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Association of functional status and hospital-acquired functional decline with 30-day outcomes in medical inpatients: A prospective cohort study

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ABSTRACT

Background: There is growing evidence that patients with functional decline are at increased risk of readmission, mortality and institutionalization. Instruments to measure the status of self-care could provide important information for efficient care planning. The widely used Self Care Index serves as an indicator for the severity of nursing dependency. To date, no evidence is available on the association of the instrument with rehospitalization, mortality and institutionalization.

Objectives: To examine the association of functional status measures (Self Care Index on admission, at discharge and functional decline) with 30-day mortality, readmission and institutionalization in hospitalized non-surgical patients.

Design: Prospective cohort study.

Participants: We included 4540 emergency medical patients at a single hospital in Switzerland.

Methods: Primary outcome was 30-day mortality rate; secondary outcomes were 30-day readmission and institutionalization. We analyzed the association of the functional status with the binary endpoints using logistic regression models and C-statistics for discrimination.

Results: All of the examined measures were significant predictors of overall 30-day mortality; Self Care Index on admission: adj. OR: 0.90 (95% CI: 0.87–0.92); Self Care Index at discharge: adj. OR: 0.86 (95% CI: 0.83–0.88); functional decline: adj. OR: 1.22 (95% CI: 1.14–1.31) and all Self Care Index single items. A combined model (functional status on admission and functional decline during hospitalization) showed a good accuracy with regard to the AUC: adj. AUC: 0.80 (95% CI: 0.74–0.86).

Conclusions: Several functional measures were associated with 30-day mortality. Self Care Index total score, five single items and a combined model showed the best performance.

1. Introduction

Acutely hospitalized adults are often already limited in their functional abilities upon admission (Palese et al., 2016). During hospitalization up to 17–43% of all patients experience a progressive deterioration of their functional abilities (Palese et al., 2016; Palleschi et al., 2011). There is growing evidence that patients with preexisting or hospital acquired functional decline are at increased risk of mortality (Matzen, Jepsen, Ryg, & Masud, 2012; Rozzini et al., 2005; Socorro Garcia, de la Puente, Perdomo, Lopez Pardo, & Baztan, 2015; Torres et al., 2004). In the context of the ageing multimorbid population, it is becoming increasingly important to identify patients with an increased risk of mortality during hospitalization. This prognostic data may provide important information for planning strategies for intervention and the intensity of care in hospital as well as for subsequent outpatient care to reach a better survival rate (Agrawal et al., 2019; Covinsky, Pierluissi, & Johnston, 2011). The easiest way to do so is to use existing, familiar instruments whenever possible. The Self Care Index is an easy to use, widespread instrument that serves as an indicator for the severity of nursing dependency. To date, no study that investigates the

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association between the Self Care Index and mortality has been published. Additional 30-day outcomes that are important in this context that have been studied in relation to self-care abilities, but for which there is less evidence, are rehospitalization and institutionalization (Bohannon & Lee, 2004; Emhoff, McCarthy, Cushman, Garb, & Valenziano, 1991; Fisher, Graham, Ottenbacher, Deer, & Ostir, 2016; Mauthe, Haaf, Haya, & Krall, 1996; Roberts et al., 2016; Tonkikh et al., 2016).

With regard to the best time to measure limitations in self-care, most studies (investigating various instruments for measuring self-care abilities) have focused either on functional status on admission (Matzen et al., 2012; Soley-Bori et al., 2015), at discharge (Hoyer et al., 2014), or on functional change during hospitalization (Covinsky et al., 2011; Palese et al., 2016; Zisberg, Shadmi, Gur-Yaish, Tonkikh, & Sinoff, 2015). Although there are some studies that have investigated the relationship between longitudinally measured functional data and certain outcomes (Tonkikh et al., 2016; Valiani et al., 2017) there is limited information on when measuring functional status is most meaningful and which specific types of limitations in self-care abilities have the strongest association with the outcomes of interest. (So, Lage, Slocum, Zafonte, & Schneider, 2019).

Thus, the aim of this study was to assess unplanned 30-day readmission, morality and institutionalization in a large sample of unselected acute medical inpatients after an emergency hospital admission using patient's functional abilities measured at different times during hospitalization (on admission, at discharge) by using the Self Care Index (total score, singe items and hospital-acquired functional decline).

2. Methods

2.1. Study design and participants

This was a secondary analysis of a prospective cohort study (Triage). The Triage study was designed to understand the value of admission biomarkers and to predict later adverse outcomes; details were reported previously (trial registration: ClinicalTrials.gov Identifier: NCT01768494. Registered January 9, 2013) (Schütz et al., 2013). For the present research question, we included all emergency medical patients (> 18 years) admitted from July 2017 to January 2019 to the medical ward (Cantonal Hospital Aarau, Switzerland). We excluded patients with a length of hospital stay shorter than 24 h or longer than 29 days (outside the observation period) and patients transferred from other hospitals, non-medical wards or prison.

2.2. Primary and secondary outcomes

Our primary outcome was out-of-hospital mortality rate within 30 days of admission. Secondary outcomes were 30-day unplanned readmission and institutionalization. Readmission was defined as any unplanned hospitalization at any hospital, occurring within 30 days after hospital admission. Institutionalization was defined as the number of patients transferred to post-acute care and lived in their own home before hospital admission. Post-acute care institutions were defined as nursing homes, retirement homes, and rehabilitation clinics.

2.3. Measures of interest

Time points of interest to assess the functional status were on hospital admission, at discharge and hospital-acquired functional status decline. Functional status was measured using the Self Care Index (Table 1). The Self Care Index is a score including 10-items from the 52-items of the “result-oriented nursing-assessment acute care” (ePA-AC) (Bartholomeyczik & Hunstein, 2006). The ePA-AC is used to measure the ability and impairments of a patient, in point values 1–4 (no ability/severely impaired ability/low impaired ability/full ability). In a validation study (n = 620), the ePA-AC presented a substantial interrater reliability (Cohen's kappa > 0.6) (Große-Schlarmann, 2007). The assessment takes place within 24 h after admission to the ward. The Self Care Index itself is used to predict post-acute care deficit and to serve as an indicator for the severity of nursing dependency. A Self Care Index-score of 10 indicates full dependence, and a score of 40 demonstrate full independence. The Self Care Index overlaps in many aspects with the internationally better known Extended Barthel Index (Prosiegel et al., 1996). Both the Self Care Index and the Extended Barthel Index measure the independence of a patient in daily activities. A recent study has shown that the extended Barthel Index overall score can be derived from the individual items of the Self Care Index (Suter-Riederer, J.S., Imhof, & Petry, 2014). For the discussion of the results, we therefore refer to various studies that have investigated similar hypotheses with the Barthel Index instead of the Self Care Index. Due to the different scoring, however, the results cannot be compared directly.

Functional decline was defined as the change in Self Care Index score, calculated by subtracting the discharge score from the admission score and transforming negative scores (functional improvement) to 0 as it has been applied in similar studies (Tonkikh et al., 2016). We also investigated whether combined models (Self Care Index total score on admission & functional decline during hospitalization and Self Care Index total score on admission & Self Care Index total score at discharge) contribute to a more accurate prediction of the outcome.

2.4. Data collection

Upon admission to the medical ward, nurses systematically assessed the ePA-AC within 24 h after admission, as part of the clinical routine work. On hospital discharge, the responsible nurse assessed the ePA-AC on that day. Data on pre- and post-discharge residence were collected from electronic patient records of the medical coding department. As part of our internal quality control, all patients were contacted 30 days after hospital admission for a telephone survey using a predefined questionnaire performed by trained study-nurses to assess various quality measures and to identify potential 30-day readmissions and out-of-hospital mortality data. If patients or relatives could not be reached, the general practitioner or post-acute care institutions were contacted to obtain objective outcomes.

2.5. Statistical analysis

Discrete variables are expressed as frequency (percentage) and continuous variables as medians and interquartile ranges (IQR). Differences between groups were tested with Pearson's chi-square test for dichotomous and categorical variables and t-test for the continuous variable age. To study associations between predictors and outcomes, logistic regression models adjusted for age, gender, Charlson Comorbidity Index (CCI), length of hospital stay (LOS), number of prior hospitalizations, pre-admission residence and main diagnosis with area under the receiver operating characteristic curve (AUC) as a measure of discrimination were calculated. To study the incremental benefit of the combined models (functional status on admission & functional decline during hospitalization and Self Care Index on admission & Self Care Index at discharge), combined regression models were calculated (both variables were entered in a block in a single step). For comparing different ROC areas generated from these models, we used Stata's roccomp command (Cleves, 2002). Unadjusted and adjusted odds ratios (OR) and corresponding 95% confidence interval (CI) as measures of association were reported. For a better illustration, we have plotted the average predicted probabilities of each group. Goodness-of-fit was assessed using the Hosmer-Lemeshow test (Lemeshow & Hosmer Jr, 1982). For internal validation we bootstrapped (1000 replications) all of the performance estimates according to Harrell, Lee, and Mark (1996). The variance inflation factor (VIF)-test was used to quantify the severity of multicollinearity. Cases with missing data were excluded on

Table 1
The Self Care Index and the corresponding Extended Barthel Index variables.

	Dimension	Additional information	Corresponding variables Extended Barthel Index[a] (Suter-Riederer et al., 2014)
Point value: 1–4 (no ability/severely impaired ability/ low impaired ability/full ability)	Movement	(e.g. from bed to chair)	Mobility: transfer to wheel chair Mobility: downstairs, upstairs Mobility: mobility level surface
	Personal hygiene upper body		Personal hygiene: face, combing, shaving Personal hygiene: wash oneself
	Personal hygiene lower body		Personal hygiene: wash oneself
	Dressing upper body		Personal hygiene: dress/undress
	Dressing lower body		Personal hygiene: dress/undress
	Eating food		Eat & drink
	Drinking liquids		Eat & drink
	Excretion urine		Excretion: toilet use
	Excretion stool		Excretion: toilet use
	Cognition/consciousness	(Ability to acquire knowledge)	Cognition: memory, gain knowledge, orientation
Scoring (sum points):	From 10 points (full dependency) until 40 points (full independency)		

[a] Items not listed (no corresponding Self Care Index variable): excretion: control urinary, excretion: control stool output, cognition: vision/neglect, cognition: problem solving, language: understanding, language: articulation, language: social interaction.

a list-wise basis. A two-sided p-value of < 0.05 was considered significant. Statistical analysis was performed using Stata 15.1 (StataCorp, College Station, TX, USA).

2.6. Trial registration

ClincialTrials.gov Identifier (https://clinicaltrials.gov/ct2/show/NCT01768494), NCT01768494. Date of registration: January 15, 2013.

2.7. Ethics approval and consent to participate

The institutional Review Board of the Canton Aargau ("Ethikkommission Nordwest- und Zentralschweiz EKNZ") approved the study and waived the need for informed consent, due to the study design (observational quality control study); EK 2012/059.

3. Results

Among 6127 eligible patients, 4540 were finally included into the analysis (see Fig. 1).

Overall, 81 (1.8%) 30-day out-of-hospital deaths and 304 (6.7%) 30-day readmissions were observed. 562 patients (11.4%) who had previously lived in their own homes, were transferred to post-acute-care institutions, as shown in Tables 2 and 5 (Supplementary material).

3.1. 30-day out-of-hospital mortality

The average age was higher in the group of deceased patients (78; IQR: 68–86) compared to those being alive at day 30 (71.0; IQR: 59–81) ($p < 0.001$). With regard to the Self Care Index total score on admission, patients deceased demonstrated a median Self Care Index score of 28.5 (IQR: 20–36) which was significantly lower compared to those being alive at day 30 (39; IQR: 33–40, $p < 0.001$). A significant difference with regard to Self Care Index total score was also observed upon hospital discharge (27; IQR: 18–34 vs. 40; IQR: 36–40, $p < 0.001$). Functional decline was higher in the deceased group than in the group of patients still alive on day 30 (2.9; SD: 4.7 vs. 0.4; SD: 1.6, $p < 0.001$). In addition, LOS (6.0; IQR: 4.0, 10.0 vs. 5.0; IQR: 3.0, 9.0) and CCI were significantly higher in the deceased group (5.1; SD: 3.2 vs. 2.6; SD: 2.6) ($p < 0.001$).

3.2. 30-day readmission

There was no difference in age ($p = 0.82$) or gender ($p = 0.71$) between the patients with or without a 30-day readmission. The groups showed a non-significantly different Self Care Index total score on admission (38; IQR: 33–40 vs. 39; IQR: 34–40) ($p = 0.19$) and at discharge (40; IQR: 36–40 vs. 40; IQR: 37–40) ($p = 0.24$), respectively. Functional decline was not significantly different between groups (0.5; SD: 1.8 vs. 0.3; SD: 1.2, $p = 0.13$). The group with readmission had a slightly higher CCI compared to the non-rehospitalized group (3.0; SD: 2.8 vs. 2.6; SD: 2.7, $p = 0.03$).

3.3. Institutionalization

The average age (77; IQR: 68–85 vs. 70.0; IQR: 58–80) and length of stay (11.0; IQR: 8.0–15.0 vs. 5; IQR: 3–7) was higher in the group of institutionalized patients compared to those not being (newly) institutionalized ($p < 0.001$). The groups showed a significantly different Self Care Index total score on admission (33; IQR: 27–38 vs. 39; IQR: 34–40, $p < 0.001$) and at discharge (36; IQR: 30–40 vs. 40; IQR: 37–40, $p < 0.001$). Furthermore, functional decline (1.1; SD: 2.8 vs. 0.4; SD: 1.5) and CCI (3.2; SD: 2.6 vs. 2.6; SD: 2.7) were significantly different ($p < 0.001$) between groups.

3.4. Predictors of 30-day out-of-hospital mortality

Multivariable logistic regression was performed adjusted for age, gender, CCI, LOS, number of prior hospitalizations, pre-admission residence and main diagnosis to determine the predictive strength of several measures of functional status and its development during hospitalization (functional decline) on 30-day out-of-hospital mortality (Tables 3 & 4).

Multivariable analysis showed that higher Self Care Index total scores on admission and at discharge were associated with lower odds of 30-day out-of-hospital mortality (OR for 1-unit increase: 0.90; 95% CI: 0.87–0.92 and 0.86; 95%CI: 0.83–0.88, respectively). However, the Self Care Index total score at discharge was significantly more accurate than the Self Care Index total score on admission (adj. AUC 0.81; 95% CI: 0.76–0.87 vs. 0.71; 95% CI: 0.65–0.78; $p < 0.001$).

Functional decline was associated with higher odds of 30-day out-of-hospital mortality (OR for one unit inhospital (from admission to discharge) Self Care Index decline: 1.22; 95% CI: 1.14–1.31). See Fig. 2 for plotted (adjusted) average predicted probabilities. The mean predicted probability of 30-day out of hospital mortality is only 0.008 if one's Self Care Index score on admission is 40 and increases to 0.15 if one's Self Care Index score on admission is 10. If one's Self Care Index score at discharge is 40 the mean predicted probability of 30-day out of

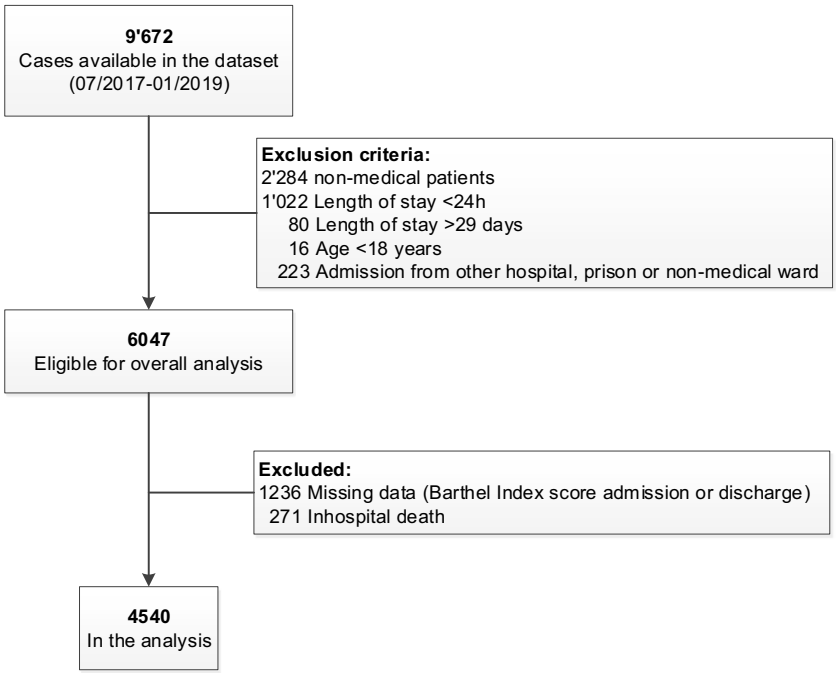

Fig. 1. Study eligibility flow chart.

hospital mortality is 0.006 and increases to 0.32 if one's Self Care Index score at discharge is 10. If one's Self Care Index decline is 0 the mean predicted probability of 30-day out of hospital mortality is 0.015 and increases to 0.85 if one's Self Care Index decline is 30.

Multivariable logistic regression analysis was performed to compare associations of a combined model (Self Care Index on admission and functional decline during hospitalization) and 30-day out-of-hospital mortality (Table 3). We also planned to examine another combined model (functional status on admission and functional status at discharge) and 30-day out-of-hospital mortality, but tests for multicollinearity indicated that a high level of multicollinearity was present when combining Self Care Index on admission and Self Care Index at discharge (VIF = 91.59). Therefore, this second model was not integrated into further analyses.

The combined model showed a good to excellent accuracy with regard to the AUC 0.80 (0.74–0.86). The combined Model was more accurate than the single predictor Self Care Index (on admission) itself ($p < 0.01$). The single predictor Self Care Index total score (at discharge) was no more accurate than the combined model ($p = 0.22$).

Goodness-of-fit was assessed using the Hosmer-Lemeshow test. The test indicated that the combined model and the two strongest predictors fitted the data well (Self Care Index admission: $\chi^2 = 9.87$, $p = 0.27$; Self Care Index discharge: $\chi^2 = 7.55$, $p = 0.48$; combined model: $\chi^2 = 6.56$, $p = 0.36$).

Multivariable analysis showed that all of the Self Care Index single items (on admission and at discharge) were associated with lower odds of 30-day out-of-hospital mortality (Table 4). The adjusted AUC of the single items (on admission) movement, personal hygiene upper body and dressing lower body are not significantly different from the Self Care Index total score on admission ($p > 0.05$). The adjusted AUC of the single items (at discharge) movement, personal hygiene upper body, personal hygiene lower body, dressing upper body and dressing lower body are not significantly different from the Self Care Index total score at discharge ($p > 0.05$).

3.5. Predictors of 30-day readmission

Multivariable logistic regression was performed adjusted for age, gender, CCI, LOS, number of prior hospitalizations, pre-admission residence and main diagnosis to determine the predictive strength of several measures of functional status and its development during hospitalization on 30-day readmission (Table 3).

Multivariable analysis showed that neither Self Care Index on admission ($p = 0.16$), Self Care Index at discharge ($p = 0.16$) nor functional decline ($p = 0.14$) were associated with lower or higher odds of readmission.

3.6. Predictors of institutionalization

Multivariable logistic regression was performed adjusted for age, gender, CCI, LOS, number of prior hospitalizations, pre-admission residence and main diagnosis to determine the association of the Self Care Index on admission on the outcome institutionalization.

Multivariable analysis showed that Self Care Index on admission is an independent predictor for institutionalization ($p < 0.001$). The p value of the Hosmer-Lemeshow test equaled $\chi^2 = 69.64$, $p \leq 0.001$, indicating poor calibration.

4. Discussion

Our results showed that none of the examined measurement points of the functional status (Self Care Index on admission, at discharge and in-between Self Care Index decline) could predict unplanned readmission within 30 days of admission from the index hospitalization. The Self Care Index total score on admission is significantly associated with a higher rate of institutionalization but Hosmer–Lemeshow test of goodness-of-fit indicated poor fit.

However, all functional status measures and functional decline were significantly associated with a higher 30-day out-of-hospital mortality rate. The Self Care Index total score at discharge demonstrated a higher diagnostic accuracy compared to the Self Care Index total score on admission. The combined model (Self Care Index on admission and functional decline during hospitalization) did not have a better prediction than the predictor Self Care Index total score at discharge. Five out of ten single items of the Self Care Index at discharge (movement, personal hygiene upper body, personal hygiene lower body, dressing upper body and dressing lower body) demonstrated the same diagnostic accuracy as the Self Care Index total score (at discharge). The outcome

Table 2
Baseline characteristics of the study participants.

Characteristics	Entire cohort (N = 4540)	30-day out-of-hospital mortality	
		Survival (n = 4459)	Out-of-hospital death (n = 81)
Age, median (IQR)	71.0 (59.0, 81.0)	71.0 (59.0, 81.0)*	78.0 (68.0, 86.0)*
Female (%)	2017 (44.4%)	1986 (44.5%)	31 (38.3%)
Length of stay, median (IQR)	5.0 (3.0, 8.0)	5.0 (3.0, 9.0)*	6.0 (4.0, 10.0)*
SPI on admission (10–40) median (IQR)	38.0 (33.0, 40.0)	39.0 (33.0, 40.0)*	28.5 (20.0, 36.0)*
SPI at discharge (10–40) median (IQR)	40.0 (36.0, 40.0)	40.0 (36.0, 40.0)*	27.0 (18.0, 34.0)*
Hospital-acquired functional status decline, mean (SD)	0.4 (1.7)	0.4 (1.6)*	2.9 (4.7)*
Place of residence before hospital (%)			
Home	3845 (84.7%)	3790 (85.0%)	55 (67.9%)
Home (with home care)	175 (3.9%)	167 (3.7%)	8 (9.9%)
Nursing home	131 (2.9%)	124 (2.8%)	7 (8.6%)
Home for the elderly	142 (3.1%)	135 (3.0%)	7 (8.6%)
Others	243 (5.4%)	239 (5.4%)	4 (4.9%)
Unknown	4 (0.1%)	4 (0.1%)	0 (0.0%)
Place of residence after hospital (%)			
Home	3416 (75.2%)	3380 (75.8%)*	36 (44.4%)*
Nursing home	266 (5.9%)	252 (5.7%)	14 (17.3%)
Home for the elderly	218 (4.8%)	205 (4.6%)	13 (16.0%)
Psychiatric clinic	38 (0.8%)	37 (0.8%)	1 (1.2%)
Rehabilitation	417 (9.2%)	415 (9.3%)	2 (2.5%)
Other hospital	167 (3.7%)	153 (3.4%)	14 (17.3%)
Others	12 (0.3%)	11 (0.2%)	1 (1.2%)
Unknown	6 (0.1%)	6 (0.1%)	0 (0.0%)
Institutionalization	562 (11.4%)	547 (11.3%)	15 (15.7%)
30-day readmission (%)	304 (6.7%)	303 (6.8%)*	1 (1.2%)*
30-day out-of-hospital mortality (%)	81 (1.8%)	–	–
Charlson Comorbidity Index, mean (SD)	2.6 (2.7)	2.6 (2.7)*	5.2 (3.4)*

Abbreviations: ICD: International Classification of Diseases 10th Revision; IQR: interquartile range; N: Numbers; SPI: Self Care Index.
* Statistically significantly differences between groups ($p < 0.05$).

30-day out-of-hospital mortality can therefore be predicted with equal accuracy by means of the Self Care Index total score at discharge (14% increase in the odds per 1-unit increase) as well as with one of the five individual items (70–76% increase in the odds per 1-unit increase). To our knowledge, this is the first study comparing different measurement times and types (total scores, single items and combined models) of functional abilities with regard to their association with 30-day out-of-hospital mortality, readmission and institutionalization risk in a large consecutive patient sample.

Our findings on mortality are in line with previous studies that examined the relationship between self-care abilities at hospital admission and mortality rates at different points in time (Agrawal et al., 2019; Inouye et al., 1998; Miller & Weissert, 2000; Nunes, Flores, Mielke, Thume, & Facchini, 2016; Rozzini et al., 2005; Sacanella et al., 2009; So et al., 2019; Socorro Garcia et al., 2015; Walter et al., 2001). This confirmed that functional status is an independent predictor for short- and long-term mortality in hospitalized patients. Besides the confirmation of the above-mentioned findings, our analysis was also able to show which point in time allows the most accurate prediction. Although we already found a high predictive value on hospital admission, the functional status of patients at discharge seems to allow a more accurate prediction. However, the two points in time of

Table 3
Crude and adjusted[a] association of functional status measures, functional decline and 30-day outcomes.

Predictor	Crude OR (95% CI)	Adj. OR[a] (95% CI)	p-Value	Adj. AUC[a] (95% CI)
Outcome: 30-day out-of-hospital mortality				
SPI (admission)[b]	0.90 (0.88–0.91)	0.90 (0.87–0.923)	< 0.001	0.71 (0.65–0.78)
SPI (discharge)[b]	0.87 (0.85–0.88)	0.86 (0.83–0.88)	< 0.001	0.81 (0.76–0.87)
Functional decline[c]	1.26 (1.18–1.33)	1.22 (1.14–1.31)	< 0.001	0.60 (0.51–0.68)
Combined model				
SPI (admission)[b]	0.89 (0.87–0.91)	0.88 (0.86–0.91)	< 0.001	0.80 (0.74–0.86)
Functional decline[c]	1.27 (1.20–1.34)	1.28 (1.19–1.37)	< 0.001	
Outcome: 30-day readmission				
SPI (admission)[b]	1.01 (0.99–1.03)	1.01 (0.99–1.04)	0.159	n/a
SPI (discharge)[b]	1.01 (0.99–1.03)	1.01 (0.99–1.01)	0.162	n/a
Functional decline[c]	0.93 (0.85–1.02)	0.93 (0.84–1.02)	0.138	n/a
Outcome: institutionalization				
SPI (admission)[b]	0.92 (0.91–0.93)	0.93 (0.92–0.95)	< 0.001	n/a

Abbreviations: SPI: Self Care Index; OR: Odds ratio; AUC: Area under the curve; CI: Confidence interval; n/a: not available.
[a] Adjusted for age, gender, Charlson Comorbidity Index, length of hospital stay, number of prior hospitalizations, pre-admission residence, main diagnosis.
[b] Odds ratio for 1-unit increase in Self Care Index.
[c] Odds ratio for 1-unit inhospital (from admission to discharge) Self Care Index decline.

Table 4
Adjusted[a] association of the Self Care Index single items and 30-day out-of-hospital mortality.

Predictor	Adj. OR[a] (95% CI)	*p*-Value	Adj. AUC[a] (95% CI)	Adj. OR[a] (95% CI)	*p*-Value	Adj. AUC[a] (95% CI)
	On admission			At discharge		
Outcome: 30-day out-of-hospital mortality						
Movement	0.47 (0.37–0.59)	< 0.001	0.68 (0.61–0.74)[b]	0.30 (0.24–0.38)	< 0.001	0.79 (0.73–0.84)[c]
Personal hygiene Upper body	0.40 (0.32–0.51)	< 0.001	0.69 (0.63–0.76)[b]	0.24 (0.19–0.30)	< 0.001	0.80 (0.47–0.87)[c]
Personal hygiene Lower body	0.43 (0.35–0.53)	< 0.001	0.73 (0.66–0.79)[b]	0.30 (0.24–0.37)	< 0.001	0.82 (0.76–0.87)[c]
Dressing upper body	0.45 (0.35–0.56)	< 0.001	0.66 (0.59–0.73)	0.27 (0.21–0.33)	< 0.001	0.79 (0.73–0.85)[c]
Dressing lower body	0.43 (0.35–0.53)	< 0.001	0.72 (0.66–0.79)[b]	0.30 (0.24–0.37)	< 0.001	0.81 (0.76–0.87)[c]
Eating food	0.49 (0.39–0.61)	< 0.001	0.56 (0.48–0.64)	0.33 (0.27–0.42)	< 0.001	0.60 (0.53–0.69)
Drinking liquids	0.48 (0.37–0.61)	< 0.001	0.53 (0.45–0.62)	0.34 (0.26–0.43)	< 0.001	0.60 (0.52–0.69)
Excretion urine	0.62 (0.53–0.74)	< 0.001	0.61 (0.54–0.69)	0.46 (0.39–0.55)	< 0.001	0.72 (0.66–0.79)
Excretion stool	0.52 (0.43–0.64)	< 0.001	0.61 (0.54–0.69)	0.35 (0.29–0.43)	< 0.001	0.73 (0.66–0.80)
Cognition/consciousness	0.43 (0.35–0.54)	< 0.001	0.63 (0.55–0.71)	0.39 (0.31–0.49)	< 0.001	0.66 (0.59–0.74)

[a] Adjusted for age, gender, Charlson Comorbidity Index, length of hospital stay, number of prior hospitalizations, pre-admission residence, main diagnosis.
[b] Not statistically significant different from the SPI on admission total score ($p > 0.05$).
[c] Not statistically significant different from the SPI at discharge total score ($p > 0.05$).

measurement differ significantly in the nature and manner of the consequences derived from them. With the knowledge from previous studies that the functional status can be positively influenced by nursing care, the measurement of the functional status on admission can be used for risk stratification in order to allocate more nursing resources for the restoration of functional abilities to those patients with a higher deficit. Meanwhile, the results of the measurement at discharge can provide the follow-up care institutions and health professionals (e.g. general practitioner, nursing services) with important information for risk-stratification and help to determine the intensity and urgency of follow-up care.

Furthermore, our results show that individual limitations in self-care abilities allow a prediction of mortality just as good as the Self Care Index total score. Future studies should investigate whether these results can be replicated with similar single items of other functional status measurements (e.g. similar single items of the Barthel Index).

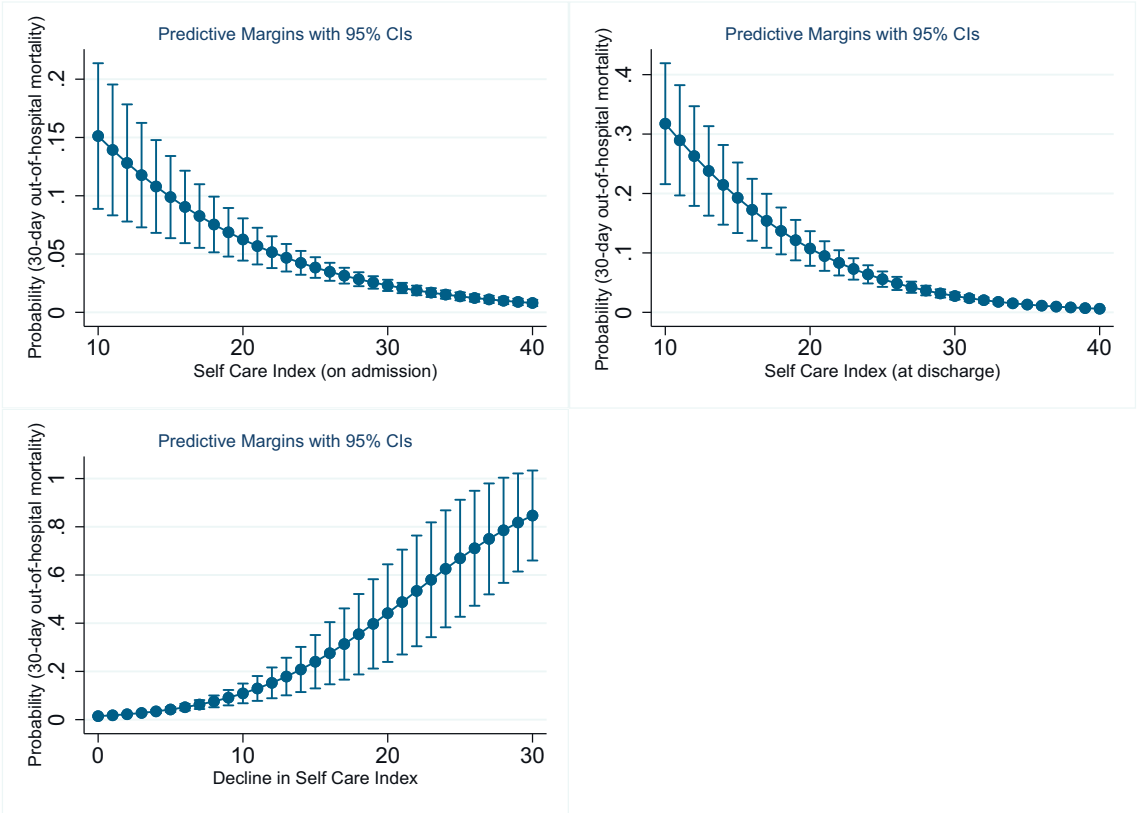

Fig. 2. Predicted probabilities for **a**) 30-day out-of-hospital mortality of each group of 1-units Self Care Index (on admission)*; **b**) 30-day out-of-hospital mortality of each group of 1-units Self Care Index (at discharge)*; **c**) 30-day out-of-hospital mortality of each group of 1-units decline in Self Care Index**.
Abbreviations: CI: Confidence interval.
*Adjusted for age, gender, Charlson Comorbidity Index, length of hospital stay, number of prior hospitalizations, pre-admission residence, main diagnosis.
**Adjusted for age, gender, Charlson Comorbidity Index, length of hospital stay, number of prior hospitalizations, pre-admission residence, main diagnosis, Self Care Index (on admission).

With the existing knowledge that the functional status in hospitalized older patients can be positively influenced by nursing care (Boltz, Resnick, Capezuti, Shuluk, & Secic, 2012), future studies should find out whether this also has a positive effect on patient outcomes. In this case, self-care measures could possibly contribute to future measurements of the quality of care for example in the form of benchmarking comparisons.

Results regarding the absence of association between functional status and readmission are not consistent with a recently published study by Tonkikh et al. (2016), in which a marginally significant association was found (Barthel Index on admission: OR for 1-unit increase: 0.99; 95% CI: 0.98–0.99 and Barthel Index at discharge: OR for each 10-point decrease in ADL = 1.32, 95% CI: 1.02–1.72). The difference could be due to the different study setting or sample, respectively. Although in both studies patients from the acute hospital setting were included, we have observed markedly fewer readmission (6.7% vs. 15%) compared to the study of Tonkikh et al. (2016). These different results should be interpreted with caution due to different definitions of the outcome (30-day readmission after hospital admission vs. after discharge). However, our numbers of rehospitalized patients correspond to the typical frequencies of readmission in Switzerland (Wasserfallen & Zufferey, 2015). Furthermore, our sample was markedly larger, had less restrictive inclusion and exclusion criteria and therefore, the study population was younger (68 years vs. 78.8 years) and had a higher functional independence at hospital admission which may could have affected the risk assessment. There are only a few other studies (Fisher et al., 2016; Hoyer et al., 2014; Morandi et al., 2013) having addressed the topic in an population of older people receiving rehabilitation services or having used other functional status measures and are therefore not comparable to our sample.

Self Care Index on admission is an independent predictor in terms of the outcome institutionalization but Hosmer–Lemeshow test of goodness-of-fit indicated poor fit. In view of these results, we assume that the Self Care Index total score on admission is therefore not suitable for predicting institutionalization for the population studied.

The strength of this study is the large sample that can be considered representative for acutely hospitalized medical patients in our hospital. Because the data on functional status were collected in real-life clinical practice, some patients with missing data had to be excluded from the analysis. The excluded patients differ significantly in age (68 vs. 71), LOS (3 vs. 5) and CCI (2.1 vs. 2.6) from the study population. There was no difference in gender and frequency of the analyzed outcomes. A selection bias is rather unlikely, but cannot be completely excluded. The study was carried out in four medical wards of a single hospital in Switzerland. Therefore, all findings should be generalized with caution. To take into account confounding by age, gender, LOS, comorbidities, number of prior hospitalizations, pre-admission residence and main diagnosis multivariable analyses were adjusted for all of them. OR of Self Care Index measures and decline were not or only slightly affected, indicating that the possible confounders had only minor influence.

5. Conclusion

In acutely admitted medical patients, several functional measures were associated with a higher risk of out-of-hospital death within 30 days after admission. The Self Care Index total score and various single items of it as well as a combined model show the same diagnostic accuracy regarding the outcome 30-day mortality.

Abbreviations

AUC	area under the receiver operating characteristic curve
CI	Confidence interval
CCI	Charlson Comorbidity Index
ePA-AC	result-oriented nursing-assessment acute care
ICD	International Classification of Diseases 10th Revision
IQR	interquartile range
LOS	length of hospital stay
N	Numbers
OR	odds ratio
SPI	Self Care Index

Supplementary data to this article can be found online at https://doi.org/10.1016/j.apnr.2020.151274.

Authors' contributions

PS and BM were the initiators and scientific project leaders. DK, AC, SH contributed to the data collection. DK, AK, CB, CG, PS, BM and TV participated in the conception and design of the study contributed methodical expertise and performed statistical analysis. DK wrote the manuscript, which was revised and approved by all authors.

Availability of data and materials

As a quality control study, and due to missing individual informed consent, there exist restrictions on sharing of patient data. Nevertheless, data will be made available upon request to all interested researchers (contact information at which data may be requested: Prof. Dr. Beat Mueller, leading senior author of the study group: happy.mueller@unibas.ch).

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Declaration of competing interest

The authors of this manuscript declare no competing financial interests related to this work.

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