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Predictive Score Model of Clinical Outcomes Sepsis in Intensive Care Unit Tertier Referral Hospital of Eastern Indonesia

Metta Octora[1,2,3], Ni Made Mertaniasih[1,2]*, Bambang Pujo Semedi[4], Eko Budi Koendhori[1,2]

[1]Department of Medical Microbiology, Faculty of Medicine, University of Airlangga, Surabaya, Indonesia; [2]Department of Clinical Microbiology, RSUD Dr. Soetomo, Surabaya, Indonesia; [3]Division of Microbiology, Faculty of Medicine, University of Mataram, Mataram, Indonesia; [4]Department of Anesthesiology and Reanimation, Faculty of Medicine, University of Airlangga, Surabaya, Indonesia

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***Correspondence:** Ni Made Mertaniasih, Department of Medical Microbiology, Faculty of Medicine, University of Airlangga, Surabaya, Indonesia. E-mail: nmademertaniasih@gmail.com
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Abstract

AIM: This study aimed to design a predictive score model of clinical outcome sepsis and bacterial profiles of blood and sputum cultures in the intensive care unit (ICU) of a tertiary referral hospital.

METHODS: An observational retrospective study was conducted in 2017–2020 using medical record data in the ICU of Dr. Soetomo Hospital as tertiary referral hospital. The predictor of sepsis prognosis was Acute Physiology and Chronic Health Evaluation II (APACHE II), blood and sputum culture results, procalcitonin (PCT) levels, and antimicrobial resistance in blood and sputum cultures. The model was prepared by logistic regression analysis and receiver operating characteristic (ROC) curves.

RESULTS: Data from 355 subjects showed that predictor score was APACHE II, blood and sputum culture results; besides PCT levels were found to contribute significantly to predictive score of sepsis clinical output ($p<0.05$), while the predictor test of antimicrobial resistance in blood and sputum cultures was not significant to predictive score of sepsis clinical output ($p > 0.05$). The resulting scores to predict sepsis clinical outcomes include PCT level >2 ng/mL (1.61), APACHE score >20 (1), sputum culture as true pathogen (1.1), and blood culture as true pathogen (1.35). When the total score ≥3, the patient will die, while when the score <3, the patient will survive. ROC curves analysis obtained area under curve 0.859 ($p < 0.05$) which indicates that the equation is statistically significant in predicting the sepsis clinical outcome. Probability scores and death outcomes indicate that the higher the predictive score, the higher the probability of dying, with a score >3 the probability of dying is above 95.27%, whereas if the score is 5, the probability of dying is above 99%. The bacterial profile of blood cultures leading to mortality is predominately Gram-positive (34.4%), consisting of coagulase-negative *Staphylococcus* (22.9%), and *Staphylococcus aureus* (4.3%), while Gram-negative is only 14.7%, which consists of Enterobacteriaceae group (8.7%), *Acinetobacter baumannii* (4%), polymicrobial infection (2%), *Burkholderia cepacia* (0.8%), and *Pseudomonas aeruginosa* (0.4%). Sputum culture profile of patients with sepsis who died in the ICU of a tertiary referral RSUD Soetomo is dominated by Gram-negative, namely, *A. baumannii* (22.1%), Enterobacteriaceae group (20.6%), *P. aeruginosa* (11.1%), while Gram-positive is *S. aureus* (22.9%).

CONCLUSION: The predictive score model for sepsis clinical outcomes in the ICU of a tertiary referral hospitals can be used as a basis for determining of patient management and the profile of the bacteria that causes sepsis that results in death.

Introduction

Sepsis is the leading cause of mortality for critically ill patients admitted to the intensive care unit (ICU). Sepsis is a life-threatening organ dysfunction resulting from the host response to infection [1]. The WHO in the Global Report on the Epidemiology and Burden of Sepsis, states that the worldwide incidence of sepsis is 48.9 million and sepsis-related mortality is 11 million, almost 20% of all global deaths [2]. Data from a systematic review of 1990–2017 states that the hospital mortality rate due to sepsis is estimated to be 27% and approximately 42% of patients are admitted to the ICU due to sepsis. The incidence of sepsis and mortality have a regional disparity between the low- and middle-income countries significantly, around 85.0% of sepsis cases and sepsis-related deaths worldwide [3]. Indonesia is the most populous country in Southeast Asia and the fourth most populous country globally, which has a high incidence of infectious diseases, including sepsis [4].

Prediction of sepsis clinical outcome can be done using a scoring system, so as to determine the appropriate patient management. Sepsis clinical outcome is known to correlate individually with score predictor of Acute Physiology and Chronic Health Evaluation II (APACHE II), blood and sputum culture results, antimicrobial resistance test in blood and sputum cultures, and procalcitonin (PCT) levels [5], [6], [7], [8], [9]. Predictor of APACHE II score has 3 main indicators, namely age, comorbidities, and acute physiological conditions. The indicator of acute

physiology condition consists of 12 parameters which are given a score of 0–4. A higher score indicates increased mortality with the maximum score of 71. A score of 25 indicates a 50% predicted mortality and a score over 35 indicates an 80% predicted mortality [9]. Vijay Ganapathy *et al*. state that the APACHE II score at 24 h after admission to the ICU was <24, so it was estimated that the patient's prognosis was good. Patients with an APACHE II score of 24–27 have a high probability of morbidity and length of stay in the ICU [10]. APACHE II scores have been used for assessing mortality, but this score is not specific to sepsis patients [11].

Sepsis mortality is often associated with bacteremia, which can be detected using the blood culture predictor. Gram-positive bacteria, the main cause of bacteraemia is *Staphylococcus aureus.* The highest incidence of mortality in relation to tertiary hospitals bloodstream infection is caused by Gram-negative bacilli and *S. aureus* [12]. Antimicrobial resistance is increasing rapidly today is related to mortality in sepsis patients. Study by Malekolkottab *et al*., states that there is a relation among clinical response and patient outcome caused by multidrug resistance (MDR) against Gram-negative and it was concluded that 58.2% of patients died due to MDR antibiotics [13]. A study by Sunenshine *et al*. states that the increased risk of mortality in *Acinetobacter baumannii* MDR related to carbapenem resistance [14].

Role of sputum culture predictor as a diagnostic tool in hospital-acquired pneumonia (HAP) as well as ventilator acquired pneumonia (VAP) which contribute to the mortality of critically ill patients is still controversial [15]. The Infectious Diseases Society of America guidelines recommend Gram stain and sputum culture to be only performed on severe pneumonia, especially intubated patient in empirical therapy of methicillin-resistant *S. aureus* (MRSA) or *Pseudomonas aeruginosa*, previously infected with MRSA or *P. aeruginosa*, especially a respiratory tract infection or hospitalized and receiving parenteral antibiotics, whether or not treated for at least the last 90 days [16].

PCT level predictors have been generally recommended for diagnosing the severity of sepsis. A study by Tsangaris *et al*. (2009) shows that high PCT levels are a marker of poor prognosis [17]. These six predictors are arranged to form a predictive score of sepsis clinical outcomes in critically ill patients in the ICU of a tertiary referral hospital of Eastern Indonesia. So far, microbiological indicators are not used to establish the prognosis of sepsis, but only using clinical and non-microbiological laboratory markers such as liver function, kidney function, etc. This study intends to make a more comprehensive mortality prognostic score.

Methods

This study aimed to design a predictive score model for sepsis prognosis in the ICU of Dr Soetomo Hospital Indonesia, as a tertiary referral hospital in Eastern Indonesia. An observational retrospective study with non-reactive research conducted in 2017–2020. Ethical clearance was issued by Dr. Sutomo Hospital with no.0321/LOE/301.4.2/II/2021.

This study was using secondary data. APACHE II components consist of 3 main components, namely (1) Acute Physiology Score: AaDO2 or PaO2 (for FiO2 ≥0.5 or <0.5, respectively), body temperature (rectal), mean arterial pressure, blood pH, heart rate, respiratory rate, serum sodium, serum potassium, creatinine (Double point score for acute renal failure), hematocrit, white blood cell count, Glasgow Coma Scale, (2) Age, (3) Chronic disease.

The APACHE score has not been specifically used to assess the mortality prognosis of septic patients but is used to assess the general mortality prognosis. So the researcher intends to use APACHE as a determinant of the model from a clinical and non-microbiological laboratory point of view The APACHE scores in this study were obtained from medical record that calculated for each patient admitted to the ICU, so it was already in a score in the medical record.

Blood culture, sputum culture, PCT level, and antimicrobial test data were obtained from medical record (secondary data). Blood and sputum culture, as well as antimicrobial test, were obtained from examination results using the Automated Identification and susceptibility testing system BD Phoenix that recorded in the patient's medical record. So the researcher only collect the data.

The predictors model used to design prognosis was the APACHE II score, blood, and sputum culture results, PCT levels, and antimicrobial resistance test to blood and sputum cultures. Inpatient data obtained from medical record data with clinical outcomes patients while being treated at Dr. Soetomo Hospital. Research subject criteria were 355 subjects with aged 17–65 years diagnosed with sepsis including septic shock. The inpatient data did not accurately excluded from the study. Data were analyzed bivariate and multivariate with logistic regression and receiver operating characteristic (ROC) curves with SPSS 25.

Results

From a total of 355 subjects, it was found that sepsis-related mortality was 21.7% while mortality

due to sepsis shock was 49.6% with a mean mortality age of 49.71 years, and a significant difference was found between the ages of the subjects surviving and dying (p = 0.039). Mean APACHE II score of surviving subjects was 15.62 while dying subjects was 23.24 (Table 1). Surviving subjects were mainly dominated by the low and moderate score categories, (34.3% and 41.2%) while dying subjects were dominated by the high moderate and high score categories (25.3% and 31.6%). The APACHE II score based on the risk of patient mortality found a significant correlation with mortality in sepsis patients (p = 0.000).

Table 1: Characteristics of research subjects

Parameters	Outcome (%)		Total (%)	p
	Survive	Death		
n = 355	102 (28.73)	253 (71.27)		
mean age	46.92	49.71		0.039
Mean APACHE II	15.62	23.24		0.01
Mean PCT	14.33	25.90		0.094
Gender				0.461
Male	48 (13.5)	130 (36.6)	178 (50.1)	
Female	54 (15.2)	123 (34.7)	177 (49.9)	

APACHE: Acute physiology and chronic health evaluation, PCT: Procalcitonin.

PCT levels <0.5 ng/mL were found the most in the group of surviving subjects (43.1%). The highest incidence of mortality (47%) was experienced by patients who had a PCT level >10 ng/mL and there was a significant correlation between PCT levels and sepsis clinical outcome (mortality) (p = 0.000) (Table 2).

Table 2: Correlation of predictors and patient outcomes

Predictor	Outcome (%)		p	r	Odds ratio
	Survive	Death			
n = 355					
APACHE II scores					
Low score 3–10	35 (34.3)	42 (16.6)	0.000	0.294	3.465
Moderate score 11–20	42 (41.8)	67 (26.5)			
High moderate score 21–30	16 (15.7)	64 (25.3)			
High score>30	9 (8.8)	80 (31.6)			
Blood culture result					
Gram negative bacteria	7 (6.8)	37 (14.7)	0.017	0.194	8.439
Gram positive bacteria	31 (30.5)	87 (34.4)			
Polymicrobial	0	5 (2)			
Candida spp	0	4 (1.6)			
Sterile	64 (62.7)	120 (47.4)			
Sputum culture result					
Gram negative bacteria	55 (53.8)	145 (57.4)	0.362	0.164	3.771
Gram positive bacteria	6 (5.9)	12 (4.8)			
Polymicrobial	8 (7.8)	18 (7.1)			
Candida spp	1 (1)	6 (2.4)			
Normal flora of the respiratory tract	32 (31.4)	72 (28.5)			
AST Blood					
Sterile	64 (62.7)	124 (49)	0.013	0.155	
Sensitive	33 (32.4)	89 (35.2)			
MDR	5 (4.9)	40 (15.8)			
AST Sputum					
Sterile	32 (31.4)	72 (28.5)	0.576	0.056	
Sensitive	18 (17.6)	37 (14.6)			
MDR	52 (51)	144 (56.9)			
PCT level					
Local infection<0.5	44 (43.1)	18 (7.1)	0.000	0.443	6.934
Systemic infection 0.5–<2	26 (25.5)	34 (13.4)			
Severe infection 2–10	17 (16.7)	82 (32.4)			
Sepsis shock>10	15 (14.7)	119 (47)			

APACHE: Acute physiology and chronic health evaluation, PCT: Procalcitonin, MDR: Multidrug resistance.

Bacteria type of blood culture were dominated by Gram-positive bacteria (33.2%), while Gram-negative bacteria were only 12.5%. The mortality of most sepsis patients is correlated with Gram-positive (34.4%), while Gram-negative is only 14.7%. The mortality of sepsis in the ICU of Dr Soetomo Hospital with the highest blood culture results was caused by coagulase-negative *Staphylococcus* (CoNS) (22.9%), others were caused by *S. aureus* (4.3%), Enterobacteriaceae group (8.7%), *A. baumannii* (4 %), *Burkholderia cepacia* (0.8%), *P. aeruginosa* (0.4%), polymicrobial infections (2%) and *Candida* spp. (1.6%). The results show that there is a significant correlation of germs in blood specimens with the outcome of sepsis (p = 0.017). The mortality of polymicrobial infection and *Candida* spp. is 100% each (Tables 2 and 3).

Table 3: Microbial profile of blood culture of sepsis patients in the ICU

Blood culture germs	Outcome (%)		Total	p/r
	Survive	Death		
n = 355				
Gram negative bacteria	7 (6.8)	37 (14.7)	44 (12.5)	p = 0.017
Acinetobacter baumanii	3 (2.9)	10 (4)	13 (3.7)	
Pseudomonas aeruginosa	0	1 (0.4)	1 (0.3)	r = 0.194
Enterobacteriaceae	4 (3.9)	22 (8.7)	26 (7.3)	
Burkholderia cepacia	0	2 (0.8)	2 (0.6)	
Other Gram negative bacteria	0	2 (0.8)	2 (0.6)	
Gram positive bacteria	31 (30.5)	87 (34.4)	118 (33.2)	
Staphylococcus aureus	1 (1)	11 (4.3)	12 (3.4)	
CoNS	28 (27.5)	58 (22.9)	86 (24.2)	
Enterococcus spp	1 (1)	9 (3.6)	10 (2.8)	
Other Gram positive bacteria	1 (1)	9 (3.6)	10 (2.8)	
Polymicrobial	0	5 (2)	5 (1.4)	
Candida spp	0	4 (1.6)	4 (1.1)	
Sterile	64 (62.7)	120 (47.4)	184 (51.8)	

ICU: Intensive care unit.

The mortality of sepsis in the ICU of Dr Soetomo Hospital with the most sputum cultures of Gram-negative bacteria (57.4%) is dominated by *A. baumannii* (22.1%), Enterobacteriaceae group (20.6%), *P. aeruginosa* (11.1%), and *S. aureus* (22.9%) (Table 4). There is no significant correlation of bacteria in sputum specimens with the outcome of sepsis (p = 0.362). Omnibus test showed that independent variables consist of APACHE II score, PCT level, blood, and sputum culture result significantly simultaneously influence clinical outcome (p = 0.000).

Table 4: Microbial profile of sputum cultures of sepsis patients in the ICU

Sputum culture germ	Outcome (%)		Total (%)	p/r
	Survive	Die		
n = 355				
Gram negative bacteria	55 (53.8)	145 (57.4)	200 (56.3)	p = 0.362
Acinetobacter baumanii	13 (12.7)	56 (22.1)	69 (19.4)	
Pseudomonas aeruginosa	15 (14.7)	28 (11.1)	43 (12.1)	r = 0.164
Enterobacteriaceae	24 (23.5)	52 (20.6)	76 (21.4)	
Other Gram negative bacteria	3 (2.9)	9 (3.6)	12 (3.4)	
Gram positive bacteria	6 (5.9)	12 (4.8)	18 (5.1)	
Staphylococcus aureus	2 (2)	5 (2)	7 (2)	
Enterococcus spp.	4 (3.9)	3 (1.2)	7 (2)	
Other Gram positive bacteria	0	4 (1.6)	4 (1.1)	
Polymicrobial	8 (7.8)	18 (7.1)	26 (7.3)	
Candida spp.	1 (1)	6 (2.4)	7 (2)	
Normal flora of the respiratory tract	32 (31.4)	72 (28.5)	104 (29.3)	

ICU: Intensive care unit.

The antimicrobial susceptibility test table is not shown because its results of the model test showed no significant results in the formation of the mortality prognostic score, so it was not included in the model.

The results of the antimicrobial resistance test in blood cultures obtain significant correlation with sepsis (p = 0.013) but in sputum culture outcomes obtain no significant correlation with the score of p = 0.567. Omnibus test showed that independent variables consisting of results of the antimicrobial resistance test in blood cultures and sputum have been eliminated in iteration steps of logistic regression.

The equation of the predictive score model for sepsis clinical outcome in the ICU of Dr Soetomo Hospital of Eastern Indonesia is as follows with a cutoff of 3.

Predictive score = 1.61*PCT level + 1.35*blood culture result + 1.1*sputum culture result + 1*APACHE score

The mortality outcome can be predicted using sepsis predictive score. The most predictor score contribute on mortality in sepsis patients, namely, PCT levels (the highest), blood culture results, sputum culture results, and APACHE II scores (the lowest). If a predictive score for the sepsis clinical outcome is obtained ≥3 then the predicted subject will die, while if the score obtained is <3 the predicted subject will survive (Table 5).

Table 5: Prognostic predictive score for sepsis patients

Variable	Score
Procalcitonin levels	
2 ng/mL	0
>2 ng/mL	2
APACHE II scores	
20	0
>20	1
Sputum culture interpretation	
Sterile/contaminant	0
True pathogen	1
Blood culture interpretation	
Sterile/contaminant	0
True pathogen	1
Total	

APACHE: Acute physiology and chronic health evaluation.

The results of the probability of the score and the outcome of mortality show that the higher the score, the higher the probability of mortality, even at a score of 5, the probability of death is above 99% (Figure 1) The equation of the clinical outcome predictive score model for sepsis with ROC analysis can be determined the best cut-off point score for predicting the incidence of sepsis mortality outcome. ROC analysis based on equation model obtained area under curve 0.859 (p = 0.000) which indicates that the equation is statistically significant in predicting sepsis clinical outcome (Figure 2).

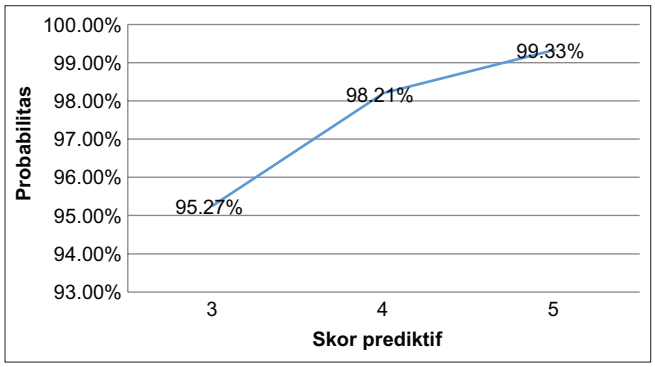

Figure 1: Probability of predictive score and died outcome

Discussion

Sepsis-related mortality of patient critically ill in the ICU of Dr. Soetomo Hospital was 21.7% while mortality in patients with sepsis shock was 49.6%. This mortality prevalence is supported by several sepsis studies in various cities in Indonesia [18]. Vincent *et al.* state that the mortality of patients with severe sepsis in intensive care reached 32.2% and increased to 54.1% in sepsis shock [19]. ICU sepsis mortality rate references like Dr. Kandou Hospital, Manado, and Dr Sardjito Hospital, Yogyakarta respectively by 65.7% and 56.83% [20], [21].

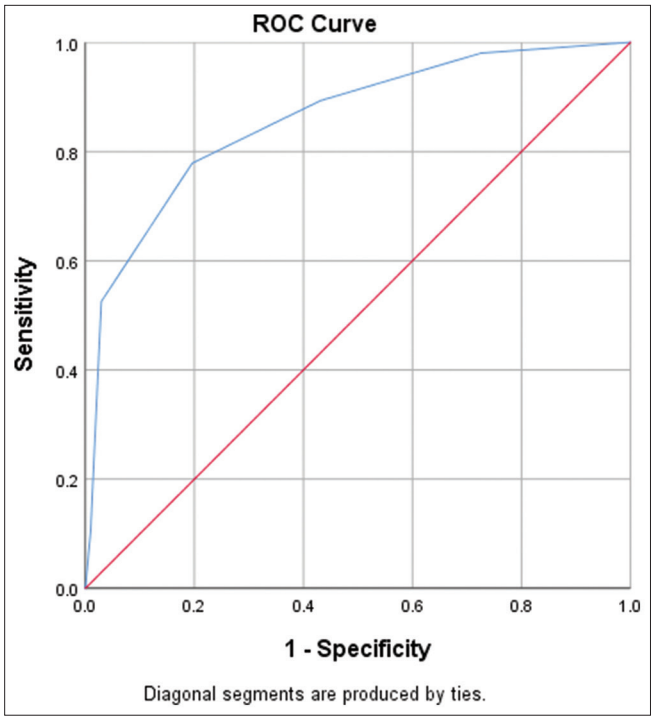

Figure 2: Receiver operating characteristic curve of predictive score for sepsis prognosis

Study by Tanriover *et al.*, in a tertiary referral hospital in Turkey showed that the incidence of sepsis mortality was 87.3%. The mortality rate was 92.2% with at least one organ dysfunction (respiratory, renal, hepatic, or hematological organ) compared to 44.4% without any organ dysfunction [22]. Severe sepsis deaths in Poland and Russia reported each 55% and 54% [23], [24].

High mortality of sepsis patient influenced by immunosuppressed conditions and the incidence of MDR when treated at ICU. Number of MDR incident is high, especially patients who have been hospitalized for a long time before being referred from a primary or secondary hospital, thereby increasing patient mortality in tertiary hospitals. Most of the patients in the ICU also using mechanical ventilation which was independently significantly correlated with mortality [25]. Multiple critical conditions also likely contributed to the high incident of nosocomial infection and mortality. Microbiological diagnosis of Enterobacteriaceae group is almost always considered as a causative agent of nosocomial infections. The positivity of blood culture in only one location is often underestimated existence possible role of fastidious pathogens due to increased

usage of intravascular catheter and device-related blood infection including prosthetics [26].

The predictor of PCT level has the greatest contribution in forming the prognostic score. From randomized control trial of PCT in the Netherlands, it was found that the use of PCT-guided antibiotics therapy significantly reduced the mortality of sepsis patients at 28 days to 1 year [27].

The spectrum of microorganisms that cause bacteremia is currently shifting from Gram-negative to Gram-positive bacteria, apart from fungi which are emerging as important pathogens. Gram-negative bacteria currently play an important role in tertiary referral hospitals [28]. Several studies suggest that blood culture results are generally dominated by 65.9% by Gram-negative bacteria. *Klebsiella* sp. *Escherichia coli* and *Enterobacter* sp. are the main Gram-negative pathogens causing bacteremia [22]. Pathogenic profiles that cause bacteremia are differentiated from community- and hospital-acquired bacteremia. The incidence of community-acquired bacteremia was dominated by Gram-positive bacteria (56.2%), while pathogens acquired in the hospital were dominated by Gram-negative bacteria (80%). Severe sepsis is dominated by Gram-negative bacteria with high MDR rates and patients are managed with broad-spectrum antibiotics [28].

Sohail *et al*., state that the most common bacteria found in patients admitted to the ICU of tertiary referral hospitals were *S. aureus* (36.38%), *E. coli* (18.28%), and MRSA (7.0%). Other bacteria include *Enterococcus faecalis*, *Salmonella typhi*, *Pseudomonas* sp, and *Candida* spp [29]. The highest death rate for tertiary hospitals in Vietnam-related bloodstream infection is caused by the Enterobacteriaceae group, which is 34.7% (61.6% of the mortality rate in the hospital), *Klebsiella pneumoniae* (37.4%) and *E. coli* (37.1%) as well as *S. aureus* (48%) [12]. The pathogenic profile of sepsis in several studies has always been related to the focus of infection, severity of infection, antibiotics resistance, comorbidities such as immunodeficiency, chronic kidney, and liver disease, besides socioeconomic, climatic, and geographic factors as well as increased life expectancy [30].

Role of sputum culture as a diagnostic tool HAP as well as VAP on mortality in critically ill patients still need to be investigated further. A prospective study on 2554 cases of adult HAP or VAP in 10 Asian countries (2008-2009), *Acinetobacter* spp. was found to be the most common organism, accounting for 36.5% of all pneumonias [31]. This is in accordance with the results found in the ICU of Dr. Soetomo Hospital, that *A. baumannii* as the second most common cause of sepsis after the Enterobacteriaceae group with a total positive sputum culture of 19.4%, and a mortality of 22.1%.

Several decades, sputum culture for diagnosing pneumonia are debated, because its reliability of microbiological diagnosis is low (low sensitivity and specificity). Most sputum specimens are improperly collected and contain oropharyngeal or upper respiratory tract secretions. A prospective study of the diagnostic value of sputum culture in acute pneumonia with transtracheal aspiration and/or bronchial aspiration techniques did not provide a better diagnostic value than sputum culture alone, even though the sputum collected was of good quality [15].

Only one-third of the pneumonia-causing organisms were found from good quality sputum. The results of positive sputum cultures in the good quality and poor quality groups according to the severity of pneumonia using the PORT system showed no significant difference [32]. Delays in processing sputum specimens for more than 24 hours are associated with increased isolation of *Candida* spp. [18] Recovery of sputum culture microorganisms is very low due to factors such as sputum processing and collection and prior antibiotic therapy, which may decrease diagnostic results [15]. Sputum culture values decreased with pre-hospitalization of antibiotics, but in a large number of samples, *Streptococcus pneumoniae* and *Haemophilus influenzae* could be isolated even though the patient had taken antibiotics prior to sputum culture. This study also shows that the correlation between sputum culture and mortality is not significant and the correlation of resistance test in sputum culture is found to be not significant to mortality [32].

Antimicrobial resistance is natural phenomenon in microbes (bacteria/fungi) that happens continuously. The crisis of antibiotic resistance occurs because antibiotics tend to lose their efficacy due to the spread of resistance among pathogenic bacteria. This resistance is mainly due to the high use of antibiotics in hospitals, especially for critically ill patients. Growing elderly population indirectly related to the increase in the use of antibiotics due to an increase in the number of patients hospitalized. This makes patients more exposed to the hospital environment, causing an increase in the number of nosocomial infections. Tertiary referral hospital, tend to accept patient case of heavy reference or failed therapy so that result in high rates of resistance and case fatality rates which are also exacerbated by MDR nosocomial infections [33]. Pea and Viale (2009), state that the pharmacokinetic and pharmacodynamic properties of antimicrobials are associated with changes in clearance and volume of distribution that are common in critically ill patients, so that it could affect drug concentration at the site of infection and subsequently affects antimicrobial resistance [34]. Antibiotic resistance is major determinants of clinical unresponsiveness to treatment and rapid progression of sepsis and septic shock incident. Sepsis due to MDRO infection carries a higher risk of in-hospital mortality. Antibiotics resistance mostly happens in gram-negative infections. Gram-negative bacterial infection in pneumonia often causes

respiratory failure, acute respiratory distress syndrome (ARDS), sepsis, and septic shock [35].

Lung dysfunction in the form of ARDS and kidney failure are multi-organ dysfunction phenomenon that related with high sepsis mortality prognosis [22].

Conclusion

It is found that the APACHE II score, blood culture result, sputum culture result, and PCT levels are significantly correlated with the clinical outcome of sepsis patients. Antimicrobial resistance test results in blood cultures dan sputum culture are not significantly correlated with sepsis outcomes. Predictive score model of sepsis clinical outcomes resulted is as follows:

Predictive score = 1.61*PCT level + 1.35*blood culture result + 1.1*sputum culture result + 1*APACHE score

APACHE II score >20, PCT level >2 ng/dL, interpretation of blood culture as true pathogen, and interpretation of sputum culture as true pathogen is an independent risk factor that simultaneously affects the mortality of sepsis patients with a cutoff value of 3. If the predictive score for sepsis prognosis is more than or equal to 3, the patient will die, while for a score of <3, the patient will survive.

The bacterial profile of blood cultures is predominately Gram-positive (34.4%), consisting of CoNS (22.9%), and *S. aureus* (4.3%), whereas Sputum culture is predominantly Gram-negative, i.e., *A. baumannii* (22.1%), Enterobacteriaceae group (20.6%), *P. aeruginosa* (11.1%), which often lead to MDR, causing a vicious cycle in the management of sepsis.

The implications of this model can be used to assess the mortality prognosis of sepsis patients at Dr. Soetomo Hospital in Surabaya, Indonesia but it still needs to be developed further by conducting a multicenter study in a wider area, so that it can be used to determine the management of sepsis management, whether it is more aggressive or not. This is very helpful in overcoming the limited resources in hospitals, especially in developing countries.

Ethics Approval

Ethical clearance was issued by Dr. Sutomo Hospital with no.0321/LOE/301.4.2/II/2021.

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