Central Venous Oxygen Saturation Is not a Predictor of Extubation Success after Simple Weaning from Mechanical Ventilation in Post-Cardiac Surgical Patients

Kaweesak Chittawattanarat MD, PhD*[1],
Khwannara Kantha MD*[1], Thitipong Tepsuwan MD*[1]

*[1] *Department of Surgery, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand*

Objective: *Central venous oxygen saturation ($ScvO_2$) is a measure of the balance between oxygen delivery and consumption. The purpose of this study was to evaluate whether $ScvO_2$ predict weaning success and extubation in simple weaning post-cardiac surgical patients.*

Material and Method: *We prospective observed critically ill post-cardiac surgical patients who were intubated and mechanically ventilated between December 2011 and October 2014. All enrolled patients underwent a spontaneous breathing trial (SBT) before extubation. Arterial and venous blood gas analysis, and hemodynamic and ventilator variables were recorded at the beginning of SBT (T1) and before extubation (T2). Weaning success was defined as successful extubation after SBT without re-intubation within 48 hours. The area under the receiver characteristic curve (ROC) demonstrated the ability to discriminate weaning success. Statistical significance was defined as $p<0.05$.*

Results: *A total 121 patients were included. Of these, 18 patients (15%) were re-intubation within 48 hours after extubation. There was no statistically significance in age, gender, and type of operations between those who were extubated successfully and those who were re-intubated within 48 hours. Regarding hemodynamic and respiratory parameters, the significant differences were found only in partial arterial oxygen pressure (PaO_2; $p = 0.048$) and PaO_2 to oxygen fraction ratio (PF ratio; $p=0.048$) at T1. There was no difference between the groups in $ScvO_2$ at either T1 or T2. The area under the ROC (95% confidence interval) of $ScvO_2$ was 0.60 (0.47-0.74) and 0.53 (0.39-0.66) at T1 and T2, respectively. Although $ScvO_2$ was combined with rapid shallow breathing index (RSBI), PF ratio and minute volume on the regression model at both T1 and T2, the discrimination ability was not significant increased.*

Conclusion: *$ScvO_2$ or its combination with RSBI, PF ratio and minute volume does not predict successful weaning from mechanical ventilators and extubation in critically ill post-cardiac surgical patients.*

Keywords: *Central venous oxygen saturation, Mechanical ventilator, Weaning, Re-intubation*

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Based on a survey of intensive care units (ICUs) in Thailand, the prevalence of mechanical ventilation is at least 60%[1]. The weaning process is the strategy to decrease mechanical support and to select patients who canbe liberated from MV and extubated. During this process, while the oxygen demand increased, the oxygen delivery decreased[2]. This could lead to imbalance between oxygen supply and utilization. Many clinical symptoms occur during this phase e.g. tachycardia, tachypnea, hypo/hypertension or acidosis. In addition, many parameters are used to predict successful weaning, including rapid shallow breathing index (RSBI), maximum minute volume, and negative inspiratory force[3]. Based on the Fick principle, cardiac output is the oxygen uptake divided by the difference of the arterial and mixed venous oxygen content[4]. De Backer et al studied the relative changes in the cardiac index and oxygen extraction ratio during weaning in patients after cardiovascular surgery[5]. In addition, Teixeira et al found the central venous oxygen saturation ($ScvO_2$) was an early and independent predictor of extubation failure and suggested that might be incorporated into weaning protocols for difficult to wean patients[6]. Regarding the post cardiac surgical patient, to the best

Correspondence to:
Chittawatanarat K, Department of Surgery, Faculty of Medicine, Chiang Mai University, Chiang Mai 50200, Thailand.
Phone: +66-53-935533, Fax: +66-53-936139
E-mail: kchittaw@gmail.com

of our knowledge, there have been no studies which demonstrate the role of $ScvO_2$ in weaning success and extubation. Therefore, the objective of this study was to evaluate the ability of $ScvO_2$ to predict weaning success and extubation in simple weaning post-cardiac surgical patients.

Material and Method

The present study was a prospective observational study. We studied patients who were admitted to the cardiovascular surgical ICU at the Maharaj Nakorn Chiang Mai Hospital from December 2011 to October 2014. All enrolled patients provided informed written consent before start this study. The inclusion criteria were cardiovascular disease patients who had received mechanical ventilation, who had a central venous catheter in place and who fulfilled the weaning criteria allowed by weaning protocol of this hospital. Cardiovascular disease as defined as 1) underlying heart disease such as ischemic heart disease, coronary heart disease, valvular heart disease, cardiac arrthymia or heart failure, and 2) perioperative or postoperative cardiovascular problem. Exclusion criteria were as follows: age <18 years old, tracheostomized patients, self-extubation, patients with severe neuromuscular pathology and patients that had previous re-intubation, and difficult to wean patient (defined as failure to tolerate the first 2-hour, spontaneous breathing trial), because the study enrolled only the simple wean patients. This study was approved by the Ethic Committee, Faculty of Medicine, Chiang Mai University.

Weaning protocol, data collection and outcomes

The weaning from mechanical ventilator was undergone by the institutional protocol as the previous report[7]. In summary, after a patient met the criteria of being ready to wean which included stable hemodynamic, no receiving high vasopressor and inotropic drug, and no anemia or need for a high volume of blood transfusion, a spontaneous breathing trial (SBT) using low pressure support ventilation (PSV) of 7 cm H_2O and positive end expiratory pressure (PEEP) up to 5 cm H_2O or T pieces method of 10 liters per minute for a duration up to 30 to 120 minute. The success of SBT was defined as rapid, shallow breathing index (RSBI, ratio of respiratory rate and tidal volume in liter) <105, pulse oximetry (SpO_2) >90%, respiratory rate <30 per minute, pulse rate <120 per minute or >50 per minute or change <20% of baseline, and systolic blood pressure <160 mmHg or >90 mmHg. Of the patients who passed the SBT were those who had a forceful cough when suction and alert were extubated. The patients who failed on the SBT obtained the full respiratory support, and were treated to find the possible cause of failing SBT. These patients underwent the SBT again the next day or after resolving the causes. Demographic data, principle of diseases and type of surgery were recorded. Arterial and venous gas analysis including $ScvO_2$, hemodynamic and ventilator variables were recorded at the beginning of the SBT (T1) and before extubation (T2). The primary outcome of this study was re-intubation in 48 hour after extubation.

Statistical analysis

The authors analyzed the data by STATA software (version 11.0, STATA Inc., College Station, Tx). For continuous variable, the Student's t-test for normal distribution data which was reported as mean andstandard deviation (SD), and the Mann-Whitney U test which was reported as median and inter-quartile range (IQR). For categorical variables, the Chi-square or Fisher's exact test were used. We used receiver-operating characteristic (ROC) plots and ROC area or a c statistic to assess the ability of $ScvO_2$ to discriminate re-intubation after extubation. The report of this was the area under ROC and 95 percent confidence interval (95% CI). Statistical significant was defined as $p<0.05$

Results

There were 1512 patients admitted to the ICU from December 2011 to October 2014. Of these, 1,388 patients were excluded from the study because 960 patients were under 18 years old, 29 patients had been re-intubated, 7 patients extubated themselves. 4 patients had tracheostomies, and 388 had not provided an informed consent because they refused or they were unable to provide the consent (Fig. 1).

After excluding the incomplete record, 121 patients were included in this analysis. Of these, 18 patients (15%) were re-intubated within 48 hours after extubation. There were no differences between groups in term of age, sex, body weight, height, body mass index, ICU diagnosis or types of surgery (Table 1). All the enrolled patients were successfully extubated within 24 hours after cardiac surgery and post-operative ICU admission. Difficulties to wean patients were not included in this study.

There were no significant differences between the groups in hemodynamic or ventilator variables on T1, T2, and change between T1 and T2 (T2-T1), except partial arterial oxygen pressure (mean PaO_2±SD in success group vs. re-intubated group: 158.43±42.16 vs. 137.33±35.77; p = 0.048) and PaO_2 to oxygen fraction ratio (mean PF ratio±SD in success group vs. re-intubated group: 396.07±105.40 vs. 343.33±89.42; p = 0.048) at T1. There were no significant differences between the groups in $ScvO_2$ at either T1 or T2 (Table 2).

The performance of $ScvO_2$ to predict successful weaning, in the area under the ROC (95% CI) of $ScvO_2$ was 0.60 (0.47 -0.74) and 0.53 (0.39-0.66) at T1 and T2, respectively (Table 3). Although $ScvO_2$ was combined with rapid shallow breathing index (RSBI), PF ratio and minute volume at both T1 and T2 in the regression model to predict successful weaning, the discrimination ability was not significant increased (Table 3).

Of these 18 patients who were re-intubated, all could be extubated after medical treatment several days after re-intubation, and discharged from hospital without mortality.

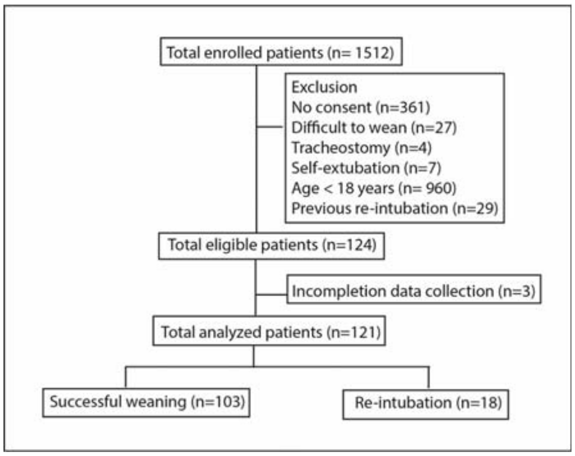

Fig. 1 Study flow.

Discussion

This study was evaluated the role of $ScvO_2$ to predict weaning and extubation success in post-operative cardiac surgical patients. The rationale of relating $ScvO_2$ to these events could be explained by the physiologic changes on oxygen utilization during weaning process and the Fick's principle related to oxygen delivery and oxygen demand. During the weaning process, the alveolar pressure and pleural pressure decreased. These lead to changing cardiac performance. Teixeira et al found that these changes of cardiac output might increase more than 10% in cardiovascular surgical patients[5]. In post-operative cardiac surgical patients, the cardiac function is decreases[8,9]. These effects might persist for at least

Table 1. Demographic data

	All (n = 121)	Success (n = 103)	Re-intubation (n = 18)	*p*-value
Age in year (IQR)	59 (51-66)	59 (49-66)	59.5 (55-68)	0.512
Male (%)	60 (49.59)	52 (50.49)	8 (44.44)	0.636
Body weight in kg (SD)	57.89 (12.26)	57.72 (12.01)	58.89 (13.92)	0.710
Height in cm (SD)	157.09 (9.41)	156.61 (9.83)	157.09 (9.41)	0.844
Body mass index(SD)	23.29 (3.38)	23.19 (3.28)	23.83 (3.95)	0.459
Principle of disease (%)				
Coronary artery diseases	60 (49.59)	51 (49.51)	9 (50.00)	0.714
Valvular heart diseases	44 (36.36)	38 (36.89)	6 (33.33)	
Aortic diseases	9 (7.44)	8 (7.77)	1 (5.56)	
Atrial septal defect (ASD)	2 (1.65)	2 (1.94)	0 (0.00)	
Ventricular septal defect (VSD)	6 (4.96)	4 (3.88)	2 (11.11)	
Type of surgery (%)				
Coronary artery bypass	60 (49.59)	51 (49.51)	9 (50.00)	0.970
Repair ASD	6 (4.96)	4 (3.88)	2 (11.11)	0.192
Repair VSD	2 (1.65)	2 (1.94)	0 (0.00)	0.551
Mitral valve surgery	37 (30.58)	33 (32.04)	4 (22.22)	0.404
Tricuspid valve surgery	11 (9.09)	10 (9.71)	1 (5.56)	0.572
Aortic valve surgery	20 (16.53)	17 (16.50)	3 (16.67)	0.986
Thoracic aortic surgery	9 (7.44)	7 (6.80)	2 (11.11)	0.520

Table 2. Predictive variables on weaning success

Mean (SD)	All (n = 121)	Success (n = 103)	Re-intubation (n = 18)	*p*-value
RR, per minute				
T1	15.50 (3.92)	15.41 (3.66)	16.06 (5.29)	0.520
T2	19.68 (9.67)	19.69 (10.20)	19.61 (5.89)	0.975
Change	4.17 (9.78)	4.28 (10.29)	3.56 (6.28)	0.773
SBP, mmHg				
T1	115.46 (12.46)	115.05 (12.03)	117.78 (14.84)	0.393
T2	116.46 (12.62)	116.16 (12.66)	118.17 (12.56)	0.535
Change	1 (14.60)	1.11 (14.61)	0.38 (13.98)	0.847
DBP, mmHg				
T1	64.44 (9.03)	64.52 (9.35)	63.94 (7.16)	0.803
T2	62.41 (9.43)	62.56 (9.82)	61.56 (6.95)	0.677
Change	-2.03 (9.29)	-1.96 (9.76)	-2.39 (6.14)	0.858
MAP, mmHg				
T1	82.64 (10.90)	82.59 (10.77)	82.93 (11.97)	0.905
T2	80.09 (8.75)	80.12 (8.77)	79.91 (8.88)	0.925
Change	-2.55 (6.82)	-2.47 (6.64)	-3.02 (7.99)	0.756
HR, per minute				
T1	83.39 (16.36)	83.25 (16.24)	84.17 (17.51)	0.828
T2	84.69 (15.40)	84.91 (15.50)	83.44 (15.23)	0.711
Change	1.31 (6.61)	1.66 (6.34)	-0.72 (7.89)	0.159
TV (mL)				
T1	483.48 (81.63)	480.97 (81.54)	497.83 (82.97)	0.421
T2	447.73 (85.74)	449.41 (89.04)	438.11 (64.79)	0.608
Change	-35.75 (75.88)	-31.56 (74.30)	-59.72 (82.50)	0.147
MV (L/min)				
T1	7.47 (2.20)	7.37 (1.99)	8.06 (3.14)	0.220
T2	8.88 (5.02)	8.94 (5.33)	8.53 (2.69)	0.754
Change	1.41 (5.13)	1.57 (5.39)	0.48 (3.22)	0.405
$ScvO_2$				
T1	66.24 (7.87)	66.64 (8.06)	63.94 (6.40)	0.181
T2	66.46 (7.51)	66.55 (7.76)	65.89 (6.01)	0.731
Change	0.22 (5.14)	-0.09 (5.20)	1.94 (4.49)	0.122
pH				
T1	7.42 (0.07)	7.42 (0.07)	7.41 (0.07)	0.738
T2	7.42 (0.06)	7.42 (0.06)	7.43 (0.04)	0.837
Change	0.01 (0.05)	0.00 (0.04)	0.01 (0.06)	0.426
PaO_2				
T1	155.29 (41.82)	158.43 (42.16)	137.33 (35.77)	0.048
T2	147.44 (35.22)	149.29 (35.06)	136.83 (35.21)	0.167
Change	-7.85 (27.59)	-9.14 (28.94)	-0.5 (16.75)	0.222
$PaCO_2$				
T1	35.48 (4.91)	35.52 (5.12)	35.22 (3.62)	0.811
T2	36.10 (4.19)	36.11 (4.26)	36.06 (3.92)	0.962
Change	0.62 (3.77)	0.58 (3.72)	0.83 (4.16)	0.796

T1, at the beginning of spontaneous breathing trial; T2, at before extubation; Change, T2 – T1; RR, respiratory rate; SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure; HR, heart rate; TV, tidal volume; MV, minute volume; $ScvO_2$, central venous oxygen saturation; PaO_2, arterial partial pressure of oxygen; $PaCO_2$, arterial partial pressure of carbon dioxide; HCO_3, bicarbonate; PF ratio, arterial partial pressure of oxygen and fraction of oxygen ratio; RSBI, rapid shallow breathing index (RR (per min)/TV (L)

Table 2. Cont.

Mean (SD)	All (n = 121)	Success (n = 103)	Re-intubation (n = 18)	*p*-value
HCO_3				
T1	23.20 (2.87)	23.20 (2.85)	23.20 (3.05)	0.997
T2	23.61 (2.71)	23.59 (2.76)	23.74 (2.45)	0.833
Change	0.42 (2.02)	0.40 (2.03)	0.54 (1.97)	0.781
O_2 saturation				
T1	99.62 (0.85)	99.63 (0.87)	99.56 (0.71)	0.729
T2	99.46 (0.81)	99.45 (0.79)	99.50 (0.92)	0.797
Change	-0.17 (0.79)	-0.19 (0.83)	-0.06 (0.54)	0.525
PF ratio				
T1	388.23 (104.56)	396.07 (105.40)	343.33 (89.42)	0.048
T2	368.60 (88.05)	373.24 (87.65)	342.08 (88.03)	0.167
Change	-19.63 (68.97)	-22.84 (72.35)	-1.25 (41.86)	0.222
RSBI				
T1	33.14 (10.64)	33.19 (10.58)	32.84 (11.28)	0.896
T2	45.06 (21.82)	44.91 (22.79)	45.91 (15.59)	0.858
Change	11.92 (20.52)	11.71 (21.31)	13.08 (15.65)	0.796

Table 3. Performance of $ScvO_2$ with and without other weaning index

	ROC area	95% confidence interval	*p*-value
Before SBT (T1)			
$ScvO_2$	0.605	0.468-0.742	Reference
$ScvO_2$ and RSBI	0.598	0.461-0.734	0.596
$ScvO_2$ and PF ratio	0.659	0.521-0.796	0.476
$ScvO_2$ and minute volume	0.592	0.431-0.753	0.826
Before extubation (T2)			
$ScvO_2$	0.527	0.389-0.665	Reference
$ScvO_2$ and RSBI	0.528	0.392-0.753	0.959
$ScvO_2$ and PF ratio	0.604	0.447-0.760	0.406
$ScvO_2$ and minute volume	0.515	0.380-0.650	0.827

$ScvO_2$, central venous oxygen saturation; PF ratio, arterial partial pressure of oxygen and fraction of oxygen ratio
RSBI = rapid shallow breathing index

30 days after on-pump cardiac surgery[8]. These result in the risk of cardiac failure during the weaning process. Based on the Fick principle, the cardiac output could be reflexed by the difference of the arterial and mixed venous oxygen content[10]. Because of difficulty in placing a pulmonary catheter, the $ScvO_2$ had been suggested as a substitution. The value of $ScvO_2$ and mixed venous oxygen were comparable in the previous study, which demonstrated correlation (r = 0.81)[11]. Currently, $ScvO_2$ is used as an end point of resuscitation in sepsis[12]. In addition, reductions in $ScvO_2$ are independently associated with post-operative complications[13].

Regarding the role of $ScvO_2$ in weaning from MV, de Backer et al reported the cardiovascular response to weaning from MV may vary according to the type of surgery[5]. Although there was no statistical significant difference in oxygen extraction, it may be slightly greater in cardiac surgical patients[5]. In addition, the weaning methods are also an important predictor of arterio-venous oxygenation difference. Lovas et al reported that weaning via T-piece improved oxygenation and resulted in increased $ScvO_2$ as compared to weaning on the pressure support mode[14].

Teixeira et al reported a reduction of $ScvO_2$ more than 4.5% during weaning process which was an independent predictor of re-intubation in difficult to wean patients (defined as failure to tolerate the first 2 hour of T tube trial)[6]. However, the $ScvO_2$ did not predict re-intubation within 48 hours in post-cardiac surgical patient in the present study. There are several reasons for these results. First, the present study selected only the simple wean patients. The re-intubation rate in this patient was lower (15% by present study) than the difficult wean patient mentioned in the previous study (42.5% by Teixeira et al)[6]. Second, the use of $ScvO_2$ is a time-dependent factor and its predictive ability is related to the decline in diaphragm function[15]. The impact of prolonged mechanical ventilation in early stages decreases diaphragmatic blood flow and induces an oxygen supply-demand imbalance in the diaphragm[15,16]. Regarding this study, all patients obtained very short period on MV. They were weaned and extubated within 24 hours after cardiac surgery. In addition, the difficult to wean patients were excluded. Therefore, the impact of $ScvO_2$ in our setting did not demonstrate the discrimination ability compared to the study by Teixeira et al (AUC-ROC in our study vs. Teixeira: 0.527 vs. 0.870)[6].

On the combination of indexes used to predict weaning outcome, Yang et al reported the RSBI was the most accurate predictor for weaning success[3]. In addition, the authors found a significant difference of PF ratio between the groups. Regarding the regression model of re-intubation, the authors did not find any significant discrimination together with or without those predictors on both time periods as well as with or without $ScvO_2$ (Table 3).

There were some inevitable limitations. First, the incidence of re-intubation rate in these patients (15%) was lower than the previous study which demonstrated the role of $ScvO_2$ as a predictor of weaning success (42.5%)[6]. Second, although the total number of eligible cases was high before initiation of the study, most patients were excluded because of failure to obtain consent. Third, the present study included only adult patients. The interpretation of the role of $ScvO_2$ results is not applicable to pediatric or young adults <18 years. Finally, the authors did not collect any respiratory and hemodynamic variables such as respiratory muscle weakness, work of breathing, cardiac output and oxygen extraction ratio (O_2ER) due to equipment limitation. However, the results of discrimination ability of $ScvO_2$ and O_2ER were comparable to the previous study (AUC-ROC of $ScvO_2$ vs. O_2ER: 0.87 vs. 0.85)[6].

Conclusion

$ScvO_2$ or its combination with RSBI, PF ratio and minute volume could not be an accurate predictor for weaning success from mechanical ventilation in simple weaning post-cardiac surgical patients.

What is already known on this topic?

The $ScvO_2$ might be an important role on the difficult weaning patients and demonstrate the discrimination ability is high for re-intubation predictor when alteration of $ScvO_2$ more than 4.5%. However, the role of $ScvO_2$ on the simple weaning patients in post-operative cardiac surgical patients still did not know.

What this study adds?

The study demonstrated the $ScvO_2$ did not add the discrimination ability for re-intubation in simple weaning patients whether with or without other predictor of weaning index.

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Potential conflicts of interest

Some parts of this study was presented as the posture presentation in 12th Congress of the World Federal Society of Intensive and Critical Care Medicine (WFSICCM) Seoul, 29th August to 1st September 2015 (Abstract No. WFSICCM-0223).

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ความอิ่มตัวของออกซิเจนในหลอดเลือดดำส่วนกลางไม่สามารถใช้พยากรณ์ความสำเร็จของการถอดท่อช่วยหายใจหลังจากการหย่าเครื่องช่วยหายใจสำเร็จในผู้ป่วยหลังผ่าตัดหัวใจที่หย่าเครื่องช่วยหายใจที่ไม่ซับซ้อน

กวีศักดิ์ จิตตวัฒนรัตน์, ขวัญนรา กันทา, ฐิติพงศ์ เทพสุวรรณ

ภูมิหลังและวัตถุประสงค์: *ความอิ่มตัวของออกซิเจนในหลอดเลือดดำส่วนกลางเป็นตัวแปรของความสมดุลของออกซิเจนที่ได้รับและที่ใช้ไป การศึกษานี้เพื่อประเมินความสามารถในการพยากรณ์ของความอิ่มตัวของออกซิเจนในหลอดเลือดดำส่วนกลาง ต่อความสำเร็จการของหย่าเครื่องช่วยหายใจและการถอดท่อช่วยหายใจในผู้ป่วยหนักหลังผ่าตัดหัวใจ*

วัสดุและวิธีการ: *ผู้นิพนธ์ทำการศึกษาแบบสังเกตการณ์ผู้ป่วยหนักหลังผ่าตัดหัวใจที่ได้ทำการใส่ท่อช่วยหายใจและใช้เครื่องช่วยหายใจระหว่างเดือนธันวาคม พ.ศ. 2554 ถึง ตุลาคม พ.ศ. 2557 ผู้ป่วยทุกรายเข้าสู่ขบวนการหย่าเครื่องช่วยหายใจก่อนการถอดท่อช่วยหายใจ ผลการตรวจวิเคราะห์ก๊าซในเลือดจากหลอดเลือดแดง หลอดเลือดดำ พลศาสตร์ของไหลเวียน การหายใจ ได้รับการบันทึกในช่วงของการเริ่มต้นการหย่าเครื่องช่วยหายใจ (T1) และก่อนการถอดท่อหายใจ (T2) ผู้ป่วยที่ทำการหย่าเครื่องช่วยหายใจสำเร็จ คือ สามารถถอดท่อช่วยหายใจโดยไม่มีการใส่ท่อช่วยหายใจซ้ำภายใน 48 ชั่วโมง พื้นที่ใต้กราฟ ROC ใช้สำหรับการประเมินความสามารถในการแยกความสำเร็จดังกล่าว ความแตกต่างอย่างมีนัยสำคัญกำหนดเมื่อ p<0.05*

ผลการศึกษา: *ผู้ป่วยจำนวน 121 คนเข้าสู่การศึกษา ผู้ป่วยจำนวน 18 คน (ร้อยละ 15) ได้รับการใส่ท่อช่วยหายใจซ้ำภายใน 48 ชั่วโมง หลังจากถอดท่อช่วยหายใจ ไม่มีความแตกต่างกันในอายุ เพศ ชนิดของการผ่าตัดระหว่างกลุ่ม เมื่อพิจารณาถึงพลศาสตร์ของการไหลเวียนเลือด การหายใจไม่มีความแตกต่างกัน ยกเว้นปริมาณความดันออกซิเจนในเลือด (PaO_2; p = 0.048) และสัดส่วนของความดันออกซิเจนในเลือดต่อความเข้มข้นของออกซิเจนที่หายใจ (PF ratio; p = 0.048) ในช่วง T1 ไม่มีความแตกต่างของความอิ่มตัวของออกซิเจนในหลอดเลือดดำส่วนกลางระหว่างกลุ่มทั้ง T1 และ T2 พื้นที่ใต้กราฟ receiving operator characteristic curve (ร้อยละ 95 ความเชื่อมั่น) ของความอิ่มตัวของออกซิเจนในหลอดเลือดดำส่วนกลางที่ T1 และ T2 คือ 0.60 (0.47-0.74) และ 0.53 (0.39-0.66) ตามลำดับ แม้ว่าจะมีการนำความอิ่มตัวของออกซิเจนในหลอดเลือดดำส่วนกลางร่วมกับค่า RSBI, สัดส่วน PF และปริมาตรของอากาศที่ใช้ต่อนาทีทั้งในช่วง T1 และ T2 ความสามารถในการแยกแยะก็ไม่มีความแตกต่าง*

สรุป: *ความอิ่มตัวของออกซิเจนในหลอดเลือดดำส่วนกลางหรือการร่วมกับ RSBI, สัดส่วน PF และ ปริมาตรของอากาศที่ใช้ต่อนาทีไม่สามารถใช้ในการพยากรณ์ความสำเร็จของการหย่าเครื่องช่วยหายใจและถอดท่อช่วยหายใจในผู้ป่วยหนักหลังผ่าตัดหัวใจได้*