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ORIGINAL ARTICLE

Frailty index predicts geriatric psychiatry inpatient mortality: a case–control study

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Abstract

Background: Many geriatric psychiatry patients suffer from complex psychiatric and medical problems and a minority of patients dies in-hospital. We assess whether a frailty index (FI) predicts inpatient mortality.

Methods: Electronic health records from 276 patients of a geriatric psychiatry department over 3 years (2015–2017) in Austria were analysed using logistic regression analysis.

Results: Mortality rate was 4.2%. The adjusted effect of frailty (per 0.1 FI) on mortality was odds ratio = 3.25 (95% CI = 2.29–4.79). The area under the curve of 0.81 (95% CI = 0.76–0.86) suggested acceptable predictive accuracy.

Conclusions: We found that a non-negligible minority of geronto-psychiatric patients died in-hospital, which can be usefully predicted by the FI derived from routine electronic patient records.

INTRODUCTION

Geriatric psychiatry inpatients are often characterised by complex psychiatric problems as well as medical co-morbidities.[1] A minority (1–16%) of these patients is known to die in-hospital,[2–5] although this evidence is both scattered and dated. In recent years, it has been shown that frailty – a state of increased vulnerability due to cumulative physiological decline[6] – operationalised by a large number of health deficits predicts in-hospital mortality.[7,8] However, this has not been assessed for acute geriatric psychiatry patients to date, which is the aim of this retrospective case–control study.

METHODS

Data came from routine health records of a total of 284 patients of the Department of Geriatric Psychiatry and Geriatric Psychotherapy of the state hospital Graz II, Austria. This clinic hosts 109 beds and provides services for 90% of all patients with psychiatric illnesses aged 65 and over in the state of Styria. Between 1 January 2015 and 31 December 2017, 142 patients (= cases) died during their stay, which were matched regarding gender with 142 discharged patients (= controls). Electronic patient data were extracted on-site, coded and anonymised. The conduct of the study was approved by the Ethics Committee of the Medical University of Graz (EK-number 29369 ex 16/17).

The outcome variable was inpatient mortality (0/1). The two predictor variables were age in years and the continuous frailty index (FI) based on patients' health records. For the FI, we followed Clegg *et al*.[9] The index is based on 30 health deficits (Table 1) which include somatic and psychiatric diagnoses (International Classification of Diseases - 10 codes in parentheses), functioning, symptoms and biomarkers. In case of multiple repeated observations of health deficits, the information refers to the last available observation. Information on medication intake was not comprehensible and thus not included. The FI is calculated as the number of reported health deficits in each patient divided by the total number of deficits, for example 5/30 = 0.17. All patients with less than 10% missing values in these 30 items (n = 276, i.e. 97%) were included in the analysis. As descriptive statistics, we report percentages for

Table 1 List of 30 health deficits contained in the frailty index (FI)

Hypertension (I10-I15): yes = 1, no = 0	Dementia (F00-F02): yes = 1, no = 0
Ischaemic heart disease (I20-I25): yes = 1, no = 0	Depression (F32-F33): yes = 1, no = 0
Heart valve disease (I34-I39): yes = 1, no = 0	Generalised anxiety disorder (F41.1): yes = 1, no = 0
Heart failure (I42-I43): yes = 1, no = 0	Braden Scale: <10 = 1, 10–12 = 0.75, 13–14 = 0.5, 15–18 = 0.25, >18 = 0
Atrial fibrillation (I48): yes = 1, no = 0	Sleep disturbances: yes = 1, no = 0
Cerebrovascular disease (I60-I69): yes = 1, no = 0	Lives alone: yes = 1, no = 0
Peripheral vascular disease (I73): yes = 1, no = 0	Hearing impairment: yes = 1, no = 0
Chronic kidney disease (N18): yes = 1, no = 0	Visual impairment: yes = 1, no = 0
Diabetes (E10-E11): yes = 1, no = 0	Incontinence: yes = 1, no = 0
Osteoporosis (M81): yes = 1, no = 0	Mobility: dependent = 1, limited = 0.5, independent = 0
Parkinsonism and tremor (G20, G25): yes = 1, no = 0	Falls: yes = 1, no = 0
Respiratory disease (J00-J99): yes = 1, no = 0	Impaired orientation: yes = 1, no = 0
Thyroid disease (E07): yes = 1, no = 0	Weight loss/anorexia: less than very good/good nutritional condition = 1, very good/good nutritional condition = 0
Diseases of the genitourinary system (N00-N99): yes = 1, no = 0	Erythrocytes > = 4.8 mil/mL in women, > = 5.0 mil/mL in men = 0 <4.8 mil/mL in women, < 5.0 mil/mL in men = 1
Delirium (F05): yes = 1, no = 0	C-reactive protein: >50 g/mL = 1, ≤50 g/mL = 0

categorical variables and mean (standard deviation) for numeric variables. The Kolmogorov–Smirnov test was used to ascertain whether FI values were normally distributed. For bivariate analysis with mortality status, we used χ^2-tests for categorical variables and *t*-tests for numeric variables. Logistic regression analysis was used to analyse the impact of age and frailty on inpatient mortality. To assess the discriminatory capability, we computed the area under the receiver operation curve (AUC) using R-package pRoc (1.15-3). All analyses were performed with R, a language and environment for statistical computing (3.6.1).

RESULTS

The mortality rate (2015–2017) of the geriatric psychiatry department was 4.2% and the average length of stay was 15.1 (20.8) days for deceased patients and 19.1 (16.7) days for discharged patients. Mean age was higher (84.0 (8.6) years) among deceased patients compared to discharged patients (77.7 (7.9) years; $t = -6$, df = 274, $P < 0.001$). Those who died were more likely to come from another hospital (49.6%) or a long-term care facility (26.3%) compared to later discharged patients (24.1% and 17.0%, respectively; $\chi^2 = 34.7$, df = 2, $P < 0.001$) and were in worse physical condition at admission (mean Braden Score = 18.6 (3.6) vs. 14.9 (3.6); $t = 8$, df = 257, $P < 0.001$). Compared to discharged patients, the deceased patients were more often diagnosed with delirium (61.2% vs. 16.9%; $\chi^2 = 57.2$, df = 1, $P < 0.001$) and dementia (59.7% vs. 47.9%; $\chi^2 = 3.9$, df = 1, $P < 0.001$), and less often with depression (23.9% vs. 50.0%; $\chi^2 = 20.1$, df = 1, $P < 0.001$) or generalised anxiety disorder (2.2% vs. 12.0%; $\chi^2 = 9.7$, df = 1, $P < 0.001$). Deceased patients also more often suffered from ischaemic heart disease (59.7% vs. 26.8%; $\chi^2 = 330.6$, df = 1, $P < 0.001$). FI values followed a normal distribution in our sample (non-significant Kolmogorov–Smirnov test) but there were considerable differences in the central tendency between deceased versus discharged patients: mean = 0.28 (0.10) versus 0.38 (0.08) (see Fig. 1A). Based on the cut-off of 0.25, 95.5% of the deceased patients but only 59.2% of the discarded patients can be considered as 'frail'. Based on the logistic regression model, the age-adjusted effect of frailty per 0.1 FI on mortality was odds ratio (OR) = 3.25 (95% CI = 2.29–4.79), which corresponds to a 21% increased probability of inpatient death (average marginal effect = 0.21, 95% CI = 0.16–0.26, see also Fig. 1B). Chronological age was also a statistically significant predictor (OR = 1.05, 95% CI = 1.01–1.09). Cox and Snell's pseudo R-squared for the logistic regression model was 0.28 and AUC was 0.81 (95% CI = 0.76–0.86), which suggests that the model containing age and frailty provides acceptable predictive accuracy for in-hospital mortality.

DISCUSSION

In this study, we assessed the impact of frailty measured by a large number of health deficits extracted from geronto-psychiatric patients' electronic health records on in-hospital mortality. Since these patients are often characterised by multiple psychiatric and

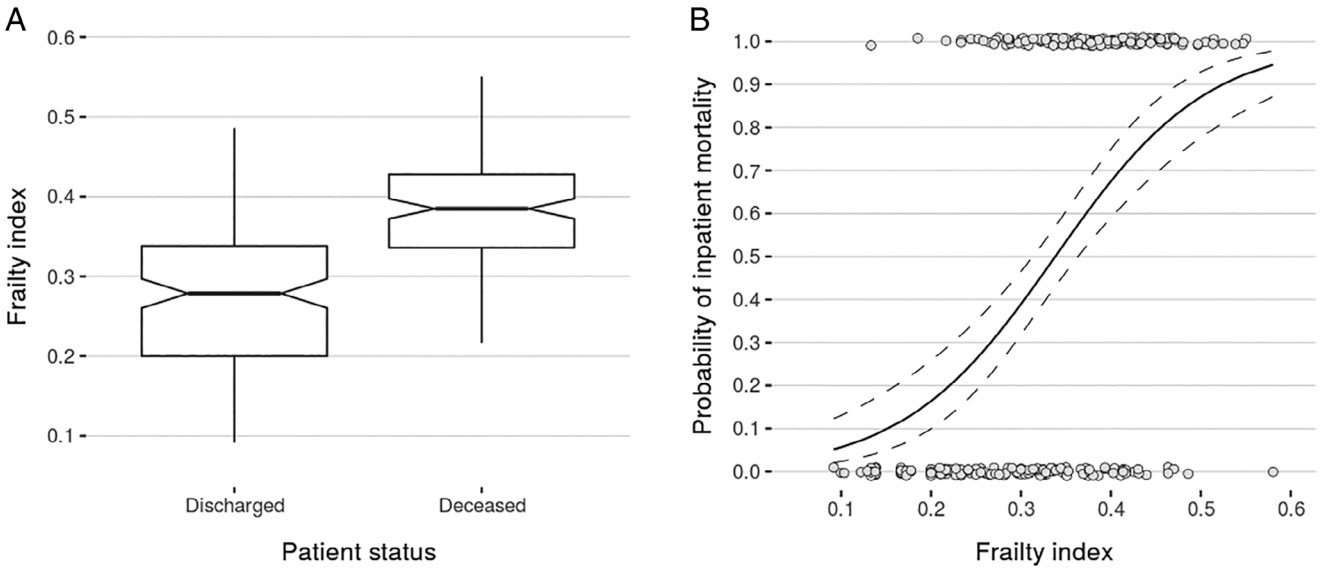

Figure 1 Relationship between frailty index and inpatient mortality. (A) Boxplot based on bivariate analysis shows substantial differences in frailty between discharged and deceased patients. The boxes represent the interquartile range, i.e. the data from the 25th–75th percentile, the whiskers represent 95% of the data. Boxes are segmented by the median and the notches around the median indicate its 95% confidence interval. (B) The solid line shows predicted probabilities based on the logistic regression model adjusted for age, the dashed lines represent 95% confidence intervals. Dots represent actual observations (n = 276) and are vertically jittered for better representation.

also medical co-morbidities,[1] it is important to go beyond a disease-centred approach[10] and to comprehensively assess a patient's whole health[6] – for example by means of a fine-grained FI – in order to improve healthcare outcomes.

Our results show that a small minority (4%) of patients died during their hospital stay. The mortality rate among geronto-psychiatric patients in our study is similar to the estimates of the few previous studies available.[2,4,5] The higher mortality risk reported in Rockwood *et al*.[3] is likely associated with the considerably longer average length of stay in that study (median = 92 days) compared to our and other studies.

FI values among our sample were normally distributed, which is a common finding among clinical samples (e.g.[8]), and were considerably higher among deceased compared to discharged patients. In comparison to the results of general geriatric samples in two previous studies,[7,8] the mean FI values among deceased patients in our study were somewhat lower, which could be due to the higher prevalence of mortality-relevant delirium at a geriatric psychiatry department.

We found the FI to be a good predictor of in-hospital mortality among geriatric psychiatric patients. Our results are similar with regard to both effect size and AUC reported in a recent study of general geriatric patients[8] based on a much larger sample size. Given the discriminatory value of the FI for inpatient mortality, it is suggested to implement a repeated routine calculation of a FI based on the comprehensive geriatric assessment[7,9] during the hospital stay in order to better identify the most vulnerable patients.

Although we lack comprehensive information about what patient characteristic or behaviour triggered admission to the geriatric psychiatric department, given the high prevalence of delirium diagnoses, poor physical health status and transfers from long-term care facilities and hospitals among patients who later died within days in-hospital, we recommend to increase the provision of conciliary or liaison geronto-psychiatric and palliative services within long-term care facilities and hospitals in order to avoid stressful transports of 'problematic' patients to a geriatric psychiatry department in their very last days of life.

This study provides recent data on mortality in geriatric psychiatric inpatients, which is a strength given the limited and dated evidence from previous studies. Furthermore, this study adds information

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on the relevance of the FI for inpatient mortality. Limitations include the small number of patients, the single-site and retrospective approach of the study, that health deficits were not assessed at multiple points in time (e.g. at admission, after 5 days, etc.) in order to calculated multiple FIs during a patient's stay, and the lack of data on several potentially relevant aspects (behaviour that led to the transfer to the geriatric psychiatric department, previous geronto-psychiatric admissions, polypharmacy, and vital status after discharge).

In summary, we found that a non-negligible minority of geronto-psychiatric patients died in-hospital. The FI derived from routine electronic patient health records provides acceptable predictive accuracy and could act as a clinically relevant screening tool.

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E. Stolz designed the study, analysed the data and wrote the paper. E. Rásky collected and coded the data on-site and carefully reviewed the paper. C. Jagsch co-designed the study, provided access to the data and carefully reviewed the paper.

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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