Original Article

Worse pre-admission quality of life is a strong predictor of mortality in critically ill patients

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Received: September 19, 2019 Accepted: October 06, 2020 Published online: March 01, 2022

ABSTRACT

Objectives: In this study, we aimed to investigate whether quality of life (QoL) before intensive care unit (ICU) admission could predict ICU mortality in critically ill patients.

Patients and methods: Between January 2019 and April 2019, a total of 105 ICU patients (54 males, 51 females; mean age: 58 years; range, 18 to 91 years) from two ICUs of a tertiary care hospital were included in this cross-sectional, prospective study. Pre-admission QoL was measured by the Short Form (SF)-12 Physical Component Scores (PCS) and Mental Component Scores (MCS) and EuroQoL five-dimension, five-level scale (EQ-5D-5L) within 24 h of ICU admission and mortality rates were estimated.

Results: The overall mortality rate was 28.5%. Pre-admission QoL was worse in the non-survivors independent from age, sex, socioeconomic and education status, and comorbidities. During the hospitalization, the rate of sepsis and ventilator/hospital-acquired pneumonia were similar among the two groups (p>0.05). Logistic regression analysis adjusted for sex, age, education status, and Acute Physiology and Chronic Health Evaluation II (APACHE II) scores showed that pre-admission functional status as assessed by the SF-12 MCS (odds ratio [OR]: 14.2; 95% confidence interval [CI]: 2.5-79.0), SF-12 PCS (OR: 10.6; 95% CI: 1.8-62.7), and EQ-5D-5L (OR: 8.0; 95% CI: 1.5-44.5) were found to be independently associated with mortality.

Conclusion: Worse pre-admission QoL is a strong predictor of mortality in critically ill patients. The SF-12 and EQ-5D-5L scores are both valuable tools for this assessment. Not only the physical status, but also the mental status before ICU admission should be evaluated in terms of QoL to better utilize ICU resources.

Keywords: EQ5D5L scores, intensive care unit, preadmission, prognosis, quality of life analysis, short form-12.

Severity scales are widely used in intensive care unit (ICU) practice to characterize disease severity, evaluate the effectiveness of treatment practices, predict outcome, and assess resource use. Both the generic and organ-specific scores estimate alliance of three key factors: demographics, medical comorbidities, and the worst acute physiological parameters including vital signs and laboratory examination results obtained within the first 24 h on ICU admission. [1,2] However, none of the determinants used in these scores evaluate pre-hospital health condition or quality of life (QoL).

Although three is no certain description widely used in the literature, pre-admission QoL can be designated

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Cite this article as: Özyılmaz E, Özkan Kuşçu O, Karakoç E, Boz A, Orhan Tıraşçı G, Güzel R, et al. Worse pre-admission quality of life is a strong predictor of mortality in critically ill patients. Turk J Phys Med Rehab 2022;68(1):19-29.

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by the capability to achieve the vital activities of daily living including mobility, self-care, usual actions, and healthy psychological status.\[^{[3]}\] Despite less attention than the analysis of mortality rate in the routine practice of ICU, recent reports have shown that it is closely related to mortality.\[^{[4-6]}\] According to a systematic analysis including 7,320 patients, ICU survivors had a lower baseline QoL which changed over time in most components and it remained lower, compared to the healthy population during long-term follow-up.\[^{[7]}\] Estimating prognosis with the light of the pre-admission QoL has critical effects on not only predicting the outcomes and characterizing patients’ requirements, but also on decision making regarding ICU admission to better use the ICU sources.\[^{[8]}\] Assessing the QoL before ICU admission may give a more detailed mapping of the patient’s condition, thus, would ease the use of World Health Organization (WHO) International Classification of Functioning, Disability and Health (ICF) framework to reveal deficiencies in body functions and structures, together with activity limitations and participation restrictions associated with deteriorating disease necessitating ICU stay and may lead to a better guided rehabilitation plan. It was shown that individuals with post-intensive care syndrome had impairments in all domains of the ICF.\[^{[9]}\] With advances in the intensive care services, the number of critical illness survivors has been increasing and it is unquestionable that patients should receive the best care from a multidisciplinary team, including the physicians, physical and occupational therapists, and nurses. It is of utmost importance that every member of the team has knowledge and awareness about the utility of rehabilitation, and they should have the skills to foster rehabilitation in the ICU. Unfortunately, there is still inadequate evidence about the effects of early mobilization on muscle strength, physical performance, and QoL in this patient population.

Recent researches have focused on several approaches for screening or identifying the patient’s QoL before the ICU admission.\[^{[5,10]}\] However, none of the indices are accepted as the gold standard and currently used in routine clinical practice. The Short Form-12 (SF-12) is a multi-item generic health assessment which measures general health concepts not specific to any disease or treatment group.\[^{[10]}\] The EuroQoL five-dimension, five-level scale (EQ-5D-5L) is a self-report instrument which assesses five dimensions including mobility, self-care, standard activities, pain/discomfort and anxiety/depression. The EQ-5D™ is a trademark of the EuroQoL Research Foundation. The EuroQoL Visual Analog Scale (EQ-VAS) is used to evaluate the general health status of the individual.\[^{[12]}\] The EQ-5D-5L has also been used in several populations including ICU survivors to date.\[^{[13-16]}\] However, pre-admission QoL has not been widely investigated using both SF-12 and EQ-5D-5L scores in critically ill patients. In the present study, therefore, we aimed to evaluate whether QoL before ICU admission could predict ICU mortality in these patients.

**PATIENTS AND METHODS**

This cross-sectional, prospective study was conducted at two ICUs of Cukurova University, Faculty of Medicine between January 2019 and April 2019. A total of 105 consecutive ICU patients (54 males, 51 females; mean age: 58 years; range, 18 to 91 years) with a length of ICU stay over 24 h were included. Exclusion criteria were as follows: <18 years old, being hospitalized for <24 h, questionnaires not completed within 48 h, and giving no consent for the study. Patients with readmission during their same hospitalization period were also excluded from the study population. During hospitalization of 24 to 48 h in the ICU, the patients were requested to fill the SF-12 and EQ-5D-5L questionnaires based on their memories of health status within the past four weeks before the ICU admission. All patients were followed until discharge. A written informed consent was obtained from each patient. If the patient was unconscious or otherwise cognitively impaired, no written informed consent was obtained and the questionnaires were filled by his/her first-degree relative living with the patient. The study protocol was approved by the Çukurova University Faculty of Medicine Ethics Committee (No. 72, Date: 28/12/2017). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Data including demographic and clinical characteristics of the patients (age, sex, body mass index, smoking history, chronic systemic diseases, marital status, education status, alcohol consumption, monthly income, and social insurance); main reason for ICU admission; sepsis, hospital- and ventilator-acquired pneumonia (HAP/VAP) development and the need of non-invasive and/or invasive mechanical ventilation during hospitalization; and severity of illness as assessed by the following scoring systems were recorded.

The Acute Physiology and Chronic Health Evaluation II (APACHE II) is a severity of disease
score usually used in estimation the prognosis of the critically ill patients were recorded. The APACHE II scale appoints 0 to 4 numerical values to 12 clinical and biochemical variables including the worst body temperature, mean arterial blood pressure, heart rate, respiratory rate, oxygenation, arterial pH, serum sodium, potassium, creatinine, white blood cell, hematocrit, and Glasgow Coma Scale parameters following the first 24 h of admission. Age group and pre-existing illnesses are also assigned. The combination of these variables composes the Acute Physiology Score of APACHE II. The score <10 points indicates relatively mild illness, while >15 points indicate moderate to severe illness. Increased scores are associated with increased mortality.[17]

The Sequential Organ Failure Assessment (SOFA) Scoring system is also valuable in prognostication of critically ill patients.[18] The score is based on the worst values of six different clinical data and laboratory results, one each for the respiratory, liver, cardiovascular, coagulation, renal and neurological systems.

The Charlson Comorbidity Index (CCI) predicts the 10-year mortality. Each comorbid condition is awarded 1, 2, 3 or 6 points depending on the risk of death.[19]

In addition, the QoL scores of the patients as obtained using the following instruments were noted. The SF-12 health survey is a shorter version of the SF-36 consisting of 12 items about physical functioning, physical role, bodily pain, general health, vitality, social functioning, role emotional, and mental health. The scores range from 0 to 100, and higher scores indicate better health. The SF-12 has been validated in the Turkish language,[20] and SF-12 has been used in various disease groups in Turkey.[21-23] There are items from each of the eight SF-36 subscales in the SF-12. Data from all items are used to build up Physical Component Scores (PCS) and Mental Component Scores (MCS). The SF-12 has adequate test-retest reliability and construct validity, and the PCS and MCS obtained with the SF-12 is reported as diligently similar to those obtained with the original SF-36.[11,24]

The EQ-5D-5L consists of two parts: the EQ-5D-5L descriptive system and the EQ-VAS. The descriptive system measures 5 dimensions (mobility, self-care, usual activities, pain/discomfort, anxiety/depression) in 5 levels ranging from no problem to extreme problems. The person surveyed indicates his/her own health state by marking the box against the most fitting statement. In EQ-VAS a 20 cm vertical VAS is used. The scale has endpoints labelled as the best or the worst health that one can imagine. Full health is given a score of one (the maximum). Originally the respondent is asked to consider “today”. In our study, the respondent was asked to recall previous four weeks and answer the questions accordingly. The EQ-5D-5L has been validated in several populations from different countries, different patient groups, and different chronic conditions.[22] It has been also validated in Turkish patients with acute coronary syndrome.[23]

**Outcomes**

The ICU mortality rate, length of ICU stay, and length of hospital stay were recorded.

**Endpoints**

The primary endpoint of this study was to compare the pre-admission QoL scores between survivors and non-survivors. The secondary endpoint was to define a cut-off value of QoL scores to predict survival.

**Statistical analysis**

Study power analysis and sample size calculation were performed using the G*Power version 3.1.9.2 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). Accordingly, the study power was 99.9% and minimum 105 subjects were needed.

Statistical analysis was performed using the IBM SPSS version 24.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency. The Kolmogorov-Smirnov test was used to analyze whether the quantitative variables were normally distributed. Continuous variables between independent groups were compared using the Student’s t-test, when the hypothesis was fulfilled and using the Mann-Whitney U test, when the hypothesis was not fulfilled. The chi-square test and Fisher’s exact test were used to compare the categorical data between the groups. Possible alternative cut-off points for the scales of both severity and QoL were investigated using the area under the curve (AUC) statistics. The prognostic ability of QoL scales were evaluated with both univariate and multivariate logistic regression analyses with forward method. The Hosmer-Lemeshow test was used to check model fit for logistic regression model. The Kaplan-Meier and log-rank tests were used for survival analysis. Overall survival was defined as the time from ICU admission to the time of any proven clinical progression, relapse, or death from
any cause. To analyze correlations between each exposure and risk of mortality, odds ratios (ORs) and 95% confidence intervals (95% CI) were calculated. The internal consistency (different questions, same construct) was used for reliability. The internal consistency was measured using the Cronbach’s alpha (α) and an α of ≥0.8 was accepted. A post-hoc power analysis was performed on SF-12 MCS and SF-12 PCS scores. A $p$ value of <0.05 was considered statistically significant.

**RESULTS**

Of a total of 256 patients screened during the study period, 105 were included. Of these patients, 28.5% (n=30) died during hospitalization. A total of 25.5% conscious patients assessed their pre-admission QoL, while the forms were filled by the first-degree relatives of the remaining patients, due to either unconsciousness or cognitive impairment. Most of the patients were hospitalized due to respiratory failure (54.5%), followed by gastrointestinal disorders (8.5%) and hemodynamic instability (6.6%). Of a total of 105 patients, 28 (26.4%) had any type of malignancy. The use of home mechanical ventilation was also comparable between the groups (2.8% among survivors vs. 11.5% among non-survivors, respectively; $p$>0.05). Baseline demographic and clinical data of the patients are shown in Table 1.

### TABLE 1

| Demographic and clinical characteristics of patients |
|----------------------------------------------------|
| **Prognosis**                                      |
|                                                   |
| **Alive**                                          | **Dead**                                           | **Total**                                         | **p**    |
| n | % | Mean±SD | n | % | Mean±SD | n | % | Mean±SD |     |
|---|---|----------|---|---|----------|---|---|----------|-----|
| Age (year) | 59.4±17.8 | 56.6±17.7 | 58.6±17.7 | 0.471** |
| Sex                                                   |                                                     |                                                     | 0.805*   |
| Female | 37 | 72.5 | 14 | 27.5 | 51 | 48.6 |
| Male   | 38 | 70.4 | 16 | 29.6 | 54 | 51.4 |
| Social insurance                                       |                                                     |                                                     | 0.503*   |
| Extended | 64 | 72.7 | 24 | 27.3 | 88 | 83.8 |
| Limited | 11 | 64.7 | 6  | 35.3 | 17 | 16.2 |
| Marital status                                         |                                                     |                                                     | 0.477*   |
| Married   | 47 | 69.1 | 21 | 30.9 | 68 | 64.8 |
| Single   | 28 | 75.7 | 9  | 24.3 | 37 | 35.2 |
| Alcohol consumption                                    |                                                     |                                                     | 0.041*   |
| None | 72 | 74.2 | 25 | 25.8 | 97 | 92.4 |
| Yes      | 3  | 37.5 | 5  | 62.5 | 8  | 7.6 |
| Smokers                                             |                                                     |                                                     | 1.000*   |
| None | 40 | 71.4 | 16 | 28.6 | 56 | 53.3 |
| Yes      | 35 | 71.4 | 14 | 28.6 | 49 | 46.7 |
| Education (years)                                     |                                                     |                                                     | 0.964*   |
| Low (<5)  | 52 | 72.2 | 20 | 27.8 | 72 | 68.6 |
| Intermediate (5-8)                                                  |                                                     |                                                     |         |
| High (>8) | 14 | 70.0 | 6  | 30.0 | 20 | 19.0 |
| Income level                                           |                                                     |                                                     | 0.507*   |
| Lower than minimum wage                               |                                                     |                                                     |         |
| Minimum wage                                          |                                                     |                                                     |         |
| Higher than minimum wage                              |                                                     |                                                     |         |
| Working status                                        |                                                     |                                                     | 0.006*   |
| Not working  | 45 | 80.4 | 11 | 19.6 | 56 | 53.3 |
| Retired     | 22 | 73.3 | 8  | 26.7 | 30 | 28.6 |
| Working     | 8  | 42.1 | 11 | 57.9 | 19 | 18.1 |
| Body mass index (kg/m²)                                | 27.4±9.0 | 26.4±11.3 | 27.1±9.7 | 0.629** |
| Hospital length of stay (day)                         | 16.3±12.9 | 18.5±15.7 | 16.9±13.8 | 0.467** |
| ICU length of stay (day)                              | 5.9±7.1 | 8.0±6.0 | 6.3±6.8 | 0.113** |

SD: Standard deviation; ICU: Intensive care unit; * Chi-square test; ** Mann-Whitney U test.
Pre-admission quality of life predicts mortality

The laboratory findings, liver and renal function test results, and serum electrolyte levels were similar between survivors and non-survivors, while hemoglobin levels and platelet counts at the time of admission were significantly lower and serum C-reactive protein levels and activated partial thromboplastin time levels were significantly higher in the non-survivors (p<0.05) (Table 2). The development of HAP/VAP and sepsis during hospitalization were also similar according to mortality (6.9% vs. 11.5% for HAP/VAP and 6.9% vs. 7.7% for sepsis among survivors and non-survivors, respectively; p>0.05).

The internal consistency was performed for the QoL scales and the value which was defined by the Cronbach α was 0.83 for SF-12 questionnaire and 0.92 for EQ-5D-5L. The comparison of severity scales and QoL scales between survivors or non-survivors is presented in Table 2. The APACHE II, CCI, and SOFA scores were significantly higher and all QoL scores (SF-12 PCS, MCS, and EQ-5D-5L) were significantly worse among the non-survivors (p<0.05) (Table 3).

According to the receiver operating characteristic (ROC) analysis, the disease severity index with the highest sensitivity (90%) and specificity (75%) was the APACHE II score which revealed an AUC of 0.876 with a ≥21.5 cut-off value. Among the QoL scales, SF-12 MCS scores resulted in an AUC of 0.842

### Table 2

| Laboratory parameters among survivors and non-survivors | Alive (n=75) | Dead (n=30) | p   |
|----------------------------------------------------------|-------------|-------------|-----|
| Hemoglobin (g/dL)                                        | 11.3±2.8    | 9.3±1.8     | 0.001|
| White blood cell count (mm³)                             | 11,620±8,870| 11,990±8,785| 0.846|
| Platelet count (10⁹/µL)                                  | 234±146     | 172±107     | 0.019|
| AST (U/L)                                                | 77±186      | 126±227     | 0.293|
| Serum creatinin (mg/dL)                                  | 1.4±1.4     | 1.6±1.4     | 0.474|
| Serum Na level (mmol/L)                                  | 136±6       | 136±4       | 0.907|
| Serum K level (mmol/L)                                   | 4.3±0.8     | 4.5±1.2     | 0.486|
| C-reactive protein (mg/L)                                | 9.2±10      | 20.9±13.9   | 0.001|
| Activated partial thromboplastin time (sec)              | 29.3±15.9   | 40.1±20.1   | 0.012|

AST: Aspartate aminotransferase; Na: Sodium; K: Potassium.

### Table 3

| Distribution of severity and quality of life scales according to prognosis | Alive | Dead | Total | p   |
|--------------------------------------------------------------------------|-------|------|-------|-----|
|                                                                          | Mean±SD | Mean±SD | Mean±SD |     |
| Severity scales                                                          |         |       |       |     |
| Charlson Comorbidity Index                                               | 5.0±2.5 | 8.0±2.6 | 5.8±2.8 | 0.0001** |
| APACHE II score                                                          | 17.6±7.2 | 29.8±8.9 | 21.1±9.5 | 0.0001** |
| SOFA Score                                                               | 5.7±3.5 | 10.8±4.1 | 7.1±4.4 | 0.0001** |
| Quality of life scales                                                    |         |       |       |     |
| SF12 PCS score                                                          | 38.9±6.1 | 31.5±7.0 | 36.8±7.2 | 0.0001* |
| SF12 MCS score                                                          | 39.7±6.7 | 30.2±7.0 | 37.0±8.0 | 0.0001* |
| EQ-VAS score                                                             | 40.8±23.7 | 21.2±14.4 | 35.2±23.2 | 0.0001** |
| EQ-5D-5L score                                                           | 0.144±0.447 | -0.264±0.225 | 0.027±0.437 | 0.0001** |

SD: Standard deviation; APACHE II Score: Acute Physiology and Chronic Health Evaluation II; SOFA Score: Sequential Organ Failure Assessment Score; SF-12 PCS: Short Form-12 Physical Component Summary; SF-12 MCS: The Short Form-12 Mental Component Summary; EQ-VAS: EuroQol Visual Analog Scale; EQ-5D-5L: EuroQol. Five-Dimension, Five-Level Scale; * Independent t-test; ** Mann-Whitney U test; p<0.05 statistically significant.
with the highest sensitivity (80%) and specificity (82%) with a cut-off value of ≥34.5. The results with the other severity and QoL scales are presented in Table 4 and Figure 1.

The multivariate logistic regression analyses adjusted for sex, age, education status, having any comorbidity, and APACHE II scores showed that pre-admission functional status as assessed by the SF-12 MCS (OR: 12.4; 95% CI: 2.5-61.7), SF-12 PCS (OR: 9.8; 95% CI: 1.9-50.5), and EQ-5D-5L (OR: 8.3; 95% CI: 1.6-44.1) were found to be independently associated with mortality (Table 5).

According to survival analyses, the length of ICU stay was found to be significantly shorter in the patients who had lower QoL scores (12.8 days vs. 23.7 days for SF-12 PCS and 12.9 days vs. 20.0 for SF-12 MCS and 13.0 days vs. 22.5 days for EQ-5D-5L, respectively; p<0.05) (Figure 2).

**DISCUSSION**

In this study, we showed that pre-admission QoL, which can be easily measured by either SF-12 or EQ-5D-5L scores, is an important surrogate of

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**TABLE 4**

| Cut of points, sensitivity and specificity values of severity scales and quality of life scales obtained by ROC analyses |
|---------------------------------------------------------------|
| AUC | Cut off point | Sensitivity (%) | Specificity (%) |
|---------------------------------|-----------------|-----------------|-----------------|
| Charlson Comorbidity Index | 0.798* | 6.5 | 73 | 71 |
| APACHE II Score | 0.876* | 21.5 | 90 | 75 |
| SOFA Score | 0.829* | 7.5 | 77 | 74 |
| SF12 PCS Score | 0.797* | 35.9 | 77 | 72 |
| SF12 MCS Score | 0.842* | 34.5 | 80 | 82 |
| EQ-VAS Score | 0.745* | 27.5 | 60 | 67 |
| EQ-5D-5L Score | 0.782* | -0.041 | 87 | 67 |

AUC: Area under curve; APACHE II Score: Acute Physiology and Chronic Health Evaluation II; SOFA Score: Sequential Organ Failure Assessment Score; SF-12 PCS: Short Form-12 Physical Component Summary; SF-12 MCS: The Short Form-12 Mental Component Summary; EQ-VAS: EuroQol Visual Analog Scale; EQ-5D-5L: EuroQol Five-Dimension, Five-Level Scale; * p<0.001.
Pre-admission quality of life predicts mortality

mortality in critically ill patients. Incorporating QoL measures in addition to routine severity scores may improve the accuracy of mortality prediction in the ICU practice.

Although QoL evaluation in critically ill patients is not a new concept, many authors have focused on the QoL after ICU discharge.[13,26-30] Several implementations have been proposed to improve QoL in post-intensive care syndrome.[31,32] However, QoL analysis before ICU admission received less attention to date. One of the main factors of this issue is the problematic nature of QoL evaluation before ICU admission due to several reasons. First, the instrument used for QoL should be directly correlated with the patient’s baseline status prior to ICU admission. Second, it must be easily completed by the proxies, since many of the ICU patients are unable to fill out a survey due to being ventilated or comatose. Third, QoL assessment is a multi-dimensional concept which covers the functional status, physiological conditions, affective states, and usual activities; however, it is challenging to find a valid method for this analysis.[4] Thus, several different tools, some of them developed for this purpose, have been used to date for the QoL evaluation before ICU admission and most of them showed a strong link with increased mortality.[5,6,10] In a previous study, Baldwin et al.[10] derived a model from medical records including data of 1,526 consecutive patients more than 65 years old and, then, validated the model in more than 1,000 patients. As a result, they showed that pre-admission functional status was independently related to six-month post-discharge mortality (OR: 2.39; 95% CI: 1.73-3.30, p<0.001). In another retrospective cohort study which classified patients into three groups and assessed functional status in three discrete categories based on performance of basic living activities (i.e., fully independent, partly dependent, and completely dependent), functional status was found to be associated with increased mortality among critically ill patients.[5] Also, mild to moderate disability and severe disability were correlated with more than two (adjusted hazard ratio [HR], 2.41; 95% CI: 1.29-4.50) and three-fold (adjusted HR, 3.84; 95% CI: 1.84-8.03) mortality risk within one year of ICU hospitalization.[6]

In addition to these novel QoL evaluation methods developed by the authors, instruments formerly used for other purposes have been used for pre-ICU QoL analysis. A previous large cohort which analyzed QoL before ICU admission with the QoL survey score and Therapeutic Intervention Scoring System (TISS) in 8,685 patients indicated that, although the QoL prior to ICU stay was linked to hospital mortality, it contributed very little to the discriminatory power

### TABLE 5
Logistic regression analysis results

| Variable          | B     | SE   | OR   | 95% CI       | p     |
|-------------------|-------|------|------|--------------|-------|
| Sex               |       |      |      |              |       |
| Male              | 0.444 | 0.912| 1.6  | 0.3-9.3      | 0.957 |
| Education         |       |      |      |              |       |
| High              | 0.580 | 1.248| 1.8  | 0.2-20.6     | 0.580 |
| Low               | 1.215 | 1.473| 3.4  | 0.2-60.9     | 0.628 |
| Comorbidity       | -0.687| 0.999| 0.5  | 0.1-3.6      | 0.608 |
| Age (>64)         | -1.574| 0.839| 4.8  | 0.9-26.1     | 0.061 |
| SF12 PCS (>35.9)  | 2.285 | 0.835| 9.8  | 1.9-50.5     | 0.006*|
| SF12 MCS (>34.5)  | 2.515 | 0.820| 12.4 | 2.5-61.7     | 0.002*|
| EQ5D5L (>0.045)   | 2.116 | 0.852| 8.3  | 1.6-44.1     | 0.013*|
| APACHE II (high)  | 2.480 | 0.902| 11.9 | 2.0-70.0     | 0.006*|
| Constant          | -5.538| 1.199|      |              | 0.004*|

B: Unstandardized coefficient (This value represents the slope of the line between the predictor variable and the dependent variable); SE: Standard error; OR: Odds ratio; CI: Confidence interval; SF-12 PCS: Short Form-12 Physical Component Summary; SF-12 MCS: The Short Form-12 Mental Component Summary; EQ-5D-5L: EuroQol Five-Dimension, Five-Level Scale; APACHE II Score: Acute Physiology and Chronic Health Evaluation II; * p<0.05 statistically significant; p=0.728 Hosmer-Lemeshow test (indicates a poor fit if the significance value is less than 0.05).
of the APACHE III prediction model.\textsuperscript{[4]} However, the ICU care significantly improved over years in parallel with the global development and it is known that the predictive performances of the instruments deteriorate over time. In another study, Rodríguez-Villar et al.\textsuperscript{[33]} showed that functional status before ICU admission was related to the improvement of functional status after ICU discharge. Another Spanish trial using the Modified Glasgow Outcome Scale also demonstrated that patients with restricted functional status before ICU stay had a higher risk of death than predicted.\textsuperscript{[34]} Functional status score have also been used to evaluate QoL in ICU.\textsuperscript{[35,36]} In another recent report, WHO Disability Schedule 2.0 was performed to evaluate pre-admission functional condition in ICU patients.\textsuperscript{[37]} However, none of these instruments were accepted as a reference method and placed in routine practice to date.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{fig2.png}
\caption{Survival curves of quality of life and severity scales.}
\end{figure}

ICU: Intensive care unit; LOS: Length of stay.
The SF and EQ scores have been used in a number of reports for evaluating the QoL among several populations outside the ICU. Parlevliet et al. assessed the link between health-related QoL (HRQoL) measured by EQ-5D score at admission in hospitalized older adults who were acutely ill. In this study, higher HRQoL at the time of admission was related to less mortality risk and functional decline. However, the data regarding the use of SF and EQ scores on QoL in ICU patients are extremely limited. In a previous study, QoL was assessed pre-morbidly and at 3, 6, and 12 months after ICU admission using the SF-36 and EQ-5D scores. The authors showed that poor pre-morbid QoL was related to worse prognosis. Later, Bukan et al. confirmed these results in a prospective, observational study including 318 ICU patients. In this study, using the physical component summary of SF, the AUC was found to be comparable with that of APACHE II (0.70; CI: 0.62-0.77 vs. 0.74; CI: 0.67-0.82, respectively). As a result, the authors concluded that SF-12 score was as good as APACHE II score in predicting mortality and this could aid decision making on ICU acceptance. In this study, we showed that pre-admission functional status which was shown by the SF-12 MCS (OR: 14.2; 95% CI: 2.5-79.0), SF-12 PCS (OR: 10.6; 95% CI: 1.8-62.7), and EQ-5D-5L (OR: 8.0; 95% CI: 1.5-44.5) were independently related to mortality. Our results also confirm the Bukan et al.'s study in terms of SF-12 PCS score which was as good as APACHE II score in predicting ICU prognosis. In addition, we showed that the importance of mental score (SF-12 MCS) with a higher specificity than APACHE II, SOFA, and CCI scores to predict ICU mortality. We also determined cut-off values for all of these QoL scales with valuable AUC values in the ROC analyses.

The QoL before ICU admission is an underestimated phenomenon in the ICU. The SF-12 and EQ-5D-5L scores are simple, easily applied, reliable, and valuable tools to assess pre-admission QoL in these patients. Our study showed that worse pre-admission QoL was a strong predictor of mortality in critically ill. In addition, we, for the first time, showed the key value of pre-admission mental score to these patients. Pre-admission QoL analysis should be added in routine clinical practice in the ICUs.

Nonetheless, our study has certain limitations. First, there might have been a recall bias in which an earlier state could not be precisely recalled due to the memory effects. This might be a consequence of general memory problems due to the passage of time or cognitive impairment. However, an earlier report showed that total hip arthroplasty patients could accurately recall their preoperative QoL and function for up to three months. Second, most of the data were obtained from the proxies due to patients’ unfavorable clinical status and this may be considered a limitation. Nevertheless, a previous report showed that QoL scores which were completed by the proxies had adequate internal consistency in ICU patients. Finally, this is a single-center study with a limited sample size and the results should be further confirmed in larger cohorts.

In conclusion, the reported cut-off values of QoL scores can be used to better predict ICU prognosis in critically ill patients which may lead to the better use of ICU sources, particularly in the limited area. However, further clinical trials with larger cohorts are required to elucidate the most valuable pre-admission QoL score to predict ICU prognosis.
Acknowledgement
We thank all of our patients and their families who participated in this study and provided valuable information.

Declaration of conflicting interests
The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding
The authors received no financial support for the research and/or authorship of this article.

REFERENCES
1. Vincent JL, Moreno R. Clinical review: scoring systems in the critically ill. Crit Care 2010;14:207.
2. Salluh JI, Soares M. ICU severity of illness scores: APACHE, SAPS and MPM. Curr Opin Crit Care 2014;20:557-65.
3. Katz S. Assessing self-maintenance: activities of daily living, mobility, and instrumental activities of daily living. J Am Geriatr Soc 1983;31:721-7.
4. Rivera-Fernández R, Sánchez-Cruz JJ, Abizanda-Campos R, Vázquez-Mata G. Quality of life before intensive care unit admission and its influence on resource utilization and mortality rate. Crit Care Med 2001;29:1701-9.
5. Krinsley JS, Wasser T, Kang G, Bagshaw SM. Pre-admission functional status impacts the performance of the APACHE IV model of mortality prediction in critically ill patients. Crit Care Med 2017;21:110.
6. Ferrante LE, Pisani MA, Murphy TE, Gabbauer EA, Leo-Summers LS, Gill TM. Functional trajectories among older persons before and after critical illness. JAMA Intern Med 2015;175:523-9.
7. Dowdy DW, Eid MP, Sedrakyan A, Mendez-Tellez PA, Pronovost PJ, Herridge MS, et al. Quality of life in adult survivors of critical illness: a systematic review of the literature. Intensive Care Med 2005;31:611-20.
8. Bukan RI, Möller AM, Henning MA, Mortensen KB, Klausen TW, Waldau T. Pre-admission quality of life can predict mortality in intensive care unit—a prospective cohort study. J Crit Care 2014;29:942-7.
9. Ohtake PJ, Lee AC, Tashjian Al, Hinkson CR, et al. Physical Impairments Associated With Post-Intensive Care Syndrome: Systematic Review Based on the World Health Organization’s International Classification of Functioning, Disability and Health Framework. Phys Ther 2018;98:631-45.
10. Baldwin MR, Narain WR, Wunsch H, Schluger NW, Cooke JT, Maurer MS, et al. A prognostic model for 6-month mortality in elderly survivors of critical illness. Chest 2013;143:910-9.
11. Ware J Jr, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. Med Care 1996;34:220-33.
12. Van Reenen M, Janssen B. EQ-5D-5L User Guide: Basic information on how to use the EQ-5D-5L instrument. Version 2.1 April 2015. https://euroqol.org/wp-content/uploads/2016/09/EQ-5D-5L_UserGuide_2015.pdf [Accessed: May, 2015]
13. Ferrão C, Quintaneiro C, Camila C, Aragão I, Cardoso T. Evaluation of long-term outcomes of very old patients admitted to intensive care: Survival, functional status, quality of life, and quality-adjusted life-years. J Crit Care 2015;30:1150.e7-11.
14. Honselmann KC, Bututh F, Heuwer B, Karadag S, Sayk F, Kurowski V, et al. Long-term mortality and quality of life in intensive care patients treated for pneumonia and/or sepsis: Predictors of mortality and quality of life in patients with sepsis/pneumonia. J Crit Care 2015;30:721-6.
15. Soliman IW, de Lange DW, Peelen LM, Cremer OL, Slootek AJ, Pasma W, et al. Single-center large-cohort study into quality of life in Dutch intensive care unit subgroups, 1 year after admission, using EuroQol EQ-6D-3L. J Crit Care 2015;30:181-6.
16. Normilio-Silva K, de Figueiredo AC, Pedroso-de-Lima AC, Tunes-da-Silva G, Nunes da Silva A, Delgado Dias Levites A, et al. Long-Term Survival, Quality of Life, and Quality-Adjusted Survival in Critically Ill Patients With Cancer. Crit Care Med 2016;44:1327-37.
17. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. Crit Care Med 1985;13:818-29.
18. Vincent JL, de Mendonça A, Cantraine F, Moreno R, Takala J, Suter PM, et al. Use of the SOFA score to assess the incidence of organ dysfunction/failure in intensive care units: results of a multicenter, prospective study. Working group on “sepsis-related problems” of the European Society of Intensive Care Medicine. Crit Care Med 1998;26:1793-800.
19. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40:373-83.
20. Koçyiğit H, Aydemir Ö, Fışek G, Ölmnez N, Memiş A. Reliability and validity of Turkish version of Short Form 36: a study of patients with rheumatoid disorder. J Drug Ther 1999;12:102-6.
21. Ata E, Kösem M, Adiguzel E. Does kinesiotaping increase the efficacy of lidocaine injection in myofascial pain syndrome treatment? A randomized controlled study. J Back Musculoskelet Rehab 2019;32:471-7.
22. Metin Ökmen B, Kasapoğlu Aksoy M, Güneş A, Eröksüz R, Altan L. Effectiveness of PELOID therapy in carpal tunnel syndrome: A randomized controlled single blind study. Int J Biometeorol 2017;61:1403-10.
23. Turhan E, Demirel M, Daylak A, Huri G, Doral MN, Çelik D. Translation, cross-cultural adaptation, reliability and validity of the Turkish version of the Olerud-Molander Ankle Score (OMAS). Acta Orthop Traumatol Turc 2017;51:60-4.
24. Lim LL, Fisher JD. Use of the 12-item short-form (SF-12) Health Survey in an Australian heart and stroke population. Qual Life Res 1999;8:1-8.
25. Kahyaoğlu Süt H, Unsar S. Is EQ-5D a valid quality of life instrument in patients with acute coronary syndrome? Anadolu Kardiyol Derg 2011;11:156-62.
26. Heyland DK, Stelfox HT, Garland A, Cook D, Dodek P, Kutsogiannis J, et al. Predicting Performance Status 1 Year After Critical Illness in Patients 80 Years or Older:
Pre-admission quality of life predicts mortality

Development of a Multivariable Clinical Prediction Model. Crit Care Med 2016;44:1718-26.

27. Roch A, Wiramus S, Pauly V, Forel JM, Guervilly C, Gainnier M, et al. Long-term outcome in medical patients aged 80 or over following admission to an intensive care unit. Crit Care 2011;15:R36.

28. Trivedi V, Bleeker H, Kantor N, Visintini S, McIsaac DI, McDonald B. Survival, Quality of Life, and Functional Status Following Prolonged ICU Stay in Cardiac Surgical Patients: A Systematic Review. Crit Care Med 2019;47:e52-e63.

29. Rydingsward JE, Horkan CM, Mogensen KM, Quraishi SA, Amrein K, Christopher KB. Functional Status in ICU Survivors and Out of Hospital Outcomes: A Cohort Study. Crit Care Med 2016;44:869-79.

30. Parry SM, Denehy L, Beach LJ, Berney S, Williamson HC, Granger CL. Functional outcomes in ICU – what should we be using? – an observational study. Crit Care 2015;19:127.

31. Daniels LM, Johnson AB, Cornelius PJ, Bowron C, Lehnerzt A, Moore M, et al. Improving Quality of Life in Patients at Risk for Post-Intensive Care Syndrome. Mayo Clin Proc Innov Qual Outcomes 2018;2:359-69.

32. Detsky ME, Kohn R, Delman AM, Buehler AE, Kent SA, Ciuffetelli IV, et al. Patients' perceptions and ICU clinicians predictions of quality of life following critical illness. J Crit Care 2018;48:352-6.

33. Rodriguez-Villar S, Fernández-Méndez R, Adams G, Rodriguez-Garcia JL, Arévalo-Serrano J, Sánchez-Casado M, et al. Basal functional status predicts functional recovery in critically ill patients with multiple-organ failure. J Crit Care 2015;30:511-7.

34. Rivera-Lopez R, Gutierrez-Rodriguez R, Lopez-Caler C, Aguilar-Alonso E, Castillo-Lorente E, Garcia-Delgado M, et al. Relationship between functional status prior to onset of critical illness and mortality: a prospective multicentre cohort study. Anaesth Intensive Care 2017;45:351-8.

35. Thrush A, Rozek M, Dekerlegand JL. The clinical utility of the functional status score for the intensive care unit (FSS-ICU) at a long-term acute care hospital: a prospective cohort study. Phys Ther 2012;92:1536-45.

36. Huang M, Chan KS, Zanni JM, Parry SM, Neto SG, Neto JA, et al. Functional Status Score for the ICU: An International Clinimetric Analysis of Validity, Responsiveness, and Minimal Important Difference. Crit Care Med 2016;44:e1155-e1164.

37. Haylett R, Gustafson O. A feasibility study to assess pre-admission status and six month outcomes of major trauma patients admitted to an intensive care unit, using the WHO DAS 2.0. J Crit Care 2018;48:140-4.

38. Parlevliet JL, MacNeil-Vroomen J, Buurman BM, de Rooij SE, Bosmans JE. Health-Related Quality of Life at Admission Is Associated with Postdischarge Mortality, Functional Decline, and Institutionalization in Acutely Hospitalized Older Medical Patients. J Am Geriatr Soc 2016;64:761-8.

39. Cuthbertson BH, Scott J, Strachan M, Kilonzo M, Vale L. Quality of life before and after intensive care. Anaesthesia 2005;60:332-9.

40. Sosnowski K, Lin F, Mitchell ML, White H. Early rehabilitation in the intensive care unit: an integrative literature review. Aust Crit Care 2015;28:216-25.

41. Gruther W, Pieber K, Steiner I, Hein C, Hiesmayr JM, Paternostro-Sluga T. Can early rehabilitation on the general ward after an intensive care unit stay reduce hospital length of stay in survivors of critical illness?: A randomized controlled trial. Am J Phys Med Rehabil 2017;96:607-15.

42. Intiso D. ICU-acquired weakness: should medical sovereignty belong to any specialist? Crit Care 2018;22:1.

43. Mizuochi K. Rehabilitation medicine in the acute care setting in Japan. Japan Med Assoc J 2012;55:246-52.

44. Blome C, Augustin M. Measuring change in quality of life: bias in prospective and retrospective evaluation. Value Health 2015;18:110-5.

45. Howell J, Xu M, Duncan CP, Masri BA, Garbuz DS. A comparison between patient recall and concurrent measurement of preoperative quality of life outcome in total hip arthroplasty. J Arthroplasty 2008;23:843-9.

46. Hofhuis JG, Dijkgraaf MG, Hovingh A, Braam RL, van de Braak L, Spronk PE, et al. The Academic Medical Center Linear Disability Score for evaluation of physical reserve on admission to the ICU: can we query the relatives? Crit Care 2011;15:R212.