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Original Research

Benefits Of Apache II In Determining Patients' Life Survival Treated In Intensive Care Unit

Diah Pujiastuti[1] Mulyani Her Krisnamurti[1], Y. Titik Wahyuningsih Setyo Ningrum[1], Buana Dewo Febialinta[1]

[1] Bethesda Yakkum Institute of Health Sciences, Special Region of Yogyakarta, Indonesia

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CORRESPONDENCE

E-mail: diah@stikesbethesda.ac.id
Affiliation : Bethesda Yakkum Institute of Health Sciences
Region : Special Region of Yogyakarta, Indonesia

ABSTRACT

Background: The need of critical care in Intensive Care Unit (ICU) is increasing. One of service improvement is using prognosis and otcome scoring system which is aimed to assess the severity of disease, ICU performance and determining prognosis of patient. Many staffs in ICU do not apply this kind of scoring because they do nout have sufficient information, so it decreases the quality of service in ICU. Acute Physiology and Chronic Health Evaluation (APACHE) II is mostly used scoring system. The aim of this research is to provide information on accuracy of APACHE II to assess ICU patients' mortality rate.

Methods: conducted through literature review by analyzing seven CHINAHL journals obtained by searching EBSCO, Pubmed, Google Scholar, and Portal Garuda online databases within the publication of 2015 to 2020 and two textbook sources on critical care.

Results: reveals that the APACHE II scoring system can be utilized to predict the mortality rate and discriminate the life survival of the patients in the Intensive Care Unit. Additionally, the scoring system will be more accurate when combined with the APM nutrition parameter and applied to non-surgery, sepsis/shock, as well as neurosurgical patients.

Conclusions: The APACHE-II scoring system has good accuracy in predicting mortality rate especially on non-surgery patients and can properly discriminate patients' life survival. However, the scoring system cannot be applied to all diseases found in ICU.

INTRODUCTION

A need for health care around the community is increasing as the technology keeps on developing. Individual health status is also influenced by physical growth, socio-cultural aspect, past experiences, expectancy, environment, and health care services (Notoadmojo, 2012). Providing health services become a top priority which includes providing health service in the Intensive Care Unit (ICU). ICU patients need fast, precise, scientific, and technological-based services that continue to prioritize the quality of service and patients' safety. The needs of ICU patients include long-term resusitation measures that encompass life support for vital functions such as *airway, breathing, circulation, brain,* and other organ functions. Critically ill, unstable, respiratory failure patients; post-cardiac or thoracic surgery patients; patients who need intensive or non-invasive monitoring; and patients who need intensive therapy to overcome possible complications; are indications for patients treated in ICU (Kemenkes RI, 2011).

Respiration failure is the most common indication found in patients treated in ICU. Critically ill patients are those who are physiologically unstable and need coordinated also continuous care from doctors, nurses, or similar other professionals. Careful attention is also required so that close and continuous monitoring and titration therapy can be applied to the patients. Furthermore, patients at risk of physiological function failure are in need of close and continuous monitoring, as well as an immediate intervention to prevent adverse complications (Kemenkes RI, 2011).

In administering Intensive Unit Care (ICU) services, Hospitals are subjected to the regulations established by the Indonesian Republic's Ministry of Health. The regulation is outlined in the guidelines for administering Intensive Unit Care (ICU) services. Based on regulations no. 1778/MENKES/SK/XII/2010, ICU is a hospital unit provided with special staff and equipment intended for observation, treatment, and therapy of patients suffering from life-threatening or potentially life-threatening diseases, injuries, or complications with dubia prognosis.

In prioritizing patients for ICU, the services should provide objective assessments to determine the severity of the patients' disease and prognosis. The assessment should be based on the Technical Guidelines for the Implementation of Intensive Care Unit Services in Hospitals issued in the decree of Director-General of the Development of Indonesian Health Efforts No. HK.02.04 /1996/11: 1) Priority one (critically ill and unstable patients who need intensive therapy such as ventilation support, continuous infusion of vasoactive drugs, and others. Belonging in this group is post cardiothoracic surgery and septic shock patients. Also, patients who experience life-threatening disorders of acid-base and electrolytes balance. Therapy for priority one patients are generally without limit); 2) Priority two (patients in need of sophisticated monitoring in ICU. This type of patient has risks that need immediate intensive therapy. The priority two patients include those suffering from basic and acute diseases of heart, lungs, or kidney failure; or those who have experienced major surgery. The therapy given to priority two patients are generally without limit since their medical conditions are prone to change); 3) Priority three (critically ill and unstable patients due to pre-existing health conditions either the underlying or acute disease (either the individual disease or combination of the two) can greatly reduce the patients' healing process and/or benefited from ICU therapy. Some examples are the cases of a patient suffering from metastatic malignancies with complications of infection; pericardial tamponade or airway obstruction; or terminal pulmonary or pulmonary heart disease with severe acute disease complications. The patients of priority three may receive intensive therapy to overcome acute disease. The therapeutic efforts may not lead to heart pulmonary intubation or resuscitation). Exceptions (the patients belonging to this category are not appropriate for ICU admission. They may be admitted to ICU with consideration of extraordinary circumstances under the approval of the head of ICU. If necessary, patients of this category must be removed from the ICU so that the facilities can be used by patients of priority one, two, or three).

As a hospital treatment unit that specializes in treating critical patients, the ICU provides a variety of medical teams including nurses with expertise in treating patients with critical conditions. Additionally, the ICU is equipped with special equipment to conduct therapy and life support for patients that do not found in other treatment units. The Technical Guidelines for the Implementation of Intensive Care Services (ICU) in Hospitals, based on the decree of Director-General of the Development of Indonesian Health Efforts No HK.02.04 /1996/11, listed the scope of ICU care services as follow: 1) Specific diagnosis and management of acute life-threatening diseases which can cause death within minutes to several days; 2) Assisting to take over the body's vital functions and also carrying out specific fulfillment of basic needs including cardiopulmonary resuscitation, airway management, oxygen therapy, continuous vital signs monitoring, enteral and parenteral nutrition administering, special laboratory examinations, conducting therapeutic titration and specific techniques according to the patient's condition, providing vital function support using portable devices during emergency patient transportation, and performing chest physiotherapy; 3) Monitoring the body's vital functions and managing complications caused by worsening disease or condition of the patient due to treatment or therapy; 4) Providing psychological assistance to patients who are dependant on life-support tool or machine and others. A variety of special equipment such as bed site monitors, on-site blood gas analysis, central monitors, resuscitation devices, ECG, central oxygen and suction, defibrillator, and mechanical ventilation are required to support ICU services.

Nursing services in ICU are categorized as critical nursing. It requires quick response services to patients in critical conditions and personnel consisting of interdisciplinary health science with special qualifications and intensive care training; quick response to patient conditions is crucial for all health teams involved in the ICU service setting (Hall, Schmidt, and Wood, 2015). In providing ICU services, the quality of services must be considered to ensure patient security and safety which can be done through monitoring and evaluation. In order to assure the quality of ICU service, Ministerial Decree No. 1778/ MENKES/SK/XII/2010 regulates self-assessment to be conducted by utilizing prognosis and outcome scoring system. The scoring system commonly used is Acute Physiology and Chronic Health Evaluation (APACHE) II, Simplified Acute Physiology Score (SAPS) II, or Multiple Organ Dysfunction Score (MODS). The scoring systems assess the severity of patients' disease based on specific data taken during treatment. The scoring systems can also predict the mortality rate in a hospital. These scoring systems have been developing in the last three decades in ICU.

The Acute Physiology and Chronic Health Evaluation (APACHE) II is a scoring system on critical diseases based on the objective physiological values obtained through variables measured during the

patient's treatment in ICU. The scoring system is the most commonly used in the ICU. APACHE II is a good model to predict mortality rate in a hospital. The APACHE II scoring provides an overview of the patient's condition before ICU treatment, as well as the outcomes and the length of their treatment in ICU (Ministry of Health Republic of Indonesia, 2011).

APACHE II is firstly developed in 1981 at George Washington University Medical Center to prove its accuracy and possible measurement on disease severity in critically ill patients. The first APACHE consists of 34 variables. The variables with the worst value are recorded and evaluated within the first 32 hours of the patient's ICU admission. The result will be used as the final physiological acute score. In 1985, Knaus, *et al*. introduced a simpler system namely APACHE II. The model assesses the worst recorded variables within the first 24 hours of ICU admission on 12 physiological variables, ages, surgical statuses, medical histories which explains the reasons for the patient's admission to ICU. The variables will be analyzed with the multiple logistical regression model. The scoring result will be used to predict the patient's mortality rate (Hall, Schmidt, and Wood's, 2015).

A hospital that administrates ICU services should use a scoring system to improve its service quality as well as the patients' security and safety. The said matter must be understood by health officers who provide health care services in line with Minister of Health Decree. The scoring aims to assess disease severity, medication effects, health care administration system, and ICU performance. Additionally, the scoring also compares intensivist performances and determines the patients' prognosis (KepMenKes RI, 2010).

To date, many ICU officers have not fully understood the needs of the scoring system, its purpose, and how the system must be utilized to facilitate the officers in scoring the patients. The condition is caused by the lack of information and socialization on the APACHE scoring system. Additionally, no scoring system has been clearly determined. Such a service condition is not in line with the purpose of ICU services administration. Furthermore, the implementation of the National Health Insurance system (JKN) by the Social Security Service Board (BPJS) demands health service providers to be capable to calculate and estimate the patients' prognosis so that quality services can be obtained with cost-efficiency. The reason is due to the APACHE scoring system can provide an overview of the efficiency of ICU services. It is also useful in providing an overview of the needs for resources, labor, and costs required at the ICU. The APACHE scoring system can also provide an overview of the length of treatment associated with an increased risk of infection, complications, mortality rates, as well as costs and mental load of the patients, their families, and the hospitals.

Noticing the problems as well as the importance of scoring the patient's conditions for ICU service, the writers conduct a literature review on APACHE II utilization as a scoring system to evaluate ICU patients. The results will be used to gain an overview of the importance of APACHE II scoring to improve the quality of service in ICU.

MATERIALS AND METHODS

The method used in this paper is a literature review. The researcher obtained 112 source journals which were then filtered through the inclusion criteria. Seven journals were obtained upon the filtering. The inclusion criteria are journal with topics of APACHE II, research conducted in intensive care units, and surgery or non-surgery medical disease. Meanwhile, the exclusion criteria include papers in the form of articles, poster reviews, and correspondence. The source journal is searched in CHINAHL obtained through searching EBSCO, Pubmed, Google Scholar, and Portal Garuda online database within the publication of 2015 to 2020. The keywords used in the search are APACHE II, mortality, and ICU. The research also uses two books on critical care as sources.

RESULTS

The analysis of the literature review reveals that the conducted researches were aimed to provide information on APACHE II accuracy in predicting patients' prognostic and mortality. The research by Andrias, Hanafie, Wijaya, (2017) adds the information on validity comparison between APACHE II, SOFA, and C SOFA. On the other hand, the research by Nematifared, Ardehali, Shahbazi, Eini-Zinab, Shariatpanahi (2018) provides the information on the APACHE II combination with Adductor Pollicis Muscle Thickness (APM) in predicting ICU patients' mortality.

Three out of seven journals use retrospective research design (Eka Damayanti, Indrisari, Iwan Fuadi, 2016; Phuping Akapivat, Jadsada Thinkhamrop, Bandit Thinkhamrop, Wimonrat Sriraj, 2019; Munawwarah, 2016). The other two journals use a prospective cohort research design (Falcao, Barros, Bezerra, Ferreira, Logato, Silva, Do Monte, Torella, Figueiredo, Moreno, Dragosavac, Andrecillo, 2019; Nematifared, Ardehali, Shahbazi, Eini-Zinab, Shariatpanahi, 2018). One journal uses observational cross-sectional research design (Andrias, Achsanuddin Hanafie, Dadik Wahyu Wijaya, 2017).

From the inclusion criteria, five of the seven journals reveal that all of the observed patients were more than 15 years of age. The time for the conducted researches was ranged between three months to more than a year. From the exclusion criteria, the patients who become research respondents in the seven journals are all forcefully discharged from ICU in less than 24 hours due to death.

The results obtained from the seven journals reveal that the APACHE II scoring system can be utilized to predict the mortality rate in the intensive care unit, especially when combined with the APM nutrition parameter. The APACHE II scoring system can function more accurately when applied to non-surgery, sepsis/shock, as well as neurosurgical patients. The APACHE II system can be utilized to differentiate the surviving and non-surviving patients.

DISCUSSIONS

The ICU monitoring and evaluation utilize prognosis and ICU outcome scoring system such as Acute Physiology Age And Chronic Health Evaluation I-IV (APACHE), Simplified Acute Physiology Score I-III (SAPS), Sequential Organ Failure Assessment (SOFA) score, and Mortality Prediction Models I-III (MPM), (Kepmenkes No. 1778 of 2010). APACHE II is one of the many methods used to measure patients' disease severity and mortality levels. The APACHE scoring system was introduced in 1981 as a system that predicts disease severity with 34 physiological variables. In 1985, the APACHE II scoring system is introduced as a revised system of APACHE. The APACHE II system reduces the previous 34 physiological variables into 12 with a maximum score of 71. Then in 1991, APACHE II was replaced by APACHE III, and in 2006 APACHE IV was introduced (Bersten Andrew D, 2014).

Despite the old version, the APACHE II score system is widely studied and used by a wide range of communities to predict the patient's mortality rate. The APACHE II scoring system is more acceptable since the data needed to determine the score are simpler, the definitions of its variables are clearer. Additionally, the variables for APACHE II are collected from routine examinations of ICU patients. APACHE II can function properly if the assessed case is similar to the base case used for its development (Nassar A.P, 2017).

APACHE II's prognostic scoring is also recommended as a prognostic predictor in the intensive care unit as regulated in the decree of Health Minister of the Indonesian Republic No. 1778/MENKES/SK/XII/2010.

The evaluation of the scoring system is done within the first 24 hours of ICU admission (Kepmenkes no 1778 of 2010). Several studies have revealed that APACHE II is more accurate in measuring the mortality rate in critical non-surgical patients including severe sepsis, OHCHA (Out of Hospital Cardiacarres), kidney failure, and poisoned patients. APACHE II can also be used for surgical patients for example in patients with secondary peritonitis caused by hollow organ perforations, in patients receiving liver transplants, and in neurosurgical patients (Naqvi, *et al.*, 2016; Choi JY., *et al.*, 2018; Prihadi, MT, *et al.*, 2016; Goswami J Tendra., *et al.*, 2018; Zhang Yun, *et al.*, 2015; Yan Aditya, *et al.*, 2019; Huang Ziang Hsu, *et al.*, 2017; Akavipac P., *et al.*, 2019).

The APACHE II scoring system is based on three variables. The first variable is acute physiology which consists of 12 categories. The second variable is an age which consists of 5 categories. While the third variable is concomitant chronic diseases which consists of 5 categories (Bersten Andrew D, 2014).

The 12 physiological categories are shown in table 1. The scoring determination for each variable is done by matching the results of the patients' examination in accordance with the physiological variable components of the scoring system. For the highest examination result, the scoring begins from the leftmost +4 to towards 0. While for the lowest examination results begins from 0 to the rightmost +4. The number used for each variable is the result of the patients' condition measurement obtained in the first 24 hours of ICU admission and is the lowest number from the normal value. The age variable is shown in table 2. The scoring determination for the age variable is done by matching the patients' age with the matching score listed in table 2.

Table 1 Physiological Variable Components

Components	APACHE II SCORING SYSTEM								
	+4	+3	+2	+1	0	+1	+2	+3	+4
Temperature	≥41	36-40.9		38,5-38,9	36-38,4	34-35,9	32-33,9	30-31,9	≤29,9
Pulse pressure	≥160	130-159	110-129		70-109		50-69		≤ 49
Heart rate frequency	≥ 180	140-179	110-139		70-109		55-69	40-54	≤ 39
Perspiration frequency	≥ 50	35-49		25-34	12-24	10-11	6-9		≤ 5
A-aPO2 (FiO2>50%) or PaO2 (FiO2<50%)	≥ 500	350-499	200-349		<200 or PaO2 > 70	PaO2 61-70		PaO2 55-60	PaO2 < 55
Blood acidity or PH level	≥ 7,7; ≥ 52	7,6-7,69; 41-51,9		7,5-7,59 ; 32-40,9	7,33-7,49 ; 32-40,9	7,25-7,32 ; 18-		7,15-7,24 ; 15-17,9	<7,15 ; < 15

Components	APACHE II SCORING SYSTEM								
	+4	+3	+2	+1	0	+1	+2	+3	+4
						22,9			
Serum sodium (mEq/L) level	≥ 180	160-179	155-159	150-154	130-149		120-129	111-119	≤110
Serum potassium level (mEq /L)	≥ 7	6-6.9		5.5-5.9	3.5-5.4	3-3.4	2.5-2.9		< 2.5
Serum creatinine level	≥ 3.5	2-3,4	1,5-1,9		0,6-1,4		<0,6		
Hematocrit level	≥60		50-59.9	46-49.9	30-45.5		20-29.9		<20
leukocyte level	≥40		20-39.9	15-19.9	3-14.9		1-2.9		<1
GCS (Glasgow Coma Score)	Severe disease is indicated with GCS ≤ 8 The moderate disease is indicated with GCS 9-12 The light disease is indicated with GCS ≥ 13								

Table 2 Age Variables

Age (year)	Score
≥75	6
65-74	5
55-64	3
45-54	2
≤ 44	0

The chronic disease variable score consists of chronic disease without a history of organ system insufficiency, with a history of organ system insufficiency (after elective surgery and emergencies), and immunologic abnormalities. Definitions of organ insufficiency and immunologic abnormalities proved to exist before the patients' admission to the hospital, are confirmed by the following criteria: 1) Liver: liver cirrhosis, upper gastrointestinal tract bleeding due to portal hypertension, encephalopathy to coma; 2) Cardiovascular: Class IV cord decompensation based on New York Heart Association criteria: 3) Respiration: chronic obstruction, chronic restriction, pulmonary hypertension, hypoxia, hypercapnia; 4) Kidney system: chronic kidney failure needing dialysis; 5) Immunocompromised: the suffering patient get a therapy that suppresses endurance, for example, immunosuppressants, chemotherapy, radiation, long-term steroids, leukemic, lymphoma, AIDS.

Table 3 Chronic disease Variables

Comorbid	Score
Elective post-operative	2
Severe organ insufficiency	5
Immunologic disorders	5
Post-operative cito	5
Non-operative	5

If two out of the diseases listed above are identified, the score of 5 will be given. While the elective post-operative conditions will be given a score of 2. The total score of APACHE II is obtained by adding each of the total scores of the three variables. Total Score = Physiological Variable Score + Age Score + Chronic Disease Score After the total score is obtained, it will be interpreted to gain the value of mortality rate. The interpretation of the APACHE II mortality rate is shown in table 4.

Table 4
APACHE II score interpretation table

Score	Mortality rate (%)
0 – 4	4
5 – 9	8
10 – 14	15
15 – 19	25
20 – 24	40
25 – 29	55
30 – 34	75
>34	85

The minimum APACHE II score increases the risk of death, an increase of 1 score causes an increase in mortality by 2% (Bersten Andrew D, 2014). The APACHE II score system is good and appropriate when utilized in intensive care units such as GICU (General Intensive Care Unit), NICU, and MICU (Damayanti Eka, et.all., 2018., Amina Godinjak, et.all., 2016). Validity means the extent to which the accuracy of a measuring instrument in carrying out its measurement functions. Several pieces of research have proven the validity of APACHE II scoring to predict the mortality rate of critical patients in ICU. The evidence of the researches' validity is obtained by comparing the validity and reliability between APACHE II and other measuring instruments, namely, APACHE III, SOFA, MPM, and SAPS.

The validity of the APACHE II scoring system to predict the mortality of non-surgical patients in the ICU is also very accurate when compared to SAPS III and MSOFA. APACHE II is more accurate in predicting the slow death rate. However, other studies have proven that the validity of APACHE II is less qualified when compared to CSOFA - for surgical cases (Hosseini Seyed Hossein, et al., 2016; Taofik Stephanus, et. All., 2015; Brahmi Nur Hajiriya, et.all., 2016; Andrias, Achsanuddin Hanafie, Dadik Wahyu Wijaya, 2017; Kadziolka Isabella, et.all., 2018). In patients, undergoing physiological parameters surgery, such as general conditions and laboratory parameters, are made normal for safety during the surgery and post-operative conditions.

Other studies have shown that the APACHE II scoring system can be combined with the measurement of nutritional parameters Adductor Pollicis Muscle (APM); wherein any increase in APACHE II score followed by a decrease in the APM will increase the risk of death (Nematifared et.al, 2018). Patients treated in the ICU are critical patients who experience changes in metabolism including changes in energy use in the body. Patients in critical conditions experience hypermetabolism so that the body will experience increased energy needs. If the hypermetabolism continues, the patient will fall into the condition of malnourishment (Ibnu, 2014). When the patient is malnourished, the destruction of lean body mass to release amino acids will occur. At such a state, the body undergoes a process of gluconeogenesis. The condition will cause decreases in body immunity, mental state (depression), wound healing rate, muscle strength (including respiratory muscles), heart function which resulted in the extension to the length patient treatment and the increase of patient's morbidity as well as mortality (Rani A, Simadibrata M, Syam F, 2011).

To date, APACHE II still becomes the option to predict mortality for patients treated in ICU because it has several advantages. The reasons APACHE II still becomes the most widely used are 1) it has 12 physiological variables which reflect the completeness in predicting the outcomes of ICU patients, 2) the chronic premorbid health status of patients is included in the APACHE II Score, 3) The APACHE II score system has been proven to properly correlate the predicted mortality and actual mortality (Lu Jievu, et.all, 2018; Eka Damayanti, Indrisari, Iwan Fuadi, 2018; Munawwaroh, 2016; Falcao, Barros, Bezerra, Ferreira, Logato, Silva, Do Monte, Torella, Figueiredo, Moreno, Dragosavac, Andrecillo, 2019; Amina Godinjak, Amer Iglica, Admir Rama, Ira Tancica, Selma Jusufovic, Adis Kukuljac, 2016).

The weakness of this APACHE II scoring system is based on old data from 1979-1982. Additionally, the system is not designed to predict individual patient outcomes and specific diseases. The calculation of the APACHE II score requires a large amount of data to be reviewed and analyzed. Thus, the APACHE II scoring system has several weaknesses, such as the high cost caused by laboratory examination on its many variables, and the long time-span to obtain results

(Andrias, et.all, 2017). Principally, there is no ideal scoring system applicable to all types of health cases. Each scoring system has limitations in its evaluation. The limitations are dependant on the type of classification of the scoring system.

There are several kinds of a scoring system to determine the prognosis of patients in ICU, among them are APACHE I-IV, SOFA, MSOFA, CSOFA, SAPS I-III. The APACHE II scoring system is the most utilized in hospitals since it is more accurate in determining the patients' prognosis and mortality. Furthermore, collecting the needed data for the scoring is easier and more complete as it consists of three parameters which are acute physiology, age, and chronic disease. APACHE II can also be combined with the use of nutritional parameters, namely the Adductor Pollicis Muscle (APM) measurement. Thus, the implementation of scoring to determine patients' mortality in the ICU using APACHE II should be done by ICU nurses in the first 24 hours upon the patient's admission. Further research regarding nurses' obstacles in utilizing the APACHE II scoring system is necessary.

CONCLUSIONS

The APACHE II scoring system has good accuracy in predicting the mortality rate, especially on non-surgery patients. The APACHE II scoring system can properly discriminate patients who can survive and not survive in the intensive care room. Each reviewed research was able to demonstrate the accuracy of APACHE II and show a comparison of validity with other scoring systems. However, the APACHE II scoring system could not be applied to all cases of a disease in the intensive care room.

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