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Prognostic Scoring System In ICU

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Abstract

Predictive/Prognostic scoring systems are tools that have been developed to describe the severity of a disease process and subsequently predict outcomes in patients. These tools typically utilise a combination of patient data including clinical health information, physiological and laboratory data to determine outcomes such as length of hospital stay and mortality rates. With the rising healthcare costs and shortage of ICU beds, clinicians by using these predictive scores, are able to appropriately triage patient admissions into ICU, avoid wasteful expenditure and unnecessary bed utilisation.

Commonly used Generic Prognostic/predictive scoring systems are Acute physiologic and chronic health evaluation (APACHE) Score, Simplified acute physiologic (SAPS) Score, Sequential organ failure scores (SOFA),Mortality predictive model (MPM) Score, Multiple organ dysfunction Score (MODS),Logistic organ dysfunction (LODS) Score, Organ dysfunctions and/or Infection (ODIN) Score, Three days recalibrated ICU outcome (TRIOS) Score ,Modified early warning score (MEWS), and Rapid emergency medicine score (REMS). Some organ or disease specific predictive scoring systems are the model for End stage liver disease (MELD) score for End stage liver disease, Glasgow coma score for predicting mortality after head injury, European systems for cardiac operative risk evaluation (EUROSCORE) to predict mortality after cardiac surgery, ABC-GOALS Score, CALL Score, COVID-GRAM Score for Covid-19.

An ideal scoring model should use easily measurable variables, has a high level of discrimination, well calibrated, validated for use in all patients in ICU and can predict length of hospital stay, and/or mortality.

Predictive scoring systems are measures of disease severity that are used to predict outcomes, typically mortality, of patient populations in the intensive care unit (ICU). They are not useful to predict outcomes in a single individual. A numerical severity of illness score is typically developed using prospectively collected data from a large number of patients from several ICUs. The score, in turn, determines outcomes at hospital discharge including mortality, and sometimes length of stay. The four major ICU predictive scoring systems are APACHE scoring system, SAPS, MPM, and SOFA. All have been validated and determined to be reliable for patients in the ICU. In addition, the SOFA score has been used as a tool to facilitate the identification of patient populations at risk of dying from sepsis. No single instrument has convincing or proven superiority to another in its ability to predict mortality, although APACHE systems tend to be more accurate than others. Although predictive scores are of little assistance to the management of individual patients, they can be used by researchers in clinical trials to ensure similar baseline risks between comparative groups, and by institutions and

healthcare administrative officials to examine ICU performance. Predictive scoring systems have important limitations including poor generalizability, deterioration with time, and possibly lead-time bias. Due to the limited availability of ICU resources in our country, it is important that we utilize multiple tools to aid in its rational use. After reviewing the literature, predictive scoring systems do have a role to play in this. The accuracy of predictive scoring systems will continue to improve with time. It should be noted that the simultaneous use of more than one predictive scoring system on the same patient should be seen as complementary, as opposed to competitive or mutually exclusive, as their combined use may possibly offer a more accurate indication of the true severity of the disease process and hence overall prognosis. Ultimately, predictive scoring systems should be considered as a tool to assist, rather than to replace the clinical Judgement.

Keywords: Predictive/Prognostic scores, APACHE SCORE, SAPS SCORE, SOFA SCORE, MPM SCORE, ABC-GOALS SCORE

Introduction

Assessment of Medical treatment outcome was started first by Florence Nightingale in 1863.initially outcome prediction in critical illness was based on subjective judgement of clinicians. In the rapid developing era of ICUs, there was a need for quantitative and clinically relevant surrogate outcome measures in order to evaluate the effectiveness of treatment practices. Hence several outcome predictive scoring systems have been developed to ascertain the prognosis and outcome of the disease process and many new ones are being developed to achieve an objective and quantitative description of the degree of organ system and evaluation of morbidity in ICU patients.

Predictive/Prognostic scoring systems are tools that have been developed to describe the severity of a disease process and subsequently predict outcomes in patients[1]. These tools typically utilise a combination of patient data including clinical health information, physiological and laboratory data to determine outcomes such as length of hospital stay and mortality rates. With the rising healthcare costs and shortage of ICU beds, clinicians by using these predictive scores, are able to appropriately triage patient admissions into ICU, avoid wasteful expenditure and unnecessary bed utilisation.

An ideal scoring model should have following characteristics: -

1. Uses easily measurable variables.
2. Has a high level of discrimination.
3. Well calibrated.
4. Validated for use in all patients in ICU.
5. Can predict length of hospital stay, and/or mortality.

Predictive/Prognostic scoring system are broadly divided into two broad categories[2]: -

1. Generic scoring systems for the use in all ICU patients: -
   (a) Acute physiologic and chronic health evaluation (APACHE) Score.
   (b) Simplified acute physiologic (SAPS) Score.
   (c) Sequential organ failure scores (SOFA).
   (d) Mortality predictive model (MPM) Score.
   (e) Multiple organ dysfunction Score (MODS).
   (f) Logistic organ dysfunction (LODS) Score.
   (g) Organ dysfunctions and/or Infection (ODIN) Score.
   (h) Three days recalibrated ICU outcome (TRIOS) Score
   (i) Modified early warning score (MEWS).
   (j) Rapid emergency medicine score (REMS). (Table 13)
2. Single organ or disease specific scoring systems such as: -
   (a) The model for End stage liver disease (MELD) score for End stage liver disease[3].

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(b) Glasgow coma score for predicting mortality after head injury[4].

(c) European systems for cardiac operative risk evaluation (EUROSCORE) , used to predict mortality after cardiac surgery[5].

(d) ICH Score For Intracerebral Hemorrhage.(Table 16)

(e) Ranson's & BISAP score for Acute Pancreatitis.(Table 17 & 18)

(f) ABC-GOALS Score, CALL Score,COVID-GRAM Score for Covid-19.(Table 15)

Commonly used Predictive Prognostic scoring systems

Acute Physiologic and Chronic Health Evaluation (APACHE)

The APACHE scoring system has been found to be efficient in predicting mortality and estimating length of stay in ICU. There are four versions that is widely used, APACHE I to IV.

The original APACHE model was developed in 1981 and consisted of two parts. The former is the Acute Physiological Score (APS) which represents the degree of the acute illness. A total of 34 physiological variables are measured and allocated a score between 0 and 4, depending on the degree of severity. The worst value of each variable measured within the first 32 hours of ICU admission are used. The latter part of the score, the Chronic Health Evaluation (CHE) that is classified from A to D, represents the physiological status of the patient before the illness. The classification of A representing excellent health while a classification of D representing severely failing health.

Developed in 1985 as a modification of the original model, the APACHE II scoring system uses a point score based on 12 physiological parameters measured during the first 24 hours after admission. A score between 0 and 71 is then calculated based on these measurements. Generally, higher scores are more predictable of severe disease and subsequently higher rates of mortality. From the APACHE II score, the estimated risk of in hospital mortality is then calculated using a logistic regression equation. (Table 1 & 2).

The APACHE III was developed in 1991 using 26 variables. It comprises of two components, namely the APACHE III score, ranging from 0 – 299, and the APACH III predictive equation that uses the APACHE III score to predict in hospital mortality rates.

Developed in 2006, the APACHE IV is more complex and entails the input of 142 variables and 115 various disease groups, however web based calculations can be done.

Despite the APACHE IV being the most recent version, the APACHE II score is still amongst the most commonly model in current clinical use.

Simplified Acute Physiologic Score (SAPS)

The SAPS II scoring system uses 17 variables i.e. 12 physiological variables which are measured within the first 24 hours after admission, age of the patient, the type of admission and three disease-related variables (Table 3 &4). Several of these variables are assigned a score depending whether they are present or not, whilst the 12 physiological variables are scored according to a range of values. The SAPS II score may vary between 0 –163 points. The probability of mortality is then calculated using a logistic regression analysis[6].

Sequential (Sepsis-related) Organ Failure Score (SOFA)

The SOFA score was developed in 1994 by the European Society of Intensive Care Medicine[7], then revised in 1996. It was originally used to understand the natural progression of individual organ failure and the interaction between failure of other organs and to describe the sequence of complications (in terms of said organ dysfunction or failure) in critically ill patients with sepsis. However, it has also been validated for use in critically ill patients with non-sepsis related organ dysfunction and as a tool for predicting mortality rate. It measures 6 organ systems with scores ranging between 0 – 4 for each (Table 5). Sequential assessment of organ dysfunction during the first few days of ICU admission is a good indicator of prognosis. Grissom *et al* proposed and published a simplified version of the SOFA score known as the Modified SOFA (MSOFA) score. The MSOFA score eliminates the necessity of laboratory examinations such as the platelet count and substitute measurements of PaO_2/FiO_2 and serum bilirubin level

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with the SPO_2/FiO_2 ratio (obtained by dividing pulse oximeter saturation with a fraction of inspired oxygen) and clinical examination for jaundice. Although simpler, this score has to have more validation.

Interpretation: Irrespective of the initial SOFA score, an increase in the score within 48 hours of ICU admission is associated with a mortality rate of ≥ 50%, an unchanged score was associated with a mortality rate of between 27 – 35% (if the initial score was < 8) and 60% (if the initial score was ≥ 8), whereas a decreasing score is associated with a mortality rate of < 6% and 27% if the initial score was < 8 or ≥ 8 respectively[8].

Mortality Predictive Model (MPM)

The Mortality Probability Model was developed in 1990. It assesses patients' probability of mortality at hospital discharge, based on measurements attained within the first hour of ICU admission. There are three models[9]. The first version of the model was developed to predict mortality based on data from admission and after the first 24 hours in the ICU. Later, models were developed to include data from 48 – 72 hours after ICU admission. This model uses the patients' chronic illnesses, acute diagnosis, some physiological variables and other variables such as mechanical ventilation.(Table 6).

Table 7 shows advantages & disadvantages of APACHE, SAPS & MPM Scores.

Multiple organ dysfunction Score (MODS)

In 1995 Marshall *et al*. proposed an objective scale to measure the severity of multiple organ dysfunction as an outcome in critical illness. They developed the MODS (Table 5) which comprises a score based on six organ failures. Scores were given from 0 to 4 (maximum of 24). Hospital mortality is then estimated after adding the total scores (Table 8). This score correlated in a graded fashion with the ICU mortality rate, both when applied on the first day of ICU admission as a prognostic indicator and when calculated over the ICU stay as an outcome measure.

Logistic organ dysfunction (LODS) Score

Le Gall *et al* initially proposed the LODS in 1996, where 12 variables were tested and six organ failures defined. The difference between the LODS on day 3 and day 1 is highly predictive of the hospital outcome. The LODS was designed to combine measurement of the severity of multiple organ dysfunctions into a single score. The probability of death is then calculated using an equation designed for its purpose. (Table 9).

Organ dysfunctions and/or Infection (ODIN) Score

Fagon *et al in 1993*, proposed the ODIN system (Table 10). This includes data recorded within the first 24 h of ICU admission if there is any presence or absence of dysfunction in six organs plus one infection and it differentiates the prognosis according to the type of failures; the highest mortality rates was found to be associated with hepatic followed by hematologic and renal dysfunctions and the lowest with respiratory dysfunction and infection. Taking into account both the number and the type of organ dysfunction, a logistic regression model was then used to calculate individual probabilities of death that depended upon the statistical weight assigned to each ODIN (in the following order of descending severity: Cardiovascular, renal, respiratory, neurologic, hematologic, hepatic dysfunctions and infection).

Three days recalibrated ICU outcome (TRIOS) Score

In 2001, Timsit *et al* proposed a composite score, the TRIOS (Table 11), using daily SAPS II and LODS for predicting hospital hospitality in ICU patients hospitalized for more 72 h. Using logistic regression, the probability of hospital mortality can be computed. This TRIOS composite score has excellent statistical qualities and may be used for research purposes.

Modified early warning score (MEWS).

Modified early warning score, (Table 12), developed in 1990, is a guide used to quickly determine the degree of illness of a patient. It is based on the vital signs (respiratory rate, oxygen saturation, temperature, blood pressure, pulse/heart rate, AVPU response). Scores suggest that in-hospital deterioration and cardiac arrest is often preceded by a period of increasing abnormalities in the vital signs.

Glasgow coma score (GCS)

The GCS(Table 14) is a universal tool for the rapid assessment of an injured patient's consciousness level and as a guide to the severity of brain injury.] Several

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studies have shown that there is a good correlation between GCS and neurological outcome.

Uses and abuses of scoring systems

Although predictive scores are of little assistance to the management of individual patients, Severity scoring systems allow generation of a score that reflects the severity of the condition resulting in ICU admission. The scores allow the factors that influence outcome and that differ between patients to be taken into account and can be standardized to allow comparison between patients[10].

Another important use for scoring systems in ICU is an audit tool. They can help individual ICUs to compare their performance over time. However, this type of comparison should be interpreted carefully and, in particular, comparisons between different units are susceptible to misinterpretation.

Scoring systems may be used in clinical trials to compare the baseline risks between comparative groups to ensure that they are similar. This is commonly used during clinical trials in patients with acute respiratory distress syndrome or sepsis whereby possible therapeutic interventions are being evaluated.

Apart from one or two exceptions (notably the Glasgow Coma Score, which is not a critical care scoring system), a higher score denotes more severe illness. However, certain disease states or conditions may generate very high severity scores, even though they do not generally result in high mortality. These are usually conditions associated with a high degree of physiological derangement but which are either self-limiting or can be managed to return towards normal relatively quickly. Classically, this arises with diabetic ketoacidosis but might also occur in patients admitted to ICU after surgery while still under the effects of general anaesthesia. In both cases, a high severity score would be obtained which might be potentially misleading.

Limitations :-

The ICU is the perfect environment for using predictive scoring systems since both the population group and patient care tends to be is well defined and the most significant predictor of mortality is the severity of the illness[11]. However, there are some limitations with regards to the use of predictive/prognostic scores such as :

The most important potential limitation of scoring systems is the inappropriate interpretation of the score. Clinicians must be aware that the probability of in-hospital mortality based on a particular score relates to a similar group of patients and not to an individual. So, although it can be useful to know the predicted mortality of a group of patients with a similar score, we cannot be sure which patients will die and which will survive. Consequently, scoring systems should not be used to make predictions for individual cases.

The predictiveness of the scoring system deteriorates over time and as such, failure to periodically update the system results in a gradual loss of discrimination and/or calibration. The net effect is that an overestimation of the predicted mortality rate may be seen.

A phenomenon known as lead-time bias may occur. This was seen when patient who were transferred in from other ICUs or hospitals had a higher mortality rate than that predicted by these scoring systems.

The quality of care is better or worse than expected resulting in a lower or higher patient mortality rate.

Unlike SAPS, MPM and SOFA, models like the APACHE require proprietary software and more data points to use, resulting in it being more burdensome, however, the integration of electronic record keeping into health systems may alleviate some of these challenges.

When predicting mortality within 24 hours of admission into the ICU, the current evidence suggests that scoring systems are not yet superior to clinical judgment.

Scoring systems do not have a linear scale: a score of 20 does not mean a patient is twice as sick as another patient with a score of 10, and likewise does not have twice the risk of dying.

Finally, all the scoring systems assess the severity of illness and the likelihood of in-hospital mortality. More important is the ability to predict outcome or morbidity after discharge from ICU; at present, no such scoring system exists. Such a system would provide potential invaluable information, particularly

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if it were combined with the currently available ICU scoring systems.

Future Directions :-

The current intensive care unit (ICU) predictive scoring systems, while useful, have significant limitations. These tools were developed in an era that lacked advanced electronic monitoring, data storage, and sophisticated computation and machine learning.

The traditional predictive models have focused mostly on hospital mortality. As ICU care has evolved, other outcomes have become important, such as post-hospitalization mortality. Traditional models are also limited because they use data recorded in the first day(s) of ICU admission. This prevents incorporating new information that might guide clinical care.

With advanced computers and machine learning, ICU information has many new opportunities. Data can be automatically and accurately collected by electronic monitoring. Complex algorithms can be frequently refined as current data is collected and shared over large populations. Machine learning may identify patterns that trigger early intervention in critically ill patients . With these tools, ICU information technology could become a better forecasting tool and a powerful instrument to guide clinical care.

The coronavirus disease 2019 (COVID-19) pandemic has already demonstrated the importance of real-time sophisticated data. With this stimulus, ICU informatics may be primed to go far beyond mortality prediction to become a tool in daily practice.

Summary & Recommendations :-

1. Predictive scoring systems are measures of disease severity , used to predict outcomes, typically mortality, of patient populations in the intensive care unit (ICU). They are not useful to predict outcomes in a single individual.
2. A numerical severity of illness score is typically developed using prospectively collected data from a large number of patients from several ICUs. The score, in turn, determines outcomes at hospital discharge including mortality, and sometimes length of stay.
3. The four major ICU predictive scoring systems are APACHE scoring system, SAPS, MPM, and SOFA. All have been validated and determined to be reliable for patients in the ICU. In addition, the SOFA score has been used as a tool to facilitate the identification of patient populations at risk of dying from sepsis.
4. No single instrument has convincing or proven superiority to another in its ability to predict mortality, although APACHE systems tend to be more accurate than others.
5. Although predictive scores are of little assistance to the management of individual patients, they can be used by researchers in clinical trials to ensure similar baseline risks between comparative groups, and by institutions and healthcare administrative officials to examine ICU performance. Predictive scoring systems have important limitations including poor generalizability, deterioration with time, and possibly lead-time bias.
6. Due to the limited availability of ICU resources in our country, it is important that we utilize multiple tools to aid in its rational use. After reviewing the literature, predictive scoring systems do have a role to play in this. The accuracy of predictive scoring systems will continue to improve with time.
7. It should be noted that the simultaneous use of more than one predictive scoring system on the same patient should be seen as complementary, as opposed to competitive or mutually exclusive, as their combined use may possibly offer a more accurate indication of the true severity of the disease process and hence overall prognosis.
8. Ultimately, predictive scoring systems should be considered as a tool to assist, rather than to replace the clinical Judgement.

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Table 1 Acute physiologic and chronic health evaluation (APACHE II)

A: Acute physiological score (12 variables)

Physiologic variable	High abnormal range				Normal range	Low abnormal range			
	+4	+3	+2	+1	0	+1	+2	+3	+4
Temperature rectal (°C)	≥41	39-40.9	-	38.5-38.9	36-38.4	34-35.9	32-33.9	30-31.9	≤29.0
Mean arterial pressure (mm Hg)	≥160	130-159	110-129		70-109		50-69		≤49
Heart rate-ventricular response	≥180	140-179	110-139		70-109		55-69	40-54	≤39
Respiratory rate per minute-non-ventilated or ventilated	≥50	35-490		25-34	12-24	10-11	6-9		≤5
Oxygen: A-a DO_2 or PaO_2 (Torr)									
FiO_2 ≥0.5 record A-a DO_2	≥500	350-499	200-349		≤200	PO_2 61-70		PO_2 55-60	PO_2<55
FiO_2 <0.5 record only PaO_2					PO_2>70				
Arterial pH	≥7.7	7.6-7.69		7.5-7.59	7.33-7.49		7.25-7.32	7.15-7.24	<7.15
Serum HCO_3 (mmol/L)-only if no ABGs	≥52	41-51.9		32-40.9	23-31.9		18-21.9	15-17.9	<15
Serum sodium (mmoL/L)	≥180	160-179	155-159	150-154	130-149		120-129	111-119	≤110
Serum potassium (mmoL/L)	≥7	6-6.9		5.5-5.9	3.5-5.4	3-3.4	2.5-2.9		≤2.5
Serum creatinine (μmoL/L)	≥350	200-340	150-190		60-140		<60		
Hematocrit (%)	≥60		50-50.9	46-49.9	30-45.9		20-29.9		≤20
White blood cell count (×1,000/mm³)	≥40		20-39.9	15-19.9	3-14.9		1-2.9		<1
Glasgow coma score=15 minus actual GCS									

B: Age points		C: Chronic health points			Apache II score
Age (years)	Points	History	Points for elective surgery	Points for emergency surgery	Sum of A+B+C
≤44	0	Liver: Biopsy-proven cirrhosis and documented portal hypertension or prior episodes of hepatic failure	2	5	A: APS
45-54	2	Cardiovascular: NYHA Class IV	2	5	B: Age points
55-64	3	Respiratory: e.g., severe COPD, hypercapnia, home O_2, pulmonary hypertension	2	5	score
65-74	5	Immunocompromised	2	5	C: Chronic health
≥75	6	Renal: Chronic dialysis	2	5	point score
Total score					

APACHE: Acute physiology and chronic health evaluation; A-a DO_2: Alveolar-arterial oxygen tension difference; PaO_2 (Torr) arterial oxygen tension; FiO_2 (%): Fractional concentration of inspired oxygen; HCO_3: Bicarbonate; ABG: Arterial blood gas; NYHA: New York heart association; COPD: Chronic obstructive pulmonary disease. To compute predicted death rates for groups of acutely ill patients, the individual risk of hospital death is calculated with the following equation; the individual risks are then summed up and the value is divided by the total number of patients. $R/1\text{-}R = -3.517 + (\text{APACHE II score} \times 0.146) + (0.603, \text{only if post-emergency surgery}) + (\text{diagnostic category weight as shown below})$, where R is the estimated risk of hospital death

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Table 2 APACHE II sore & Hospital mortality interpretation

APACHE II Score	Hospital mortality
0-4	4%
5-9	8%
10-14	15%
15-19	24%
20-24	40%
25-29	55%
30-34	73%
35-100	85%

Table 3-- Simplified acute physiologic score II (SAPS II)

Variable	Range	Points
Patient age	<40 years	0
	40-59 years	7
	60-69 years	12
	70-74 years	15
	75-79 years	16
	≥80 years	18
Type of admission	Scheduled surgery	0
	Medical	6
	Unscheduled surgery	8
Temperature	<39°C, <102.2°F	0
	≥39°C, ≥102.2°F	3
Systolic blood pressure	≥200 mmHg	2
	100-199 mmHg	0
	70-99 mmHg	5

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	<70 mmHg	13
Heart rate	≥160 bpm	7
	120-159 bpm	4
	70-119 bpm	0
	40-69 bpm	2
	<40 bpm	11
Glasgow coma scale	14-15	0
	11-13	5
	9-10	7
	6-8	13
	<6	26
Urine output	≥1 L/24 hr	0
	0.5-0.999 L/24 hr	4
	<0.5 L/24 hr	11
White blood cell count	<1000 /mm^3	12
	1000-19,000 /mm^3	0
	≥20,000 /mm^3	3
Blood urea nitrogen	≥30 mmol/L, ≥84 mg/dL	10
	10-29.9 mmol/L, 28-83 mg/dL	6
	<10 mmol/L, <28 mg/dL	0
Potassium level	<3 mEq/L	3
	3-4.9 mEq/L	0
	≥5 mEq/L	3
Sodium level	<125 mEq/L	5

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	125-144 mEq/L	0
	≥145 mEq/L	1
Bicarbonate level	<15 mEq/L	6
	15-19 mEq/L	3
	≥20 mEq/L	0
Bilirubin level	<4 mg/dL, <68.4 micromol/L	0
	4-5.9 mg/dL, 68.4-102.5 micromol/L	4
	≥6 mg/dL, ≥102.6 micromol/L	9
PaO2/FiO2 (if mechanically ventilated or receiving CPAP)	<100 mmHg	11
	100-199 mmHg	9
	≥200 mmHg	6
AIDS	Yes	17
	No	0
Metastatic carcinoma	Yes	9
	No	0
Hematologic malignancy	Yes	10
	No	0

Table 4 SAPS II Score and Hospital Mortality Interpretation.

SAPS II Score	Mortality
29	10 %
40	25 %
52	50 %
64	75 %
77	90 %

Table 5 Sequential organ failure assessment score

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Organ system	Variable	Score 0	1	2	3	4
Pulmonary	Lowest PaO_2 (Torr)/FiO_2 (%)	>400	≤400	≤300	≤200+respiratory support	≤100+respiratory support
Coagulation	Lowest platelet (10^3/mm^3)	>150	≤150	≤100	≤50	≤20
Hepatic	Highest bilirubin (μmol/L)	<20	20-32	33-101	102-204	>204
Circulatory	Blood pressure status	Mean arterial pressure (mmHg) >70	Mean arterial pressure (mmHg) <70	Dopamine* dose≤5 or dobutamine any dose	Dopamine dose>5 or epinephrine≤0.1 or norepinephrine≤0.1	Dopamine dose>15 or epinephrine>0.1 or norepinephrine>0.1
Neurologic	GCS	15	13–14	10-12	6–9	<6
Renal	Highest creatinine level (μmol/L)	<110	110-170	171-299	300-440	>440
	Total urine output (mL/24 h)				<500	<200
Score	0-6	7-9	10-12	13-14	15	15-24
Score %	<10	15-20	15-20	50-60	>80	>90

PaO_2: (Torr) arterial oxygen tension; FiO_2: Fractional concentration of inspired oxygen; GCS: Glasgow coma score

Table 6 -- Mortality prediction model II (MPM II)

Variable	Response	Points
Patient age*		
Medical or unscheduled surgical admission?	Yes	1
	No	0
Cardiopulmonary resuscitation prior to admission?	Yes	1
	No	0
Coma (Glasgow coma scale 3-5)? (Does not include patients whose coma is due to overdose or who received neuromuscular blocking agents)	Yes	1
	No	0
Heart rate ≥150 bpm?	Yes	1
	No	0
Systolic blood pressure ≤90 mmHg?	Yes	1
	No	0
Mechanical ventilation?	Yes	1
	No	0
Acute renal failure? (Does not include pre-renal azotemia)	Yes	1
	No	0
Cardiac dysrhythmias?	Yes	1
	No	0
Cerebrovascular accident?	Yes	1

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	No	0
Intracranial mass effect?	Yes	1
	No	0
Gastrointestinal bleeding?	Yes	1
	No	0
Metastatic carcinoma? (Distant metastases only; does not include local lymph node involvement)	Yes	1
	No	0
Cirrhosis?	Yes	1
	No	0
Chronic renal insufficiency? (Creatinine >2 mg/dL chronically)	Yes	1
	No	0

* Patient age does not receive points when calculating the severity score; however, it is used in the formula to calculate predicted mortality

Table 7 :-Main advantages and disadvantages for the Acute Physiology and Chronic Health Evaluation-IV, MPM0-III and Simplified Acute Physiology Score 3 scores(SAPS-3)

Scoring system	Advantages	Disadvantages
APACHE-IV	▪ Coefficients regularly updated ▪ Provides algorithms for LOS prediction ▪ Specific algorithm to predict mortality in CABG surgery patients ▪ Less prone to be affected by the case-mix	▪ Developmental sample restricted to one country ▪ More complex data collection ▪ High abstraction burden ▪ Proprietary scoring system*
MPM_0-III	▪ Low abstraction burden ▪ Less prone to interobserver variability ▪ By using less physiologic data, may be preferred when laboratory resources are constrained	▪ Developmental sample mostly restricted to one country ▪ More susceptible to case-mix effects
SAPS 3	▪ Lowest abstraction burden ▪ Less prone to interobserver variability	▪ Does not provide estimation for LOS

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	▪ Developmental sample from 35 countries in five continents ▪ Customized equations to predict hospital mortality according to seven different geographic regions ▪ Potential use for international benchmarking	▪ Some regional equations were developed using relatively low sample size

APACHE: acute physiology and chronic health evaluation; LOS: length of stay; CABG: coronary artery bypass graft; MPM: mortality probability model; SAPS: simplified acute physiology score.

Table 8 Multiple organ dysfunction score

Multiple organ dysfunction score							
Organ system and their variables	Score						
	0	1	2	3	4		
Hematologic: Platelet count ($\times 10^3/mm^3$ or $10^9/L$)	>120	81-120	51-80	21-50	≤20		
Hepatic: Serum bilirubin (μmol/L)	≤20	21-60	61-120	121-240	>240		
Renal: Serum creatinine (μmol/L)	≤100	101-200	201-350	351-500	>500		
Cardiovascular: PAR*	≤10	10.1-15	15.1-20	21-30	>30		
Glasgow coma score	15	13-14	10-12	7-9	≤6		
Respiratory: PO_2/FiO_2	>300	226-300	151-225	76-150	≤75		
Score	0	1-4	5-8	9-12	13-16	17-20	21-24
ICU mortality %	0	1-2	3-5	25	50	75	100

ICU: Intensive care unit; CVP: Central venous pressure (mmHg); GCS: Glasgow coma score; HR: Heart rate (beats/min); MAP: Mean arterial pressure (mmHg); PAR: Pressure adjusted heat rate (which is calculated as the product of the HR and the ratio of CVP to MAP); PaO_2 (Torr) arterial oxygen tension; FiO_2: Fractional concentration of inspired oxygen. If the result for a specific test is not available, then a score of 0 is used for that test. The serum creatinine concentration is measured without the use of dialysis and the PO_2/FiO_2 ratio (PO_2 in mmHg and FiO_2 in %) is calculated without the use of mechanical ventilation or positive end-expiratory pressure

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Table 9 Logistic organ dysfunction score

Measurements of organic systems	5	3	1	0	1	3	5
Neurological (GCS)	3-5	6-8	9-13	14-15			
Cardiovascular							
HR (beats/min)	<30	40-69	70-89	30-139	≥140		
SBP (mmHg)	<40			0-239	240-269	≥270	
Renal							
Ureic nitrogen (mmol/L)	-	-	-	<6	6-9.98	9.99-19.98	≥19.99
Serum creatinine (μmol/L)	-	-	-	<106.08	106.08-140.55	≥141.44	-
Urine output (L/24 h)	<0.5	0.5-0.74	-	0.75-0.99	-	≥10	-
Respiratory							
PaO_2 (Torr)/FiO_2 (%) in MV or CPAP	-	<150	≥150	With no ventilation, CPAP or IPAP	-	-	-
Hematologic							
TLC (mm^3)×10^3	-	<1.0	1.0-2.4	2.5-49.9	≥50	-	-
Platelets (mm^3)×10^3	-	-	<50	≥50	-	-	-
Hepatic							
Serum bilirubin (μmol/L)				<34.2	≥34.2		
PT (seconds and %)			<25	<3 s, >25	≥3 s		

LOD: Logistic organ dysfunction; GCS: Glasgow coma score; HR: Heart rate; SBP: Systolic blood pressure; PaO_2: (Torr) arterial oxygen tension; FiO_2: Fractional concentration of inspired oxygen; MV: Mechanical ventilation, CPAP: Continued positive airways pressure; IPAP: Intermittent positive airways pressure; TLC: Total leucocyte count; PT: Prothrombin time. The probability of death is then calculated using the formula: Probability of death=$e^{logit}/(1+e^{logit})$. Logit=−3.4043+0.4173 (LOD score)

Table 10 Organ dysfunctions and/or infection

Organ system dysfunction	Variables	Values (1 if yes, 0 otherwise)
Respiratory	PaO_2<60 Torr (FiO_2=0.21) or need for ventilatory support	
Cardiovascular	SBP<90 mmHg with signs of peripheral hypoperfusion or continuous infusion of vasopressor or inotropic agent to maintain SBP>90 mmHg	
Renal	Serum creatinine>300 μmol/L or urine output<500 mL/24 h or<180 mL/8 h or need for hemodialysis or peritoneal dialysis	
Neurologic	GCS<6 (in absence of sedation at any time in the day) or sudden onset of confusion or psychosis	
Hepatic	Serum bilirubin>100 μmol/L or alkaline phosphatase>3 times normal value	
Hematologic	Hematocrit≤20% or TLC<2000/mm^3 or platelet count<40000/mm^3	
Infection (with clinical evidence)	2 positive blood cultures or presence of gross pus in a closed space or source of the infection determined during hospitalization or at autopsy in case of death within the 24 h	

PaO_2: (Torr) arterial oxygen tension; FiO_2: Fractional concentration of inspired oxygen; SBP: Systolic Blood Pressure; GCS: Glasgow coma score; TLC: Total leucocyte count. Probability of death is calculated using the formula: Probability of death=$e^{logit}/(1+e^{logit})$. Logit=−3.59+(1.09×respiratory)+(1.19×cardiovascular)+(1.18×renal)+(0.86×hematologic+(0.57×liver)+(0.99×neurologic)+(0.53×infection)

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Table 11 TRIOS (3 days recalibrated ICU outcome score)

Variables	Value: 1 if yes, 0 otherwise (except for LODS and SAPS II admission)
Transfer from ward	
Chronic illness	
SAPS II day 2-SAPS II day 3 alteration	
LODS day 2-LODS day 3 alteration	
LODS on admission	
SAPS II on admission	

TRIOS: Three-day recalibrating ICU outcomes; ICU: Intensive care unit; LODS: Logistic organ dysfunction score; SAPS: Simplified acute physiology score. To compute the probability of hospital mortality, *P*: $P\ (e^{Logit})/(1+e^{Logit})$ where e=2.7182818 (the base of the natural logarithm). Logit=(−4.44)+0.5543 (transfer from ward) +0.1536 (LOD on admission)+0.0388 (SAPS II on admission)+0.8507 (chronic illness)+0.4161 (SAPS2-SAPS3 alteration)+0.6940 (LOD2-LOD3 alteration)

Table 12 Modified Early Warning Score

Score	**3**	**2**	**1**	**0**	**1**	**2**	**3**
Respiratory rate (breaths/min)	>35	31-35	21-30	9-20			<7
SpO2 (%)	<85	85-89	90-92	>92			
Temperature (C)		>38.9	38-38.9	36-37.9	35-35.9	34-34.9	<34
Systolic BP (mmHg)		>199		100-199	80-99	70-79	<70
Heart rate (bpm)	>129	110-129	100-109	50-99	40-49	30-39	<30
AVPU				Alert	Verbal	Pain	Unresponsive

A score of five or more is statistically linked to increased likelihood of death or admission to an ICU.

Table 13 Rapid emergency medicine score (REMS)

	Score						
Variable	**0**	**+1**	**+2**	**+3**	**+4**	**+5**	**+6**
Age (years)	<45		45–54	55–64		65–74	>74
PR (/min)	70–109		55–69 110–139	40–54 140–179	≤39 >179		
MAP (mmHg)	70–109		50–69 110–129	130–159	≤49 >159		
RR (/min)	12–24	10–11 25–34	6–9	35–49	≤5 >49		
GCS	14 or 15	11–13	8–10	5–7	3 or 4		
SpO_2 (%)	>89	86–89		75–85	<75		

PR, pulse rate; MAP, mean arterial pressure; RR, respiratory rate; GCS, Glasgow Coma Scale; SpO_2, peripheral oxygen saturation

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Table 14 Glasgow Coma Scale (GCS)

	Score
Eye opening	
Spontaneous	4
Response to verbal command	3
Response to pain	2
No eye opening	1
Best verbal response	
Oriented	5
Confused	4
Inappropriate words	3
Incomprehensible sounds	2
No verbal response	1
Best motor response	
Obeys commands	6
Localizing response to pain	5
Withdrawal response to pain	4
Flexion to pain	3
Extension to pain	2
No motor response	1
Total	

The GCS is scored between 3 and 15, 3 being the worst and 15 the best. It is composed of three parameters: best eye response (E), best verbal response (V), and best motor response (M). The components of the GCS should be recorded individually; for example, E2V3M4 results in a GCS score of 9. A score of 13 or higher correlates with mild brain injury, a score of 9 to 12 correlates with moderate injury, and a score of 8 or less represents severe brain injury.

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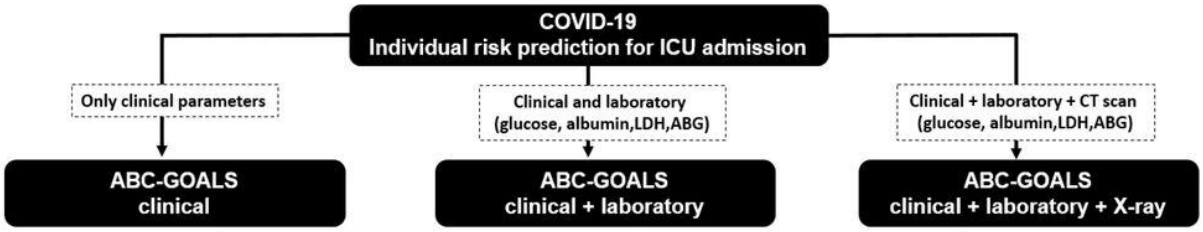
Table 15 ABC-GOALS Score for COVID-19.



Parameter	Score if	ABC-GOALS$_c$	ABC-GOALS$_{cl}$	ABC-GOALS$_{clx}$
M ale	yes	1	1	1
A rterial pressure systolic	<100 mmHg	4	4	4
B reathlessness	yes	1	1	
B reaths per minute	<24 per min 24-28 per min >28 per min	0 1 4		
C harlson index	0 1-2 ≥ 3	0 1 3	0 0 2	0 0 2
G lucose	>200 mg/dL		2	2
O besity	BMI ≥ 30 kg/m²	2	2	2
A lbumin	<3.5 mg/dL		1	
L actate dehydrogenase	> ULN		2	2
S aO_2/FiO_2 ratio	< 300		4	3
S evere lung CT scan	> 50%			4

ABC-GOALS clinic		
Risk	Total Points	Probability of ICU admission
Low 8%	0	3%
	1	5%
	2	11%
Moderate 32%	3	18%
	4	27%
	5	37%
	6	46%
	7	53%
High 73%	8	63%
	9	76%
	10	80%
	11	88%
	12	90%
	13	94%
	14	95%
	15	97%

ABC-GOALS clinic + laboratory		
Risk	Total Points	Probability of ICU admission
Low 4%	0	4%
	1	10%
	2	13%
	3	13%
Moderate 35%	4	23%
	5	33%
	6	35%
	7	35%
	8	36%
	9	40%
High 81%	10	53%
	11	64%
	12	81%
	13	86%
	14	94%
	15	94%
	16	97%
	≥ 17	99%

ABC-GOALS clinic + lab + x-ray		
Risk	Total Points	Probability of ICU admission
Low 3%	0	2%
	1	4%
	2	6%
Moderate 46%	3	10%
	4	18%
	5	20%
	6	30%
	7	40%
High 90%	8	56%
	9	58%
	10	71%
	11	84%
	12	88%
	13	93%
	14	96%
	15	97%
	≥ 16	99%

Abbreviations. ICU, intensive care unit; LDH, lactate dehydrogenase; ABG, arterial blood gas analysis; BMI, body mass index in kg/m^2; ULN, upper limit of normality reported by the laboratory; SaO_2/FiO_2, ratio of hemoglobin oxygen saturation to fraction of inspired oxygen.

Table 16 Intracerebral Haemorrhage score

(ICH volume=abc/2, where a-max length of bleed on NCCT, b-max width, c-number of slices on which the bleed is visible multiplied by slice thickness)

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(Slice with ≥75% Area of Hemorrhage: Counts as 1 slice; Slice with 25-75% Area of Hemorrhage: Counts as 0.5 slices; Slice with <25% Area of Hemorrhage: Counts as 0 slice)

Feature	Finding	Points
GCS	3-4	2
	5-12	1
	13-15	0
Age	>=80	1
	<80	0
Location	Infratentorial	1
	Supratentorial	0
ICH volume	>=30cc	1
	<30cc	0
Intraventricular Blood	Yes	1
	No	0
ICH SCORE		0-6 points

ICH Score	30 Day Mortality
0	0%
1	13%
2	26%
3	72%
4	97%
5	100%
6	100%

Table 17 BISAP Score for Acute Pancreatitis.

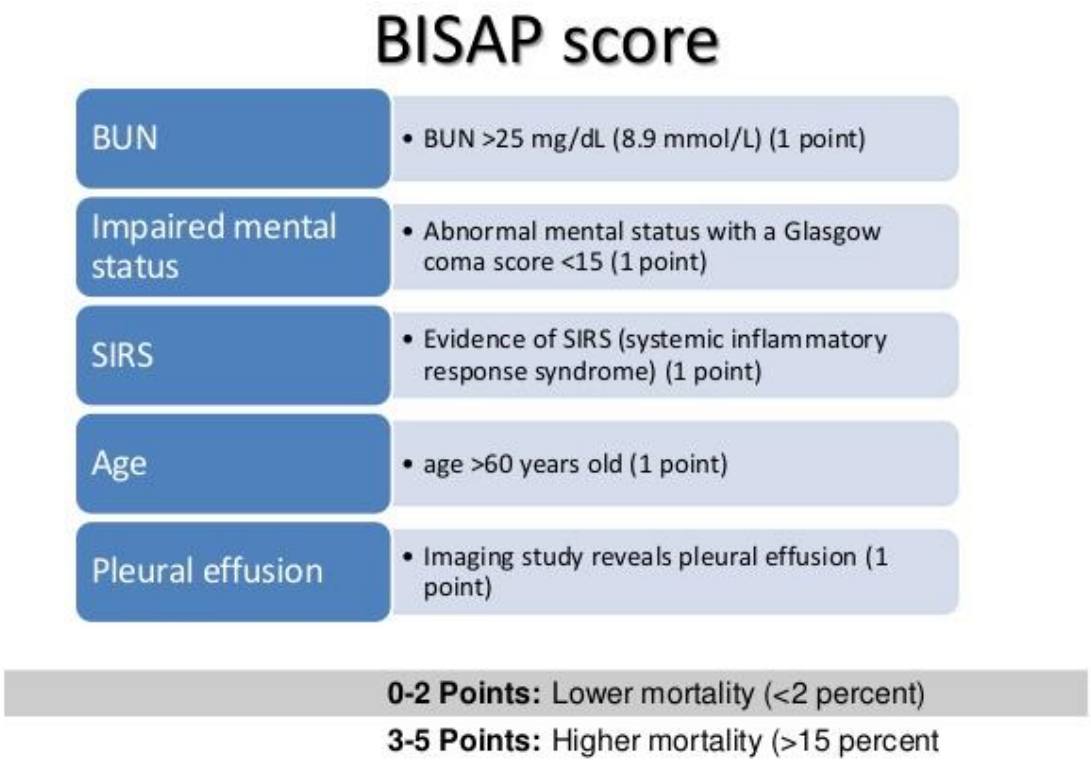

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Table 18 Ranson Crieria for Acute pancreatitis.

Ranson criteria to predict severity of acute pancreatitis

0 hours	
Age	>55
White blood cell count	>16,000/mm3
Blood glucose	>200 mg/dL (11.1 mmol/L)
Lactate dehydrogenase	>350 U/L
Aspartate aminotransferase (AST)	>250 U/L
48 hours	
Hematocrit	Fall by ≥10 percent
Blood urea nitrogen	Increase by ≥5 mg/dL (1.8 mmol/L) despite fluids
Serum calcium	<8 mg/dL (2 mmol/L)
pO2	<60 mmHg
Base deficit	>4 MEq/L
Fluid sequestation	>6000 mL

The presence of 1 to 3 criteria represents mild pancreatitis; the mortality rate rises significantly with four or more criteria.

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