

Original Article

Study on Outcome of Patients with Acute Respiratory Failure on Mechanical Ventilation Monitored on SOFA and APACHE II Score

Rajendra R. Mane¹, Lakhbir Singh²

¹Associate Professor, ²Resident, Department of Medicine, D.Y. Patil Medical College and Hospital, Kolhapur, Maharashtra, India

ABSTRACT:

Background: Mechanical ventilation has been a need for the hour these days and there has been an increasing trend in the patients getting admitted in intensive care unit for prolonged duration. About 10% of the patients with mechanical ventilation end up getting it for longer duration. **Aim of the study:** To study outcome of patients with acute respiratory failure on mechanical ventilation monitored on SOFA and APACHE II score. **Materials and methods:** The present study is a prospective observational clinical study. It was conducted at Dr. D.Y. Patil Hospital and Research Centre, Kolhapur, Maharashtra, India. The study duration was from September 2016 to August 2018. Total 50 patients admitted in ICU of Dr. D.Y. Patil Hospital during study period and whoever put on ventilator was taken as subjects. Procedure include three parts i.e., brief history, physical examination and collected lab values of patients on first day which ventilator support was given. **Results:** At end of follow up period 30% patients survived. Proportion of non-survivors was significantly more than of survivors. The maximum mean SOFA score observed in age-group of 31-40, followed by age-group 51-60 and age-group 71-80. Maximum mean APACHE II score was observed in age-group of 71-80 followed by age-group 51-60 and 61-70. **Conclusion:** From the results of present study, we conclude that SOFA score ≥ 8 and/ APACHE II score ≥ 10 were strong predictors of mortality in patients on mechanical ventilation in acute respiratory failure.

Key words: APACHE score, SOFA score, ventilation, respiratory failure

Received: 16 August 2018

Revised: 25 September 2018

Accepted: 28 September 2018

Corresponding Author: Dr. Lakhbir Singh, Department of Medicine, D.Y. Patil Medical College and Hospital, Kolhapur, Maharashtra, India

This article may be cited as: Mane RR, Singh L. Study on Outcome of Patients with Acute Respiratory Failure on Mechanical Ventilation Monitored on SOFA and APACHE II Score. J Adv Med Dent Scie Res 2018;6(10):114-119.

INTRODUCTION:

Mechanical ventilation has been a need for the hour these days and there has been an increasing trend in the patients getting admitted in intensive care unit for prolonged duration.¹ About 10% of the patients with mechanical ventilation end up getting it for longer duration. Overall, in terms of time, manpower and money resource, these patients are responsible for major loss, even though these form a smaller cohort of intensive care units.^{2,3} Many studies conducted to evaluate the mortality rates in Prolonged Mechanical Ventilation (PM,V) patients have found out that the 1 year mortality is 56 to 71%.^{4,6} Of the

survived, majority of them die in first year of follow up only. This interests many researchers in evaluating PMV patients and what parameters predict the survival of the patient. Some of clinical decisions like timing of tracheotomy, use of intensive glycemic control, initiation of nutrition and transfer to long term ventilatory units or referrals are influencing factors for duration of mechanical ventilation.² Many factors have been studied across the world for identifying such factors. Two of them which interested us are Sr. albumin levels and C reactive protein levels. Traditionally C reactive protein levels are studied as markers of inflammation which help in monitoring the

course of infection and inflammatory diseases. Further, many studies have been conducted to evaluate that CRP is a marker of organ failure. Increased CRP levels have been strongly associated with respiratory impairment in various studies.^{7,8} Another such marker is Sr. albumin levels which is a marker of nutritional depletion. It has been associated with increase in hospital mortality and morbidity.⁹⁻¹¹

Apart from these markers, researchers have also studied various scoring systems which influence the outcome of ventilation status in ICU patients. SOFA score & APACHE II score are some of the widely used scoring systems. SOFA score has score from 6 organ systems-respiratory, cardiovascular, hepatic, coagulation, renal, and neurological graded from 0 to 4 according to the severity of the dysfunction or failure of the organ.¹² APACHE score was originally developed in 1981 and later modified in 1985 is now most widely used severity of illness score. APACHE II is the newer version which has 12 physiological variables. Since C reactive protein and Sr. albumin also cover one aspect of the inflammation in the body, predicting their role in the outcome of patients on mechanical ventilation monitored on SOFA score and APACHE II score is an important aspect. Hence, the present study was conducted to study outcome of patients with acute respiratory failure on mechanical ventilation monitored on SOFA and APACHE II score.

MATERIALS AND METHODS:

The present study is a prospective observational clinical study. It was conducted at Dr. D.Y. Patil Hospital and Research Centre, Kolhapur, Maharashtra, India. The study duration was from September 2016 to August 2018. Total 50 patients admitted in ICU of Dr. D.Y. Patil Hospital during study period and whoever put on ventilator was taken as subjects. Informed written consent was taken. Approval from institutional ethical committee was taken.

Inclusion criteria:

- All patients of ICU on mechanical ventilation due to acute respiratory failure.
- Patients age > 18 years.

Exclusion criteria:

- . Patients on mechanical ventilation with
 - Chronic Kidney Disease
 - Decompensated liver disease

- Cardiac disease
- Admission transferred in from another ICU

Procedure include three parts i.e., brief history, physical examination and collected lab values of patients on first day which ventilator support was given.

Lab values analyzed were

- CBC
- Hematocrit
- ABG analysis
- Sr. bilirubin
- Sr. creatinine
- Sr. albumin
- Sr. C-reactive protein
- Sr. sodium
- Sr. potassium

APACHE II SCORE and SOFA score was calculated at day one of ICU admission from the data collected above.

Statistical analysis

Data was compiled and tabulated by MS Excel spread sheet (2013). Software SPSS version 20 was used to analyze data. Chi square test and Fishers exact test was used to know the significant association. ROC curve was drawn to find the cut off for various continuous variables. Data were presented in the form of tables, figures and graph wherever necessary. For all practical purposes p value less than 0.05 was considered as statistically significant.

RESULTS:

Table 1 shows demographic characteristics of study subjects. Out of total 50 patients 80% were males & 20% females. At end of follow up period 30% patients survived. Proportion of non-survivors was significantly more than of survivors (p<0.01). Mean age of patients was 53.58 years. Table 2 shows mean SOFA & APACHE II scores in study subjects. Mean SOFA & APACHE II scores in all patients were 7.80 & 12.76 [Fig 1]. Table 3 shows that maximum mean SOFA score observed in age-group of 31-40, followed by age-group 51-60 and age-group 71-80. Maximum mean APACHE II score was observed in age-group of 71-80 followed by age-group 51-60 and 61-70. It observed that APACHE II score increases with increase in age [Fig 2].

Table 1: Demographic characteristics of study subjects

Males	40 (80%)
Females	10 (20%)
Mean age in years	53.58 ± 16.78
Survived	15 (30%)
Died	35 (70%)

Table 2: Mean SOFA & APACHE II scores in study subjects

Score	Mean	SD
SOFA	7.80	3.30
APACHE II	12.76	7.39

Figure 1: Mean SOFA & APACHE II scores

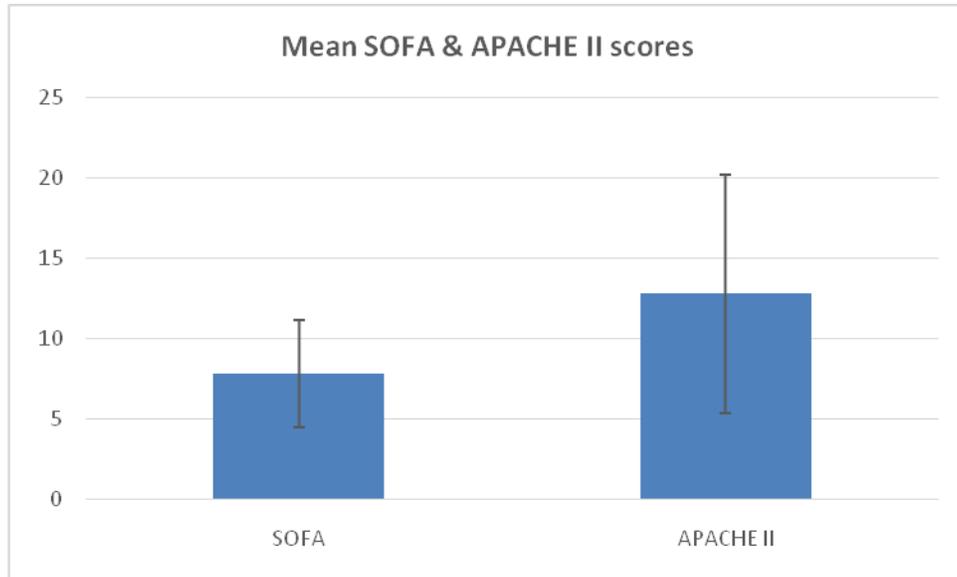
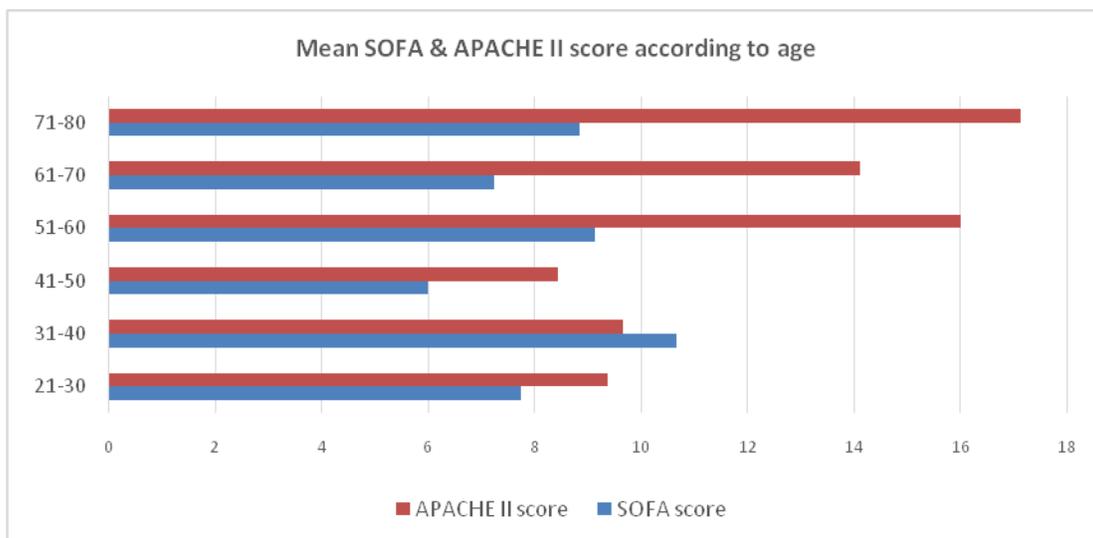


Table 3: Mean SOFA & APACHE II score according to age

Age group	SOFA score	APACHE II score
21-30	7.75 ± 3.65	9.37 ± 6.58
31-40	10.66 ± 1.65	9.66 ± 2.88
41-50	6 ± 3.96	8.44 ± 8.61
51-60	9.14 ± 3.38	16 ± 8.90
61-70	7.25 ± 2.88	14.12 ± 6.05
71-80	8.85 ± 2.54	17.14 ± 5.92

Figure 2: Mean SOFA & APACHE II scores according to age



DISCUSSION:

The present study was a prospective observational study carried out in a Dr. D. Y. Patil Hospital from September 2016 to August 2018. A total of 50 patients were included in the study according to given inclusion & exclusion criteria. All the patients admitted in ICU of Dr. D. Y. Patil Hospital and whoever put on ventilator were taken as subjects. In present study out of total 50 patients 80% were males & 20% females. At end of follow up period 30% were survived. Proportion of non-survivors was significantly more than of survivors ($p < 0.01$). Mean age of patients was 53.58 years. Maximum study subjects were present in 61-70 age group i.e. 32%. This is followed by 18% & 16% in 41-50 & 21-30 age group respectively. Death rate was maximum in 71-80 age group i.e. 85.71%. This was followed by 61-70 age-group (75%), 51-60 age-group (71.42%). This shows that as age increases death rate increases. Death rate was unexpectedly least in age-group 41-50 (55.55). Death rate was more in females (80%) as compared to males (67.5%). This difference in death rate was not statistically significant. Jacob C. Jentzer (2009)¹³ in their study included 9961 patients, with a mean age of 67.5 ± 15.2 years; all-cause hospital mortality was 9.0%. Somnath S. Kumar (2014)¹⁴ found 45% mortality in their study while in our study it was 70%. Aakash Teja Durbesula (2017)¹⁵ in their study included 50 cases, females (52%) were slightly more than the male patients and the most common age group was 31–50 years. In our study maximum study subjects were present in 61-70 age group i.e. 32%. Remyasri Nair (2016)¹⁶ found no significant association between age & survival status. Aditi Jain (2016)¹⁷ conducted study in CI patients in ICU in which mortality rate was 39%. Abdelbaset Saleh (2015)¹⁸ in their study observed survival rate which was 47.7%. Survivors were younger than non survivors (41.4 ± 15.4 versus 54.1 ± 16.9 years, respectively; $p = 0.002$).

In present study mean SOFA & APACHE II scores in all patients were 7.80 & 12.76. Maximum mean SOFA score observed in age-group of 31-40, followed by age-group 51-60 and age-group 71-80. Mean SOFA & APACHE II score was more in expired as compared to survived patients & this difference was statistically significant ($p < 0.01$). In the current study SOFA score has very strong association in predicting the mortality from mechanical ventilator (p value < 0.01 , $AUC = 0.7638$). It has a sensitivity of 74.29% and specificity of 86.67%. The SOFA score ≥ 8 is derived as a cut off value for prediction of mortality. Death rate in study subjects having SOFA score ≥ 8 (92.85%) was significantly more than of study subjects having score < 8 (40.90%). Kuo-Chin Kao (2009)¹⁹ conducted study and in their multivariate logistic regression analysis identified SOFA score (OR 1.127, 95% CI 1.054–1.206, $p < 0.001$) was independently associated with hospital mortality. Jacob C. Jentzer (2009)²⁰ conducted study and found that day 1 SOFA score predicted hospital mortality, with an area under the receiver-operator characteristic curve value of

0.83. Patients with an increasing SOFA score from day 1 and day 2 had higher mortality. Patients with day 1 SOFA score < 2 were at low risk of mortality. Increasing tertiles of day 1 SOFA score predicted higher long-term mortality ($P < 0.001$ by log-rank test). Afshan Shabir (2017)²¹ in their study found that significantly higher mean SOFA score of 5.50 ± 1.89 in survivors and 11.67 ± 2.87 in non-survivors. They also observed that initial SOFA score had a strong statistical correlation with mortality (P value < 0.05) in patients admitted with sepsis, COPD, CAP & cardiac causes. Wael Elabbassi (2017)²² in their univariate analysis showed that SOFA score more than 18 was associated with increased 30 day mortality. Aakash Teja Durbesula (2017)²³ in their study found that factors associated with poor outcome and high mortality was high SOFA scores (P value 0.001). Remyasri Nair (2016)¹⁶ found that initial SOFA score were found to be statistically significant as mortality predictors. Aditi Jain (2016)¹⁷ conducted study in CI patients in ICU and found that the maximum SOFA score in survivors (3.92 ± 2.17) was significantly lower than non survivors (8.9 ± 3.45). The initial SOFA score had a strong statistical correlation with mortality. Duration of the stay did not correlate with the survival ($P = 0.461$). Kun Xiao (2015)²³ in their study found that SOFA score was significantly lower than those of the non-survivors ($P < 0.001$). The sensitivity (0.902) and the AUC (0.890) of the SOFA score at a cut-off point of 7.5 was remarkably higher than those of the other scoring models. Abdelbaset Saleh (2015)¹⁸ observed that SOFA score & Multiple Organ Dysfunction score was significantly lower for survivors than for non survivors in their study. Charan Bale (2013)²⁴ in their study SOFA score at admission to ICU was calculated. In the group of patients in whom SOFA was < 7 at admission, there were 44% survivors. In patients who had SOFA score between 8 and 15, there were 70% non-survivors. Mean SOFA score of the patients who did not survive, was 6.62 and the mean score of those who survived was 4.5 (t -test = 1.69, $P = 0.0989$). Mona Mansour (2013)²⁵ found mean admission SOFA score was higher in non survivors compared with survivors in their study. The cutoffs obtained by the receiver operating characteristic curve was 7.5 for SOFA. Alvaro Sanabria (2013)²⁶ conducted study on prediction of prolonged mechanical ventilation in ICU patients and found that SOFA score was slightly more in not extubated group as compared to extubated group. Özkan Devran (2012)²⁷ in their study of sepsis due to nosocomial infection found that higher SOFA scores on 3rd day, was found to be risk factors for mortality.

In the current study APACHE II score has very strong association in predicting the mortality from mechanical ventilator (p value < 0.01 , $AUC = 0.7162$). It has a sensitivity of 68.57% and specificity of 66.67% the APACHE II score ≥ 10 is derived as a cut off value for prediction of mortality. Death rate in study subjects having APACHE II score ≥ 10 (83.75%) was significantly more than of study subjects

having score < 10 (52.38%). Maximum mean APACHE II score was observed in age-group of 71-80 followed by age-group 51-60 and 61-70. It observed that APACHE II score increases with increase in age. Chih-Cheng Lai (2018)²⁸ conducted study and found that APACHE II score was significantly more in non survivors group as compared to survivor. Amina Godinjak (2016)²⁹ found that APACHE II score was significantly different between survivors and non-survivors. The APACHE II scoring system represents a statistically significant predictive marker of fatal outcomes of patients (area under the curve of 0.920, CI 0.87-0.97, p=0.001). Cut off value for APACHE II was 27.5, with sensitivity of 74.5% and specificity of 93.4%. Anna Rojek-Jarmuła (2016)³⁰ in their study observed that APACHE II was higher in non-survivors (15; IQR 10.25-19.5) compared to survivors (11; 8.25-14) (P < 0.001). In a bivariate analysis, APACHE II predicted mortality with good diagnostic accuracy (AUROC = 0.714; P = 0.007). Abdelbaset Saleh (2015)¹⁸ in their study observed that APACHE II was significantly lower for survivors than for non survivors. Xiao-Yu Zhou (2015)³¹ conducted study on CI patients in ICU and found that APACHE II score was significantly higher in non-survivors compared to survivors (23.1 ± 4.8 vs. 16.7 ± 4.6, p < 0.001). Mona Mansour (2013)²⁵ found admission APACHE II was higher in non survivors compared with survivors. The cutoffs obtained by the receiver operating characteristic curve were 11 for APACHE II. In our study cut off for APACHE II was 10. Alvaro Sanabria (2013)²⁶ conducted study on prediction of prolonged mechanical ventilation in patients in the intensive care unit and found that APACHE II score was slightly more in not extubated group as compared to extubated group. MevlütTüre (2005) carried out study in CI patients and found that there were 98 (47.6%) survivors and 108 (52.4%) non-survivors. The survivors had APACHE II scores (11 vs 16, P<0.0005).³²

CONCLUSION:

From the results of present study, we conclude that SOFA score ≥ 8 and APACHE II score ≥ 10 were strong predictors of mortality in patients on mechanical ventilation in acute respiratory failure.

REFERENCES:

1. Marmar AJ, Kondapaneni S, Vance GB, Gaughan JP, Martin UJ, Criner GJ. Survival in Patients Receiving Prolonged Ventilation: Factors that Influence Outcome. *Clin Med Insights Circ Respir Pulm Med* [Internet]. *Libertas Academica*; 2011 Apr 25;5:17–26. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/21573034>
2. Ambrosino N, Vitacca M. The patient needing prolonged mechanical ventilation: a narrative review. *Multidiscip Respir Med. BioMed Central*; 2018;13(1):6.
3. Moitra VK, Guerra C, Linde-Zwirble WT, Wunsch H. Relationship between ICU length of stay and long-term mortality for elderly ICU survivors. *Crit Care Med. NIH Public Access*; 2016;44(4):655.

4. Kojicic M, Li G, Ahmed A, Thakur L, Trillo-Alvarez C, Cartin-Ceba R, et al. Long-term survival in patients with tracheostomy and prolonged mechanical ventilation in Olmsted County, Minnesota. *Respir Care. Respiratory Care*; 2011;56(11):1765–70.
5. Lee JH, Kim J, Kim K, Jo YH, Rhee J, Kim TY, et al. Albumin and C-reactive protein have prognostic significance in patients with community-acquired pneumonia. *J Crit Care. United States*; 2011 Jun;26(3):287–94.
6. Sierros V, Fleming R, Cascioli M, Brady T. The prognostic value of C-reactive protein in long-term care patients requiring prolonged mechanical ventilation. *Chron Respir Dis. 2009*;6(3):149–55.
7. Sproston NR, Ashworth JJ. Role of C-Reactive Protein at Sites of inflammation and infection. *Front Immunol. Frontiers Media SA*; 2018;9.
8. Shrivastava AK, Singh HV, Raizada A, Singh SK. C-reactive protein, inflammation and coronary heart disease. *Egypt Hear J. Elsevier*; 2015;67(2):89–97.
9. Hill A, Nesterova E, Lomivorotov V, Efremov S, Goetzenich A, Benstoem C, et al. Current Evidence about Nutrition Support in Cardiac Surgery Patients—What Do We Know? *Nutrients. Multidisciplinary Digital Publishing Institute*; 2018;10(5):597.
10. Nicholson JP, Wolmarans MR, Park GR. The role of albumin in critical illness. *Br J Anaesth. Elsevier*; 2000;85(4):599–610.
11. Garwe T, Albrecht RM, Stoner JA, Mitchell S, Motghare P. Hypoalbuminemia at admission is associated with increased incidence of in-hospital complications in geriatric trauma patients. *Am J Surg. Elsevier*; 2016;212(1):109–15.
12. Jones AE, Trzeciak S, Kline JA. The Sequential Organ Failure Assessment score for predicting outcome in patients with severe sepsis and evidence of hypoperfusion at the time of emergency department presentation. *Crit Care Med. United States*; 2009 May;37(5):1649–54.
13. Jacob C. et al. Predictors of in-hospital mortality among older patients. *Clinics vol.64 no.7 São Paulo* 2009.
14. Somnath S. Kumar et al. Evaluation of the Methods and Management of Acute Coronary Events (EMMACE)-3: protocol for a longitudinal study. *BMJ Open* 2014;006256.
15. Aakash Teja et al. A study on the prevalence of direct vs indirect etiology, prognostic determinants and mortality in ARDS. *Annals of Tropical medicine and Public health. 2017. Vol: 10:(2) 409-416.*
16. Remyasri Nair et al. Initial Sequential Organ Failure Assessment score versus Simplified Acute Physiology score to analyze multiple organ dysfunction in infectious diseases in Intensive Care Unit. *Indian Journal Of Critical Care Medicine. 2016 Vol.20:(4)210-215.*
17. Aditi Jain et al. Sequential organ failure assessment scoring and prediction of patient's outcome in Intensive Care Unit of a tertiary care hospital. [J Anaesthesiol Clin Pharmacol](#) . 2016 Jul-Sep; 32(3): 364–368.
18. Abdelbaset Saleh, et al. Comparison of the mortality prediction of different ICU scoring systems (APACHE II and III, SAPS II, and SOFA) in a single-center ICU subpopulation with acute respiratory distress syndrome. *Egyptian Journal of Chest Diseases and Tuberculosis* (2015) 64, 843–848.

19. Kuo-Chin Kao, et al. Organ dysfunction as estimated by the SOFA score is related to outcome in critically ill patients. *Shock*. 2009 Feb;31(2):125-31.
20. Jacob C. et al. Predictors of in-hospital mortality among older patients. *Clinics* vol.64 no.7 São Paulo 2009.
21. Shabir A, Maqbool M. Accuracy of SOFA Score in Predicting Outcome in Medical Patients with Various Diagnosis in Intensive Care Unit in a Tertiary Care Hospital in Northern India. *Int J Contemp Med Res [Internet]*. 2017;483(1):77–2393.
22. Wael Elabbassi et al. The impact of severity of initial illness, determined by SOFA score, and presence of anemia on outcomes among patients requiring Extra Corporal Membrane Oxygenation (ECMO) support: A single center experience. *Indian Heart Journal* 69 (2017) 762–766.
23. Kun Xiao et al. Prognostic value of different scoring models in patients with multiple organ dysfunction syndrome associated with acute COPD exacerbation. *J Thorac Dis* 2015;7(3):329-336.
24. Charan Bale et al. Sequential organ failure assessment score as prognostic marker in critically ill patients in a tertiary care intensive care unit. *International Journal of Medicine and Public Health*, Jul-Sep 2013, Vol 3, Issue 3.
25. Mona Mansour et al. Study of the role of different severity scores in respiratory ICU. *Egyptian Journal of Bronchology* 2013 7:55–59.
26. Sanabrai A. et al. Prediction of prolonged mechanical ventilation for intensive care unit patients: A cohort study. *Colomb Med*. vol.44 no.3 Cali July/Sept. 2013.
27. OzkanDevran et al. C-reactive protein as a predictor of mortality in patients affected with severe sepsis in intensive care unit. *Multidisciplinary Respiratory Medicine* 2012, 7:47.
28. Chih-Cheng Lai et al. The outcomes and prognostic factors of the patients with unplanned intensive care unit readmissions. *Medicine* (2018) 97:26.
29. Amina Godinjak et al. Predictive value of SAPS II and APACHE II scoring systems for patient outcome in a medical intensive care unit. *Acta MedicaAcademica* 2016;45(2):97-103.
30. Anna Rojek-Jarmuła et al. Does the APACHE II score predict performance of activities of daily living in patients discharged from a weaning center? *KardiochirurgiaITorakochirurgiaPolska* 2016; 13 (4): 353-358.
31. Xiao-Yu Zhou et al. A comparison of APACHE II and CPIS scores for the prediction of 30-day mortality in patients with ventilator-associated pneumonia. *International Journal of Infectious Diseases*. 2015. Volume 30, Pages 144–147.
32. MevlütTüre et al. Predictive value of thyroid hormones on the first day in adult respiratory distress syndrome patients admitted to ICU: comparison with SOFA and APACHE II scores. *Ann Saudi Med* 2005;25(6):466-472.

Source of support: Nil

Conflict of interest: None declared

This work is licensed under CC BY: ***Creative Commons Attribution 3.0 License.***