**Supplementary materials**

**1. Expanded Methods**

We adhere to the TRIPOD statements of transparent reporting of a multivariable prediction model for individual prognosis and diagnosis [11].

*Source of the data*

The methods and patients have been described in previous publications [4][7]. Briefly, the VIP1 is a prospective European study performed in multiple ICUs. Each participating ICU included up to 20 consecutive patients during a three-month period. Individual ICUs started the data collection between October 2016 and February 2017. A website was set up to facilitate information about the study and to allow for data entry using an electronic CRF. The study was registered on ClinicalTrials.gov (ID: NTC03134807).

*Participants*

All consecutive patients who were aged 80 years or over and admitted to the 311 participating ICUs of 24 countries were eligible. For this analyses we have excluded patients that were admitted after elective surgery because they have a better prognosis [4].

*Outcome*

Outcome in ICU (dead or alive) and mortality at day 30 after ICU admission were collected for all included patients. The 30-days after ICU admission outcome was assessed by the treating physicians and was not blinded.

*Variables*

The following variables were available during the study: age, gender, reason for ICU admission among a pre-defined list of 11 admission groups, the abbreviated clinical frailty scale (9 items) was assessed by physicians by asking relatives to give their opinion [12], the worst Sequential Organ Failure Assessment (SOFA) score of the entire ICU stay, any period of non-invasive mechanical ventilation (NIV) during the entire ICU stay, any period of invasive mechanical ventilation (requiring endotracheal intubation, IMV) during the entire ICU stay, use of vasoactive drugs during the entire ICU stay, renal replacement therapy (RRT), and length of stay (LOS) prior to ICU admission. The 11 reasons for ICU admission were Respiratory Failure, Circulatory failure, Respiratory and circulatory failure, Sepsis, Multi-trauma without head injury, Multi-trauma with head injury, Isolated Head Injury, intoxication, non-trauma CNS causes, Emergency surgery, and Other.

*Sample size*

It has been suggested, as a general rule, that the number of events per included variables should be at least 10. During the model development, we initially included 12 variables of which the covariate reasons for ICU admission consist of 11 categories. In total we included 21 different degrees of freedom necessitating a sample size of at least 210 deaths.

*Missing data*

Patients with missing data on variables included in the multivariable logistic regression model were excluded from further analyses.

*Multivariable logistic regression model*

A model was developed to predict the mortality of elderly patients 30 days after ICU admission using all variables available in the dataset. To correct for similarities among patients within the same country, and within the same ICU, we included country and ICU as random factors into the model.

The variables were included in a multivariable logistic regression model. These were tested for multicollinearity to assess which variables could be included in model development. The multicollinearity was assessed using the variance inflation factor (VIF), in which a VIF of 4 or higher was defined as multicollinearity present. Furthermore, interaction between age and frailty score was tested. An ANOVA test was used to determine whether the continuous variables should be included as restricted cubic spline, by comparing the Akaike Information Criterions (AIC) of a model with and a model without restricted cubic spline for the continuous variables. To select the best variables for inclusion in the multivariable logistic regression model, the Least Absolute Selection and Shrinkage Operator (LASSO) procedure was applied in a 10-fold cross-validation. During this methods the regression coefficients of the included variables are shrinked as much as possible without enlarging the prediction error. The variables of which the regression coefficient could be shrinked to zero are not selected in the final model. For a more elaborate explanation on the LASSO methodology we refer to a publication by Tibshirani (Tibshirani R. Regression Shrinkage and Selection via the Lasso. J. R. Statist. Soc. B. 1996;58(1):267-288.)

The performance of the final multivariable regression model was assessed for the total ICU population and for several diagnostic subgroups by measures of discrimination, accuracy, and calibration. The discrimination was expressed as the area under the receiver operating characteristic curve (AUC). The accuracy of the model was assessed by the Brier score. Estimates of the AUC, Brier score and the associated 95% confidence intervals of the models were obtained by bootstrapping with 500 samples [13]. The calibration is analyzed using the GiViTi calibration belt [19].

*Simple bedside model based on a point system*

The simple bedside model is based on the variables included in the final multivariable regression model. A practical point system founded on the beta of each predictor was developed using the following 6 steps according to the Framingham method. This has been described in more detail in a previous publication by Brandenburg et al. [20].

* + 1. Continuous variables were categorised and a reference value for each category was set. This reference value was usually the median of the specific category, for instance the reference value for the age category 83-85 year was 84 years.
    2. For each predictor a reference category, receiving zero points in the point system, was set. For age, the base category was <81 year with a reference value of 80 years. For all binary variables, the base category was set at 0, indicating that the specific diagnosis was absent.
    3. For all non-based categories, the differences between the reference value of the specific category and the reference value of the base category was calculated. For the age category 83-85 years with a reference value of 84, this difference was 4 years. For all binary variables this difference was 1.
    4. The risk factor of each category was set by multiplying the calculated differences with the beta of the specific variables. In the final multivariate regression model the beta of the predictor age was 0.05, resulting in a risk factor of 0.2 for the age category 83-85 years.
    5. The constant of the point system was defined by multiplying the beta of the predictor age by 5 and was 0.25.
    6. The points, rounded to the nearest integer, assigned to each category were calculated by dividing the risk factor by the constant. For the age category 83-85 years this results in 1 point.

The total of the assigned number of points to each patient is defined as the cumulative prognostic score (CPS) of the patient. To determine the performance of the bedside model, the sensitivity and specificity of several cut-off points based on the CPS were assessed.

The statistical analyses were performed using IBM SPSS statistics 21 and the statistical environment R version 3.3.3.

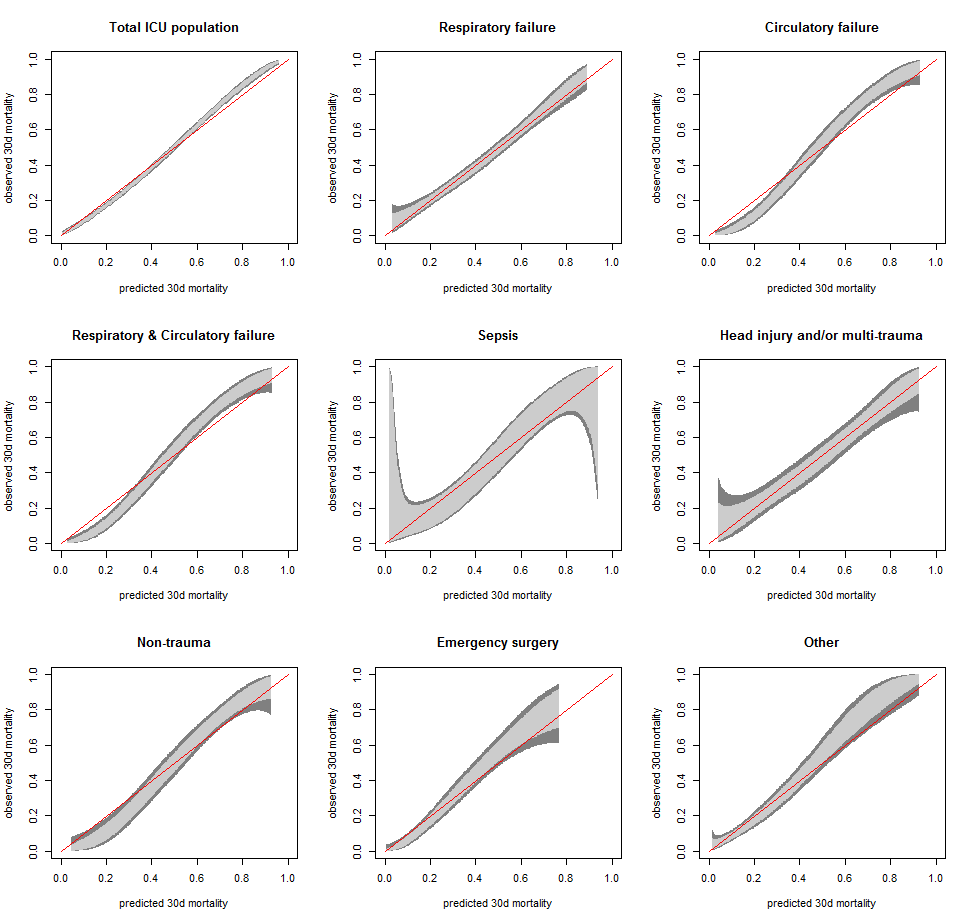
*Ethics*

An institutional research ethical board approval was obtained from each country and/or study site. No specific funding was received, but the study was endorsed by ESICM.

**2. Performance of Multivariate logistic regression model**

|  |  |  |
| --- | --- | --- |
|  | AUC (CI) | Brier (CI) |
| Total ICU population | 0.80 (0.80-0.81) | 0.18 (0.18-0.18) |
| Respiratory failure | 0.74 (0.72-0.75) | 0.20 (0.20-0.21) |
| Circulatory failure | 0.84 (0.82-0.85) | 0.16 (0.16-0.17) |
| Respiratory and circulatory failure | 0.78 (0.78-0.78) | 0.19 (0.19-0.19) |
| Sepsis | 0.78 (0.77-0.80) | 0.19 (0.18-0.20) |
| Head injury and/or multi-trauma | 0.76 (0.73-0.78) | 0.20 (0.19-0.21) |
| Non-trauma | 0.81 (0.79-0.83) | 0.18 (0.17-0.19) |
| Emergency surgery | 0.81 (0.79-0.83) | 0.15 (0.14-0.15) |
| Other | 0.81 (0.79-0.83) | 0.14 (0.13-0.14) |

**3. GiViTi calibration belt**



GiViTI (Italian Group for the Evaluation of Interventions in Intensive Care Medicine) has developed a tool to assess the confidence bands for the calibration curve based on a function that relates expected to observed probabilities across classes of risk. The calibration belt allows the ranges of risk to be spotted where there is a significant deviation from the ideal calibration.

**4. Prediction model based on a point system**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| CPS Points | **Age** | **Gender** | **Reason for ICU admission\*** | **SOFA score** | **Clinical Frailty score** | **Invasive Mechanical Ventilation** | **Renal replacement Therapy** | **Vasoactive drugs** |
| 0 | <83 | female | 9 | <3 | <3 | 0 | 0 | 0 |
| 1 | >83-<87 | male |  | >3-<6 | 3 |  |  | 1 |
| 2 | >87 |  |  |  | 4,5 |  | 1 |  |
| 3 |  |  | 11,99 | >6-<8 | 6 | 1 |  |  |
| 4 |  |  |  | >8-<11 |  |  |  |  |
| 5 |  |  | 1,2,4,5 |  | >7 |  |  |  |
| 6 |  |  | 3,7 | >11 |  |  |  |  |
| 7 |  |  | 6,10 |  |  |  |  |  |

Legend to Table S4:

CPS means the Cumulative Prognostic Score, ICU means Intensive Care Unit, \*Reasons for admission to the ICU are: 1=Respiratory Failure, 2=Circulatory failure, 3=Respiratory and circulatory failure, 4=Sepsis, 5=Multi-trauma without head injury, 6=Multi-trauma with head injury, 7=Isolated Head Injury, 9=intoxication, 10=non-trauma CNS causes, 11=Emergency surgery, 99=Other

**5. Demographics for patients with ≤10 and >10 Cumulative Prognostic Score (CPS)**

|  | **Number of patients with 30day CPS ≤10** | **Percentages of patients with 30day CPS ≤10** | **Number of patients with 30day CPS >10** | **Percentages of patients with 30day CPS >10** |
| --- | --- | --- | --- | --- |
| Total | 897 | 24 | 2833 | 76 |
| ICU mortality | 52 | 5.8 | 1013 | 35.8 |
| 30-days mortality | 127 | 14.2 | 1435 | 50.7 |
| Male | 394 | 43.9 | 1538 | 54.3 |
| Intubation and mechanical ventilation | 66 | 7.4 | 1858 | 65.6 |
| Vaso-active drugs | 161 | 17.9 | 1994 | 70.4 |
| Non-invasive ventilation (NIV) | 229 | 25.5 | 755 | 26.7 |
| Renal Replacement Therapy (RRT) | 14 | 1.6 | 391 | 13.8 |
| Reason for ICU admission |  |  |  |  |
| Respiratory failure | 10 | 1.1 | 3 | 0.1 |
| Circulatory failure | 210 | 23.4 | 690 | 24.4 |
| Respiratory and circulatory failure | 121 | 13.5 | 416 | 14.7 |
| Sepsis | 12 | 1.3 | 436 | 15.4 |
| Multi-trauma without head injury | 61 | 6.8 | 419 | 14.8 |
| Multi-trauma with head injury | 15 | 1.7 | 40 | 1.4 |
| Head injury | 4 | 0.4 | 53 | 1.9 |
| Intoxication | 18 | 2.0 | 92 | 3.2 |
| Non-trauma | 32 | 3.6 | 261 | 9.2 |
| Emergency surgery | 153 | 17.1 | 226 | 8.0 |
| Other | 261 | 29.1 | 197 | 7.0 |

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