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CASE REPORT

Relationship Between Simple Oxygen Extraction Ratio to Cardiac Index and Mean Arterial Pressure in Septic Shock Patient Treated in ICU Dr. Sardjito Hospital Yogyakarta

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ABSTRACT

Background : Oxygen extraction ratio (O2ER) having any relationship with cardiac index and mean arterial pressure in septic shock patient.

Objective: Discover any relation between simplified oxygen extraction ratio with cardiac index and mean arterial pressure in shock septic condition at ICU of RSUP Dr Sardjito Yogyakarta

Method : 32 subject with crossectional study was performed by inclution criteria such as : patient in ICU diagnosed as shock septic, more than 18 years old, inerted cvc in right atrium, inserted arterial line in arterial radialis or brachialis which connected mostcare. BGA (arterial and venous) sampel was taken by I-STAT® together with recording mean arterial pressure (MAP) and cardiac index value.

Result : Correlation between O_2ER and cardiac index p=0,009 (p<0,05) with r -0,456. Correlation between O_2ER and MAP p=0,006 (p<0,05) with r-0,474.

Conclusion : Anesthesia management of TGA TGA cases is to avoid reducing cardiac output and SVR and keep the PVR lower than the SVR.

Keyword : Cardiac index; Mean arterial pressure; Oxygen extraction ratio; Septic Shock.

INTRODUCTION

Sepsis is a serious condition caused by organ dysfunction caused by disturbances in the regulation of the body's response to infection[1]. Sepsis and septic shock are major problems in health centers that affect millions of people worldwide and are the biggest cause of death[2]. Early identification and good management within the first hour after the diagnosis of sepsis is made can improve the outcome[3]. The oxygen extraction ratio is the ratio or fraction between oxygen consumption in the body (VO_2) and oxygen delivery (DO_2), which describes the delivery of oxygen to the microcirculation taken up by the tissues[4]. Normal oxygen extraction ratio is 0.25 – 0.3 (25% - 30%).(5) If there is a decrease in oxygen delivery, the oxygen extraction ratio will increase where as compensation the tissues will extract more oxygen delivery[6]. The oxygen extraction ratio is a good parameter to describe the quality of the oxygen delivery system in the body[7]. Cardiac index is a hemodynamic measurement that can be used to evaluate some types of shock which is obtained from the formula of cardiac output compared to body surface area or heart rate multiplied by stroke volume compared to body surface area[8]. Some conditions that can affect the cardiac index are anemia and heart rate where if anemia levels contribute to the occurrence of compensatory tachycardia causing changes in cardiac index[8]. The relationship between cardiac index and oxygen extraction ratio can present a basis that can be used to interpret hemodynamic parameters in patients with acute conditions[9].

METHOD

This study used a prospective observational study design, which assessed the relationship between simple oxygen extraction ratio based on blood chemistry parameters, blood gas analysis with mean arterial pressure and

cardiac index in sepsis patients in ICU Dr. Sardjito Yogyakarta. The design chosen is cross-sectional in which the researcher observes or measures variables at one time. A cross-sectional study is a type of observational study to determine the relationship between risk factors and disease. The sample in this study was obtained through measurement data of patients treated in the intensive care unit of RSUP Dr. Sardjito. Sampling data was collected for all patients diagnosed with septic shock. The sample size was taken based on calculations according to the unpaired categorical analytical study of 32 samples that met the inclusion and exclusion criteria. Inclusion criteria in this study were patients with a diagnosis of septic shock who were treated in the ICU of Dr. Sardjito General Hospital, Yogyakarta, patients over 18 years of age, CVC installed in the right or left subclavian/jugular vein with the tip of the catheter in front of the right atrium, arterial catheter attached to the artery. right or left radial periphery, right or left brachial. Exclusion criteria in this study were patients with cyanotic congenital heart disease The independent variable in this study is the simple oxygen extraction ratio. The dependent variable in this study was mean arterial pressure, cardiac index. Other variables in this study were age, sex, infection, vasopressor, Hb, heart rate, body surface area, pCO_2gap, BE,$ScvO_2$, lactate. The data analysis obtained was recorded on a form sheet, filtered and analyzed. Data were entered in MS EXCEL and analyzed with SPSS version 20 [International Business Management (IBM), Corporatiouns, New York, USA]. Demographic data is presented in the form of mean (SD) for data with normal distribution, or median (interquartile range) for data with abnormal distribution. Categorical data

are presented in numbers (proportions), and compared with the chi-square test. External variables are presented as Mean ±SD and compared using the t-test. P < 0.05 was considered statistically significant.

RESULT

The research subjects consisted of 32 patients who met the inclusion criteria and obtained permission from the UGM Ethics Committee on August 30, 2022 with a letter number. Ref.No: KE/FK/119/EC/2022, as well as permission from the education and training department of RSUP Dr Sardjito (LB.02.01/XI.2.2/15977/2022). Mean arterial pressure, cardiac index, simple oxygen extraction ratio are numerical data that are tested for normality beforehand to determine if the distribution of data is normally distributed or not with the Shapiro Wilk test because the sample is <50.

The results of the Shapiro Wilk test obtained a value of p>0.05 which means that the data is normally distribute that it can be analyzed with pearson correlation General and clinical characteristics of the patient after the homogeneity test is carried out is presesntes in table 1. Of the 32 samples, it was found that the average age was 58.9 years. Most of the patients were male i.e.21 (65.6%). The minority of patients who had thrombocytopenia 3 (9.4%) and coagulopathy 1 (3.1%). The mean MAP was 72.88, O_2ER was 0.28, pCO_2gap was 5.83, lactate was 2.89, BE was -2.09, cardiac index was 2.49, Hb was 11.64 and $ScvO_2$ was 71.9.

The results of O_2ER correlation with cardiac index obtained p=0.009 (p<0.05) meaning that there is a significant correlation of O_2ER with cardiac index. The correlation coefficient r = - 0.456 is negative.

Tabel 1 analyzed with pearson correlation General and clinical characteristics of the patient after the homogeneity test

		$\bar{x}$ ± SD	n(%)
Age (year)		58.94±14.26	
Gender	Male		21(65.6)
	Female		11(34.4)
Trombositopeni	Yes		3(9.4)
	No		29(90.6)
Coagulopathy	Yes		1(3.1)
	No		31(96.9)
Dobutamine	Yes		2(6.3)
	No		30(93.8)
Dose Dobutamine		2.19±.74	
Dose epinefrine		1.94±.34	
MAP(mmHg)		72.88±8.64	
O_2ER		0.28±0.08	
pCO_2gap(mmHg)		5.93±0.87	
Lactat(mmol/L)		2.89±1.64	
BE(mmol/L)		-2.09±5.99	
Cardiac index (L/min/m^2)		2.49±0.83	
Hb(g/dL)		11.64±1.55	
$ScvO_2$(%)		71.90±7.94	

explanation : SOFA=*sepsis retaled organ failure*,MAP=mean arterial pressure, O_2ER=oxygen xtraction ratio ,*pCO_2gap*=gap of *pCO_2* arterial and central venous *BE=base escess*, *CI= cardiac index*, Hb= hemoglobin,*$ScvO_2$*=saturation central vein

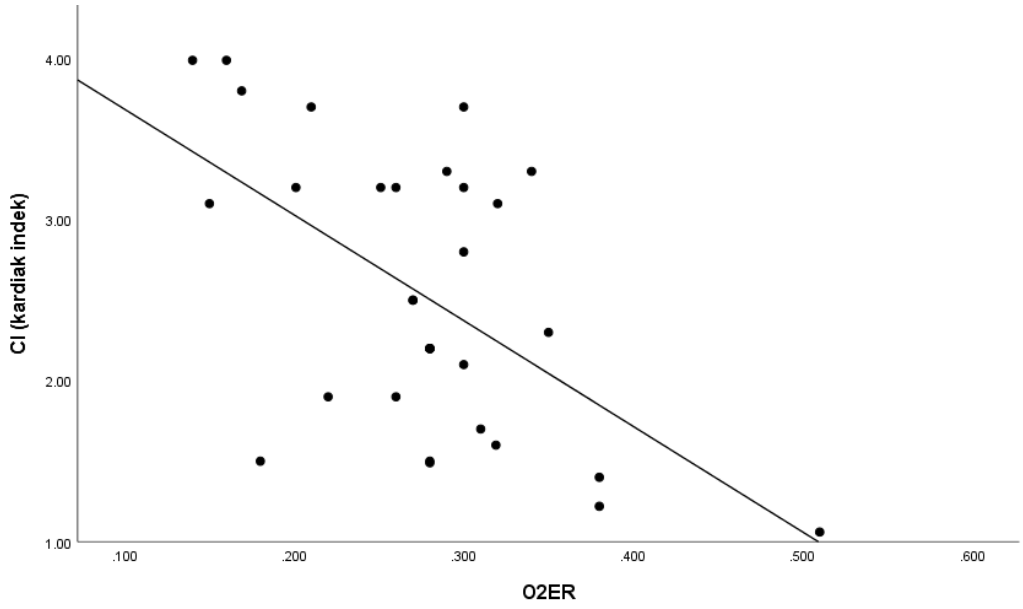

Figure 1. Correlation O_2ER with cardiac index

Meaning that in the 32 samples it can be concluded that the lower the cardiac index (in the range 1.5-4L/minm2), the higher the O_2ER (in the range 0.15-0.38). In conditions of increased O_2ER when oxygen content has decreased which in some cases is caused by acute anemia, sepsis, hypoxia, impaired preload, afterload and contractility, the body will compensate by reducing blood viscosity by increasing blood flow in microcirculation and increasing cardiac index as compensation mechanism. In this study the cardiac index was low, but the O_2ER increased. This can be assumed not to have adequate tissue perfusion. The inadequacy of adequate tissue perfusion can be shown from the high average pCO_2gap value (5.93+0.87), where some researchers target <6mmHg as an indicator of adequacy.

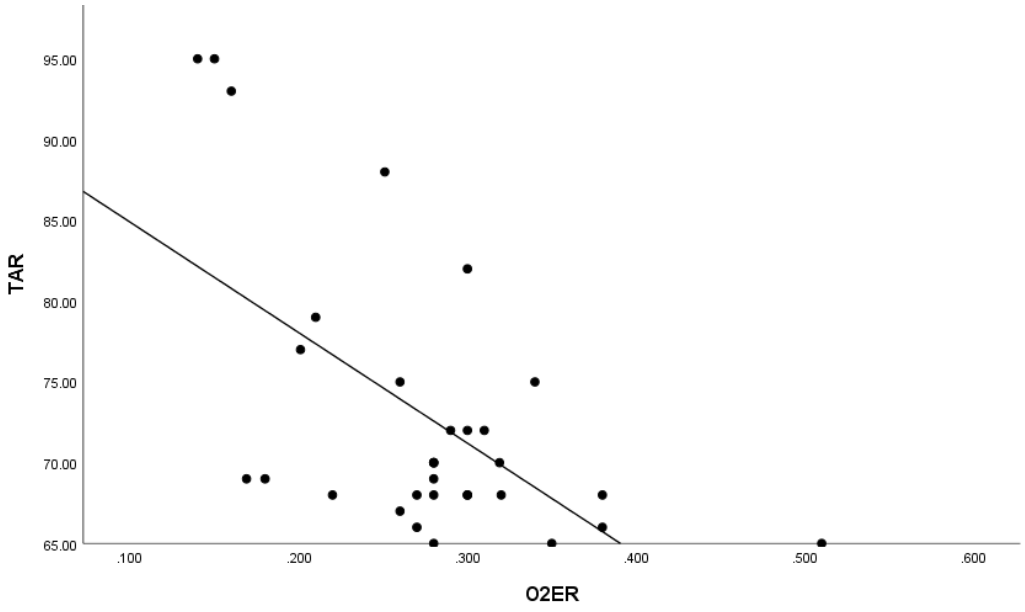

Figure 2. Correlation O_2ER with MAP

The results of the correlation of O_2ER with MAP obtained p=0.006 (p<0.05) meaning that in the 32 samples of this study there was a significant correlation between O_2ER (in the range of 0.15-0.38) and MAP (in the range of 65-90mmHg). The correlation coefficient r = 0.474 is positive, meaning that the higher the MAP, the higher the O_2ER. This is a compensation for the body when hemodilution occurs there will be an increase in MAP to increase the

distribution of blood flow to vital organs such as the heart and brain.

This research is a follow-up study of previous research, namely the relationship between simple ratio extraction and MAP in septic shock patients at Dr Sardjito General Hospital which showed a significant relationship. In this study, cardiac index was added as an independent variable. Several previous studies abroad stated that several conditions were related to high O2ER, namely in conditions of impaired oxygen delivery such as in shock conditions, the things that contributed to this were oxygen (hypoxic hypoxic conditions: low FiO_2, lung disease) impaired. hemoglobin (anemia), impaired contractility, rhythm, afterload, preload and tissue hypoperfusion. Meanwhile, low O_2ER conditions lead to increased oxygen delivery conditions such as hyperoxia (high FiO2), hyperbaric oxygen, and use of ECMO.(10) Figure 1 shows an even distribution of most of the O_2ER data with a negative correlation with the cardiac index, which means that the higher the O_2ER, the lower the cardiac index. This can be explained that in septic shock, the hemodynamics are unstable, causing a decrease in cardiac output and the body is trying to compensate. by increasing O_2ER. Figure 1 shows an even distribution of most of the O_2ER data with a negative correlation with the cardiac index, which means that the higher the O_2ER, the lower the cardiac index. This can be explained. that in septic shock, the hemodynamics are unstable, causing a decrease in cardiac output and the body is trying to compensate.by increasing O_2ER. Figure 1 shows an even distribution of most of the O_2ER data with a negative correlation with the cardiac index, which means that the higher the O_2ER, the lower the cardiac index. This can be explained that in septic shock, the hemodynamics are unstable, causing a decrease in cardiac output and the body is trying to compensate by increasing O_2ER.(9)

The relationship between O_2ER and TAR can be seen in Figure 2 with a negative correlation with an even distribution. In this study, the results showed that the higher the O_2ER value, the lower the MAP value. This can be explained that when tissue hyperfusion occurs, the body will respond by increasing oxygen extraction to the tissues. experienced a

higher incidence of hypotension during hemodialysis.(11)

Vallet B conducted a study of 56 septic shock patients who were resuscitated until they reached an $ScvO_2$ above 70% and found that in patients who had lactate> 2mmol/L and normal $ScvO_2$, there was a difference in the distance between venous and arterial pCO_2 (more than 6mmHg).(12) CO_2 is the end product of anaerobic metabolism and is concentrated in the veins which is one of the features that reflects global tissue blood flow to the needs of metabolic conditions.(13) Consistently Vallet proved that patients with high $cvaCO_2$gap values have lower lactate clearance values and cardiac index, thereby providing a significant decrease in SOFA score compared to conditions with low $cvaCO_2$gap.(12) Thus, the $cvaCO_2$gap is a complementary tool for identifying patients who are inadequately resuscitated once a $ScvO_2$ value of 70% has been achieved. The obvious limitation of $ScvO_2$ makes normal/high values unable to distinguish whether delivery is adequate or exceeds demand.(12) A high $ScvO_2$ profile has even been shown to be associated with increased blood lactate concentrations and lower survival rates. Determining the pCO_2gap during resuscitation of critically ill patients is useful when deciding when to discontinue resuscitation despite strong evidence of organ ischemia and an $ScvO_2$ greater than 70%. Various forms of circulatory pressure have the potential to be associated with hyperlactatemia, but hyperlactatemia is not a discriminatory factor in determining the cause of stress.(14) The goal of a gap lower than 6mmHg can be a useful complementary tool in evaluating the adequacy of blood flow to global metabolic demand. In this case, it helps to titrate inotropic drugs to adjust DO_2 to VO_2, or to choose between correcting hemoglobin or adding infusion of fluids/inotropes. Pierre et al conducted a study in 2014 which stated that a comparison between MAP 65-70mmHg (low target) and 80-85mmHg (high target) in septic shock patients who were in the resuscitation stage found no significant difference in terms of mortality on the 28th or 90th day of hospitalization ICU In the high target group, the rate of new atrial fibrillation events was greater than in the low target group, in addition, patients with chronic hypertension who were in the

high target group used renal replacement therapy less than the low target group, but this was not associated with a difference in incidence death. Leone conducted a critical review of some of the literature, found that the MAP target of 65mmHg was stated to be sufficient in conditions of septic shock, however it was said that the TAR 75-85mmHg could reduce the development of acute kidney failure in patients with a history of chronic hypertension.(15) Montassier conducted a study on base excess as a predictor of increased lactate values in critical patients in the emergency department, it was concluded that base excess is an accurate parameter predicting increased serum lactate.(4) The limitation of this study is that the study was conducted in only one hospital. Data taken from 1 large hospital may not be able to provide an overall picture of the existing situation for the existing problems. In this study, sampling was carried out according to the applicable SOP, namely within 24 hours after the patient entered the ICU. There is heterogeneity in the sampling time within the first 24 hours, while the patient's condition can change at any time, so the results obtained cannot describe the success of the resuscitation carried out.

There is a relationship between O2ER in septic shock patients in the ICU of Sardjito General Hospital and the cardiac index and mean arterial pressure in septic shock patients treated in the ICU of Dr Sardjito General Hospital, Yogyakarta.

CONCLUSION

Anesthesia management of TGA TGA cases is to avoid reducing cardiac output and SVR and keep the PVR lower than the SVR. The administration of an anesthetic regimen for newborns with TGA must consider circulatory and pulmonary physiology and the patient's clinical status.

CONFLICT OF INTEREST

The Authors declare that they have no conflict of interest.

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