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A Multidimensional Prognostic Index (MPI) based on a comprehensive geriatric assessment predicts short- and long-term all-cause mortality in older hospitalized patients with transient ischemic attack

Daniele Sancarlo,

Geriatric Unit and Gerontology-Geriatrics Research Laboratory, Department of Medical Sciences, IRCCS Casa Sollievo della Sofferenza, Viale Cappuccini 1, 71013 San Giovanni Rotondo, Foggia, Italy

Andrea Pilotto,

Neurological Unit, University of Brescia, Brescia, Italy

Francesco Panza,

Geriatric Unit and Gerontology-Geriatrics Research Laboratory, Department of Medical Sciences, IRCCS Casa Sollievo della Sofferenza, Viale Cappuccini 1, 71013 San Giovanni Rotondo, Foggia, Italy

Massimiliano Copetti,

Unit of Biostatistics, IRCCS Casa Sollievo della Sofferenza, San Giovanni Rotondo, Italy

Maria Grazia Longo,

Geriatric Unit and Gerontology-Geriatrics Research Laboratory, Department of Medical Sciences, IRCCS Casa Sollievo della Sofferenza, Viale Cappuccini 1, 71013 San Giovanni Rotondo, Foggia, Italy

Piero D'Ambrosio,

Geriatric Unit and Gerontology-Geriatrics Research Laboratory, Department of Medical Sciences, IRCCS Casa Sollievo della Sofferenza, Viale Cappuccini 1, 71013 San Giovanni Rotondo, Foggia, Italy

Grazia D'Onofrio,

Geriatric Unit and Gerontology-Geriatrics Research Laboratory, Department of Medical Sciences, IRCCS Casa Sollievo della Sofferenza, Viale Cappuccini 1, 71013 San Giovanni Rotondo, Foggia, Italy

Luigi Ferrucci, and

Longitudinal Studies Section, Clinical Research Branch, National Institute on Aging, Baltimore, MD, USA

Alberto Pilotto

Correspondence to: Alberto Pilotto, alberto.pilotto@sanita.padova.it.

Conflict of interest None.

Geriatrics Unit, Azienda ULSS 16 Padova, S Antonio Hospital, Via Facciolati 71, 35127 Padova, Italy

Alberto Pilotto: alberto.pilotto@sanita.padova.it

Abstract

A multidimensional impairment may influence the clinical outcome of acute diseases in older patients. The aim of the current study was to evaluate whether a Multidimensional Prognostic Index (MPI) based on a comprehensive geriatric assessment (CGA) predicts short- and long-term all-cause mortality in older patients hospitalized for transient ischemic attack (TIA). In this prospective study with 1-year follow-up, 654 patients aged 65 and older with a diagnosis of TIA according to the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM 435.x) were enrolled. A standardized CGA that included information on functional (activities of daily living, ADL, and Instrumental ADL), cognitive status (Short Portable Mental Status Questionnaire), nutrition (Mini Nutritional Assessment), risk of pressure sores (Exton-Smith Scale), comorbidities (Cumulative Illness Rating Scale), medications and co-habitation status was used to calculate the MPI for mortality using a previously validated algorithm. Higher MPI values were significantly associated with higher 1-month all-cause mortality (incidence rates: MPI-1 low risk = 0.32%, MPI-2 moderate risk = 5.36%, MPI-3 high risk = 10.42%; $p < 0.001$), 6-month all-cause mortality (MPI-1 = 1.95%, MPI-2 = 9.77%, MPI-3 = 27.22%; $p < 0.001$) and 12-month all-cause mortality (MPI-1 = 5.19%, MPI-2 = 16.47%, MPI-3 = 44.32%; $p < 0.001$). Age- and gender-adjusted Cox regression analyses demonstrated that MPI was a significant predictor of all-cause mortality. MPI showed a significant high discriminatory power with an area under the receiver operating characteristics (ROC) curve of 0.819, 95% CI = 0.749–0.888 for 1-month mortality, 0.799, 95% CI = 0.738–0.861 for 6-month mortality and 0.770, 95% CI = 0.716–0.824 for 12-month mortality. The MPI, calculated from information collected in a standardized CGA, appeared to be effective in estimating short- and long-term all-cause mortality in older patients hospitalized for TIA.

Keywords

Transient ischemic attack (TIA); All-cause mortality; Risk factor; Multidimensional Prognostic Index (MPI); Aging; Comprehensive geriatric assessment (CGA)

Introduction

Transient ischemic attacks (TIAs) are common disorders in older people [1, 2]. About two-thirds of the total TIA events occur in older patients as TIA incidence rate increases exponentially with age [3, 4]. It ranges from 0.5% per year in patients younger than 65 years up to 6.41% per year in patients over 85 years [3–5]. In different settings, patients with TIA have a substantial increased risk of recurrent stroke and others cardiovascular events, such as myocardial infarction [1–7]. Thus, the identification of patients at higher risk for vascular events during the first weeks after a TIA would allow appropriate choices for secondary prevention strategies. Some prognostic methods have been validated to predict short- and long-term risk for stroke, death, and composite vascular outcomes in TIA patients with a time window from 2 days to 5 years [8–16]. In particular, the stroke prognosis instrument

(SPI) I and II stratified patients with TIA or ischemic stroke by prognosis for stroke or death in 2 years [11, 12]. Furthermore, the California score [13], the age, blood pressure, clinical features and duration (ABCD) score [14], and the more recent ABCD2 score [15] are the most accurate indices to predict the risk of stroke 2, 9, 30, and 90 days after the TIA, with some evidence suggesting that ABCD2 score may be associated with an increased general risk for vascular events in the medium- to long-term follow-up after TIA [16]. Finally, also the presence of lesions on diffusion-weighted magnetic resonance imaging (DW-MRI) has been also associated with an increased risk of early stroke and death after 90 days in TIA patients [17, 18].

Factors identified in previous studies as associated with an increased 1-year risk of death are old age [7, 19], diabetes [7, 19], previous stroke [19], or myocardial infarction [7, 19], previous history of claudication or peripheral vascular surgery [7], and the presence of Q waves or negative T waves on baseline electrocardiography [7]. An accurate score evaluating the long-term prognosis of all-cause mortality in TIA patients, however, has not yet been defined, especially in older patients. Since in older subjects all-cause mortality results from a combination of biological, functional, psychological, and environmental factors, tools that effectively identify patients with different life expectancy should be multidimensional in nature [20, 21]. Recently, a Multidimensional Prognostic Index (MPI) for 1-year all-cause mortality derived from a standardized comprehensive geriatric assessment (CGA) was developed and validated in two independent cohorts of elderly patients hospitalized for acute disease or relapse of a chronic disease [22]. The aim of the present study was to evaluate the prognostic accuracy of the MPI, derived from a standardized CGA, on predicting short-(1 month) and long-term (12 months) all-cause mortality in elderly patients hospitalized for TIA.

Methods

Subjects and setting

Patients aged 65 years and older admitted from January 1, 2005 to December 31, 2007 to the Geriatric Unit of the Casa Sollievo della Sofferenza Hospital, IRCCS, San Giovanni Rotondo, Italy, due to acute disease or relapse of a chronic disease were screened for eligibility. Inclusion criteria were: (1) age ≥ 65 years; (2) diagnosis of TIA; (3) ability to provide an informed consent or availability of a proxy for informed consent and (4) a complete CGA performed during hospitalization. At baseline, the following parameters were collected by a systematic interview, clinical evaluation, and review of records from the patients' general practitioners: date of birth, gender, clinical history, current pathologies, and medication history. A neurological evaluation was performed and serum sample were taken for the analysis of complete blood count, chemistry panel, and coagulation tests. Clinical information pertinent to potential risk factors of TIA were collected during hospitalization in all patients, including smoking habit, regular use of alcohol, and the presence of concomitant diseases. Early diagnostic management also included an ultrasound Doppler of the supra-aortic vessels and the electrocardiography. In all patients, cerebral imaging, i.e., tomography (TC), and/or magnetic resonance (MRI), was also performed to exclude acute brain ischemic damage and/or tumors of the brain. All patients received a standard CGA.

Vital status up to December 31, 2008 was assessed by directly contacting the participants or consulting the registry offices of the cities where the patients were residents at the time of hospital admission. Dates of death were identified from death certificates. The protocol of the study was approved by our Institute Ethic Committee.

Diagnosis of TIA and comprehensive geriatric assessment (CGA)

The study population included hospitalized patients with a primary discharge diagnosis of TIA according to the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM 435.x), as previously reported in a large TIA study in elderly people [23]. The CGA was carried out using assessment instruments widely employed in clinical practice. Functional status was evaluated by the activities of daily living (ADL) score [24] and by the instrumental activities of daily living (IADL) score [25]. Cognitive status was assessed by the short portable mental status questionnaire (SPMSQ) [26]. Comorbidity was examined using the cumulative illness rating scale (CIRS) [27], while nutritional status was explored with the mini nutritional assessment (MNA) [28]. The Exton-Smith scale (ESS) was used to evaluate the risk of developing pressure sores [29]. Medication use was defined according to the Anatomical Therapeutics Chemical Classification code system (ATC classification), and the number of drugs used by patients at admission was recorded. Cohabitation status, i.e., living with family (with spouse and/or other relatives and/or a caregiver), institutionalized or living alone, was also recorded. The approximate time required to collect data for the CGA was 20 min (range from 15 to 25 min).

Multidimensional Prognostic Index (MPI)

We used the MPI, an algorithm developed and previously validated in two independent cohorts of elderly hospitalized patients that accurately predicts 1-year mortality [22]. This MPI was developed by the inclusion of information from the above-reported eight domains of the CGA, i.e., ADL, IADL, SPMSQ, CIRS-CI, MNA, ESS, medication use, and cohabitation. For each domain, a tripartite hierarchy was used, i.e., 0 = no problems, 0.5 = minor problems, and 1 = major problems, based on conventional cut-off points derived from the literature for the SPMSQ [26], MNA [28], EES [29], and ADL/IADL [24, 25] or observing the frequency of distribution of patients in the previous validation study for comorbidities and the number of medications. The sum of the calculated scores from the eight domains was divided by eight to obtain a final MPI risk score between 0 = no risk and 1 = higher risk of mortality. The specific thresholds used to define the three categories are available in the Table 1. As previously reported [22], the MPI was expressed as three grades of risk: MPI-1 low risk (MPI value ≤ 0.33), MPI-2 moderate risk (MPI value between 0.34 and 0.66), and MPI-3 severe risk (MPI value >0.66).

Statistical analysis

Patients' baseline characteristics were reported as mean $\pm$ standard deviation (SD) or frequencies and percentages for continuous and categorical variables, respectively. Baseline comparisons between men and women were made using Pearson's Chi-square test for categorical variables and Mann-Whitney *U* test for continuous variables. Baseline differences according to MPI grades were assessed with ANOVA *F* test for trend on ranks or

Mantel–Haenszel Chi-square test for continuous and categorical variables, respectively. All-cause mortality incidence rates for 100 persons according to gender and MPI were reported and a p value for trend was assessed with a Poisson regression model: 1-month all-cause mortality was reported as events/person-month, 6-month all-cause mortality was reported as events/person-6-months, and 12-month all-cause mortality was reported as events/person-12-months. Time to event analysis was performed using proportional hazard regression models adjusting for age and gender. Risks were reported as hazard ratios (HR) along with their 95% confidence interval (CI). Age- and sex-adjusted survival curves derived from proportional hazards regression models were also shown. The discriminatory power of MPI, considered as a continuous variable, for 1-month, 6-month, and 12-month all-cause mortality was assessed by estimating the area under the receiver operating characteristic (ROC) curves, along with their 95% confidence intervals using DeLong's method, following logistic regression models adjusted for age and sex. Survival C-index was computed according to Harrell's approach following proportional hazards regression models adjusted for age and sex [30]. A p value <0.05 was considered for statistical significance. All analyses were performed using SAS Release 9.1 (SAS Institute, Cary, NC, USA).

Results

Study population

During the enrolment period, 705 patients were consecutively discharged from the Geriatric Unit with a diagnosis of TIA. Twelve patients were excluded because they were younger than 65 years, 17 patients were excluded because the CGA was not completed, and 22 patients were excluded because they did not consent to participate in the study. Thus, the final study population included 654 patients, 306 men (46.8%) and 348 women (53.2%) with a mean age of 79.3 years (± 6.5 years) and a range from 66 to 99 years. The characteristics of patients included in the study, divided according to gender, are available in Table 2. The overall all-cause mortality incidence rates were 3.65 at 1 month, 8.24 at 6 months, and 14.35 at 12 months of follow-up, without significant differences between men and women.

Multidimensional Prognostic Index

Table 3 shows the characteristics of TIA patients divided by MPI grade. In MPI 1 group, 316 patients (48.3%) were included, 235 patients (35.9%) in MPI 2 group, and 103 patients (15.7%) in MPI 3 group. Higher MPI grade was significantly associated with female sex ($p < 0.009$) and older age ($p < 0.001$). With increasing MPI grade, a progressively higher all-cause mortality incidence rates were observed after 1 month, after 6 months, and after 12 months of follow-up. Cox regression analyses, adjusted for age and gender, demonstrated that MPI and most of its individual components (ADL, IADL, SPMSQ, CIRS-CI, MNA, EES) were significant predictors of all-cause mortality in TIA patients after either 1, 6, or 12 months of follow-up (Table 4). Conversely, others variables, i.e., smoking habit, regular use of alcohol and the presence of diabetes, peripheral vascular disease, atrial fibrillation, heart failure, ischemic cardiac disease, and dyslipidemia failed to show a significant predictive ability for all-cause mortality. In this population, however, the presence of hypertension was significantly protective for the mortality after 1 year of follow-up. The estimated all-cause

mortality risk by the MPI was higher during the first month of follow-up than after 6 or 12 months of follow-up.

Figure 1 shows the age- and sex-adjusted survival curve for different grades of MPI; patients with higher MPI grades demonstrated a significantly higher mortality than patients with lower MPI grades ($p < 0.0001$). The predictive performance of the MPI score had a significant high discriminatory power for 1-month all-cause mortality (age- and sex-adjusted area under the ROC curve = 0.82, 95% CI = 0.75–0.89, $p < 0.0001$), 6-month all-cause mortality (age- and sex-adjusted area under the ROC curve = 0.80, 95% CI = 0.74–0.86, $p < 0.0001$) and 12-month all-cause mortality (age- and sex-adjusted area under the ROC curve = 0.77, 95% CI = 0.72–0.82, $p < 0.0001$) (Table 5). Furthermore, overlapping results were observed using the age- and sex-adjusted Survival C index: 1-month all-cause mortality = 0.81 (95% CI = 0.74–0.88; $p < 0.0001$), 6-month all-cause mortality = 0.79 (95% CI = 0.73–0.85; $p < 0.0001$) and 12-month all-cause mortality = 0.76 (95% CI = 0.71–0.81; $p < 0.0001$). For sake of completeness, the predictive performance was also assessed for unadjusted and age-adjusted regression models and separately for males and females (Table 5), and consistent results were found.

Discussion

In the present study, we demonstrated that the MPI, derived from a standardized CGA, was effective in predicting short- and long-term all-cause mortality risk in older patients with TIA admitted to a geriatric hospital ward. These data are similar to the results reported in previous studies carried out with the MPI in older patients with acute diseases or relapse of a chronic disease, such as gastrointestinal bleeding [31], pneumonia [32], dementia [33], heart failure [34], and liver cirrhosis [35].

To the best of our knowledge, this is the first description of a prognostic index based on data available from a standard CGA for older hospitalized patients with TIA. This instrument is easy to use and the time to complete all the tests is about 20 min per evaluation. As was shown by the ROC curves, the discrimination of the MPI was also good with the area under the ROC curves of 0.82 at 1 month, 0.80 at 6 months, and 0.77 at 12 months of follow-up. These values are similar to the areas under the ROC curves reported in previous studies carried-out with the MPI in hospitalized elderly patients with different main diagnoses [31–35]. In our sample, the overall 1-month mortality of 3.65% was relatively higher compared to 1–2% reported in previous studies [36, 37]. It should be noted that the present study included older patients (mean age = 79.3 years), who were acute hospitalized and possibly at high risk for short-time death. As expected, the mortality incidence rates for 100 person-month decreased during the follow-up in all three MPI groups. The overall 1-year mortality observed in our study was 14.35% without significant differences between men and women. This rate was in agreement with data from a recent large study reporting a total 13.6% of all-cause mortality in elderly patients with TIA [17].

In this population of older patients, the Cox regression analysis demonstrated that the MPI and most of its individual components (ADL, IADL, SPMSQ, MNA, CIRS, and ESS) were significantly predictive of short- and long-term mortality. Conversely, several diseases and

conditions potentially associated with TIA in older people, including diabetes, peripheral vascular disease, atrial fibrillation, ischemic cardiopathy, dyslipidemia, and cigarette smoking and alcohol use were not. Indeed, the ABCD2 score well predicted the risk of stroke after a TIA in the first 90 days, having a fundamental role in early management of patients; no score, however, has yet been identified to evaluate short- and long-term risk of all-cause mortality in TIA patients.

The present study has some limitations. First, since the study population includes selected patients admitted to a single geriatric unit, it is possible that the sample is unrepresentative of the older population hospitalized with TIA. Furthermore, it is possible that it may not be applicable to institutionalized or ambulatory TIA patients. Second, the diagnosis of TIA by coding ICD 9, even if supported by a strong clinical and instrumental evaluation, has less accuracy of a specialist-assigned TIA diagnosis, as previously reported [38]. Third, because MPI needs a complete CGA assessment in an acute setting, it is possible that it is a complex bedside index to use in all elderly patients with TIA. Moreover, the outcome of the present study (all-cause mortality) includes fatal vascular events, which presumably may be preventable, but also other causes of death that are not. However, other prediction models have composite vascular outcome (stroke, myocardial infarction, or vascular death or fatal or nonfatal stroke or coronary event) [8–10], or only stroke has an outcome [14–16], supporting the need for a prognostic tool also for all-cause mortality in TIA patients. A very recent study suggested that discrimination was poor for all currently available risk prediction models for patients with a recent TIA or minor stroke, indicating the need for stronger predictors [39] with selected outcomes. Finally, the patients were recruited within a single hospital. Thus, larger prospective multicenter studies are needed to confirm the findings. In conclusion, we have described a MPI in hospitalized elderly patients with TIA. This index was a sensitive measure of the multidimensional risk assessment that might be useful in identifying elderly patients with TIA at different risk of all-cause mortality.

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Fig. 1.
Survival curve for 1-year all-cause mortality adjusted for age and gender for different grades of Multidimensional Prognostic Index (MPI)

Table 1

Multidimensional Prognostic Index (MPI) score assigned to each domain based on the severity of the problems

Assessment	Problems		
	No (value = 0)	Minor (value = 0.5)	Severe (value = 1)
Activities of daily living (ADL) ^a	6–5	4–3	2–0
Instrumental IADL (IADL) ^a	8–6	5–4	3–0
Short portable mental status questionnaire (SPMSQ) ^b	0–3	4–7	8–10
Comorbidity-index (CIRS-CI) ^c	0	1–2	3
Mini nutritional assessment (MNA) ^d	24	17–23.5	< 17
Exton–Smith scale (ESS) ^e	16–20	10–15	5–9
Number of medications	0–3	4–6	7
Social support network	Living with family	Institutionalized	Living alone

^aNumber of active functional activities,

^bnumber of errors,

^cnumber of diseases,

^dMNA score: 24 = satisfactory nutritional status; 17–23.5 = at risk of malnutrition; <17 = malnutrition,

^eESS score: 16–20 = minimum risk; 10–15 = moderate risk; 5–9 = high risk of developing scores

Table 2

Functional and clinical characteristics of hospitalized patients with transient ischemic attack divided according to gender

Characteristics	All	Males	Females	<i>p</i> value
Age, mean $\pm$ SD (years)	79.34 $\pm$ 6.5	78.75 $\pm$ 6.4	79.87 $\pm$ 6.6	0.027
Education level, mean $\pm$ SD (years)	4.09 $\pm$ 3.38	4.74 $\pm$ 3.78	3.49 $\pm$ 2.84	< 0.001
ADL, mean $\pm$ SD, score	4.12 $\pm$ 2.32	4.28 $\pm$ 2.33	3.98 $\pm$ 2.30	0.006
IADL, mean $\pm$ SD, score	3.79 $\pm$ 3.13	3.73 $\pm$ 3.04	3.83 $\pm$ 3.20	0.801
SPMSQ, mean $\pm$ SD, score	2.99 $\pm$ 2.92	2.76 $\pm$ 2.92	3.19 $\pm$ 2.91	0.013
MNA, mean $\pm$ SD, score	22.18 $\pm$ 5.17	22.85 $\pm$ 4.97	21.48 $\pm$ 5.27	< 0.001
ESS, mean $\pm$ SD, score	15.79 $\pm$ 3.56	16.28 $\pm$ 3.47	15.34 $\pm$ 3.58	< 0.001
CIRS-CI, mean $\pm$ SD, score	2.71 $\pm$ 1.66	2.75 $\pm$ 1.69	2.68 $\pm$ 1.63	0.695
No of drugs, mean $\pm$ SD, score	3.77 $\pm$ 2.55	3.63 $\pm$ 2.61	3.90 $\pm$ 2.49	0.146
MPI value, mean $\pm$ SD, score	0.39 $\pm$ 0.23	0.35 $\pm$ 0.23	0.42 $\pm$ 0.22	< 0.001
Regular user of alcohol, no. (%)	63 (11.6)	54 (20.8)	9 (3.2)	< 0.001
Cigarette smoking, no. (%)	75 (13.2)	74 (27.1)	1 (0.3)	< 0.001
Diabetes, no. (%)	130 (19.9)	63 (20.6)	67 (19.3)	0.669
Hypertension, no. (%)	407 (62.2)	179 (58.5)	228 (65.5)	0.065
Atrial fibrillation, no. (%)	86 (13.1)	42 (13.7)	44 (12.6)	0.683
Heart failure, no. (%)	12 (1.8)	6 (2.0)	6 (1.7)	0.822
Ischemic heart disease, no. (%)	45 (6.9)	21 (6.9)	24 (6.9)	0.986
Peripheral vascular disease, no. (%)	13 (2.0)	9 (2.9)	4 (1.1)	0.101
Dyslipidemia, no. (%)	211 (32.3)	85 (27.8)	126 (36.2)	0.021
All-cause mortality at 1 month (events/p-1m, % ir)	23/630 (3.65)	9/296 (3.05)	14/334 (4.19)	0.455
All-cause mortality at 6 months (events/p-6m, % ir)	50/607 (8.24)	21/286 (7.34)	29/321 (9.05)	0.484
All-cause mortality at 12 months (events/p-12m, % ir)	86/599 (14.35)	44/281 (15.64)	42/318 (13.20)	0.434

ADL activities of daily living, *IADL* instrumental activities of daily living, *SPMSQ* short-portable mental status questionnaire, *ESS* Exton-Smith scale, *CIRS-CI* cumulative illness rating scale-comorbidity index, *MNA* mini-nutritional assessment, *MPI* Multidimensional Prognostic Index, *p-1m* person-1 month, *p-6m* person-6 month, *p-12m* person-12 month, *ir* incidence rate

Table 3

Demographic and clinical characteristics of the patients divided according to the Multidimensional Prognostic Index (MPI) grade

	MPI 1 (low risk)	MPI 2 (moderate risk)	MPI 3 (severe risk)	<i>p</i> value
Patients, no. (%)	316 (48.3)	235 (35.9)	103 (15.7)	–
MPI value, mean (SD)	0.19 (0.09)	0.50 (0.09)	0.75 (0.08)	–
Women, no. (%)	149 (47.2)	139 (59.1)	60 (58.3)	0.009
Age: mean (SD) (years)	77.16 (5.82)	81.03 (6.32)	82.17 (6.82)	< 0.001
Age: range (years)	65–93	65–98	65–99	–
Educational levels, mean (SD), y	4.4 (3.19)	3.46 (2.88)	4.47 (4.72)	0.334
Regular use of alcohol, no. (%)	51 (18.5)	9 (4.7)	3 (3.9)	< 0.001
Cigarette smoking, no. (%)	44 (15.2)	25 (12.4)	6 (7.8)	0.085
Diabetes, no. (%)	46 (14.6)	59 (25.1)	25 (24.3)	0.004
Hypertension, no. (%)	194 (61.4)	157 (66.8)	56 (54.4)	0.548
Atrial fibrillation, no. (%)	30 (9.5)	41 (17.4)	15 (14.6)	0.039
Heart failure, no. (%)	5 (1.6)	6 (2.6)	1 (1)	0.971
Ischemic heart disease, no. (%)	15 (4.7)	17 (7.2)	13 (12.6)	0.008
Peripheral vascular disease, no. (%)	6 (1.9)	4 (1.7)	3 (2.9)	0.637
Dyslipidemia, no. (%)	112 (35.4)	70 (29.8)	29 (28.2)	0.103
All-cause mortality at 1 month (events/p-1m, %ir)	1/310 (0.32)	12/224 (5.36)	10/96 (10.42)	< 0.0001
All-cause mortality at 6 months (events/p-6m, % ir)	6/307 (1.95)	21/215 (9.77)	23/84 (27.22)	< 0.0001
All-cause mortality at 12 months (events/p-12m, % ir)	16/308 (5.19)	35/212 (16.47)	35/79 (44.32)	< 0.0001

p-1m person-1 month, *p-6m* person-6 months, *p-12m* person-12 months, *ir* incidence rate

Table 4

Risks of all-cause mortality according to the Multidimensional Prognostic Index (MPI), the individual factors used to calculate the MPI, and clinical variables after 1 month, 6 months, and 12 months of follow-up

Risk factors	HR (95% CI) 1 month	p value	HR (95% CI) 6 months	p value	HR (95% CI) 12 months	p value
MPI						
1	1		1		1	
2	14.13 (1.80–110.58)	0.012	3.86 (1.53–9.77)	0.004	2.56 (1.39–4.71)	0.003
3	26.17 (3.25–210.42)	0.002	9.78 (3.87–24.75)	< 0.001	6.37 (3.44–11.78)	< 0.001
Age	1.09 (1.02–1.16)	0.008	1.1 (1.06–1.15)	< 0.001	1.09 (1.06–1.13)	< 0.001
Gender (male)	1.37 (0.59–3.17)	0.458	1.23 (0.70–2.15)	0.478	0.84 (0.55–1.29)	0.425
ADL	1.45 (1.20–1.76)	< 0.001	1.4 (1.23–1.58)	< 0.001	1.3 (1.19–1.42)	< 0.001
IADL	1.54 (1.19–1.98)	< 0.001	1.33 (1.16–1.52)	< 0.001	1.27 (1.15–1.40)	< 0.001
SPMSQ	1.13 (0.95–1.35)	0.165	1.16 (1.05–1.29)	0.005	1.16 (1.07–1.25)	< 0.001
CIRS-CI	1.09 (0.87–1.36)	0.464	1.2 (1.03–1.39)	0.019	1.2 (1.06–1.35)	0.003
MNA	1.17 (1.10–1.26)	< 0.001	1.16 (1.11–1.22)	< 0.001	1.14 (1.10–1.18)	< 0.001
Exton-Smith scale	1.34 (1.20–1.50)	< 0.001	1.28 (1.19–1.38)	< 0.001	1.23 (1.16–1.30)	< 0.001
No. of drugs	1.12 (0.96–1.31)	0.161	1.06 (0.95–1.18)	0.302	1.03 (0.95–1.12)	0.512
Social network	1.40 (0.57–3.43)	0.465	1.43 (0.78–2.63)	0.244	1.32 (0.83–2.11)	0.241
Education level	0.97 (0.81–1.15)	0.688	0.98 (0.88–1.08)	0.647	1.01 (0.94–1.09)	0.83
Use of alcohol	–		0.23 (0.03–1.69)	0.148	1.26 (0.61–2.61)	0.531
Cigarette smoking	1.31 (0.25–7.02)	0.749	0.77 (0.25–2.32)	0.636	0.82 (0.39–1.73)	0.607
Diabetes	1.43 (0.52–3.91)	0.49	1.32 (0.65–2.68)	0.435	1.62 (0.97–2.71)	0.063
Heart failure	1.95 (0.26–14.62)	0.515	0.85 (0.12–6.15)	0.868	0.47 (0.06–3.37)	0.451
Hypertension	0.8 (0.35–1.82)	0.591	0.61 (0.35–1.06)	0.079	0.6 (0.40–0.92)	0.02
Ischemic heart disease	1.24 (0.29–5.28)	0.773	0.82 (0.26–2.64)	0.741	0.94 (0.41–2.16)	0.89
Peripheral vascular disease	–		0.97 (0.13–7.04)	0.978	1.11 (0.27–4.50)	0.886
Atrial fibrillation	0.89 (0.27–3.01)	0.856	1.49 (0.75–2.99)	0.258	1.39 (0.80–2.39)	0.239
Dyslipidemia	0.58 (0.17–1.99)	0.387	0.87 (0.42–1.81)	0.704	0.94 (0.54–1.64)	0.84

HR hazard ratio, 95% CI 95% confidence interval, ADL activities of daily living, IADL instrumental activities of daily living, SPMSQ short-portable mental status questionnaire, ESS Exton-Smith scale, CIRS-CI cumulative illness rating scale-comorbidity index, MNA mini-nutritional assessment

Table 5

Predictive performance of the Multidimensional Prognostic Index (MPI) for 1-month, 6-month, 9-month, and 12-month all-cause mortality

	AUC ROC			Survival C-index		
	MPI	95% CI	p value	MPI	95% CI	p value
1-month all-cause mortality						
Unadjusted models						
Overall sample	0.816	(0.749–0.884)	< 0.0001	0.821	(0.754–0.888)	< 0.0001
Male sample	0.853	(0.760–0.946)	< 0.0001	0.862	(0.768–0.955)	< 0.0001
Female sample	0.782	(0.682–0.883)	< 0.0001	0.786	(0.692–0.879)	< 0.0001
Age-adjusted models						
Overall sample	0.819	(0.749–0.889)	< 0.0001	0.815	(0.744–0.885)	< 0.0001
Male sample	0.878	(0.800–0.956)	< 0.0001	0.881	(0.805–0.957)	< 0.0001
Female sample	0.781	(0.687–0.876)	< 0.0001	0.774	(0.686–0.862)	< 0.0001
Age and sex-adjusted model						
Overall sample	0.819	(0.749–0.888)	< 0.0001	0.815	(0.744–0.885)	< 0.0001
6-month all-cause mortality						
Unadjusted models						
Overall sample	0.793	(0.730–0.857)	< 0.0001	0.792	(0.732–0.852)	< 0.0001
Male sample	0.822	(0.734–0.911)	< 0.0001	0.820	(0.740–0.900)	< 0.0001
Female sample	0.769	(0.680–0.859)	< 0.0001	0.770	(0.685–0.855)	< 0.0001
Age-adjusted models						
Overall sample	0.799	(0.738–0.861)	< 0.0001	0.790	(0.732–0.849)	< 0.0001
Male sample	0.839	(0.753–0.926)	< 0.0001	0.829	(0.748–0.909)	< 0.0001
Female sample	0.770	(0.681–0.859)	< 0.0001	0.760	(0.676–0.844)	< 0.0001
Age and sex-adjusted model						
Overall sample	0.799	(0.738–0.861)	< 0.0001	0.790	(0.731–0.848)	< 0.0001
12-month all-cause mortality						
Unadjusted models						
Overall sample	0.751	(0.696–0.806)	< 0.0001	0.749	(0.698–0.801)	< 0.0001
Male sample	0.751	(0.675–0.826)	< 0.0001	0.748	(0.678–0.818)	< 0.0001
Female sample	0.765	(0.688–0.843)	< 0.0001	0.762	(0.689–0.835)	< 0.0001

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AUC ROC				Survival C-index			
	MPI	95% CI	p value		MPI	95% CI	p value
Age-adjusted models							
Overall sample	0.761	(0.707–0.816)	< 0.0001		0.751	(0.700–0.800)	< 0.0001
Male sample	0.760	(0.683–0.837)	< 0.0001		0.750	(0.680–0.821)	< 0.0001
Female sample	0.777	(0.701–0.853)	< 0.0001		0.762	(0.691–0.832)	< 0.0001
Age and sex-adjusted model							
Overall sample	0.770	(0.716–0.824)	< 0.0001		0.757	(0.707–0.806)	< 0.0001

AUC ROC area under the receiver operating characteristics curve