Original Article

Outcomes Prediction in Critically Ill Elderly Patients Using APACHE II, APACHE IV, and SOFA Scores.

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Abstract

Background

In intensive care units, scoring systems allow the assessment of disease severity and provide an estimate of in-hospital mortality**.** The use of scoring systems in critical care unit has reduced many problems, especially for elderly patients.

Objective

The objective of this study was to evaluate APACHE II, APACHE IV and SOFA as predictors of outcomes in critically ill elderly patients in the geriatric critical care unit (CCU).

Patients and methods

A prospective observational study was carried out in the geriatrics and gerontology department's CCU at Ain Shams University Hospitals. The study included 106 elderly patients from both sexes aged 60 years old and more who were admitted to the Geriatrics CCU between March 2023 and August 2023. APACHE II and APACHE IV scores were calculated on admission. SOFA score was recorded on admission and every 48 hours until discharge. All enrolled patients were followed up, and outcomes were recorded as survivors and nonsurvivors. Observed mortality rates were compared with predicted mortality rates for the APACHE II, APACHE IV, and SOFA.

Results: At the end of the study period, 54 (50.95%) patients were survivors and 52 (49.05%) were non-survivors. There was a highly significant increase in all scores in non-survivor patients. Also, they showed a good ability to predict mortality rates, except for SOFA Initial.

Conclusion: Discrimination and calibration were better for all studied score models. However, SOFA Highest had the best calibration and discrimination. SOFA delta showed the highest specificity, and APACHE II showed the highest sensitivity.

Key words: APACHE II; APACHE IV; SOFA Scores; Outcomes Prediction; Critically Ill Elderly.

Introduction

Life expectancy is increasing globally, and during the past few decades, one of Egypt's most notable demographic trends has been a steady rise in both the absolute and relative numbers of elderly citizens**.** [1]

The elderly has a higher prevalence of chronic diseases and an age-related diminution of physiological reserve, which makes them more vulnerable to acute illnesses. This vulnerability renders them more susceptible to a higher risk of mortality when admitted to the ICU, and this makes them represent a particular subgroup of ICU patients. [2]

Since resources for intensive care units (ICUs) are expensive and limited, mortality prediction in ICUs is important for patient care and resource allocation. Early diagnosis and management of patients with a high risk of mortality will lead to better outcomes and lower mortality rates. [3]

Therefore, there are many intensive care unit (ICU) scoring systems, and different new ones are being produced to provide an objective and quantitative description of the extent of organ dysfunction and evaluation of morbidity in ICU patients. [4] These models have not frequently been applied to study risk prediction in older patients because they were designed for general usage in heterogeneous ICU populations, so it was necessary to assess their predictive accuracy among elderly patients specially in our country. [5]

APACHE and SOFA scores are commonly used in ICU for severity-of-disease scoring, mortality prediction and prognosis estimation.[6] While the SOFA scoring system is based on organ failure in critically ill patients, age, past health condition, and physiological characteristics are the basis for the APACHE scoring system. [7].

SOFA score was originally created to estimate mortality in patients with sepsis. [8] In recent years, its use has been extended to other critically ill subjects that were treated in the ICU setting, with acceptable diagnostic accuracy. [9]

APACHE II scoring system, which was designed in 1985 as a modification to the original APACHE score, is made up of age points and chronic health points, along with a reduction in acute physiology score (APS) variables from 34 to 12. [10]

APACHE IV scoring system is the recent model for APACHE scoring system. It was developed in 2006 and was upgraded for hospital mortality prediction for critically ill patients. It included new predictor variables, such as position prior to ICU admission, pre-ICU hospital length of stay, mechanical ventilation, Pao2/fio2 ratio, impact of sedation on Glasgow Coma Scale, thrombolysis, and 116 disease specific groups besides the variations introduced in the APACHE III. [11]

With medical advances, the characteristics of patients coming to critical care services are different, with a greater percentage of older patients hospitalized who have coexisting multiple morbidities and frailty. Continual refinement of scoring systems is therefore required to reflect the changing situation and enable the prognostication of this increasingly aging and frail population. [12]

Aim/Objectives

The purpose of this study was to assess the predictive power of APACHE II, APACHE IV, and SOFA scores in elderly critically ill patients receiving care in the geriatric critical care unit (CCU) at Ain Shams University Hospital.

Patients and methods

This study was a prospective observational one that was performed at the CCU of the Geriatrics and Gerontology Department at Ain Shams University Hospitals. The study included 106 elderly patients from both sexes aged 60 years old and more who were admitted to the Geriatrics CCU during a period of 6 months between March 2023 and August 2023, with exclusion of those who died within the first 24 hours of admission and who were admitted twice or more within the period of the study. Ethical approval was obtained from MASRI ethical committee and the Research Review Board of the Geriatrics and Gerontology Department at

Ain Shams University. Consent was obtained from the hospital administration to review the needed data, as the data had been obtained from the confidential files of patients upon admission, ensuring complete privacy. The following was applied to each patient on admission : Full detailed history including demographic data, co-morbidities, and thorough medical history , laboratory investigation, assessment of outcomes as total length of stay (LOS) that was calculated from hospital admission to hospital discharge and that included length of CCU stay (days from admission to discharge from the CCU) and length of post-CCU stay (days from discharge from the CCU until discharge from hospital), date and location of death either CCU, ward, palliative care unit or outside the hospital as patients were contacted by phone to check in with their family members about their status one month after discharge. measurement of the Sequential Organ Failure Assessment (SOFA) score [8] on admission to the CCU and every 48 h until discharge using MDCalc Medical calculator [13], measurement of the Acute Physiology and Chronic Health Evaluation (APACHE) II [10] and APACHE IV scores [11] that were calculated on admission to predict the prognosis in patients receiving intensive care using MDCalc Medical calculator. [14][15] Also, the discharge site either to ward, palliative care unit, home, nursing home or others was specified.

Statistical analysis

Statistical analyses were performed using Statistical Package for Social Sciences software (SPSS 28) using Student's t-test, Pearson's correlation coefficient and Hosmer–Lemeshow goodness-of-fit test.

Results

The Current study included 106 medical patients, 58 (54.7%) were females and 48 (45.3%) were males. The mean age and standard deviation (SD) was 74.8±8.34 years. Out of the included patients, there were 54 (50.95%) survivors and 52 (49.05%) non-survivors. On comparison between survivors and non-survivors as regard demographic data there were no significant differences. (Table 1).

As regard the cause of admission, out of the 106 patients studied, 23 (21.7%) had respiratory diseases; 16 of them had died. Thirteen patients (12.3%) had unspecified septic shock; 11 of them had died (84.6%). (Table 2)

On comparison between survivors and non-survivors as regards mean and standard deviation of APACHE II, APACHE IV, initial, highest, and delta scores of SOFA. It revealed a highly statistically significant increase in the group of non-survivors (P<0.001). (Table 3).

Our study revealed that APACHE II, APACHE IV, and SOFA (Initial, Highest, and Delta) scores for prediction of mortality showed fair to good discriminative power, as their area under the curve (AUC) were 0.761, 0.777, 0.790, 0.879, and 0.788, respectively (P<0.001 for all), and the SOFA Highest score gave the best AUC. (Table 4 and Figure1)

Calibration of the scoring systems was done by using the Hosmer-Lemeshow statistics, where it is considered good if the Hosmer-Lemeshow statistic P value is >0.05. The calculated P value was 0.710 for APACHE II, 0.423 for APACHE IV, 0.121 for SOFA Initial, and 0.773 for SOFA Highest. SOFA Highest has the best calibration followed by APACHE II, APACHE IV, SOFA Initial and then SOFA Mean. Logistic regression analysis was also done to estimate odds of mortality using the different scores where they were highly significant for all (P<0.001). (Table 5)

Table (6) shows nonsignificant differences between actual and predicted mortality for APACHE II, APACHE IV, and SOFA highest, which indicates that the observed number of deaths in the study is not statistically significantly different from the predicted number of deaths recorded by these scores (P>0.05).While there is a significant difference for SOFA initial.

This study showed that the median CCU length of stay for studied patients was 7 days, ranged from 2–30 days (interquartile range, 4–11.25), for survivors was 6 (interquartile range, 3–8.25), and for non-survivors was 8 (interquartile range, 4.25–14.5). The study showed that the length of CCU stay was statistically significantly longer in non-survivors in comparison to survivors (P =0.044), while the length of post-CCU stay was significantly longer in survivors (P <0.001). Thirty-day mortality in the CCU was also recorded. The total number of non-survivors was 52 (49.05%), out of them, 50 patients (47.1%) had died in the CCU, 42/50 (84%) patients had died in their first CCU admission, 8/50 (16%) patients had died in their second CCU admission, and the rest (2 patients (1.9%)) had died after hospital discharge.

As regard discharge, 45 patients (42.5%) were discharged to the ward, 13 patients (12.3%) were discharged to the palliative care unit, and only 6 patients (5.7%) were discharged home, the total number was 64 patients. Out of these patients, 10 (15.6%) died after discharge, so the total number of survivors was 54 (50.95%).

Table (1): Demographic data and comparison between survivors and non-survivors:

	All Patients (n=106) (Mean±SD)	Survivors (n=54) (Mean±SD)	Non-survivors (n=52) (Mean±SD)	t	P
Age (years) (Range=60-98)	74.8±8.34	72.5±7.3	77.1±8.8	-2.9	0.22 (NS)
	n (%)	n (%)	n (%)	X^2	P
Sex					
Male	48 (45.3%)	25 (52.1%)	23 (47.9%)	0.045	0.83 (NS)
Female	58 (54.7%)	29 (50.0%)	29 (50.0%)		
Smoking status					
Non-Smokers	81 (76.4%)	45 (55.6%)	36 (44.4%)	3.846	0.15 (NS)
Current Smokers	8 (7.5%)	4 (50%)	4 (50%)		
Ex-smokers	17 (16%)	5 (29.4%)	12 (70.6%)		

No significance (NS) between survivors and non-survivors as regard age, sex and smoking habits
SD=Standard deviation, t=Student "t" test, X2=Chi square test

Table (2): Cause of admission and the survivors and non-survivors numbers from each cause:

ICD10 Code	All Patients (n=106)	Survivors (n=54)	Non-survivors (n=52)
	n (%)	n (%)	n (%)
RENAL	10 (9.4%)	8 (14.8%)	2 (3.8%)
CHEST	23 (21.7%)	7 (13%)	16 (30.8%)
CARDIOVASCULAR	5 (4.7%)	3 (5.6%)	2 (3.8%)
NEUROLOGIC	11 (10.4%)	6 (11.1%)	5 (9.3%)
Septic SHOCK	13 (12.3%)	2 (15.4%)	11 (84.6%)
HEPATIC	9 (8.5%)	4 (7.4%)	5 (9.6%)
Others			
Sepsis	9 (8.5%)	5 (55.6%)	4 (44.4%)
Severe Anemia	2 (1.9%)	2 (100%)	0 (0%)
Hypoglycemic coma	1 (0.9%)	1 (100%)	0 (0%)

Table (3): Descriptive analysis (Mean±SD) of the different model scores used in this study in both survivors and non-survivors' groups:

Assessment scores	Range	All patients (N = 106)	Survivors Mean±SD (N = 54)	Non-survivors Mean±SD (N = 52)	P
APACHE II	(4 - 46)	17.36 ± 7.15	14.22 ± 5.68	20.62 ± 7.1	<0.001
APACHE IV	(30 - 155)	69.58 ± 19.91	60.52 ± 14.01	79 ± 20.84	<0.001
SOFA Initial	(0 - 13)	4.86 ± 2.85	3.43 ± 1.71	6.35 ± 3.03	<0.001
SOFA Highest	(0 - 17)	7.07 ± 4.91	3.78 ± 1.95	10.48 ± 4.73	<0.001
Δ SOFA	(0 - 16)	2.21 ± 3.66	0.35 ± 1.28	4.13 ± 4.3	<0.001

APACHE II and IV= Acute Physiology and Chronic Health Evaluation II AND IV respectively
SOFA= Sequential Organ Failure Assessment (initial and highest and delta value)
Delta value= highest value – initial value

Table (4): Diagnostic accuracy of different scores in the ICU to predict mortality:

ICU Mortality	APACHE II	APACHE IV	SOFA Initial	SOFA Highest	SOFA delta
Sensitivity (%)	90.38	63.46	71.15	78.85	59.62
Specificity (%)	51.85	83.33	77.78	88.89	94.44
Cutoff	>13	>69	>4	>6	>1
AUC	0.761	0.777	0.79	0.879	0.788
P value	<0.001	<0.001	<0.001	<0.001	<0.001

ICU = Intensive care unit, AUC= area under the curve

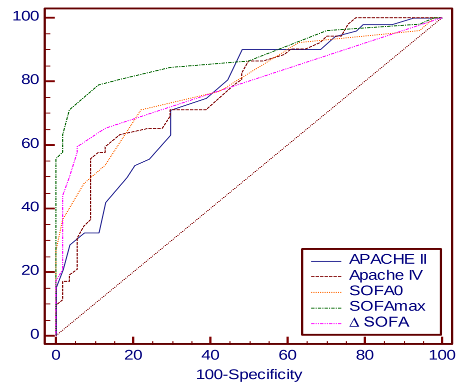

Figure (1) area under the curve (AUC), Sensitivity and Sensitivity of different scores

Table (5): Logistic regression/odds ratio, Hosmer-Lemeshow (HL) calibration for APACHE II, APACHE IV, SOFA scores for prediction of mortality in the CCU:

Model	Logistic regression			Hosmer-Lemeshow	
	Odds	95%CI	P	X^2	P
APACHE II PMR%	1.065	1.034-1.096	<0.001 (HS)	3.75	0.710
APACHE IV PMR%	1.082	1.044-1.122	<0.001 (HS)	8.11	0.423
SOFA Initial PMR%	1.089	1.043-1.137	<0.001 (HS)	8.72	0.121
SOFA Highest PMR%	1.096	1.-049-1.145	<0.001 (HS)	2.52	0.773

PMR%= Predictive Mortality rate
APACHE II and IV= Acute Physiology And Chronic Health Evaluation II AND IV RESPECTIVELY
SOFA= Sequential Organ Failure Assessment (initial and highest)

Table (6): Comparison between the observed and the predicted/expected mortality rates by the scores studied using SMR equation:

Model PMR%	**Mortality**			
	Actual Mortality rate (Observed)	**Predicted Mortality (Mean) (Expected)**	**Standard Mortality Rate (95% CI) (Observed/Expected)**	**P**
APACHE II	49.05	37.3	1.31 (0.94-1.68)	>0.05 (NS)
APACHE IV	49.05	35.5	1.38 (0.99-1.77)	>0.05 (NS)
SOFA Initial	49.05	26.4	1.86 (1.34-2.38)	<0.05 (S)
SOFA Highest	49.05	52.5	0.93 (0.67-1.19)	>0.05 (NS)

PMR%= Predictive Mortality rate

Discussion

The prognostic scoring systems in the ICU are widely used for mortality prediction, prognosis, evaluating outcomes, and length of stay of critically ill patients. [16] Risk-prediction models for ICU were significantly developed, validated and refined over the past twenty years. They were constructed for usage in different ICU populations and have not often been used to study risk prediction in elderly patients, so it was necessary to evaluate their predictive accuracy among elderly patients specially in our country. [5]

This study aimed to evaluate APACHE II, APACHE IV and SOFA score as a predictor of outcomes in 106 critically ill elderly patients in geriatric critical care unit of Ain Shams University hospitals. Main outcome measures were recorded as death in CCU versus survival at discharge.

The current study revealed that there was no statistical significance between survivors and non survivors as regard age & sex distribution (P=0.22 and 0.83 respectively). Matching enables a comparison of outcomes among groups reducing bias due to confounding and making equivalent groups.

The results of our study showed that respiratory diseases were the most common cause of admission as the number of patients was 23 (21.7%), 7 (13%) were survivors and 16 (30.8%) were non-survivors, followed by septic shock as the second most common cause of admission, the number of patients was 13 (12.3%), 2 (15.4%) were survivors and 11 (84.6%) were non-survivors. Neurologic causes were the third cause of admission, the total number of patients was 11 patients, 6 (11.1%) were survivors and 5 (9.3%) were non-survivors. Also showed that, the number of non-survivors who had pulmonary diseases and previously ICU admission was significantly higher than survivors (P=0.04, 0.02).

These results were comparable with results by Stein et al. who reported that respiratory failure, alternation level of consciousness, shock, and high risk postoperative were most common causes for ICU admission in elderly [14], and Lee et al. reported that the most common comorbidities were diabetes mellitus, hypertension and chronic lung diseases, and respiratory failure (60.8%) followed by sepsis (15.4%) were the most common causes of admission[15]. Katsiari et al. Found that acute respiratory failure, cardiac or neurological events and sepsis respectively were the admission primary diagnosis [19].

On the contrary, Agalu et al. found that cardiovascular diseases (30.4%) followed by various surgical interventions (18.8%) and respiratory tract infections (11.6%) were the commonest diagnoses for ICU admission [20]. Tesema et al. demonstrated that cardiovascular diseases (36.1%), respiratory diseases (17.9%) and infectious diseases (13.11%) were the most common diagnosis at admission[21]. These differences between studies could be partially attributed to the fact that our study population exclusively included geriatric patients aged > 60 years, also can be explained by differences in sample size and selection, precomorbidity state, study settings, methodological approaches, and population characteristics.

Our study showed a highly significant difference for all model scores between survivors and non-survivor patients. This is in agreement with many studies as: Gupta and Arora reported that APACHE II score statistically significant increase in non-survivors in comparison to survivors [22]. Zedan et al. reported a significant difference of APACH IV between survivors (57.08 ±16.83) and non-survivors (125.58 ±30.40) $p < 0.001$[23]. Kamal et al. found that APACHE IV (mean ± SD) in survived patients was (78.9± 12.6) and in non-survived was patients was (106.4±2.9) (p-value=0.001) [21]. Mansour et al. found significant increase in SOFA score in nonsurvivors[25]. Abu-Humaidan et al. found that mean SOFA score at admission was significantly higher in non-survivors (7.5 ± 3.9) in comparison to survivors (2.4 ± 2.2) [26].

However, some studies have mentioned the failure of these scores to predict outcomes. Desai and Lakhani found that the APACHE II score on the day of admission was not reliable in predicting the mortality rate in patients with sepsis and modification was recommended [27]. Ghorbani et al. in their retrospective study, showed that APACHE-IV overestimate the predicted mortality in emergency ICU and concluded that APACHE-IV score is poor in prediction of mortality and length of stay in emergency ICU [28].

The differences between results may be due to study settings, population characteristics and severity of illness. Also, the retrospective design is prone to selection bias due to potential miscoding of the ICU database and missing data.

Our study reported that cutoff point of APACHE II, APACHE IV, SOFA (Initial, Highest and delta) scores for prediction of mortality were >13, >69, >4, >6 and >1scores respectively.

The cut-off point for APACHE II of ≥ 13 was predictive of mortality, with sensitivity (90.38%) and specificity (51.85%). The cut-off point for APACHE IV of ≥ 69 was predictive of mortality, with sensitivity (63.46%) and specificity (83.33%),

The cut-off point for SOFA (Initial, Highest and delta) scores for prediction of mortality were (>4, >6, >1) respectively with (71.15, 78.85, 59.62) Sensitivity and (77.78, 88.89, 94.44) specificity respectively.

All scores showed fair to good discriminative power as their area under the curve (AUC) were 0.761, 0.777, 0.790, 0.879 and 0.788 respectively. There was a substantial difference in ICU mortality between the cut off points (p<0.001), and SOFA Highest score gave the best AUC.

Also, our study demonstrated that all scores showed fair to good calibration power, The calculated X2 value was 3.75 (P=0.710) for APACHE II, 8.11 (P=0.423) for APACHE IV, and 8.72 (P=0.121) for SOFA Initial, 2.52 (P=0.773) for SOFA Highest. SOFA Highest had the best calibration followed by APACHE II, APACHE IV and SOFA Initial.

Logistic regression analysis was also done to estimate odds of mortality (represents the constant effect of a predictor, on the likelihood that one outcome will occur) using the different scores where they were highly significant for all (P<0.001)

These findings were supported with many review studies. Qiao et al. discovered that area under ROC curve for APACHE II score was (0.76) and ranged from (0.74) for the initial SOFA score to (0.98) for the maximum SOFA score and concluded that both scores can predict mortality outcome precisely in critically ill elderly patients, especially the maximum SOFA score [29].

Ayazoglu compared APACHE II and APACHE IV scoring systems in predicting outcome of patients admitted in ICU with stroke. It discovered that APACHE IV cutoff point was > 84, indicating high probability of mortality with a sensitivity (94.7 %), specificity (94%), and area under ROC curve (0.93) [30].

Zimmerman et al. evaluated the impact of the APACHE IV score on hospital mortality. The area under the ROC curve was (0.88) [11].

According to Zedan et al., the APACHE IV score could predict mortality with a sensitivity of (91.7%), specificity (97.4%), and a cutoff of (87.5%) with patient discrimination [16]. Keegan et al. reported that APACHE III and IV had good discriminatory capability [31].

Ko et al. studied APACHE II and APACHE IV performances in medical ICU patients and concluded that APACHE IV provided the best discrimination and calibration and was useful in predicting mortality and quality assessment [32]. Kramer et al. found that the performance of APACHE IV mortality prediction in a multi-institutional ICU had good discrimination and calibration [33].

According to Mansour et al. the SOFA score threshold determined using the ROC curve was 7.5 [22] ; Shrestha et al. demonstrated that, with sensitivity (90.91%) and specificity (65.75%), the cutoff value for the SOFA score between survivors and non-survivors was 8 [34]. The SOFA score cutoff determined by the ROC curve was 7, and the area under the ROC curve was (0.825), as demonstrated by Acharya et al. [32]. Abu-Humaidan et al. reported that maximum SOFA had the best area under the ROC curve values (AUROC = 0.966, 95% CI: 0.928–1.000) [26].

However, Lee et al. demonstrated that the APACHE IV and APACHE II showed poor calibration in their study [36]. Brinkman et al. demonstrated that the original APACHE IV showed good discrimination and accuracy but poor calibration [37]. In their ICU population, Varghese et al. found that both APACHE II & IV had poor calibration and APACHE IV showed superior discrimination over APACHE II [38].

This difference between studies could be due to ICU population, which in our study was geriatric medical, while those of Lee et al. were surgical [36] and of Brinkman et al. were coronary artery bypass grafting (CABG) patients [37]. This difference in case mix explains the difference in scores observed in these studies.

The results of this study showed that the mortality rate was 49.05% (52 out of 106 patients) among critically ill elderly patients admitted to a critical care unit. The mean age of our studied patients was 74.8±8.34 years. In agreement with our results, Stein,et al. reported that Mortality rate was 57.3% among 199 patients with 75.4±6.8 years as the mean age [17]. Nierman et al. demonstrated a mortality rate of 48% among 455 very elderly patients (≥85 years old) admitted to ICU [39]. Grigorakos et al. (2015) reported a mortality rate of 47% in 200 patients of 70-74 years old [40]. Shrestha et al. was 37.6% [34]; Mansour et al. was 55.2% [25]; Ayazoglu was 34.5% [30]; and Kamal et al. was 32% [24]. Most of these studies were among elderly patients where mortality rates usually are higher.

However other studies reported lower or higher rates of mortality. Becker et al. showed that ICU short-term outcomes were (18.3%) and hospital mortality was (30.9%) [41]. Other studies showed ICU mortality rates ranging from 14.6 [42] to 36.6 %. [43] in patients >85 years. In a study by Thakur et al. included 72 patients with Sepsis, the estimate mortality rate was 87.50% [44].

Mortality rates commonly are higher in elderly ICU patients in comparison to younger patients. This may be attributed to associated premorbid functional status, severity of disease and comorbidity, socio-economic differences between countries that appear to be responsible for the worse prognosis. [45]

As regard outcome:

This study showed that a median CCU length of stay for studied patients was 7 days, ranged from 2-30 days (interquartile range, 4–11.25) ,for survivors was 6 (interquartile range, 3-8.25) and for non-survivors was 8 (interquartile range, 4.25-14.5). The study showed that Length of CCU stay was significantly longer in non-survivors in comparison to survivors (P =0.044), while length of post- CCU stay was significantly longer in survivors (P <0.001).

Thirty-day mortality in CCU was also recorded. The total number of non-survivors was 52 (49.05%), out of them, 50 patients (47.1%) had died in CCU, 42/50 (84%) patients had died in their 1st CCU admission and 8/50 (16%) patients had died in their 2nd CCU admission and the rest (2 patients (1.9%)) had died after hospital discharge. As regard discharge, 45 patients (42.5%) were discharged to the ward, 13 patients (12.3%) were discharged to the palliative care unit and only 6 patients (5.7%) were discharged home, the total number was 64 patients. out of these patients, 10 patients (15.6%) died after discharge so the total number of survivors was 54 (50.95%).

Our results were comparable with results reported by Refaee and Rasheedy who showed that the survivors had a statistical significantly shorter ICU stay than non-survivors (p=0.01) [46]. Moitra et al. concluded that ICU higher mortality correlated to longer ICU stay either in mechanically ventilated or non-mechanically ventilated patients [47].

Katsiari et al. found that 16.2% of patients died within 28 days after ICU discharge [19].

Readmission rate in our geriatric critical care unit was (16%) like others studies showed similar values from 0.9% to 19%. Ponzoni et al. recorded 576 (10%) out of 5,779 patients were readmitted to the ICU during the same hospitalization [48]. Rosenberg and Watts found that the average ICU readmission rate was 7% [49]. Rosenberg et al. reported that out of 3,310 patients admitted to the ICU, 317 (9.6%) patients were readmitted [50]. Levy et al. reported that 19% of liver transplantation patients were readmitted and this was the highest percentage reported in the literature [51]. Williams et al. concluded that ICU LOS was not an independent risk factor for in-hospital mortality. Long-term mortality associated with ICU LOS reaches a plateau after the first ten days in ICU. It was reported that ICU LOS has mild effect on long-term mortality after hospital discharge after other risk factors adjustment [52].

These discrepancies of the results may be due to the differences of the sample size and population, initial hemodynamic instability, ICU facilities and therapy protocols which are different among ICUs.

This study has some limitations. Firstly, this was a single-center study. Secondly, patients were enrolled over a short period a 6 month period. Effect of therapy changes cannot be excluded on the results of this study.

Conclusion

The APACHE II, APACHE IV and SOFA model scores were good at predicting hospital mortality in elderly patients and would be helpful to make clinical and therapeutic opinions in the future.

Recommendation

1. With advances in critical care services and admission of elderly patients with multiple co-morbidities and frailty, continuous improvement of scoring systems is needed.
2. Endorsement of new scoring systems for elderly patients admitted in ICU is needed for prognosis assessment of geriatric and frail population.

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