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A novel score for predicting 1-year mortality of intensive care patients

Laura Pietiläinen[1,2] | Johanna Hästbacka[3] | Minna Bäcklund[4] |
Tuomas Selander[5] | Matti Reinikainen[1,2]

[1]Department of Anaesthesiology and Intensive Care, Kuopio University Hospital, Kuopio, Finland

[2]University of Eastern Finland, Kuopio, Finland

[3]Department of Anesthesia and Intensive Care, Tampere University Hospital, and Tampere University, Tampere, Finland

[4]Division of Intensive Care Medicine, Department of Perioperative, Intensive Care and Pain Medicine, University of Helsinki and Helsinki University Hospital, Helsinki, Finland

[5]Science Service Center, Kuopio University Hospital, Kuopio, Finland

Correspondence
Laura Pietiläinen, Department of Anaesthesiology and Intensive Care, Kuopio University Hospital, P.O. Box 100, FI 70029 KYS, Finland.
Email: laura.pietilainen@pshyvinvointialue.fi

Abstract

Background: We aimed to develop a simple scoring table for predicting probability of death within 1-year after admission to an intensive care unit. We analysed data on emergency admissions from the nationwide Finnish intensive care quality registry.

Methods: We included first admissions of adult patients with data available on 1-year vital status (dead or alive) and all five variables included in a premorbid functional status score, which is the number of activities the person can manage independently of the following five: get out of bed, move indoors, dress, climb stairs and walk 400 m. We analysed data on patient characteristics and admission-associated factors from 2012 to 2014 to find predictors of 1-year mortality and to develop a score for predicting probability of death. We tested the performance of this score in data from 2015. We assessed the 1-year functional status score of survivors with data available.

Results: Out of 25,261 patients, 20,628 (81.7%) patients were able to perform all five functional activities independently prior to the intensive care unit admission. At 1-year post admission, 19,625 (77.7%) patients were alive. 1-year functional status score was known for 11,011 patients and 8970 (81.5%) patients achieved functional status score 5, managing all five activities independently. The score based on age, sex, preceding functional status, type of intensive care unit admission, severity of acute illness and the most significant diagnoses predicted 1-year mortality with an area under the receiver operating characteristic curve 0.78 (95% CI, 0.76–0.79). The calibration of our prediction model was good, with calibration intercept −0.01 (−0.07 to 0.05) and calibration slope 0.96 (0.90 to 1.02).

Conclusion: Our score based on data available at intensive care unit admission predicted 1-year mortality with fairly good discrimination. Most survivors achieved good functional recovery.

KEYWORDS
functional outcome, intensive care, outcome prediction, prediction model, severity score

Editorial Comment

In this study from the Finnish Intensive Care registry, the authors have used a large cohort of cases from 2015 to test a prognostic score that includes functional activity prior to ICU admission. This new scoring system demonstrates with fairly good discrimination for mortality as an outcome.

1 | INTRODUCTION

The goal of intensive care is to support the patient's life over a temporary period of mortal danger. Baseline risk-adjusted mortality reflects the success of an intensive care unit ICU in this task.[1,2] Prediction models traditionally used in intensive care predict the risk of death during the current hospitalisation.[3–6] In addition to traditional prediction models several new generation models have been developed to predict outcome, but still the most common endpoint is hospital mortality.[7] Recently, studies have focused increasingly on longer-term outcomes and outcome measures like functional recovery and quality of life.[8–10] However, data on predictors of long-term mortality and their relative weights are scarce.[7]

Decision-making, admitting a patient to intensive care or withholding care, is a complex process often based on limited data and involving uncertainty about the patient's ability to benefit from ICU admission.[11,12] Knowledge of factors that predict patients' risk of long-term mortality or ability to achieve functional recovery after intensive care could lead to better quality of life and patient satisfaction as well as a more efficient use of healthcare resources. Previous studies have found that physical health and health-related quality of life predict longer-term outcome, ability to recover or achieve adequate functional capacity, or health-related quality of life.[13–15]

The aim of this study was to evaluate the risk of 1-year mortality and to find predictors of mortality of adult ICU patients in Finland. In addition, we explored the functional recovery of survivors. Our objective was to create and validate a score for predicting probability of death within 1 year after ICU admission based on data available at the time of admission.

2 | METHODS

All data used in this study are part of a dataset routinely recorded in the nationwide database of the Finnish Intensive Care Consortium for each ICU admission in Finland. Ethics committee approval was obtained from the Research Ethics Committee of Northern Savo Hospital District (225/13.02.00/2016). Permission to perform the study was obtained from the National Institute for Health and Welfare (THL/1585/5.05.00/2016), which waived the need for informed consent of the patients.

This is a nationwide retrospective observational registry study. We retrieved data from the nationwide database of the Finnish Intensive Care Consortium and included admissions of adult patients (≥18 years) from May 2012 to December 2015 with 1-year follow-up data until the end of 2016. We included data on emergency ICU admissions. We excluded readmissions and non-emergency admissions after scheduled surgery.

We included admissions only if all five functional status score (FSS) variables representing the situation before the acute critical illness were available. The FSS variables include the abilities to get out of bed, move indoors, dress, climb stairs and walk 400 m, with each activity equalling 1 point. FSS is the sum of the five physical activities that a person is able to perform independently and thus has a value between 0 and 5.[16]

The primary outcome of this study was 1-year mortality. The secondary outcome was functional recovery of survivors. The objective of the study was to develop and validate a score that predicts the probability of death within 1-year.

We analysed the baseline characteristics of patients and admission-related factors to find predictors of 1-year mortality. We used variables representing organ failures based on six organ systems (respiratory, circulatory, coagulation, renal, central nervous system and liver failure) of the Sequential Organ Failure Assessment (SOFA) during the first 24 h (SOFA 24) in the ICU.[17] In SOFA, each organ systems is scored 0–4 points depending on the presence and severity of dysfunction. We defined organ failure as a score of 3 or 4 points for an individual organ system, in accordance with Vincent et al., the creators of the SOFA score.[17]

We present data as medians with interquartile ranges for continuous variables and numbers of cases with percentages for categorical variables. We used the Mann–Whitney U test and chi-squared test for between-group comparisons. We used logistic regression analysis to calculate odds ratios (ORs) with 95% confidence intervals (95% CIs) to all individual variables as predictors for 1-year mortality. In logistic regression analyses, we analysed continuous variables (points of the SAPS, APACHE or SOFA scores as well as FSS) as linear. We categorized age in six groups (<40 years, 40–59 years, 60–69 years, 70–79 years, 80–84 years and 85 years or older). Other variables (sex, each functional ability, admission type and SOFA organ failures) were dichotomized and analysed as categorical. We performed univariable and multivariable analyses with the enter and stepwise forward selection methods.

Based on the logistic regression analysis results in 2012–2014 data, we developed a score for predicting probability of death within 1 year. Variables tested as candidate predictors included age divided in groups, accommodation type (lives at home or in institutional care), all FSS variables, activities of daily living status (independent or needing assistance in activities of daily living), admission type (surgical or medical) and organ failure status (yes/no) for each organ system. We

also performed univariable logistic regression analysis for all APACHE III diagnoses, and based on this test, we excluded rare diagnoses representing <1% of admissions and those that were not statistically significantly associated with 1-year mortality.

The SAPS II model[4] includes chronic diseases such as metastatic cancer, hematologic malignancy and AIDS. The APACHE II model[3] includes chronic lung disease, chronic kidney disease and chronic liver disease. We included these diseases in the multivariable analyses in addition to the previous analyses. Multivariable analyses with the forward variable selection method was applied to reduce the number of predictors. To the final score, we selected APACHE III diagnoses that were statistically significant independent predictors with regression coefficients higher than 0.4 or lower than−0.4, which correspond to ORs >3/2 (i.e., 1.5) or <2/3 (i.e., 0.67), respectively, in multivariable logistic regression analysis.[18]

We included all selected variables in multivariable logistic regression analysis to obtain the regression coefficient for each variable. To assign points to our prediction score, we multiplied the regression coefficient of each variable with 10 and rounded the result to the nearest integer, using the same approach used to create the SAPS II score.[4]

We tested the discrimination ability of the risk score in data from 2015 by calculating the area under the receiver operating characteristic curve with 95% CIs. To evaluate the calibration of the risk score, we performed the modified Hosmer–Lemeshow goodness-of-fit test for large samples and calculated the calibration intercept and calibration slope.[19]

Using the same variables, we developed score 2. We repeated the logistic regression analysis for patients who were discharged alive from the ICU, to find out to whether the variables predicting outcome at ICU admission remain predictive at the time of ICU discharge.

For 1-year functional recovery evaluation, we excluded the admissions of 1-year survivors with missing data on 1-year FSS. This functional outcome study population includes admissions with available data on both pre-morbid and 1-year post-admission FSS from May 2012 to December 2015. We explored the 1-year FSS of the survivors and analysed the factors influencing their functional recovery.

We used the IBM SPSS software (IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp) for the statistical analyses. p-values <.05 were interpreted as indicating statistically significant results. We assessed our model's calibration with the R statistical software, version 4.0.4, using the CalibrationCurves R package. We report the results of this study according to recommendations of the Strengthening the Reporting of Observational Studies in Epidemiology initiative.[20] We also used the checklist of the Transparent Reporting of a Multivariable Prediction Model for individual Prognosis or Diagnosis initiative (the checklist in Additional file S1) for reporting both development and validation of our multivariable prediction model for prognosis.[21]

We have previously published studies on ICU care of elderly patients in 2012–2013[16] and in 2012–2015.[22] These studies were based on parts of the same registry data that we have used in the current study.

3 | RESULTS

There were 65,444 adult admissions to Finnish ICU's during the study period from May 2012 to December 2015. After excluding readmissions, scheduled surgical admissions and admissions with missing premorbid FSS or missing 1-year vital status, 25,261 emergency admissions were available for analysis of 1-year mortality (mortality study population). After the exclusion of 1-year non-survivors and survivors with missing 1-year FSS, there were a total of 11,001 admissions for functional recovery analyses (functional outcome study population) (Figure 1).

Baseline characteristics of the whole mortality study population and divided into 1-year survivors and non-survivors are presented in Table 1. Baseline characteristics and outcome of the patients with missing data and those with data available on premorbid FSS (mortality study population) as well as 1-year survivors with missing data and those with data available on 1-year FSS (functional outcome study population) are presented in Additional file S2.

In the whole mortality study population, ICU, hospital and 1-year mortalities were 3.9%, 10.2% and 22.3%, respectively. Of all admitted patients, 19,625 (77.7%) survived at least 1 year after ICU admission. Of the 1-year non-survivors, 17.6% died in the ICU and 45.8% during the index hospital admission. Premorbid functional characteristics of the mortality study population according to 1-year mortality are presented in Table 2.

The development cohort (admissions during 2012–2014) included 16,786 admissions, while the validation cohort (admissions in 2015) included 8475 admissions in the mortality study population. Baseline characteristics of the development and validation cohorts are presented in Additional file S3. The univariable analysis of candidate predictors of 1-year mortality in the development cohort are presented in Additional file S4.

The final score for predicting probability of 1-year mortality includes the following patient characteristics preceding the acute illness: age (<40 years, 40–59 years, 60–69 years, 70–79 years, 80–84 years and 85 years or older), sex, ability to walk 400 metres, ability to climb stairs, ability to get out of bed, independency in activities of daily living, chronic lung disease, chronic liver disease and metastatic cancer. In the multivariable analysis, hematologic malignancy and chronic kidney disease were not statistically significant and were therefore not included in the score.

Of the admission-associated variables, the following were included into the score: admission type, totally 13 APACHE III diagnoses and all six SOFA-based organ failures: respiratory failure, circulatory failure, central nervous system failure, renal failure, coagulation failure and liver failure. Results of the multivariable analysis of predictors of the risk of 1-year mortality in the development cohort and regression coefficients for each variable are presented in Additional file S5. The variables included in the final score with the points assigned for individual factors are presented in Table 3.

When the scoring is ready, the precise probability is calculated with the following equations: logit $= -3.919 + 0.098(\text{SCORE})$, and
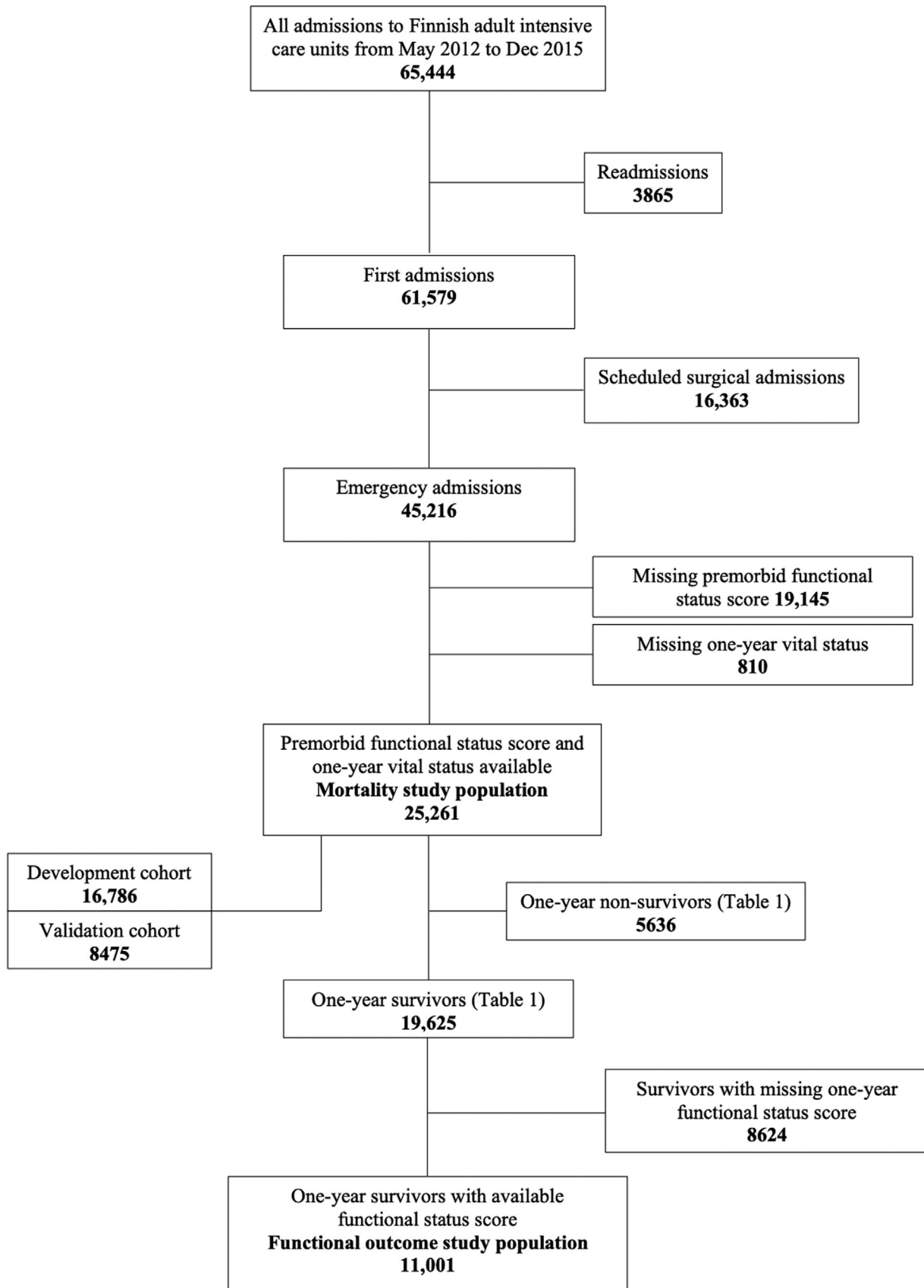
FIGURE 1   Flowchart of inclusion and exclusion criteria of intensive care unit admissions.

TABLE 1 Baseline characteristics of the mortality study population.

Characteristics	All	1-year non-survivors	1-year survivors
Number of admissions	25,261	5636 (22.3)	19,625 (77.7)
Age, years	63 (50–73)	70 (62–79)	61 (47–71)
Sex, male	15,823 (62.3)	3635 (64.5)	12,188 (62.1)
Surgical admission type	6374 (25.2)	1222 (21.7)	5152 (26.3)
SAPS II without admission type and age points	16 (8–27)	26 (16–39)	14 (7–24)
APACHE II	19 (13–25)	25 (20–31)	17 (12–23)
SOFA	6 (3–8)	8 (5–11)	5 (3–8)
SOFA respiratory failure[a]	5909 (23.4)	1902 (33.7)	4007 (20.4)
SOFA circulatory failure[a]	11,982 (47.4)	3528 (62.6)	8454 (43.1)
SOFA Central nervous system failure[a]	4658 (18.4)	1613 (28.6)	3045 (15.5)
SOFA renal failure[a]	2394 (9.5)	989 (17.5)	1405 (7.2)
SOFA liver failure[a]	297 (1.2)	156 (2.8)	141 (0.7)
SOFA coagulation failure[a]	746 (3.0)	303 (5.4)	443 (2.3)
Number of SOFA organ failures			
0	9335 (37.0)	1118 (19.8)	8217 (41.9)
1	8358 (33.1)	1797 (31.9)	6561 (33.4)
2	5421 (21.5)	1700 (30.2)	3721 (19.0)
3	1840 (7.3)	817 (14.5)	1023 (5.2)
4	272 (1.1)	179 (3.2)	93 (0.5)
5	32 (0.1)	23 (0.4)	9 (0)
6	3 (0)	2 (0)	1 (0)

Note: Data for continuous variables are presented as median values (interquartile ranges), and data for categorical variables are presented as numbers of patients (%). In the comparisons between survivors and non-survivors: $p < .001$ for all variables.
Abbreviations: APACHE II, Acute Physiology And Chronic Health Evaluation II Score; SAPS II, Simplified Acute Physiology Score II; SOFA, Sequential Organ Failure Assessment Score, based on the first 24 h in the ICU.
[a]SOFA organ (respiratory/circulatory/coagulation/renal/central nervous system/liver) failure if ≥3 points.

TABLE 2 Premorbid functional characteristics of the mortality study population.

Data variables	All patients	1-year non-survivors	1-year survivors
Number of admissions	25,261	5636	19,625
Able to live at home	23,856 (94.9)[a]	5145 (91.7)[b]	18,711 (95.9)[c]
Able to move indoors	24,405 (96.6)	5225 (92.7)	19,180 (97.7)
Able to walk 400 m	21,408 (84.7)	3981 (70.6)	17,427 (88.8)
Able to climb stairs	21,928 (86.8)	4161 (73.8)	17,767 (90.5)
Able to dress themselves	23,952 (94.8)	5011 (88.9)	18,941 (96.5)
Able to get out of bed	24,385 (96.5)	5199 (92.2)	19,186 (97.8)
Independent in ADL	18,529 (74.7)[d]	3161 (57.9)[e]	15,368 (79.4)[f]
Functional status score			
5	20,628 (81.7)	3700 (65.6)	16,928 (86.3)
4	1783 (7.1)	623 (11.1)	1169 (5.9)
3	1502 (5.9)	656 (11.6)	846 (4.3)
2	496 (2.0)	230 (4.1)	266 (1.4)
1	308 (1.2)	157 (2.8)	151 (0.8)
0	544 (2.2)	270 (4.8)	274 (1.4)

Note: Data are presented as numbers of cases (%), number of missing data: [a]136, [b]467, [c]112, [d]442, [e]174, [f]268, [g]442, [h]174 and [i]268. ADL: activities of daily living; Functional status score: the sum of manageable five physical activities (getting out of bed, moving indoors, dressing, climbing stairs and walking 400 m).

TABLE 3 Factors in the score for predicting probability of death within a year and the points assigned for each factor.

Variables		Points
Age group[1]	40–59	6
	60–69	12
	70–79	17
	80–84	19
	85–	22
Sex[2]	Male	2
Functional capacity	Unable to walk 400 m	3
	Unable to climb stairs	3
	Unable to get out of bed	4
Independency in activities of daily living[3]	Non-independent in activities of daily living	4
Admission type[4]	Medical	5
Organ failure	Respiratory failure	3
Based on the first 24 h Sequential Organ Failure Assessment score; organ failure if ≥3 points	Circulatory failure	4
	Central nervous system failure	8
	Renal failure	9
	Coagulation failure	9
	Liver failure	12
Chronic disease	Chronic lung disease	3
	Chronic liver disease	4
	Metastatic cancer	6
Diagnosis group[5]	Multiple trauma without head trauma[a]	−10
Acute Physiology And Chronic Health Evaluation III diagnosis group	Drug overdose[a]	−8
	Coronary artery bypass grafting[b]	−7
(a) Non-operative	Head trauma[a]	−6
(b) Postoperative	Diabetic ketoacidosis[a]	−3
	Bleeding gastric ulcer[a]	2
	Heart failure[a]	2
	Aspiration pneumonia[a]	4
	Cardiac arrest[a]	4
	Gastrointestinal obstruction[b]	6
	Gastrointestinal perforation[b]	6
	Intracerebral haemorrhage[a]	6
	Gastrointestinal neoplasm[b]	8

Note: Factors with a value of zero points in the score [1]age group <40 years, [2]female sex, [3]independent in ADL, [4]surgical admission type, [5]any other diagnosis.

Probability = exp(logit)/(1 + exp(logit)). The relationship of the score with the probability of death within 1 year in the validation cohort is presented in Figure 2.

The discrimination ability of the final risk score in the validation cohort was fairly good, with the area under the receiver operating characteristic curve 0.78 (95% CI, 0.76–0.79). In the Hosmer–Lemeshow test for large samples, calibration was good in the validation cohort ($p = .22$). In the development cohort, calibration intercept was 0.01 (−0.03 to 0.05) and calibration slope was 1.00 (0.96–1.04). In the validation cohort, calibration intercept and slope were −0.01 (−0.07–0.05) and 0.96 (0.90–1.02), respectively. The calibration plots of the development cohort are presented in Figure 3, and calibration plots of the validation cohort are presented in Figure 4.

Score 2, based on data on ICU survivors is presented in Additional file S6. The weights of acute organ failures were lower, and the impact of high age was stronger compared to the score based on the whole study population.

We analysed the data of 11,001 (66.1%) 1-year survivors whose 1-year FSS was available (functional outcome study population). Totally 10,089 (92.5%) patients in the functional outcome study population were able to live at home 1 year after ICU admission. In addition, the majority of patients were able to move indoors (95.9%), walk 400 m (84.6%), climb stairs (85.7%), dress themselves (92.0%) and get out of bed (95.2%). 1-year FSS in each premorbid FSS group is presented in Figure 5. Among patients who were able to manage physical activities before the critical illness, the vast majority of survivors were able to manage the activities also 1 year afterwards (Figure 6). Of those patients who were not able to manage physical activities before the critical illness, a few were able to manage the activities 1 year afterwards (Figure 7).

In the group of 1-year survivors with 1-year FSS 0 ($n = 407$, 2.5% of all survivors), premorbid FSS had been 0 in 63 (15.5%) patients but 5 in 224 (55.0%) patients. Of those with 1-year FSS 0, the most common diagnostic groups were neurological/neurosurgical diseases (134, 32.9%), cardiovascular diseases (61, 15.0%), trauma (59, 14.5%) and respiratory diseases (52, 12.8%). Central nervous system failure at the beginning of ICU care was rather common (31.0%) in the group of survivors with 1-year FSS 0. Of the survivors with 1-year FSS 0, one-third (32.9%) were still able to live at home. 1-year FSS in each age group is presented in Figure 8.

4 | DISCUSSION

In this Finnish nationwide retrospective registry study, we found that age, sex, preceding functional status, type of ICU admission, severity of acute illness and some major diagnoses are predictive of 1-year mortality in ICU patients. We created a simple scoring system that can be used to estimate the probability of death within 1 year after ICU admission. This score demonstrated fairly good discrimination and good calibration.

The strongest single predictors of death within 1 year after intensive care unit admission and thus the factors that are assigned the highest points to our risk score were old age, central nervous system failure, renal failure, coagulation failure, liver failure, metastatic cancer and a diagnosis of gastrointestinal neoplasm. We also found some

FIGURE 2 Relationship of the score with the probability of 1-year mortality.
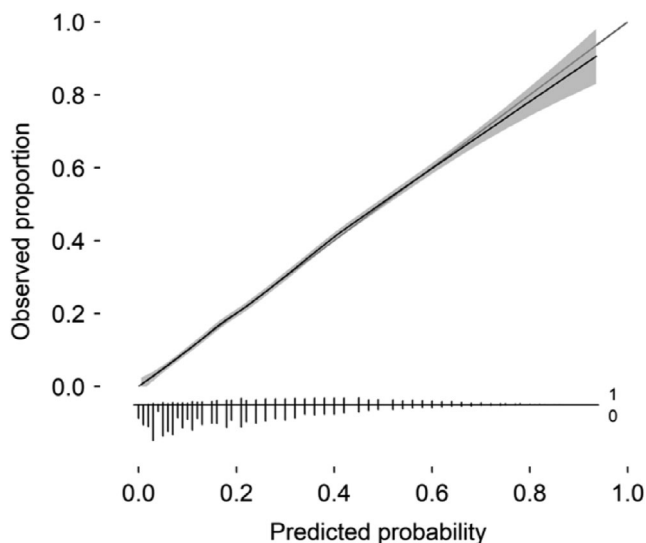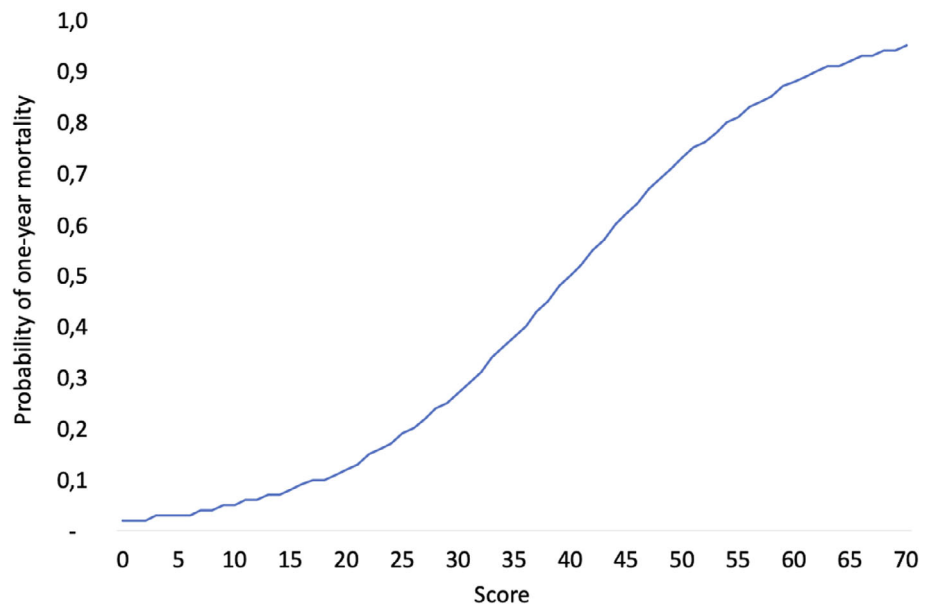

FIGURE 3 Calibration plot of the development cohort. Calibration intercept 0.00 (−0.04 to 0.04) and calibration slope 1.00 (0.96 to 1.04). Discrimination c-statistic 0.78 (0.78–0.79). The red line shows the ideal calibration, the black line shows the actual flexible calibration.
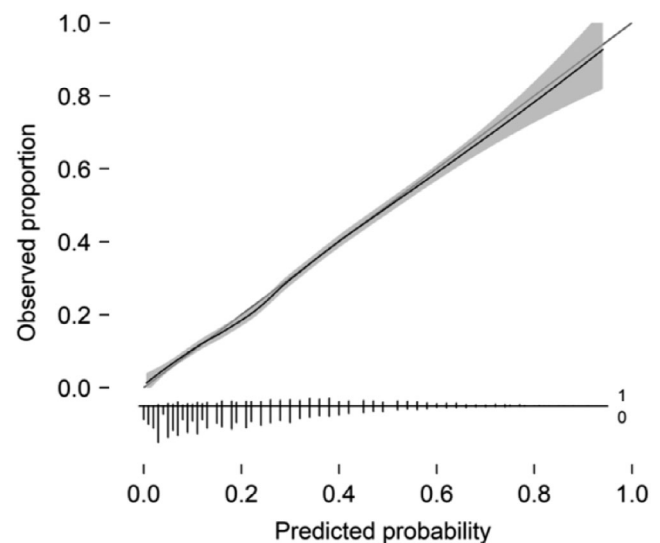
FIGURE 4 Calibration plot of validation cohort. Calibration intercept −0.02 (−0.07 to 0.04) and calibration slope 0.95 (0.89 to 1.00). Discrimination c-statistic 0.77 (0.76–0.78). The red line shows the ideal calibration, the black line shows the actual flexible calibration.

diagnostic groups that were associated with good prognosis and that therefore score negative points to the risk score: non-operative multiple trauma without head trauma, drug overdose and coronary artery bypass grafting. In addition, premorbid functional capacity had a major impact on long-term prognosis: a very poor premorbid functional status, as reflected by maximum points for variables reflecting poor functional capacity and dependency on help, increased the likelihood of death within a year more than any one of the individual diagnoses or any one of the individual organ failures.

Higgins et al.[14] determined the prevalence and predictors of death or new disability at 6 months after ICU admission. Less than

half (41.1%) of all patients in their study were alive and free of new disability at 6 months after admission to ICU. The study population included 628 patients who were mechanically ventilated for more than 24 h and had a median age of 62 (interquartile ranges 49–71) years. Age, severity of illness and admission diagnosis were independent predictors of outcome.[14]

Recently, Heyland et al.[23] developed a clinical prediction model that included baseline measurements associated with good functional recovery. Physical recovery was associated with age, marital status, sex, some admission diagnoses, baseline functional status and severity of acute illness. The goal of functional recovery was defined as a
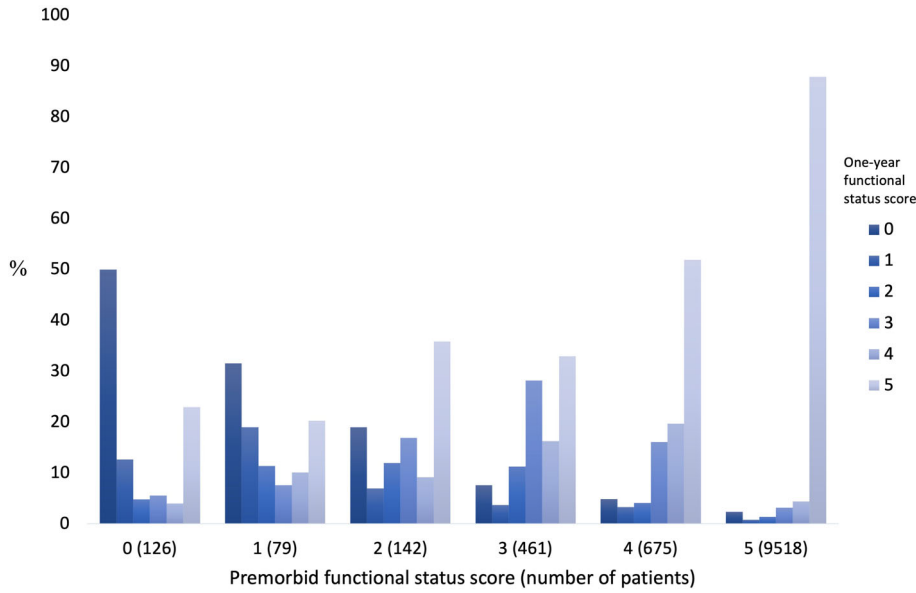
FIGURE 5 1-year functional status score in each premorbid functional status score group.
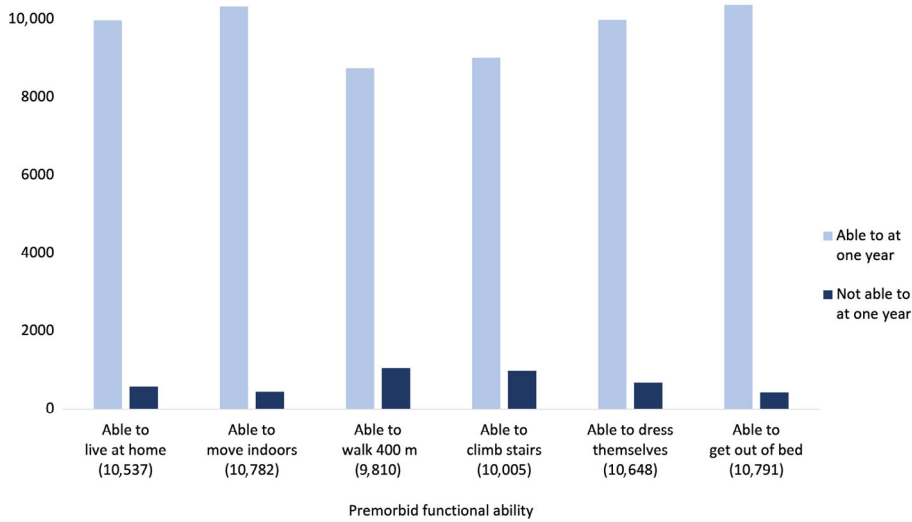

FIGURE 6 The ability to manage physical activities at 1 year post-intensive care unit admission among patients who were able to manage the activities before the critical illness.
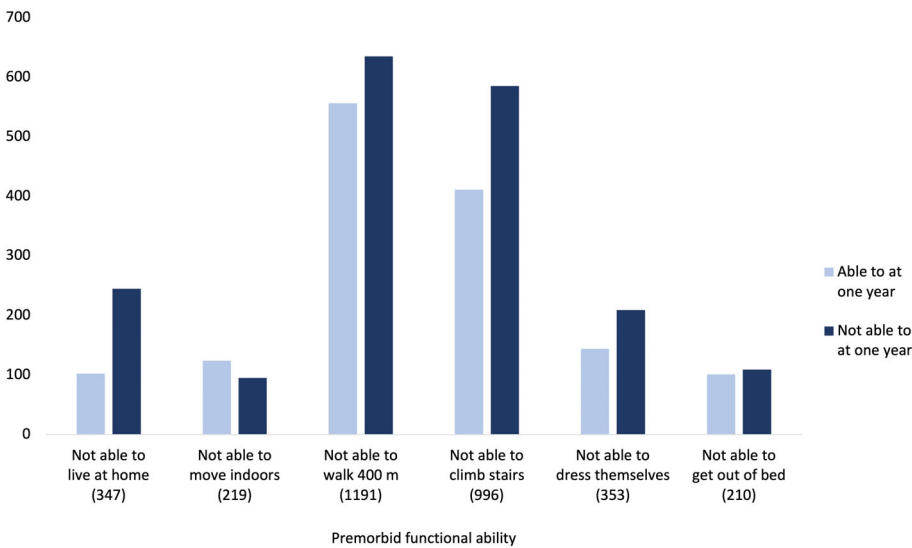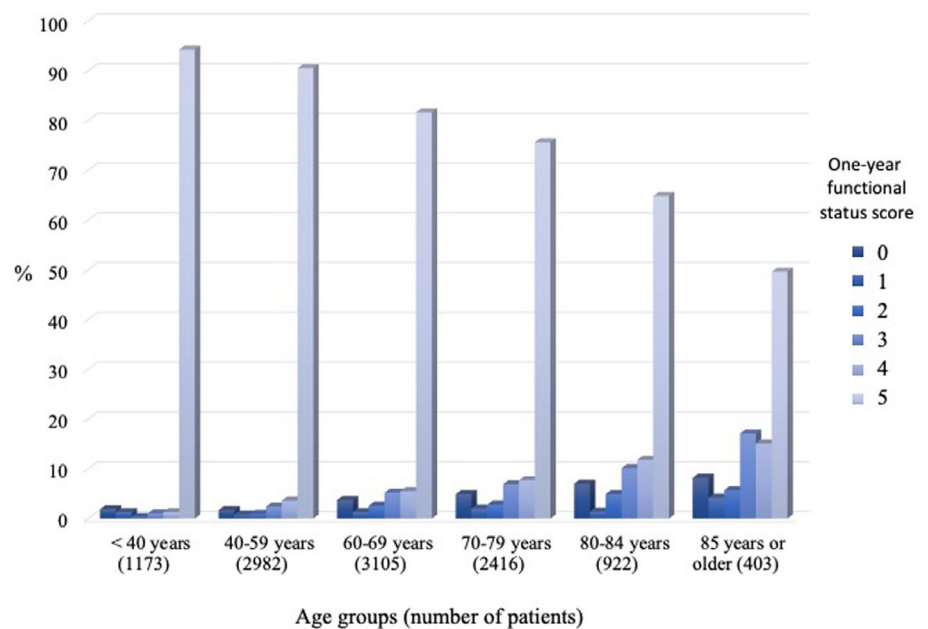

FIGURE 7 The ability to manage physical activities at 1 year post-intensive care unit admission among patients who were not able to manage the activities before the critical illness.

FIGURE 8 1-year functional status score in each age group.

Palliative Performance Scale of 60 points regardless of the baseline score. Heyland et al. found 50% mortality in their study population aged 80 years or older. Only 29% of all the patients (about 58% of survivors) reached the level of good functional recovery.[23]

Our goal was also to develop a prediction score for favourable outcome. However, data on functional recovery of survivors were frequently missing, whereas survival data were complete. Because of imbalances in missing data, a prediction model based on available data would have been biased. We chose not to use imputations of the missing outcome variables.

In our study, overall 1-year survival was 77.7%. For 66.1% of survivors, data were available both about baseline functional status and 1-year functional status. The most common functional outcome for survivors was the maximum functional status score of 5, in 81.5% of survivors with data available. For 7.0% of survivors, the 1-year functional status score was better than the premorbid score, and for 79.3%, the score remained unchanged. The 1-year functional status score was lower than the baseline functional status score for only 13.7% of all survivors. This means that for the majority of 1-year survivors, functional outcome was good.

Defining functional recovery is complex, and a comparison between studies is difficult because the patients included, length of follow-up and outcome measured (functional recovery, cognitive or mental capacity, health-related quality of life, etc.) vary between studies. People may have varying perceptions about what level of functioning is good or acceptable. The impact of decreased functional level is probably dependent on the baseline level, degree of impairment and multiple social factors. In our study, the variables describing functional status include five functions that are closely related to everyday life and are part of the routine ICU data collection in all Finnish ICUs. Variables collected at the time of admission also include the physical performance according to the WHO/ECOG performance status classification to describe the patient's ability to perform

activities of daily living. These variables have not been pre-validated for any outcome prediction model before.

The strengths of this study include its nationwide design, data of long-term (1-year) outcome, including data of functional recovery, and data of patients' baseline functional status. We included admissions regardless of the length of stay, treatment intensity or possible restrictions of care. Using the data of our nationwide registry, we developed and validated a novel score for predicting long-term mortality. We used the Hosmer–Lemeshow goodness-of-fit test for large samples accompanied by calibration intercept and calibration slope calculation to assess both the overall calibration and calibration in different risk groups or individuals.

The main limitation of this study is the exclusion of a large number of patients due to missing premorbid or 1-year FSS data. The excluded population with missing premorbid functional capacity appears to represent patients with a high risk of death, based on available baseline characteristics, severity of illness and outcome data. We consider it possible that the excluded population with missing 1-year FSS is more heterogeneous. There were differences in age and sex between 1-year survivors with available data on 1-year FSS and those with missing data. 1-year data are based on patients' responses to a follow-up questionnaire. Survivors who did not respond to the questionnaire were younger and more often males than survivors who responded. In addition, hospital mortality and 1-year mortality were lower in the validation cohort than in the development cohort. This means that the development and validation cohorts were not completely similar. However, despite this we found an acceptable calibration of the prediction score.

Another important limitation is that we have data only about patients who were admitted to ICUs. Intensive care is often withheld as futile when the patient's prognosis is estimated to be very poor. It is possible that in many cases poor functional status may have had an impact on the assessment of prognosis.

The retrospective nature of our study brings inherent limitations. Furthermore, the variables included in the FSS had an equal weight in our analyses for simplicity. Their true weights may differ, and there are likely interactions between the variables used. Variables of functional abilities are not objectively measured but are based on reporting by the patient or their relatives, which may cause either overestimation or underestimation of abilities. In addition, it is possible that in some cases the acute illness may have caused a deterioration in functional status and that poor status has been erroneously recorded as the premorbid functional status.

In this study, we only analysed the factors available at time of admission or at the early phase of ICU care. Usually we receive more detailed information about the patient's baseline health, the nature of the acute illness and patient's response to the treatment after their admission and during their ICU stay. Recently, several studies have aimed, with modest success, to solve this challenge of decision making and prediction with methods of machine learning or artificial intelligence.[24–26]

Prediction models provide population averages but are not able to predict with certainty outcomes of individual patients.[27] In admission decisions, clinicians' judgement may be partly based on data not included in quality registries. However, patient selection, clinical decision making and adjusting the intensity of treatment according to the patient's odds for recovery are everyday tasks to ICU clinicians, who may benefit from a validated and well-calibrated prediction tool such as the score created in this study.

We developed a novel score, including weighted points based on age, sex, preceding functional status, type of ICU admission, severity of acute illness and some major diagnoses, that predicts 1-year mortality with fairly good discrimination.

AUTHOR CONTRIBUTIONS

This study is designed by LP and MR. The data were analysed and interpreted by TS, LP and MR. The draft was wrote by LP and MR assisted by JH and MB. All the authors were contributors in writing the manuscript and all the authors read and approved the final version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Research data are not shared.

ORCID

Laura Pietiläinen https://orcid.org/0000-0001-5457-9466
Johanna Hästbacka https://orcid.org/0000-0002-3613-7231
Tuomas Selander https://orcid.org/0000-0002-0070-8565
Matti Reinikainen https://orcid.org/0000-0001-6878-3740

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.