Prognostic Scoring Systems as a Tool to Predict the Clinical Outcomes for Patient with Critical Condition

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Abstract

Background: ICU scoring systems allowed an assessment of the severity of disease and death prediction. The use of prognostic scoring system to predict possibility of mortality and evaluating outcomes in critically ill patients is an important in the modern evidence –based critical care. **Aim:** This study aimed to assess prognostic scoring systems as a tool to predict the clinical outcomes for patient with critical condition**. Design:** A descriptive exploratory design was conducted to achieve the aim of this study. **Setting**: The study was carried out in intensive care units (ICUs) of Ain Shams University Hospital (surgical, Internal medicine and neurological ICUs) affiliated to Ain Shams University, Cairo-Egypt. **Study subject:** A Purposive sample of (200) patients admitted to the previous mentioned setting. **Tools of data collection;** were consisted of patient assessment tool, APACHE IV, SAPS III, SOFA and MPM II and the last tool was used (at admission MPM0, MPM at 24hrs, MPM at 48hrs and MPM at 72 hrs). **Results:** Revealed that, more than half of studied patients were male, with age ranged from 23.00 to 80.00 years old. The overall mortality observed was 25% in all the patients. APACHE IV predicted mortality rate sensitivity and specificity were 94.11% and 95.97% respectively. Also, APACHE IV score had moderate positive correlation between predicated ICU length of stay and real ICU length of stay. **Conclusion**: APACHE IV established the best discrimination and superior calibration makes it the most appropriate model for comparisons of mortality rates with the other scores in ICU. APACHE IV score was better than SAPS III, SOFA and MPM II scores as they were significantly higher between non-survivors to predict mortality and length of stay among ICUs patients. **Recommendations:** Applications of APACHE IV score system to assess of all admitted patient to ICU in nursing assessment.

Keywords: Prognostic Scoring Systems, Clinical Outcomes, Critical Condition

Introduction:

Prognostic scoring systems called the illness severity scores or outcome prediction scores that are designed to provide an estimate of the probability of hospital mortality for critically ill patients *(Hamza, et al., 2009).* They were developed approximately 30 years ago. They are very important in clinical practice as they are widely used to predict the outcome, characterize the critical illness, the degree of organ dysfunction, assess the resource use and measure the needs of patients to be in the ICU. The scoring systems can also be very valuable for evaluating the quality of care (benchmarking) and for risk stratification or ensuring comparability of patient populations in clinical trials (*Fika et al., 2014).*

Prognostic Scoring systems have been developed in response to an increasing importance on evaluation and monitoring health services. The rapid development of ICUs with dedicated teams of physicians and nurses where patients admissions were defined by severity and not by their primary disease or the specialty of his/her attending physician. This created a need for the systematic evaluation of the effectiveness of ICU procedures and practices. Most treatments in ICUs are time dependent, so it is important to determine whether ICUs are admitting the right patients at the right time,as well whether they are discharging the right patients at the right time to save money, scarce and valuable resources **(Dólera-Moreno, et al., 2016).**

Patient outcome prediction in the 1980s was one of signs of intensive care modern medicine. Outcome prediction in critical illness was based on the subjective judgment of the clinicians. The rapid progress of ICUs created the needs for quantitative and clinically applicable outcome measures in order to

evaluate the effectiveness of the treatment provided. From that time, prognostic scoring systems had been developed and applied. An outcome of patients in the Intensive care depends on several factors present from the first day of ICU admission, and then on the patient's progression in ICU so many scoring systems have been developed but few are used *(Rapsang & Shyam, 2014)*.

The patients treated in ICU have considerably unstable clinical status and physiological capacity. Therefore, care services, backed by accurate clinical judgment, have a great impact on their recovery. Accurate clinical assessment could facilitate not only prognostic prediction and therapeutic decision making, but also assessment and comparison of ICU performance or quality of critical care services. Among the measures of illness severity, mortality rate or survival rate is widely used because it is an easy to use, simple, and powerful tool. However, this measure cannot be used as performance indicator of ICU service for comparison as it cannot be adjusted for patient severity in each ICU *(Jeong, 2018)*.

In fact, scoring systems have become a necessary tool to describe patient's conditions in ICU patients and to predict patient's outcomes. However, it is also important to note that the choice of the severity score scale model should accurately match the event, setting, or application because misuse of such systems could lead to waste time, increased cost and unwarranted extrapolations *(Sekulic et al., 2015)*.

Intensive care unit is not just a clinical specialty but a system of care delivered by a skilled and highly professional group that includes physicians, nurses, respiratory therapists, physiotherapists, pharmacists, micro-biologists, social workers, nutritionists and many others. ICU nurses play a vital role in the patients care. They are constantly looked after, monitored and evaluating the patient condition. ICU nurses helping the patient to obtain the necessary care, continuous patient monitoring, respect and support the patients independency, administering treatment, provide information to family, application of policy and procedure, record all patient activities, they also work to maintain infection control principles, and keep update with advance information, new technologies and equipment *(Greenwood, 2019)*.

Common scoring systems used in ICU are the Glasgow Coma Scale (GCS), Acute.

Physiology, Age and Chronic Health Evaluation Systems (APACHE), Therapeutic Interventions Scoring System (TISS), Simplified Acute Physiology Score (SAPS), Mortality Prediction Models (MPM), Sequential Organ Failure Assessment (SOFA), Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM) and disease/ patient group specific scoring systems such as Euro score (CABG), MELD score (liver failure), etc *(Nickson, 2016)*.

Significant of the Study:

Critical care is a complicated, high risk, resource-dependent environment. Intensive care unit imposes financial burden over the patient's family in our country. The ability to identify critically ill patients who will not survive to hospital discharge? for providing more comprehensive care and more attention. Thus it is pertinent to have instruments for severity evaluation and outcome prediction regarding critical care conditions. Developing countries face common barriers to deliver quality of care due to the lack of supplies, coordination, organization, technology, and human resources. A recent survey performed by the CERTAIN (Checklist for Early Recognition and Treatment of Acute Illness and Injury; reported that investigators network in 15 ICUs from 11 in low- and middle-income countries showed that 77% of ICUs singled out lack of protocols and trained staff, which are the most important barriers to improve the care and outcomes of critically ill patients *(Kashyap et al., 2015)*.

The rapid development of intensive care units ICU created the need for quantitative and clinically relevant outcome measure in order to evaluate the effectiveness of treatment practices and to decrease medical cost. The outcome of intensive care patient depends on several factors presents in the first 24 hours in the ICU. Many systems have been developed

but few are used. The aim of this study is to assess the use of prognostic scoring systems to predict outcomes of critically ill patient. That helps health care team responsible in the intensive care unit to evaluate the patient general condition and decide the proper way of treatment.

Aim of the study:

This study aimed to assess prognostic scoring systems as a tool to predict the clinical outcomes for patient with critical conditions.

Research Questions:

1. Do prognostic scoring systems able to predict the clinical outcomes for patient with critical conditions?

2. What is the most sensitive and specific in predicting the clinical outcomes for patient with critical conditions among the different prognostic scoring systems?

Operational definition:

Prognostic scoring systems: Systems are used widely in the critical care inside or outside the intensive care unit; they are used as in objective way of measuring and recording the severity of complex clinical condition to predict patient condition, disease, treatment and services as APACHE IV, SAPS, SOFA and MPM II score.

Clinical outcomes: It is the results of the care that patient have been received in the hospital; it includes length of stay, incidence of infection and mortality rate.

Subjects and methods:

1-Technical Design:

Research design: A descriptive exploratory design was used in this study.

Research Design:

A descriptive exploratory design will be utilized to achieve the aim of this study and to answer the research question. Descriptive design: is under taken to describe answer to question of who, what, where, when and how. Exploratory design is conducted when the

investigator doesn't know much about the problem and need additional information or desires new or more recent information. It will be adapted from **(Stephen, 2022)**

Setting:

This study was conducted in three Intensive Care Units (ICUs) in Ain Shams University Hospitals (surgical, Internal medicine and neurological ICUs) affiliated to Ain Shams University, Cairo-Egypt. **Surgical ICU:** located at 2rd floor, contains 30 beds, **Internal medicine ICU**: located at 1st floor, contains 2 areas, ICU A and ICU B, each ICU had 12 beds and **Neurological ICU:** located at the ground floor, first floor contains 12 beds.

Subjects:

- A purposive sample of 200 patients with critical conditions admitted to the previously mentioned setting.

- The sample was selected based on statistical power analysis test (the confidence level was 90% and margin of error was 5%).

(Population Size: 180-Expected Frequency=50% - Acceptable Error = 10% - Confidence Co Efficient = 99 % - Minimum Sample Size=96). Through the following equation:

$$n = \frac{N \times p(1-p)}{\left[\left[N - 1 \times \left(d^2 \div z^2\right)\right] + p(1-p)\right]}$$

Nxp(1-p)　　　　　=(200*(0.5*(1-0.5)))/
N-1　　　　　　　=(200-1)*
d^2/z^2　　　　　　=0.0025 / 3.8416+
p(1-p)　　　　　　=0.5*(1-0.5)
N　　　　　　　　=105

N= Community size
z= Class standard corresponding to the level of significance equal to 0.95 and 1.96
d= the error rate is equal to 0.05
p= Ratio provides a neutral property = 0.5

(Chow, Shao, & Wang, 2007)

Inclusion Criteria:

Adult patients older than 18 years old from both gender, critically ill who newly admitted to the ICU in the first 24 hours, who had at

least one organ failure, had acute life threatening illness and excluded the end stage cancer and brain death patients from previous mentioned setting.

Tools of data collection:
1) Patients' assessment record.
2) Acute and Chronic Health Evaluation APACHE IV Score.
3) Simplified Acute Physiology SAPS III score.
4) Sequential Organ Failure Assessment SOFA score
5) Mortality Probability Model MPM II scores.

Tool (1): Patients assessment tool:

It included 2 parts as follows:

Part (A): Patient demographic characteristics:

It was used to assess demographic characteristics of the studied patients as age and gender.

Part (B): Patients actual clinical outcomes:

It was concerned with assessment of the incidence of infection, length of stay and actual mortality rate.

Scoring System:

This part was scored as "yes" and "no" occurrence of infection and counted as frequency and percentage of infection.

Chronic Health Evaluation (APACHE) IV score system:

- The most recent version of the APACHE scoring system. It was adopted **from (Zimmerman, Kramer, McNair & Malila, 2006).**

- APACHE IV is used to assess severity of illness, progress and predicts the length of patient stay in an intensive care unit. It has been evaluated and validated in ICU patients for mortality outcome.

- APACHE score used to measure the worst measurement during the first 24 hrs in the ICU patient admission.

- APACHE IV is a complex score with 17 physiologic criteria and includes 116 disease specific scores.

- The APACHE IV scoring system contain age, chronic health conditions, and the acute physiology score (APS) into account.

- APACHE IV score data were entered including the following: Age, temperature, vital signs, mechanical ventilation, FiO2, PaO2, PaCO2, arterial pH, random blood sugar. Serum Na+, urine output, serum creatinine, blood urea, serum albumin, total bilirubin, hematocrit, white blood cell. Coma scale: eyes, verbal, motor. Chronic health conditions including chronic renal failure, hemodialysis, AIDS.

- APACHE IV score also have variables that covered patient states as ICU admission diagnoses; admission source (emergency surgery, or was an ICU readmission or from ward); length of stay before ICU admission; whether a patient received mechanical ventilation on day 1, and whether a patient with acute myocardial infarction received thrombolytic therapy in the 24 hrs before or after ICU admission. Also it included Age, vital signs, mechanical ventilation. Serum Na+, urine output, serum creatinine, blood urea, serum albumin, total bilirubin, hematocrit, white blood cell *(El-Naggar et al., 2016)*.

Scoring System:

- APACHE IV score is a web-based calculation from the next web https://intensivecarenetwork.com/Calculators/Files/Apache4.html

- The worst measurement during the first 24 hrs in the ICU, each value for the physiologic parameter was entered by the researcher.

- APACHE IV score calculate Acute Physiology Score (APS) score, predicted mortality rate and predicted ICU length of stay.

- APACHE IV score ranged from 0 to 286 *(El-Nagar, et. al, 2019)*.

Tool (3): Simplified Acute Physiology Score (SAPSIII):

- Simplified Acute Physiology Score (SAPSIII) was adopted **from (Le Gall, Lemeshow & Saulnier, 1993).**

- It provides a numeric result which is then transformed (via specific equation) to a mortality risk percentage.

- It focused on data available within 24h from patient admission to the ICU.

- SAPS 3 include twenty variables, represented by two tables the first one has the calculation sum of three parts or boxes: as:

➢ **-** Box I: it has five variables for evaluating the patient characteristics before ICU admission; age, previous health status, co-morbidities, location before ICU admission, and length of stay in the hospital before ICU admission, and use of major therapeutic options before ICU admission.

➢ **-** Box II: it has five variables for evaluating the circumstances of ICU admission: reason(s) for ICU admission, anatomic site of surgery (if applicable), planned or unplanned ICU admission, surgical status and infection at ICU admission.

- Box III: it has ten variables (GCS, total bilirubine, body temperature, serum creatinine, heart rate, leukocytes, pH, platelets, systolic blood pressure and oxygenation) for evaluating the presence and degree of physiologic instability at ICU.

- The second table contains Reason(s) for ICU admission and Anatomical site of surgery *(Moreno et al., 2005)*

Scoring systems:

- The scoring method provides a numeral point score between (until -21 and 229) which is then correlated to mortality rates given in percentage (between 0 and 100%)..
• SAPS 3 can even be computed manually, using a simple score sheet, although it was designed to be integrated into computerized data gaining and storage systems that allow the automatic check of the registered data. *(Moreno et al., 2005).*

- SAPS III scores and predicted mortality rate (PMR) were calculated using web-based

calculators:http://intensivecarenetwork.com/ Calculators/Files/

- The following table provides examples of the SAPS III scores that are associated with different mortality rates:

SAPSIII Score	Mortality rate %
Until -21	**0**
22-44	**1-10**
44-52	**10-20**
53-57	**20-30**
58-62	**30-40**
63-67	**40-50**
68-72	**50-60**
73-78	**60-70**
79-86	70-80
87-96	80-90
91-112	90-95
113-159	95-99
160-229	100

Tool (4): Sequential Organ Failure Assessment Score (SOFA) system:

- It was adopted from *(Vincent, Moreno, Takala, Willatts, Mendon~a, Bruining, Reinhart, Suterm Thijs, 1996)* to assess patient status during the stay in an intensive care unit (ICU) to determine the extent of a patient organ function or rate of organ failure. It provides scale which is associated with a mortality risk percentage.

- The nurse is recording the worst value in the determinations? from the first 24 hours and monitored every 24 hours until the patient is discharged from the ICU.

- This score attempts to check the condition and the degree of dysfunction in six of the body systems as respiratory; cardiovascular; hepatic; coagulation; renal and neurological system.

- Sequential Organ Failure Assessment Score (SOFA) used to evaluate the following variables that were chosen by the European Society of Intensive Care Medicine:

➢ PaO_2/FiO_2 – partial oxygen pressure or fraction of inhaled O_2 – used to evaluate the state of the respiratory function.

➢ Platelet Count ($\times 10^3/\mu L$) – state of blood conformation and coagulation.

➢ Glasgow Coma Scale – assessment of the patient's level of consciousness and reaction to pain, voice and movement. According to the GCS points, the SOFA given number of points as

➢ Bilirubin level (mg/dL / μmol/L), to evaluate the metabolic state of the body and function of the liver.

➢ Mean arterial pressure and whether there is hypotension or the patient is under any medication to relieve pressure on the circulatory system.

➢ Creatinine level to check the filtration function of the kidneys (**Vincent, et al., 1996**).

Scoring system:

SOFA score calculated on admission to ICU. The tool employs six criteria reflecting the function of an organ system (respiratory, cardiovascular, renal, neurological, hepatic and haematological) and allocates a score of 0–4 as described in the table below. Has assigned points from 0 (normal function) to 4 (high degree of dysfunction). This means that the overall score is between 0 and 24. The next table presents the score categories and the associated mortality percentages.

SOFA score categories

SOFA score	Mortality risk %
0-6	<10%
7-9	15-20%
10-12	40-50%
13-14	50-60%
15	>80%
16-24	>90%

Tool (5): Mortality Probability Models (MPM II):

• It adopted from (***Lemeshow, Teres & Klar, 1993).***

• The MPM system is unique among ICU severity systems in that it is based on a series of models rather than a single model that is applied repeatedly over the time period a patient is in the ICU.

• It used to assess severity for critically ill patients; the MPM0 is the only model available for use at ICU admission

• MPM II was used (0 time) it means on admission. Then it was used at 24hrs, 48hrs and 72 hrs in the same model**.**

• Mortality probability model has 15 variables as the following age, Medical or unscheduled surgery admission, acute renal failure/chronic renal insufficiency, metastatic neoplasm, cirrhosis, CPR, coma, heart rate, systolic blood pressure, cardiac dysrhythmia, cerebrovascular incident, GI bleeding, intracranial mass, and mechanical ventilation.

Scoring system:

• The patient who had abnormal value-give one degree

• The patient who had normal value -gives zero degree.

Tools Validity:

The four tools that were used in the study were adopted from (***Zimmerman, Kramer, McNair & Malila, 2006)*** for APACHE IV score & (***Le Gall, Lemeshow & Saulnier 1993***) for SAPS III score **&** (***Vincent, Moreno, & Takala, et al., 1996)*** for SOFA score & (***Lemeshow, Teres & Klar, 1993)*** for MPM II score, without any modifications or translation into Arabic language as it was be used by the investigator.

Tools Reliability: The reliability of APACHE IV, SAPS III and SOFA scores was 0.88, 0.80 and 0.82 respectively. The reliability for MPM II 0 (on admission), 24, 48 and 72 hrs was 0.837, 0.836, 0.812 and 0.794 respectively. These reliability values were tested by the tool authors.

Administrative design:

An official permission letter was issued from the Faculty of Nursing, Ain-Shams University to the directors of Ain-Shams University Hospitals (surgical, Internal Medicine and neurologic ICU units) at which the study conducted, explaining the purpose of the study and requesting the permission for data collection from the studied patients.

Ethical considerations:

• The research approval for protocol was obtained from the faculty ethical committee before starting the study.

- An official permission was obtained from the director of Ain- Shams university hospital and director of General, Internal Medicine, and neurologic ICU to conduct the study.

- The investigator clarified the objectives and aim of the study to conscious patients included in the study before starting.

- The investigator assured maintaining anonymity and confidentiality of data of the patients included in the study.

Operational design:

The study was conducted through two phases:

I. Preparatory phase.

II. Implementation and evaluation phase.

I. Preparatory phase:

It included reviewing of the recent related literature, and theoretical knowledge of various aspects of the study using textbooks, articles, internet, and magazines to develop data collection.

Pilot Study:

A pilot study was conducted to test feasibility and applicability of the study tools used in this study. It was carried out on 10% of patients (20 patients) with critical conditions in ICU at Ain Shams University Hospital. No modifications were done so that, the patients who included in the pilot study were included in the main studied patients.

A. Implementation phase (field work):

- Data were collected within six months, from the beginning of September 2021 to the end of February 2022.

- The research tools were obtained by their authors by communicating with them personally on the mail.

- The investigator was available 3 days /week during morning and afternoon shifts, because most of the entry and exit cases are in these two shifts

- The nursing supervisors in each intensive care unit from which the data was taken made a care tour in order to inform about the locations of the patients files, how to follow the patients, and to facilitate the collection of data using search tools.

- Assessment of patient demographic characteristics and medical conditions, time of admission, and reason of discharge from patients and patients file that took about 40-50 minutes for each patient.

- The investigator collected data using the APACHE IV, that took about 15 mins, SAPS III that took about 10 mins, SOFA that took about 5 mins and MPM II 0, 24, 48 and 72hrs, it took about 5 mins for each assessment.

- The investigator assessed 2 to 3 patients in each session.

- The investigator used to collect the data on the computer program and it gives the final results; such as the length of stay, death rate and so on.

Statistical design:

All Data were collected, tabulated and subjected to statistical analysis, which is performed by SPSS in general (version 17). While Microsoft office Excel is used for data handling and graphical presentation. Data were presented in tables and graphs. The statistical analysis included; number (No.), percentage (%) & standard deviation (SD).

The following tests were done:

- The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following:

- Sensitivity is the ability of test to predict mortality. Sensitivity Equation % = (True Died / (True Died + False Alive)) * 100

- Specificity is the ability of test to predict survival- Specificity Equation % = (True Alive / (True Alive + False Died)) * 100.

- Positive predictive value (PPV) is the probability of death if test results were positive. PPV Equation % = (True Died / (True Died + False Died)) * 100

- Negative predictive value (NPV) is the probability of survival if test results were negative. NPV Equation % = (True Alive / (True Alive + False Alive)) * 100.

- Pearson's correlation coefficient (r) test was used to assess the degree of association between two sets of variables

- Probability (P-value)

P-value $\leq$0.05 was considered significant.

P-value $\leq$0.001 was considered as highly significant.

RESULTS:

Table (1): Frequency distribution of studied patients regarding demographic characteristics (N=200): This table showed the frequency distribution of studied patients regarding demographic characteristics. The age group of the patients ranged from 23.00 to 80.00 years old. 47% of the studied patients aged from 45-60 years old. And the mean ± SD of studied patients were 53.99 ± 11.80. As regarding to gender, the results revealed that 60.0% of studied patients were male and 40% of studied patients were female.

Table (2): Mean scores of actual outcomes (length of stay) of the studied patients in intensive care unit (n=200): This table showed that means score of actual length of stay was 8.99± 2.38.

Figure 1: Frequency distribution of studied patients according to mortality in the Intensive Care Unit (n=200): This figure showed that actual mortality represent 25.5% of the studied patients.

Figure 2: Frequency distribution of studied patients according to incidence of Intensive Care Unit Infection (n=200): This figure showed that 38.00% of studied patients at intensive care unit developed infection.

Of studied patients according to incidence of infection was 38.00% (N=76). The overall mortality rate was 25.5% (N=51). As for length of stay, this table the

Table (3): The performance of Acute Physiology and Chronic Health Evaluation (APACHE IV) scoring system on predication of mortality of the studied

patients (n=200): This table showed that APACHE IV score, APS score and predicted mortality were significantly higher among died group and alive group with (P value < 0.001). It showed also that patients predicted to be alive by APACHE IV score were 97.94% alive compared to 11.12% of patients predicted to die by APACHE IV score (P value <0.001).

Table 4: Table (4) The performance of Simplified Acute Physiology Score (SAPS III) scoring system on predication of mortality of the studied patients (n=200): this table showed that SAPS III score and predicted mortality were significantly higher among died group and alive group with (P value < 0.001). It also showed that patients predicted to be alive by SAPS III score were 96.55% alive compared to 16.37% of patients predicted to be die by SAPS III score with (P value <0.001).

Table 5: Table (5) The performance of Sequential Organ Failure Assessment (SOFA) scoring system on predication of mortality of the studied patients (n=200): This table showed that SOFA score and predicted mortality were significantly higher among died group and alive group with (P value < 0.001). It also showed that patients predicted to be alive by SOFA score were 93.57% alive compared to 30% of patients predicted to be die by SOFA score with (P value <0.001).

Table 6: The performance of MPM II scoring Table (6) The performance of Mortality Probability Models (MPM II) scoring system on predication of mortality of the studied patients (n=200): This table showed that predicted mortality for MPM II-0h, 24h, 48h, 72h were significantly higher among died group and alive group with (P value < 0.001). It also showed that patients predicted to be alive by MPM II-0hrs score were 93.75% compared to 25% of patients predicted to be die by MPM II-0hrs score with (P value <0.001). The patients predicted to be alive by MPM II-at 24h,48hrs score were 94.48% alive compared to 21.81% of patients predicted to be die by MPM II- at 0hrs score with (P value <0.001). The patients predicted to be alive by MPM II- at 72hrs score were 95.20% alive compared to 18.52% of patients

predicted to be die by MPM II-0h score with (P value <0.001).

Table 7: The Relation between performance of four scores (APACHEIV, SAPSIII, SOFA and MPMII) scoring systems in prediction of intensive care unit mortality among the studied patients (n=200): This table showed that APACHE IV score has the highest sensitivity (94.11%), highest specificity (95.97%), highest positive predictive value (88.88%) and highest negative predictive value (97.94%) while SOFA score has the lowest sensitivity (82.35%), lowest specificity (87.91%), lowest positive predictive

value (70.00%) and lowest negative predictive value (93.57%).

Table 8: correlation between APACHE IV predicted ICU LOS and actual ICU LOS among studied patients (n=200): This table showed the correlation between APACHE IV predicted ICU LOS and real ICU LOS of studied patient by using the Pearson correlation to determine the correlation between APACHE IV predicated ICU length of stay and real ICU length of stay. There was moderate positive correlation between predicated ICU length of stay and Real ICU length of stay in the present study with (r = 0.56 and p < 0.001.

**Table (1):** Frequency distribution of studied patients regarding demographic characteristics (N=200):

Demographic characteristics		Minimum	Maximum	Mean	SD
Age		23.00	80.00	53.99	11.80
		N		%	
Age	18 - < 30 years	11		5.5%	
	30 - < 45 years	25		12.5%	
	45 - <60 years	94		47%	
	60 - <75 years	61		30.5%	
	≥ 75years	9		4.5%	
Gender	Female	80		40.0%	
	Male	120		60.0%	

* SD: standard deviation

Table (2): Mean scores of actual outcomes of the studied patients in intensive care unit (N =200):

Actual patients' outcomes	Minimum	Maximum	Mean	SD
ICU LOS (day)	3.00	14.00	8.99	2.38

*LOS: length of stay * ICU: Intensive Care Unit * SD: standard deviation
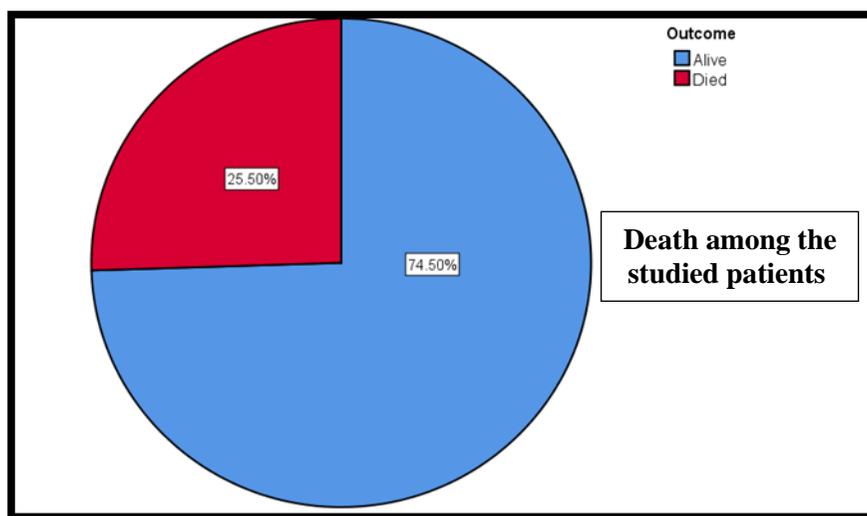
Figure 1: Frequency distribution of studied patients according to mortality in the Intensive Care Unit (n=200).
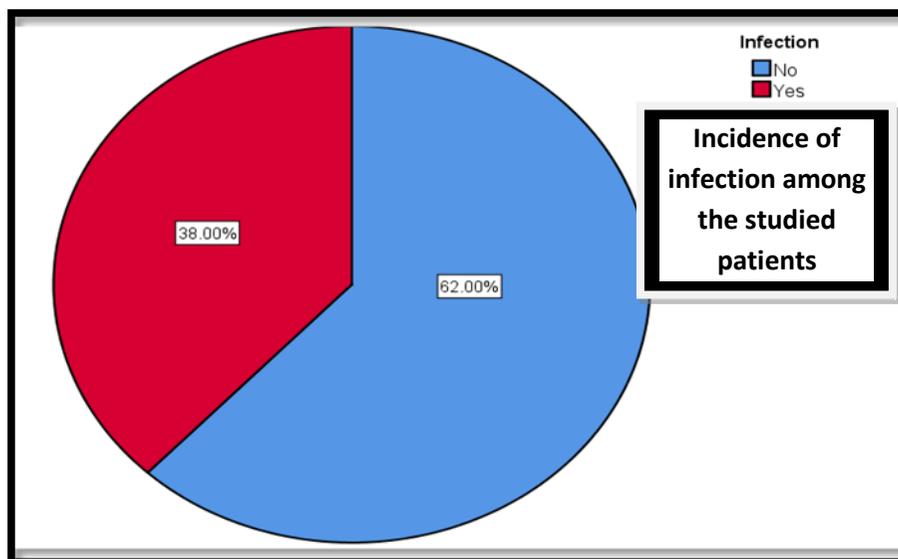
Figure 2: Frequency distribution of studied patients according to incidence of Intensive Care Unit Infection (n=200).

Table (3): The performance of Acute Physiology and Chronic Health Evaluation (APACHE IV) scoring system on predication of mortality of the studied patients (n=200)

		Minimum	Maximum	Mean	SD
APACHE IV score		25.00	224.00	83.80	31.62
APS score		20.00	200.00	67.06	25.43
Predicated mortality rate%		0.96	88.00	37.53	26.16
Predicated ICU LOS (day)		**1.83**	**11.44**	**7.10**	**1.40**
		N		**%**	
Apache IV Mortality	**Alive**	146		73.00%	
	Died	**54**		**27.00%**	

Table (4): The performance of Simplified Acute Physiology Score (SAPS III) scoring system on predication of mortality of the studied patients (n=200)

		Minimum	Maximum	Mean	SD
SAPS III score		**20.00**	**102.00**	**58.54**	**18.02**
SAPS III probability of death (%)		**0.90**	**92.20**	**36.06**	**26.25**
		N		**%**	
SAPS III death	**Alive**	**145**		**72.50%**	
	Died	**55**		**27.50%**	

Table (5): The performance of Sequential Organ Failure Assessment (SOFA) scoring system on predication of mortality of the studied patients (n=200)

		Minimum	Maximum	Mean	SD
SOFA Score		**1.00**	**16.00**	**9.85**	**3.63**
SOFA probability of death (%)		**1.00**	**94.00**	**34.76**	**25.62**
		N		**%**	
SOFA death	**Alive**	**140**		**70.00%**	
	Died	**60**		**30.00%**	

Table (6): The performance of Mortality Probability Models (MPM II) scoring system on predication of mortality of the studied patients (n=200)

		Minimum	Maximum	Mean	SD
MPM II - 0h probability of death (%)		3.00	90.00	38.13	26.50
MPM II - 24h probability of death (%)		3.00	92.00	35.61	29.59
MPM II - 48h probability of death (%)		3.00	92.00	35.59	29.58
MPM II - 72h probability of death (%)		3.00	94.00	33.54	32.75
		N		%	
MPM II - 0h death	Alive	144		72.00%	
	Died	56		28.00%	
MPM II - 24h death	Alive	145		72.50%	
	Died	55		27.50%	
MPM II - 48h death	Alive	145		72.50%	
	Died	55		27.50%	
MPM II - 72h death	Alive	146		73.00%	
	Died	54		27.00%	

Table (7): The Relation between diagnostic performance of four scores (APACHEIV, SAPSIII, SOFA and MPMII) scoring systems in prediction of intensive care unit mortality among the studied patients (n=200):

Scoring systems performance in prediction of ICU mortality		Outcome		Sensitivity	Specificity	PPV	NPV
		Died	Alive				
SOFA death	Died	42	18	82.35%	87.91%	70.00%	93.57%
	Alive	9	131				
SAPS3 death	Died	46	9	90.19%	93.96%	83.64%	96.55%
	Alive	5	140				
MPM II - 0h death	Died	42	14	82.35%	90.60%	75.00%	93.75%
	Alive	9	135				
MPM II – 24h death	Died	43	12	84.31%	91.94%	78.18%	94.48%
	Alive	8	137				
MPM II – 48h death	Died	43	12	84.32%	91.94%	78.18%	94.48%
	Alive	8	137				
MPM II – 72h death	Died	44	10	86.27%	93.28%	81.48%	95.20%
	Alive	7	139				
APACHE IV Mortality	Died	48	6	94.11%	95.97%	88.88%	97.94%
	Alive	3	143				

*PPV: Positive Predictive Value *NPV: Negative Predictive Value * MPM: Mortality Probability Models *SAPS: Simplified Acute Physiology Score *SOFA: Sequential Organ Failure Assessment *APACHE: Acute Physiology and Chronic Health Evaluation*

Table (8): correlation between APACHE IV predicted ICU LOS and actual ICU LOS among studied patients (n=200):

Item		Real ICU LOS (day)
Predicated ICU LOS (day)	Pearson Correlation(r)	0.56
	P value	<0.001 HS

* ICU: Intensive Care Unit *LOS: length of stay

Discussion

Prognostic scoring systems are widely used in the ICU to predict patient outcomes, predict mortality, prognosis and length of stay in ICU that monitoring and assessment of new therapies, characterize disease, severity of illness, to assess withdrawal of treatment, clinical decision making, and used to comparison between different health care centers. This study aimed to assess prognostic scoring systems as a tool to predict the clinical outcomes for patient with critical condition. **The demographic characteristics among the**

studied patients. Regarding age of studied patients, the current study revealed that the age group of the patients ranged from 23to 80years old. Near half of the studied patients aged from 45-60 years old. From the **investigator point of view**, the numbers of elderly people were near one third due to the burden of comorbid and chronic disease rise with age. Also advanced age is variable that increase intensive care admission and mortality probability**.** Age has always been believed to be to be strongly associated with severity of illness, even when adjusted for degree of physiological impairment, age remains the predictor factor of mortality.

This was agreeing with *Neilson et al., (2011)* who **conducted** a study titled "Mortality in elderly patients admitted to the intensive care unit". As they reported that the ICU death increased with advancing age in Singapore.

Another research by *Sekulic et el., (2015)* who **conducted** a study titled " Scoring Systems in Assessing Survival of Critically Ill ICU Patients" and who stated that age, although the main variable of almost all the scoring systems used in critically ill patients also it may not be the main parameter for admission or discharge from the ICU.

Regarding gender, the results of the current study revealed that near two third of the studied patients were male. Which may be due to the immunological effect of sex hormone on incidence of critical illness as estrogen hormone improve the heart, hepatic and immunity function and decrease number of illness in female than in male.

This finding agreed with *Ilker, et al., (2015)* who **conducted** a study titled "Study of Effectiveness of The SAPS II-III, APACHE II-IV and MPMII Scores in the determination of prognosis of the patients in reanimation Intensive Care Unit" and who mentioned that more than half of the studied patients 58.2% were males and 41.8% were female.

Actual patient's outcomes, infection, mortality rate and length of stay of studied patients in the intensive care unit

Regarding incidence of mortality rate in the intensive care unit, the finding in the current study represented that slightly more than one quarter of the studied patients died. **From the investigator point of view,** there are many causes led to increase the number of mortality rate among critically ill patient as age and comorbidities, hemodynamic instability, infection**.**

This finding was in agreement with **Ghorbani (2018**) who **conducted** a study titled "A study on the efficacy of APACHE-IV for predicting mortality rate and length of stay in an intensive care unit in Iran" and who found the overall observed mortality in ICU was 22.8%.

Regarding incidence of infection in intensive care unit, the current study **found that** more than one third of ICU studied patients had infection. **From the investigator point of view,** There are many causes increase incidence of infection among such group of patients as advanced age, present of comorbidities, invasive procedures, suppressed immunity, multiple pharmacology, cross infection. This finding agreed with *Sekulic et al., (2015)* finding in the study as they found that sepsis was 30% among the studied patients.

Regarding incidence of actual length of stay in ICU, the current study found that length of stay among studied patients in intensive care unit ranged from 3 to 14 days. **From the investigator point of view,** patient length of stay in ICU was depending on patient condition, comorbid disease and quality of care.

This finding was in agreement with *Ghorbani et al., (2018)* who **conducted** a study titled "A study on the efficacy of APACHE-IV for predicting mortality and length of stay in an intensive care unit in Iran" and found that the actual length of stay in ICU was 5.98±14.60 days.

As regard to the performance of ABACHEIV, SAPSIII, SOFA and MPM II scoring systems for prediction of intensive care unit mortality

Regarding the performance of ABACHEIV score for prediction of intensive care unit mortality, the current study revealed that ABACHE IV probability

of death rate that measured in the first 24 h from intensive care unit of patient admission was more than one quarter of the studied patients .Regarding predicted intensive care unit length of stay were ranged from 1.83 to 11.44 days. **From the researcher point of view,** ABACHE IV scoring system has the ability to predict ICU mortality patients. This finding was supported by **Zimmerman et al., (2006**) who **conducted** a study titled " Acute Physiology and Chronic Health Evaluation (APACHE) IV: hospital mortality assessment for today's critically ill patients" and stated that APACHE IV has better accuracy than the previous systems, and older models should not be used. They also added that a major advantage of the APACHE IV model is its ability to select 116 detailed admitting diagnostic options, which promote outcome analysis in specific subgroups. The death rate prediction by APACH IV is more than one fourth, which is very similar to SAPS III, and SOFA score, APACH IV had higher percentage in sensitivity and specificity in the current study to predict the death rate.

This finding agreed with *Choi, et al., (2017)* who conducted a study titled "The Ability of the Acute Physiology and Chronic Health Evaluation (APACHE) IV Score to Predict Mortality in a Single Tertiary Hospital" and illustrated that ABACHE IV was more accurate and showed satisfactory discriminatory performance ability of the score to separate survivors from the non-survivors**.**

As regard to the performance of Simplified Acute Physiology Score (SAPS III) scoring system for predication of mortality of the studied patients, the current study revealed that of SAPS III probability of death rate was more than one quarter of the studied patients that measured in the first 24 h from ICU of patient admission. **From the researcher point of view,** SAPS III scoring system has the ability to predict ICU mortality patients. SAPS III which is the latest version has a greater potential for universal use. SAPS III score includes 20 variables divided into three sub- scores related to patient characteristics prior to ICU admission.

This finding wasn't in agreement with a cohort of Brazilian study done by **Silva Júnior**

et al., (2010) who conducted a study titled "Applicability of the simplified acute physiology score (SAPS 3) in Brazilian hospitals" and mentioned that SAPS III is a useful tool for determining which patients will need more care, and for the evolution of high-risk surgical patients. It also added that SAPS III overestimated hospital mortality.

Regarding the performance of SOFA score for prediction of intensive care unit mortality, the current study revealed that the SOFA probability of death rate measured in the first 24 h from ICU of patient admission was near one third of the studied patients. **From the researcher point of view,** SOFA scoring system has the ability to predict ICU mortality patients and incidence of infection. This because that SOFA was based on six different scores, one for each of the respiratory, cardiovascular, hepatic, coagulation, renal and neurological systems each scored from 0 to 4with an increasing score reflecting worsening organ dysfunction.

Regarding the performance of MPM II**0, 24, 48 and 72h score for prediction of intensive care unit mortality,** the current study revealed that the of MPM II probability of death rate that measured 0hrs , 24, 48 and 72hrs in the ICU was more than one quarter of the studied patients. **From the researcher point of view,** MPMII scoring system has the ability to predict ICU mortality patients. MPM II score uses less physiological data where laboratory resources are limited or still gathering patient data. This model uses the patients' chronic illnesses, acute diagnosis, some physiological variables.

This finding was similar to **Lemeshow & Teres (1994),** who conducted a study titled" The MPM II System for ICU Patients" and found that The MPM system is unique among ICU severity systems that it is based on a series of models rather than a single model that is applied repeatedly over the time period a patient is in the ICU. They also added that the models presented that include the MPM II system should play an increasingly important role in the future, not only for providing accurate estimates of a patient's probability of hospital mortality, but especially as a quality assessment tool.

Regarding Relation between performance of the four scores (APACHEIV, SAPSIII, SOFA and MPMII) scoring systems in prediction of intensive care unit mortality rate among the studied patients and actual clinical outcomes, the finding of the current study revealed there are relation between (APACHEIV, SAPSIII, SOFA and MPMII) scoring systems regarding the prediction of intensive care unit mortality rate and actual patients clinical outcomes. The investigator found that APACHE IV score has the highest sensitivity, highest specificity, and highest positive and negative predictive value while SOFA score has the lowest sensitivity and specificity. APACHE IV score is an updated and advanced prediction model. in addition to the modifications introduced in the APACHE III such as mechanical ventilation support, thrombolysis, Pao2/fio2 ratio, impact of sedation on Glasgow Coma Scale, pre-ICU hospital length of stay, location prior to ICU admission and 116 disease specific subgroups. Which promote outcome analysis of the ICU patients.

This finding are supported by other studies as **(Pellathy et al., 2021)** who **conducted** a study titled "ICU Scoring Systems" and reported that Although APACHE IV, SAPS 3 and MPM0-II were developed from large databases with a varied case-mix, research demonstrates certain scoring systems which are superior to others when applied to specific types of patients such as Post-cardiac arrest, coronary and cardiac surgery patients, Also SAPS 3 performs poorly in patients with acute coronary syndrome and post-cardiac arrest. Although a tendency to overestimate mortality rate, APACHE IV had a good performance and calibration model with these types of patients. Also they found that Awareness of the strengths, limitations, and specific characteristics of severity scoring systems commonly used among ICU patients are vital for critical care nurses to effectively employ these tools in clinical practice and to critically appraise research findings based on their usage.

Also, **Ilker et al., (2015)** in their **study titled "**Effectiveness of the SAPS II-III, APACHE II-IV and MPM II Scores In The Determination of Prognosis of The Patients In

Reanimation Intensive Care Unit" found that regarding comparison between variables in the scoring systems. The mortality prediction of the APACHE IV was the best mortality predictive scores system than APACHE II, SAPS III, SAPS II, and MPM II.

These findings were supported by **Korkmaz_ Toker et al., (2019)** who **conducted** a study titled **"**SAPS III or APACHE IV: Which score to choose for acute trauma patients in intensive care unit**?**" and reported that The performance of the SAPS III was more sensitive and discriminative than the APACHE IV scoring system for multi-trauma ICU patients.

Also, **Dosi et al., (2021)** who **conducted** a study titled **"**The predictive ability of SAPS II, APACHE II, SAPS III, and APACHE IV to assess outcome and duration of mechanical ventilation in respiratory intensive care unit" who stated that APACHE IV scoring system was found more effective than other systems, not only significantly differentiating outcomes of mechanical ventilation (MV) but also predicting duration of Non-Invasive Ventilation (NIV), which may be the result of consideration of use MV and including a disease specific reason for admission in its risk prediction.

Another study supported the result by **Yousefian et al., (2022)** Who conducted a study titled "Mortality rate in patients admitted to the ICU based on LODS, APACHE IV, TRIOS, SAPS II" Who conducted a study titled "Mortality rate in patients admitted to the ICU based on LODS, APACHE IV, TRIOS, SAPS II" Who conducted a study titled "Mortality rate in patients admitted to the ICU based on LODS, APACHE IV, TRIOS, SAPS II" and who showed that among all four indices, the best and efficient system in the prediction of mortality rate in patients was APACHE IV, which had good calibration in comparison with other indices.

Also, by **Ko et al.,(2018)** who **conducted** a study titled "Performance of APACHE IV in Medical Intensive Care Unit Patients: Comparisons with APACHE II, SAPS 3, and MPM0 III" and who reported that APACHE IV provided the best discrimination and calibration abilities and was useful for quality

assessment and predicting mortality in ICU patients.

This finding was inconsistent with *Ghorbani, et al., (2018)* who **conducted** a study titled "A study on the efficacy of APACHE-IV for predicting mortality and length of stay in an intensive care unit in Iran" and suggested that APACHE-IV was a poor predictor mortality rate and length of stay in ICU in Iran.

Also, *Lee et al., (2014)* "revealed that the discriminatory performance of the APACHE IV model was very good and similar to those of the APACHE II, SAPS 3, and Korean SAPS 3 models. All of the models, showed poor calibration, although some subgroups with a relatively high mortality rate showed good calibration.

The correlation between APACHE IV predicting of intensive care unit length of stay and the actual intensive care unit length of stay among studied patients: the current study showed positive correlation between predicated ICU length of stay and Real (observed) ICU length of stay present study.

This finding was agreeing with *Verburg et al., (2016)*, who **conducted a study titled "Which Models Can I Use to Predict Adult IC Length of Stay? A Systematic Review"** and mentioned that APACHE IV model fulfilled all of our requirements for planning ICU resources and identifying patients with expectedly long ICU LOS.

This study disagrees with *Chattopadhyay & Chatterjee (2016),* who conduct a study titled "Predicting ICU length of stay using APACHE-IV in persons with severe sepsis – a pilot study" and who proved that APACHE-IV poorly predicted ICU-LOS in severe sepsis cases. Overall, the under-prediction of actual ICU-LOS was by about 4.5 days. This underestimation is about 44.5% of the actual mean ICU-LOS and dependence on this prediction method may adversely impact hospital readiness for accommodating and managing patients in ICUs.

Conclusion:

All prognostic scoring system; APACHE IV, SAPS III, SOFA and MPMII had the ability to predict the clinical outcomes for patient with critical condition; but APACHE IV score was the most accurate predictive tool.

Recommendations:

1. Applications of APACHE IV score system to assess of all admitted patient to ICU in nursing assessment.

2. Provide continuous education session and scientific courses for CCNs to revise their knowledge about scoring systems importance, uses, types and new technology (using computer) that helping to predicting ICU patient outcomes.

3. More researches are needed to evaluate the predictive efficacy of APACHE IV in different diseases and at other ICUs.

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