | -0.19      | -0.50;1.04 | 0.727 |            |          |       |

|                       | Model 3 Corrected $R^2$=0.046 | Model 4 Corrected $R^2$=0.039 |
|-----------------------|-------------------------------|-------------------------------|
|                       | $\beta$ or B | 95% CI | P     | $\beta$ or B | 95% CI | P     |
| Age (years)           | 0.03        | -0.12;0.21 | 0.519 |          |          |       |
| Sex (male vs female)  | 0.24        | -0.41;0.82 | 0.513 | 0.21      | -0.41;0.82 | 0.513 |          |          |       |
| Number of admission diagnoses | -0.06        |          |       | -0.06      | -0.17;0.16 | 0.954 |          |          |       |
| ISAR score            | 0.05        | -0.13;0.21 | 0.669 | 0.04      | -0.13;0.21 | 0.669 |          |          |       |
| ADL impairment (yes vs no) | 1.03        | 0.25;1.82 | $0.011$ | 1.03      | 0.24;1.83 | $0.011$ |          |          |       |
| Mobility impairment (yes vs no) | -0.36        | -1.59;-0.38 | 0.378 | -0.36      | -1.27;-0.45 | 0.379 |          |          |       |
| Cognition impairment (yes vs no) | 0.36        | -0.26;0.96 | 0.252 | 0.36      | -0.26;0.97 | 0.253 |          |          |       |
| Signs of depression (yes vs no) | -0.19        | -1.27;0.89 | 0.725 | -0.19      | -1.28;0.90 | 0.732 |          |          |       |

ADL, activities of daily living; ISAR, Identification of Seniors at Risk; $\beta$, standardized regression coefficient; B, unstandardized regression coefficient; CI, confidence interval
|                                | Unadjusted | Model 1 Corrected $R^2=0.050$ | Model 2 Corrected $R^2=0.291$ |
|--------------------------------|------------|-------------------------------|-------------------------------|
|                                | RR         | 95% CI | P | RR   | 95% CI | P   | RR   | 95% CI | P  |
| Age (years)                    | 1.01       | 0.99;1.04 | 0.357 | 1.01 | 0.98;1.03 | 0.751 | 0.97 | 0.93;1.02 | 0.206 |
| Sex (male vs female)           | 1.52       | 1.08;2.16 | 0.018 | 1.52 | 1.07;2.14 | 0.018 | 1.02 | 0.59;1.61 | 0.933 |
| Number of admission diagnoses  | 1.06       | 1.04;1.08 | <0.001 |       |         |      |      |         |     |
| ISAR score                     | 1.17       | 1.00;1.36 | 0.050 | 1.16 | 0.99;1.35 | 0.053 | 3.16 | 1.76;5.67 | <0.001 |
| ADL impairment (yes vs no)     | 3.54       | 2.29;5.47 | <0.001 |       |         |      |      |         |     |
| Mobility impairment (yes vs no)| 1.44       | 0.84;2.46 | 0.186 |      |         |      | 0.69 | 0.39;1.22 | 0.206 |
| Cognition impairment (yes vs no)| 1.77     | 1.20;2.62 | 0.004 |      |         |      | 1.69 | 0.96;2.97 | 0.070 |
| Signs of depression (yes vs no)| 1.99       | 1.39;2.85 | <0.001 |       |         |      |      |         |     |

|                                | Model 3 Corrected $R^2=0.291$ | Model 4 Corrected $R^2=0.336$ |
|--------------------------------|-------------------------------|-------------------------------|
|                                | RR   | 95% CI | P | RR   | 95% CI | P   |
| Age (years)                    | 0.97 | 0.93;1.02 | 0.203 | 0.98 | 0.93;1.02 | 0.288 |
| Sex (male vs female)           | 1.04 | 0.62;1.74 | 0.896 | 1.05 | 0.62;1.77 | 0.854 |
| Number of admission diagnoses  | 1.06 | 1.02;1.09 | 0.001 |      |         |      |
| ISAR score                     | 1.04 | 0.79;1.37 | 0.791 | 1.02 | 0.76;1.36 | 0.914 |
| ADL impairment (yes vs no)     | 3.12 | 1.71;5.67 | <0.001 | 2.86 | 1.57;5.20 | 0.001 |
| Mobility impairment (yes vs no)| 0.69 | 0.39;1.22 | 0.198 | 0.75 | 0.42;1.32 | 0.315 |
| Cognition impairment (yes vs no)| 1.67 | 0.94;2.96 | 0.080 | 1.75 | 1.00;3.05 | 0.050 |
| Signs of depression (yes vs no)| 1.85 | 1.03;3.33 | 0.039 | 1.75 | 0.96;3.20 | 0.070 |

ADL, activities of daily living; ISAR, Identification of Seniors at Risk; CI, confidence interval; RR, relative risk

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