Sapporo Medical Journal
Volume 55, Issue 07, July 2021

The Influence of Perioperative Factors Towards In-Hospital Mortality on Tetralogy of Fallot Patients After Total Correction Repair

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Abstract— Purpose: To identify various perioperative factors that could affect early mortality in Tetralogy of Fallot (TF) patients after the total correction procedure. Method: This retrospective cohort study used a cross-sectional design using secondary data from medical records of TF patients who underwent total correction procedures at Dr. Soetomo Academic General Hospital, Surabaya, Indonesia from August to September 2019. The study outcomes were a single risk factor or concomitant risk factor that affected the mortality rate during post-total correction treatment of TF patients. Results: Forty-two patients undergoing total repair surgery during the study period, this study had a mortality rate of 33.3% (14 patients). Univariate analysis reveals factors influencing mortality namely age <24 months (OR=15.0, p=0.02), weight <10 kgs (OR=6.25, p=0.025), SaO2 <75% (OR=12.833, p=0.013), HCT >65% (OR=4.5, p=0.049), ventilator time >48 hours (OR=4.5, p=0.031), Fever (OR=50, p=<0.001), residual PS (OR=14, p=0.021), residual VSD (OR=16.1, p=0.003), VIS (OR=59.8, p=<0.001). Conclusion: In our study, we found variables that influenced mortality rate in univariate analysis. A cardiac surgeon can take this into contemplation while choosing the best option for the patient by seeing these perioperative factors to reduce the mortality rate in TF cases after total repair.

Keywords: Mortality rate, Perioperative Factors, Tetralogy of Fallot, Total Correction

1. Introduction

Tetralogy of Fallot (TF) is a common cyanotic congenital heart disease with an incidence rate of three per 10,000 live births and contributes 5-10% of all congenital heart disease.[1,2] Since the first palliative TF surgery by Blalock and Taussig in 1945, surgical techniques have evolved into a total correction that could be performed safely in all age groups. Total repair is a routine procedure and standard of care in TF with a low mortality rate ranging from 0-2% in all age groups, including neonates.[3]

Medical centers in developed countries have conducted successful total correction procedures with no early mortality. However, the mortality rate still ranges from 6.9-15.3% in developing countries.[4,5] On the other hand, total correction surgery does have complications such as hypoxemia, arrhythmias, cardiac dysfunction, sudden death, decreased functional capacity, and valvular disorders. In addition, the morbidity and mortality rate in an intensive care unit (ICU) are still relatively high after the total correction of TF repair.[6]

Reducing mortality rate mainly after post-total correction of TF is related to preoperative preparation, reflecting improvements in surgical preparation and postoperative care following a learning curve. The largest cardiac surgery center in Indonesia, Harapan Kita Hospital, Jakarta, reported a 3.9% mortality rate (29/733 cases) of TF patients who underwent a total correction from January 2013-December 2017, especially in patients who underwent transannular patch procedures (89.65 %).[7]

This study aims to identify various perioperative factors that could affect early mortality in TF patients after total correction procedure.

2. Materials and Methods

Study design

This study was a retrospective analytic study with a cross-sectional design using secondary data from patients' medical records at Dr. Soetomo Academic General Hospital, Surabaya, Indonesia from August to September 2019.

Study sample

The study population was secondary data from medical records of TF patients who underwent total correction procedure (primary correction) from January 2016 to September 2019 at Dr. Soetomo Academic General Hospital, Surabaya, and secondary data from the database of our department of Airlangga University. The study sample was our patients who met inclusion and exclusion criteria, with the total sampling technique without randomization.

The study inclusion criteria included all TF patients who underwent total correction procedure (primary correction). The study exclusion criteria included:

- Past palliative surgery history
- History of preoperative hypercyanotic spell
- History of preoperative minimally invasive procedures
- Incomplete medical record data

Statistical analysis

We compiled the collected data from each documented independent and dependent variable, processed it, and presented it in tabular form. Furthermore, We performed descriptive statistical analysis on each variable in the form of median ± interquartile range (IQR).

Data analysis in the form of univariate logistic regression and multivariate logistic regression were used to identify mortality risk factors. Univariate logistic regression analysis was used to assess the single mortality predictor. If the significance test result was <0.25, the variable was included for multivariate analysis. The results of the multivariate analysis were considered significant if $p \leq 0.05$ with a 95% confidence interval. Statistical analysis was performed using SPSS software version 20 (SPSS, Inc., Chicago, IL, USA) for Windows. The study outcomes were single or concomitant risk factors that affected mortality rate during post-total correction treatment of TF patients.

3. Results

Sample characteristics

A total of 49 patients had undergone the total correction procedure. From 49 patients, one patient with an incomplete medical record and six patients who had undergone previous BT shunt procedures were excluded, leaving 42 patients who could be included in this study. From a total sample of 42 patients, 14 patients died during hospitalization (33.3%), with the most common cause being sepsis with seven patients (50%). We sorted patients' data into three main variable groups: preoperative, intraoperative, and postoperative variable groups. The sample characteristics are described in Table 1.

Table 1. Characteristics of TF patients who underwent total correction

Variable	Total	Outcome				P
		Survived	%	Died	%	
Preoperative						
Age (median, IQR)	55 (110)	945 (105)		26.5 (49)		
≤24 months	6	1	17	5	83	0.011*
>24 months	36	27	75	9	25	
Weight (median, IQR)	14.7 (15.3)	18,1 (15.8)		11.4 (5.9)		
≤10 kg	9	3	34	6	66	0.041*
>10 kg	33	25	76	8	24	
McGoon(median, IQR)	2 (0.48)	2.0 (0.62)		1.9 (0.45)		

<1.7	8	6	75	2	25	0.697
≥1.7	34	22	65	12	35	
O_2 saturation(median, IQR)	80.5 (11)	83 (8)		74 (20)		
≥85 %	13	11	85	2	15	0.019*
75–85 %	19	14	74	5	26	
<75 %	10	3	30	7	70	
Haematocrit (median, IQR)	47.6 (19.9)	43.4 (10.3)		55.4 (19.5)		
<65 %	32	24	75	8	25	0.059
≥65 %	10	4	40	6	60	
Comorbid						
Present	18	13	72	5	28	0.742
Absent	24	15	63	9	38	
Intraoperative						
Aortic Cross-Clamp (AOX) time(median, IQR)	79,5 (28)	74 (27)		90 (20)		
<90 minutes	29	22	75.86	7	24	0.082
≥90 minutes	13	6	46.15	7	54	
Cardiopulmonary bypass (CPB) time (median, IQR)	139 (30)	132 (24)		141 (31)		
<120 minutes	5	5	100	0	0	0.151
≥120 minutes	37	23	62.16	14	38	
Modified Ultrafiltration (MUF)						
Yes	5	4	80	1	20	0.65
No	37	24	64.86	13	35	
Post-operative						
Ventilator time (median, IQR)	25 (72)	23.5 (60)		85 (69)		
<48 hours	25	20	80	5	20	0.045*
≥48 hours	17	8	47.06	9	53	
Length of ICU stay (median, IQR)	3.7 (4)	3.44 (6)		4.98 (6)		
<7 days	33	23	69.7	10	30	0.451
≥7 days	9	5	55.56	4	44	
Fever(median, IQR)	37.5 (2.7)	37 (1.1)		39,8 (1.3)		
≤38°C	27	25	92.59	2	7	<0.001*
>38°C	15	3	20	12	80	
Residual Pulmonary Stenosis (PS)						
None-mild	19	18	94.74	1	5	<0.001*
Moderate	16	9	56.25	7	44	
Severe	7	1	14.29	6	86	
Residual Pulmonary Regurgitation (PR)						
None-mild	25	19	76	6	24	0.171
Moderate	16	8	50	8	50	
Severe	1	1	100	0	0	
Vasoactive-Inotropic Score (VIS) (median, IQR)	15 (22.5)	13 (8.4)		32.8 (8.9)		

<20	24	23	95.83	1	4	<0.001*
≥20	18	5	27.78	13	72	
Residual Ventricular Septal Defect (VSD)						
None	25	23	92	2	8	<0.001*
≤2 mm	12	5	41.67	7	58	
>2 mm	5	0	0	5	100	
Other complication						
Present	35	22	62.86	13	37	0.392
Absent	7	6	85.71	1	14	

ICU: Intensive Care Unit

From the preoperative-variable group in Table 1, we found that ≤24 months patients had a significantly higher mortality rate than older patients (p=0.011). In patients weighing ≤10 kg, the mortality rate was 66%. Remarkably, this value was different from the mortality rate of patients weighing >10 kg (p=0.041). In the preoperative-variable group, the mortality rate was significantly higher in the group with lower preoperative blood gas saturation (SaO2), especially patients with SaO2 <75% (p=0.019).
In the intraoperative-variable group, we found no significant differences in mortality rates in AOX time <90 or >90 minutes, CPB time <120 or >120 minutes, and patients who received muffing procedure or not after being removed from the CPB machine.
In the postoperative variable group, ventilator time, fever, residual PS (pulmonary stenosis), vaso-inotropic score, and residual VSD showed significant differences between several patients who survived and died, with p=0.045; p=<0.001; p=0.001; p<0.001; and p<0.001, respectively.

Preoperative variable group analysis
Respectively, the result of univariate analysis in the preoperative-variable group regarding mortality rate showed that age, weight, preoperative SaO2, and hematocrit significantly affected mortality rate, with significance values and odds ratios (OR) of p=0.02 – OR=15; p =0.025 – OR=6.25; p=0.013 – OR=12.833; and p=0.049 – OR=4.5. In the multivariate analysis, there were no preoperative variables that concomitantly affected the mortality rate. The results of univariate and multivariate analysis are described in Table 2.

Table 2. Univariate and multivariate analysis of preoperative variable group on mortality rate

Variable	Univariate		Multivariate	
	OR	p	OR	p
Age	15.0	0.02*	8.438	0.233
Weight	6.25	0.025*	1.187	0.904
SaO_2				
≥85 %				
75 – 85 %	1.964	0.467	2.206	0.428
<75 %	12.833	0.013*	6.429	0.158
Hematocrit	4.5	0.049*	1.729	0.620
McGoon	0.611	0.581		
Other Abnormalities	1.56	0.51		

Intraoperative Variable Group Analysis
From the univariate analysis of the intraoperative variable group on mortality rate, no variable was statistically significant in affecting mortality rate even though the odds ratio was large. In univariate

analysis of CPB time, the significance value and odds ratio were p=0.999 – OR = 9.83x108. It might be because all patients with CPB time <120 minutes survived, therefore it could be stated that CPB time ≥120 minutes had a very significant effect on mortality rate. Two variables were chosen, AOX and CPB time, for multivariate analysis to determine the variables that concomitantly affect the mortality rate. The two variables concomitantly did not appear to affect mortality rate, even though the odds ratios of the two variables were more than one. Univariate and multivariate analyses of the intraoperative variable group on mortality rate are described in Table 3.

Table 3. Univariate and multivariate analysis of intraoperative variable group on mortality rate

Variable	Univariate		Multivariate	
	OR	p	OR	p
AoX Time	3.667	0.066	2.833	0.145
CPB Time	$9.83x10^{8}$	0.999	$6.65x10^{8}$	0.999
Muffing	2.167	0.509		

Postoperative variable group analysis

Univariate analysis of postoperative variable group on mortality rate showed that body temperature, residual PS, residual VSD, and vaso-inotropic score significantly affected mortality rate, with significance values and odds ratios of p≤0.001 – OR=50, p=0.021 – OR=14, p=0.002 – OR=5.185, p=0.003 – OR=16.1, p=0.999 – OR=1.85x1010, and p≤0.001 – OR=59.8, respectively. There were two significant results in the residual PS variable, which were moderate PS residual to none-mild residual PS and severe residual PS to none-mild residual PS. Similarly, there were also two significant results in the residual VSD variable, which were residual VSD of ≤2 mm to no residual VSD and residual VSD of >2 mm to no residual VSD. In univariate analysis of residual VSD of >2 mm, which was compared to no residual VSD on mortality rate, the OR value was 1.85x1010, which is a large value. However, this value was not statistically significant in affecting the mortality rate (p=0.999) because all patients with residual VSD of >2 mm died.

For multivariate analysis, the included variables were ventilator time, fever, residual PS, vaso-inotropic score, and residual VSD. Multivariate logistic regression analysis began by entering the most significant variable one by one using the forward stepwise method until a presentable result appeared. The variables included were fever (p<0.001), residual PS (p<0.001), and residual VSD (p<0.001). Vaso-inotropic score variable at the end of multivariate analysis (forward stepwise method) was excluded from the statistical calculation model because this variable did not affect the analysis results. The ventilator time variable (p=0.045) was not included in multivariate analysis because the maximum number of variables that could be included was only four variables.

Multivariate analysis results showed that there were no variables that concomitantly affected the mortality rate. In other complication variables, the mortality rate remained high even though there was no postoperative complication. From univariate analysis results, there was an increased mortality risk in patients who had no complications (OR = 3.545), although this value was not statistically significant (p = 0.265). Univariate and multivariate analyses of the postoperative variable group on mortality rates are described in Table 4.

Table 4. Univariate and multivariate analysis of postoperative variable group on mortality rate

Variable	Univariate		Multivariate	
	OR	p	OR	p
Ventilator Duration	4.5	0.031		
Length of ICU stay	184	0.429		
Body Temperature	50.0	<0.001*	$6.1x10^{21}$	0.995
Residual PS				
None-mild				

Moderate	14.0	0.021*	$5.29x10^{28}$	0.995
Severe	108.0	0.002*	$1.73x10^{22}$	0.995
Residual PR				
Severe				
Moderate	3.167	0.092		
None-mild	0.0	1.0		
Residual VSD				
None				
≤ 2 mm	16.1	0.003*	0.000	0.997
> 2 mm	1.85×10^{10}	0.999	$7.66x10^{37}$	0.996
VIS	59.8	<0.001*		
Complication	3.545	0.265		

4. Discussion

In 45 months, only 42 TF patients underwent a total correction procedure and were included in inclusion criteria with a relatively high mortality rate of 14 patients (33.3%). The closest comparison is data from Harapan Kita national heart center, Jakarta, with a mortality rate of 3.9% (29/733) in TF patients who underwent total correction from January 2013–December 2017, especially in patients who underwent tricuspid annuloplasty (TAP) procedure (89.65 %).[7]

Preoperative variable group

A study conducted by Sandoval N et al divided TF patients into 3 age groups: <1 month, 1 month – 1 year, and 1-17 years to facilitate their analysis due to a small number of young patients and overall in-hospital mortality of 3.3%, with the highest total mortality rate found in < 1-month group (16.7%).[8] Loomba RS et al performed a meta-analysis and found that neonates with fully corrected TF were associated with increased mortality, longer ICU stays, and longer hospital stay.[9] Furthermore, Azari et al stated that younger patients who underwent total correction had significantly higher postoperative mortality rates.[10] This is in line with our study results, where a higher mortality rate was found in ≤24 months group and was significantly different from the>24 months group (p=0.011). In addition, this study found that patients aged ≤24 months had a 15-fold risk of mortality and was statistically significant compared to older age (p=0.02). Our data did not found patients who underwent total correction surgery at age <1 year. Consequently, we divided the patients into ≤24 and >24 months age groups. There is yet a reference that has determined the most recommended age group for total correction. Based on the HBTKVI Clinical Practice Guideline 2018, it did not specifically state that the recommended age of TF patients who could undergo total correction. Instead, it only provided guidelines for TF correction procedure flow according to age.[11]

Egbe and Saygi stated that a patient's weight was not directly related to mortality but significantly affected ventilator time and length of ICU stay.[5, 12] This was in contrast to our study result, where low body weight was found to have a higher and statistically significant mortality rate (p=0.041), where bodyweight ≤10 kg had a 6.25-fold risk of mortality and statistically significant compared to bodyweight >10 kg (p=0.025).

We divided the patient into several groups based on their SaO2: 85%, 75-85%, and <75% because apart there is no reference to SaO2 value associated with mortality and we also aimed to facilitate data interpretation. In our study, lower preoperative SaO2 value had a significantly higher mortality rate (p=0.019), where SaO2 <75% had a 12.833-fold risk of mortality and was statistically significant compared to SaO2 of 85% (p=0.013). Our study results were similar to previous studies from Saygi et al and Azari et al, which reported that patients with preoperative saturation of 75.7±7.7% significantly affected mortality rate compared to patients with preoperative saturation of 84.1±10.1%.[10,12] Our results were also in line with a study from Sandoval et al, where they also divided the patients into three groups, 90%, 70-89%, and <70%. They reported that oxygen saturation <70% had a 6.7-fold risk of in-

hospital mortality (p=<0.001).[8] Jonas suggested that a SaO2 value of 80-85% during rest is an indication for surgery, and periodically SaO2 decreases to 65-75% is an urgent indication of surgery.[13]
Pulmonary vascular maturity is not only assessed by McGoon's ratio assessment, but also by other maturity parameters such as Kirklin table assessment or Nakata index. Sasmazel and Saygi stated that the McGoon score was not associated with mortality.[2,12] Total correction of TF with McGoon borderline score is a safe measure with low morbidity and mortality rates.[14] These findings were in line with our findings where the McGoon score <1.7 and ≥1.7 did not have a significant difference in mortality rate. Our univariate analysis also revealed that the McGoon score did not affect the risk of mortality.
High hematocrit level in TF patients is associated with the cyanotic condition in patients. When the hematocrit level reaches 65% or more, there was a significant increase in blood viscosity and adverse polycythemic response is present, especially in patients with congestive heart failure.[15] High preoperative hematocrit level in TF patients and decrease of thrombocyte function explained the positive correlation between preoperative hematocrit and postoperative blood loss. Furthermore, there is impaired fibrinogen function in cyanotic patients. High hematocrit levels have a significant correlation with mortality.[16,17] In this study, there was no significant difference in mortality rate between hematocrit levels of ≥65% and <65%. However, there was a 4.5-fold risk of mortality and statistically significant (p=0.049) in TF patients with a hematocrit level ≥of 65% compared to a hematocrit level of <65%. Polycythemia does not affect the mortality rate. However, this condition had a 4.5-fold risk of exposure to mortality. This condition should be observed further to determine the factors that could bias the data in this study or unrecorded preoperative procedures, such as phlebotomy, which might affect statistical output.
Other comorbidities that could be found in TF are coronary artery and right aortic arch abnormalities, patent ductus arteriosus (PDA), atrial septal defect (ASD), persistent left superior vena cava (PLSVC), major aortopulmonary collateral arteries (MAPCAs), and trisomy 21 abnormalities/22q11 deletion. (Lapierre C. et al. 2016) In our study, the presence of comorbidity did not affect the mortality rate significantly and was not a significant direct risk factor for mortality in this study. This was probably due to a combination of comorbidities that were not analyzed individually related to the risk of mortality.
Various preoperative variables that were analyzed to determine the risk factors that concomitantly affected mortality rate were not found in our study. A study conducted by Guevara et al revealed that preoperative hematocrit alongside CPB use duration predicted postoperative blood loss and preoperative hematocrit alongside with postoperative transfusion affects 30-day mortality.[16] Currently, there is no available study that analyzes preoperative variables on mortality rate using multivariate logistic regression test.

Intraoperative variable group

In our study, there were no significant differences in AOX and CPB time as well as in MUF use in terms of mortality. In line with our study, Abdelgawad et al reported that CPB and AOX time was significantly higher in patients who had a history of palliative procedures but no significant difference in mortality rate.[14] Modified ultrafiltration might contribute to improving clinical conditions immediately after CPB usage, although its impact on overall clinical outcome might not be significant.[18]
No single or concomitant intraoperative risk factors affected the mortality rate in this study. In the CPB time variable, there was a very high risk of mortality with a significance value close to 1. This was because all patients survived in CPB duration <120 minutes, therefore logistic regression analysis described CPB time ≥120 minutes as having a very high odds ratio on mortality rate. Guevara et al successfully revealed CPB time (univariate analysis), as well as CPB time and preoperative hematocrit (multivariate analysis), were risk factors that affected postoperative blood loss. The CPB and AOX time failed to reveal their effect on 30-day mortality.[16] Likewise, in a study conducted by Mercer-Rosa et al, it was found that CPB and AOX time increased prolonged in-hospitalization by 11-14 %.[19] Ischemia due to cross-clamp and increase in inflammatory mediators due to CPB as well as MUF use are interrelated, where MUF mechanism improves hemodynamics by inducing hemoconcentration, reducing myocardial edema, preventing coagulopathy, and eliminating inflammatory mediators due to cross-clamp

ischemia and CPB time themselves. This situation does not necessarily affect mortality rate but rather affects ventilator time, length of ICU stay, vasoactive-inotrope use, and length-of-stay. Multivariate logistic regression to analyze intraoperative variables in this study was not successful show the effect on mortality rate.

Postoperative variable group

In our study, ventilator time >48 hours, fever, residual PS, VIS >20, and residual VSD had significant differences in mortality rate. Egbe and Saygi in their study reported that postoperative factors that cause ICU-related mortality were prolonged ICU stay (≥7 days) and ventilator time (≥48 hours).[5,12] These study results were partly inconsistent with our results, where the length of ICU stay had no risk factor for mortality, even though our data showed that all patients with ICU stay >7 days were also on ventilator >48 hours. This condition explains how the length of ICU stays indirectly affected mortality through its correlation to ventilator time. Intensive Unit Care stay had strong correlations with preoperative factors, especially intraoperative factors such as CPB and AOX time and surgical technique.[5]

Postoperative complications in our study were sepsis (20%), right ventricle (RV) dysfunction (12%), pleural effusion (7%), acute kidney injury (AKI) (7%), arrhythmia (2%), and pulmonary edema (2%). Of all patients who experienced sepsis, almost all patients had ventilator time >3 days, VIS >20, and CPB time>120 minutes. However, there was no significant difference in mortality rate. The number of postoperative complications in our study is in line with Azari's study, where they reported complications in the form of arrhythmias (28%), heart failure (5%), pacemaker need (4%), pneumothorax (4%), gastrointestinal bleeding (3%), impaired renal function (1.5%), pulmonary edema (1.5%), reopen bleeding (1%), and sternal-dehiscence redo (1%.).[10]

In our study, the fever had a 50-fold risk of mortality and was statistically significant (p=<0.001) compared to no fever. Eighty-eight percent of patients who experienced fever were related to prolonged CPB use (>120 minutes), 88% of patients had high VIS (>20), and 65% of patients had prolonged ventilator use (>48 hours), therefore these three variables indirectly affected mortality through fever especially prolonged CPB and ventilator use. It seems that these three conditions caused very high odds ratios of fever, which was up to 50-fold. Agarwal HS et al reported that prolonged CPB use was not only associated with cardiac and extracardiac complications, but also with prolonged ventilator use, length of ICU stay, and mortality due to an increase in circulating proinflammatory mediators and cytokines in line with CPB use duration.[20,21] Alvarez et al in their study revealed that endotracheal tube insertion >24 hours associated with ventilator use increased postoperative fever risk by 20%.[22] Our results are in line with previous study results, where ventilator time >48 hours had a 4.5-fold risk of mortality and was statistically significant (p = 0.031) compared to ventilator time <48 hours, with a possible positive correlation with fever.

In our study, residual VSD <2 mm had a 16.1-fold risk of mortality times and was statistically significant (p=0.003) compared to no residual VSD, and five patients with residual VSD >2 mm did not survive. This explains why residual VSD >2 mm had a very high odds ratio with a significance value close to 1 when compared to no residual VSD. Our data revealed that four out of five patients (80%) had high VIS, experienced fever, prolonged ICU stay, and prolonged ventilator and CPB use. It seems that any residual VSD size affects RV function and is also influenced by residual PR and PS, therefore adding burden to RV function. Furthermore, RV function is also influenced by intermediary variables such as VIS, fever, ICU stay, and ventilator and CPB time, explaining why patients with residual VSD >2 mm experienced mortality, although multivariate analysis could not prove its effect on mortality. Residual VSD could also increase RV volume-overload,[23] thus requiring vasoactive-inotropic support which is a strong predictor of length of ICU stay, ventilator time, and mortality.[24,25]

Based on studies from Yoo-Park and Latus H, they reported that RV diastolic phase in residual PR was protected from RV dilatation incidence by the presence of residual PS by maintaining its RV hypertrophy property. These results supported the fact that RV diastolic compliance has a crucial role in limiting RV dilatation due to residual PR and indicates that we should choose a conservative RVOT dilation strategy even if there is residual PS later.[26,27] Latus reported that residual RVOT obstruction improved the

performance and interaction of both ventricles better, but failed to determine the cut-off value of residual RVOT obstruction that could interfere with RV function.[27] In this study, we divided the PS/PR variables into three groups according to their severity and to facilitate the study results interpretation. Our study revealed there were significant differences between groups in the residual PS variable in terms of mortality. Our study also revealed that moderate and severe residual PS had 14-fold and 108-fold risk of mortality, respectively, and were statistically significant (p=0.021 and p=0.002) when compared to no PS or mild residual PS. Of the total seven patients with severe residual PS, six patients (85%) experienced mortality, which explained the very high odds ratio for mortality rate. However, there was no significant difference between groups in the residual PR variable in terms of mortality, and residual PR was not a risk factor for mortality in our study.

Vasoactive and inotropic postoperative use could be calculated into the vasoactive-inotropic score (VIS), which predicts TF patient's prognosis who undergo total correction. The maximal vasoactive-inotropic score in the first 48 hours is a strong predictor of length ICU of stay, prolonged ventilator duration, continuous renal replacement therapy (CRRT) use, cardiac arrest, and mortality.[24] Dilek et al in their study reported that high VIS was positively correlated with ventilator use duration (p=0.009 r=0.33) and mortality (0=0.003).[25] Our result was in line with the previous result where high VIS (>20) had a 59.8-fold risk of mortality and was statistically significant (p=<0.001) compared to low VIS (VIS <20). From our data, 72% of patients who experienced mortality had high VIS and was associated with CPB and ventilator use duration, length of ICU stay, and fever, although the association between these variables could not be proven statistically.

In this study, there was not enough sample to reveal all risk factors for postoperative variables that simultaneously affected mortality based on multivariate logistic regression analysis. With a small sample size, it possible might that concomitant risk factors that affected mortality have not yet emerged. There were no similar studies to ours in determining the perioperative factor of TF patient mortality after total correction during hospitalization.

As a follow-up, it is necessary to analyze several variables that could be improved to reduce mortality rates for the general improvement of congenital heart surgery services at our hospital and could be compared to other national heart surgery centers. Analysis of modifiable variables in preoperative groups such as hematocrit level >65% with phlebotomy, and intraoperative variables such as AOX and CPB time could be shortened, although in this study AOX and CPB time did no affect mortality rate. Postoperative variables, such as length of ICU stay and ventilator and hemodynamic support drug use, were closely related to intraoperative conditions such as residual VSD PS, therefore their continuation requires special analysis. One thing that could be compared objectively according to us is the number of ventilator-associated pneumonia (VAP), where the VAP rate in the intensive room of Harapan Kita Hospital was 1.43‰ in 2018 then decreased to 0.76‰ in 2019, while the VAP rate in the intensive care of Dr. Soetomo Academic General Hospital amounted to 6.7‰ 2018. It seems that this condition is most likely to affect mortality where further research should be carried out as proof.[7,28]

The limitation in this study is that there are only a few subjects, with 49 patients with a mortality rate of TOF cases with complete correction repair is 33.3% during three years study. Even though it was a small number study, the mortality rate is considered high in a developing country like Indonesia. In our research, we found our patients to have less favorable circumstances. Dr. Soetomo General Academic Hospital is a reference point from eastern Indonesia whereas we know Indonesia is a maritime country consisting of islands. Many of our patients come from not the same island as our center, Java island, therefore it takes a longer time to transport the patient to our center and often causes delays in referring patients to our center or patients came with a high severity level that makes it more difficult for us to achieve better outcomes. Moreover, the financial problem of the patient's family may result in delays patient's transportation.

Indonesia is a developing country that has only two cardiac surgery centers in this country. In other words, we are still trying to develop our preparedness to perform cardiac surgery which requiring teamwork to be able to perform cardiac surgery well synergic collaboration within a team consisting of

anesthesiologists, pediatric cardiologists, and intensive care unit team and nurses are extremely needed to treat patients since preoperative until postoperative so that patients can survive.

5. Conclusion

Given the presence of significant perioperative factors that influenced mortality rate in TF patients in this study, it can be a potential value to the cardiac surgeon can take this into contemplation while choosing the best option for the patient to reduce the mortality rate in TF cases after total repair correctionin the future.Further research with large population is needed.

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