Pulse Oximetry Effectivity For Measuring Oxygen Saturation In Hypovolemic Shock Patient Compared To Blood Gas Analysis At Rsup H. Adam Malik Medan

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***Abstract*- Background :** For patients with critical condition, healthcare professional need to asses actual body oxygenation as soon as possible. Until recently, the gold standard of this measurement is with blood gas analysis (BGA). Pulse oximetry is very useful by it's practicable and portable and been expected represent actual body oxygenation condition especially for non-BGA available centre.

Objective : To measure pulse oximetry's oxygen saturation accuracy for patients in shock condition in comparison to gold standard of BGA.

Method : This is an observational study and had collected cohort prospective data to acknowledge pulse oximetry accuracy for patients in shock condition based on Mean Arterial Pressure (MAP) <65mmHg who admitted to emergency unit.

Result : This study include 39 subjects with mean age 53,36 years old, male composition 53,8% and female 46,2%, dominated by MAP>60mHg about 46,2%, MAP 56-60 about 25,6%, MAP 50-55 about 17,9% and MAP<50 about 10,3%. The mean result of peripheral oxygen saturation with pulse oximetry is 93,35±6,51%, in comparison to arterial saturation of BGA about 98,21±3,50%. The group of MAP<50 mmHg, 50-55 mmHg, 56-60mmHg and >60mmHg in shock condition patients ascertain that there is no difference between oxygen saturation based on pulse oximetry compared to BGA, by no statistical significance difference which p>0.05.

Conclusion : Peripheral oxygen saturation based on pulse oximetry in patients with shock condition (MAP < 65mmHg) could represent actual arterial oxygen saturation by BGA as the gold standard.

***Index Terms*-** Pulse oximetry, BGA, Oxygen saturation, mean arterial pressure (MAP), emergency, Peripheral oxygen saturation, Arterial oxygen saturation

I. Introduction

Critical condition need oxygenation measurement as soon as possible. Oxygen partial pressure changing could cause hypoxia and induce vasoactive changing in the brain. In prevention of bad condition to the organ especially brain that could affect the prognosis, routine check of the oxygen saturation is a must. Until now, the mass usual measurement still remain in two, pulse oximetry and blood gas analysis, and the late one, is still the gold standard for this topic.[1,2]

Hypoxemia condition is hard detected, as ideal condition, clinically not significance until oxygen saturation below 80%. Arterial oxygen is oxygen transfer from lung to cell that brought by haemoglobin molecule in red blood cell. Total amount of oxygen in blood include haemoglobin form bond with oxygen (97-98% of total) and oxygen dissolved in plasma (about 2%). Haemoglobin level with oxygen in artery could measured with oxygen saturation (SaO2) as the oxy-haemoglobin (HbO2) compared to haemoglobin total in blood. In intensive care, an inadequate of oxygen to vital organ, put patient in high risk, we must to keep saturation 94% - 96% even with mechanical ventilation. Inaccuracy belief of SPO2 in critical patient is expected, because it's calibration for the healthy patient and could not applicable for critical patient.[3]

For shock condition, imbalance of oxygen transport and consumption could cause higher oxygen use. As critical condition, oxygen extraction with increase of oxygen delivery, and the consumption relate to it's delivery. Clinically venous saturation 5% decrease from normal point 70% indicate that significance decrease at oxygen delivery and or increase demand of oxygen. Venous saturation is also important that it's high level could show tissue inability for using oxygen.[4-6]

Pulse oximetry is very useful because it is practicable and portable and could accompany medical health worker in any condition especially emergency. But for some condition, it is assumed that pulse oximetry could not give representative result

for the actual body oxygenation condition such as shock and low blood pressure. Because it's practical and easy use that could give the best result and benefit for critical condition, we want to acknowledge it's accuracy for that condition we told first such as shock. This study especially discuss about using pulse oximetry for shock patients in emergency room for emergency situation, with mean arterial pressure (MAP) below 65mmHg.[7,8]

II. METHOD

This study is an descriptive analytic study with a cohort prospective design to acknowledge the accuracy of pulse oximetry in emergency room at Haji Adam Malik Hospital Medan. Total sampling is used to represent population which all subjects who come and meet the selection criteria are included in the study until the number of subjects is met. After obtaining approval from the Ethics Committee, Faculty of Medicine, University of North Sumatra, based on inclusion and exclusion criteria 39 research samples were collected. All samples were admitted to emergency room with shock criteria, which MAP below 65mmHg. At the same moment, we measured pulse oximetry at the index finger, blood pressure at the other arm, blood sample was taken from femoral artery. For normally test, we used software SPSS 24. Normal if $p>0.05$, and $p<0.05$ for not normal, we used one way Annova for normally distributed, and kruskal wallis for not normally distributed. Correlation was considered significant if the p value <0.05.

III. RESULT

This study was attended by 39 subjects who met the inclusion criteria. The characteristics of this study were displayed on table 4.1.

Table 4.1 Basic characteristics parameter of subject

Characteristics	**N (%)**
Age, years	53,26±12,176
Gender, n(%)	
Male	21 (53,8)
Female	18 (46,2)
Consciousness, n(%)	
Alert	3 (7,7)
Verbal	9 (23,1)
Pain	26 (66,7)
Unresponsive	1 (2,6)
Systolic blood pressure, mmHg	81,43±8,47
Diastolic blood pressure, mmHg	46,48±8,03
MAP (*Mean arterial pressure)*	
<50	4 (10,3)
50-55	7 (17,9)
56-60	10 (25,6)
>60	18 (46,2)
SpO2, %	93,35±6,51
SaO2, %	98,21±3,50
pH	7,32±0,16
PCO2, mmHg	28,11±9,67
PO2, mmHg	148,23±40,06
HCO3, mEq/l	17,83±10,26
BE	-8,71±10,54

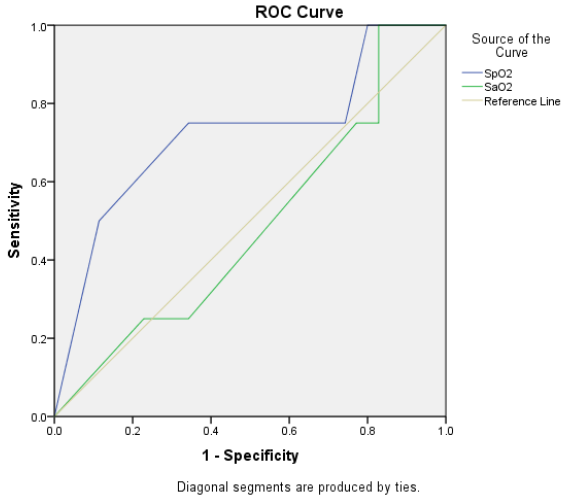
From the analysis, using one way annova and kruskal wallis, we acknowledge that there is no significance difference statistically compared to MAP, for peripheral oxygen saturation by pulse oximetry, arterial oxygen saturation by BGA, pH, PCO2, PO2, HCO3 and Base Excess. The data is showed at table 4.2

Table 4.2 Oxygen saturation difference between pulse oximetry and BGA based on *Mean arterial pressure* (MAP) in shock patient

	Mean Atrial Pressure (MAP)				**Nilai p**
	<50	**50 – 55**	**56 – 60**	**>60**	
SpO2	98,5 (91-99)	88 (82-99)	93 (68-99)	96,5 (82-99)	0,096
SaO2	99 (97,6-100)	99 (79-100)	99 (93-100)	99 (96-100)	0,871
pH	7,27(7,18-7,34)	7,33(6,9-7,56)	7,33(7,26-7,43)	7,35(7,07-7,67)	0,303
PCO2	25,45±7,09	25,28±8,44	27,04±9,74	30,41±10,66	0,581

PO2	136,5±44,32	141,28±49,79	154,36±44,79	150,14±35,01	0,854
HCO3	12,35 (8,5-12,9)	15,3 (4,3-28,4)	12,35 (9,7-34,5)	18,9 (5,60-50,0)	0,313
BE	-15 (-16-(-12,8))	-9,8- (-26,9-4,6)	-12,8-(-17,9-11)	-8,4-(-20,3-24,6)	0,465

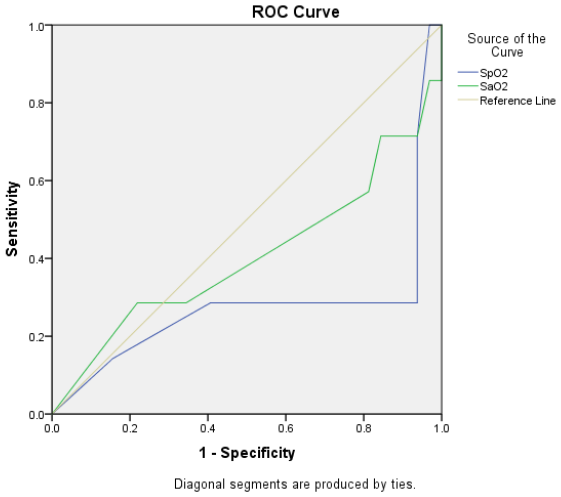
For acknowledge the comparison between SpO2 by pulse oximetry to SaO2 by BGA in measuring oxygen saturation, we used determination test to identify area under curve (AUC) from receiver operating characteristic (ROC) curve, that shown in table 4.3 to 4.6.



50-55 mmHg	
SpO2	**SaO2**
Sen: 28,6%	**Sen: 71,4%**
Spes:6,2%	**Spes:12,5%**
AUC: 0,275	**AUC: 0,406**
Cut off: 82,5%	**Cut off: 97,2%**
p value: 0,065	**p value: 0,442**

Picture 4.1 The Comparison of SpO2 to SaO2 in measuring oxygen saturation for MAP <50

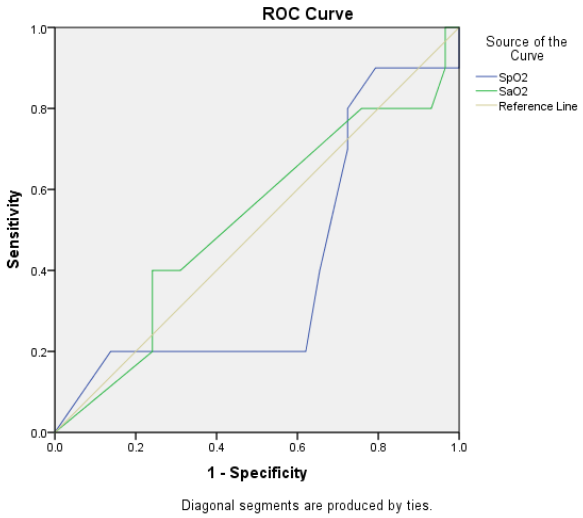
Pulse oximetry could measure oxygen saturation until cut off 96.5% in shock patients with MAP <50 with 75.5% sensitivity and 62.9% specificity with fair relationship (AUC SpO2 0.721) compared to oxygen saturation by BGA in shock patients but there is no significance difference statistically as p>0.05.



MAP < 50 mmHg	
SpO2	**SaO2**
Sen: 75,5%	**Sen: 75,0%**
Spes:62,9%	**Spes:22,9%**
AUC: 0,721	**AUC: 0,486**
Cut off: 96,5%	**Cutoff:98,5%**
p value: 0,151	**p value: 0,926**

Picture 4.2 The Comparison of SpO2 to SaO2 in measuring oxygen saturation for MAP 50-55.

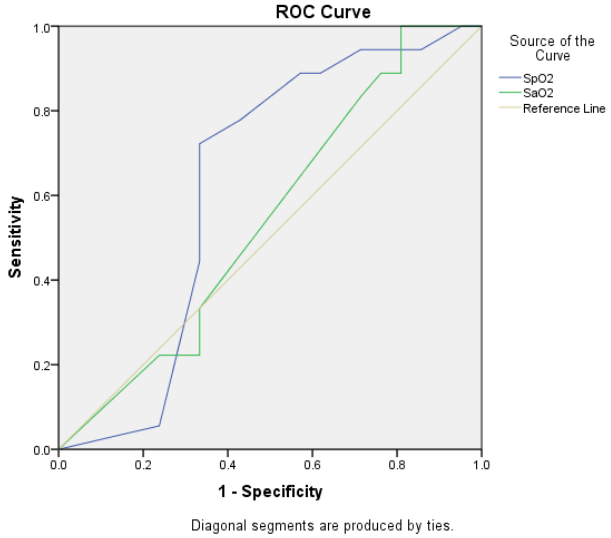
Pulse oximetry could measure oxygen saturation until cut off 82.5% in shock patients with MAP 50-55 with 28.6% sensitivity and 6.1% specificity with no relationship (AUC SpO2 0.275) compared to oxygen saturation by BGA in shock patients but there is no significance difference statistically as p>0.05.



56-60 mmHg	
SpO2	**SaO2**
Sen: 80%	**Sen: 80%**
Spes:27,6%	**Spes:24,1%**
AUC: 0,403	**AUC: 0,522**
Cut off: 91,5%	**Cut off: 98,5%**
p value: 0,368	**p value: 0,834**

Picture 4.3 The Comparison of SpO2 to SaO2 in measuring oxygen saturation for MAP 56-60.

Pulse oximetry could measure oxygen saturation until cut off 98.5% in shock patients with MAP 56-60 with 80% sensitivity and 24.1% specificity with poor relationship (AUC SpO2 0.522) compared to oxygen saturation by BGA in shock patients but there is no significance difference statistically as p>0.05.



>60 mmHg	
SpO2	**SaO2**
Sen: 88,9%	**Sen: 88,9%**
Spes:42,9%	**Spes:23,8%**
AUC: 0,626	**AUC: 0,544**
Cut off: 92,5%	**Cut off: 97,8%**
p value:0,181	**p value:0,642**

Picture 4.4 The Comparison of SpO2 to SaO2 in measuring oxygen saturation for MAP >60.

Pulse oximetry could measure oxygen saturation until cut off 92.5% in shock patients with MAP>60 with 88.9% sensitivity and 42.9% specificity with poor relationship (AUC SpO2 0.626) compared to oxygen saturation by BGA in shock patients but there is no significance difference statistically as p>0.05.

IV. CONCLUSIONS

Based on result and discussion, we conclude that:

1. Pulse oximetry could be used until MAP below 50 mmHg, where the result show no significance difference compared to oxygen saturation by BGA
2. Pulse oximetry could be used as basic for oxygen therapy so decrease mortality risk that caused by late action, in addition, as low as MAP, as much as possible become acidosis
3. Oxygen saturation is still related to microvascular blood flow, noticing also that the measuring could take time more as MAP get lower.

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