



Hemostatic changes and complications in patient undergoing extracorporeal mechanical membrane oxygenation: A prospective study in Thailand.

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BACKGROUND

Acquired von Willebrand syndrome (AVWS) and FXIII deficiency are acquired bleeding disorders that are observed in patients undergoing extracorporeal membrane oxygenation (ECMO). However, monitoring of VWF and FXIII have not been routinely practiced.

METHODS

A prospective study was conducted at Ramathibodi hospital between November, 2023 and December, 2024. Patients undergo VA-ECMO and VV-ECMO support were included. Blood samples were collected at four time points: at baseline, 24 hours after installation, 72 hours after installation, and 1 hour after decannulation of ECMO circuit, to obtain VWF parameters and FXIII level. The diagnosis of AVWS was made using both a ratio of collagen-binding capacity to VWF-antigen (VWF:CB/VWF:Ag) and a VWF multimeric analysis. AVWS was diagnosed when vWF:CB/vWF:Ag ratio was below 0.7 and HMW multimers were missing. Thrombotic and bleeding complications were recorded. Statistical analysis was performed using the Stata Version 18 software program.

Table 1. Demographic data

Characteristics	Patients (n=12)
Mean age ± SD, years	55.3 ± 16.6
Gender, n (%)	
Female	7 (58.3)
Male	5 (41.7)
ECMO mode (VA/VV), n	9/3
Indication for ECMO	ARDS: 4, Cardiac arrest: 4, Cardiogenic shock: 3, Pulmonary hypertension: 1
Comorbidities, n	Diabetes: 6, Hypertension: 6, Dyslipidemia: 6, CAD: 1, CKD: 1, Chronic lung disease: 1, Others: 7
Anticoagulants/antiplatelets, n	Aspirin: 2, Clopidogrel: 2, Dabigatran: 2, Enoxaparin: 2, Heparin: 1

Table 2. Number of patients with a decreased ratio of vWF:CB to vWF:Ag

	Reduced vWF:CB/vWF:Ag ratio (< 0.7)	Loss of HMW multimers (Decreased HMW multimers)
Before ECMO implantation (baseline)	10/12	4/12 (2)
During ECMO implantation 24 hr	9/11	7/11 (0)
During ECMO implantation 72 hr	9/11	7/11 (0)
After ECMO explantation 1 hr	9/11	7/11 (0)

Table 4 Bleeding and thrombotic complications

	Number of events
Bleeding event, n (%)	4/8 (33)
Cannulation site bleeding	2
GI bleeding	1
Hematoma	1
Thrombotic event, n (%)	3/9 (25)
Deep venous thrombosis	2
Pulmonary embolism	1
Catheter-related thrombosis	1

Table 5 ECMO setting

Parameters	Baseline	24 hour Post-ECMO	72 hour Post-ECMO	Post-Decannulation 1 hour
Revolutions per minute (rpm)	4012.5 ± 1667.8	4017.5 ± 1760.1	3922 ± 1648.8	3388.1 ± 1577.3
Flow rate (L/min)	3.7 ± 0.7	3.4 ± 0.94	3.1 ± 0.7	2.2 ± 0.9
Sweep gas flow (L/min)	3.2 ± 0.7	2.7 ± 1.1	2.4 ± 1.2	1.7 ± 0.8
FiO2	1	1	0.93 ± 0.2	0.8 ± 0.3
Temperature (degree Celsius)	37 ± 0.2	37 ± 0.2	37	37

OBJECTIVE

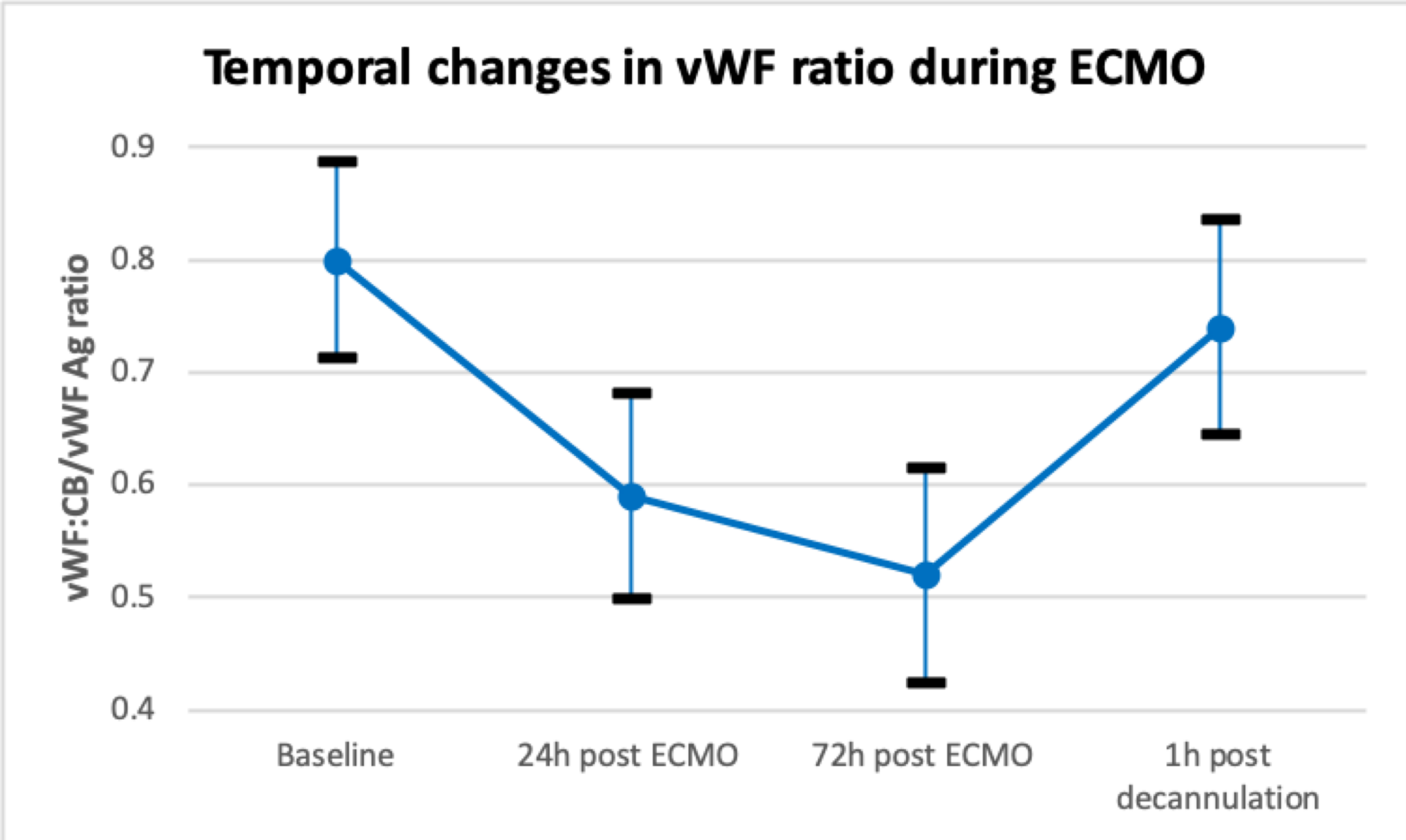
This study evaluated the prevalence and progression of AVWS and FXIII deficiency in patients with ECMO support.

RESULTS

A total of twelve patients were eligible in this study. The mean age was 55 years old and slight male predominance. Prior to ECMO cannulation, the mean vWF:CB/vWF:Ag ratio was 0.8. Seven in twelve patients (64%) were diagnosed with AVWS. Within 24 hours after implantation, we detected a decline in VWF:CB/VWF:Ag and loss of high molecular weight (HMW) multimers. A reduction in FXIII level was observed. Bleeding events occurred in 33% of the patients, and among them, half was diagnosed with AVWS. 25% of the patients developed thrombotic complications including deep venous thrombosis, pulmonary embolism, and catheter-related thrombosis. There was no association between AVWS and bleeding or thrombotic complications. However, patients with increased vWF ratio tend to have lower bleeding complications (OR 0.18; p=0.209). Furthermore, flow rate appears to not affect hemostatic changes.

Table 3. Hemostatic parameters of ECMO patients

Parameters	Baseline	24 hour Post-ECMO	72 hour Post-ECMO	Post-Decannulation 1 hour
Hematological parameters				
Hemoglobin (g/dL)	9.7 ± 0.5	8.6 ± 0.5	8.9 ± 0.5	8.4 ± 0.5
Hematocrit (%)	29 ± 1.5	25.7 ± 1.4	26.5 ± 1.6	25.2 ± 1.5
Coagulation tests				
Platelets (x10^3/cumm)	153 ± 12.4	103.1 ± 12.9	84 ± 13.5	104.3 ± 12.9
Prothrombin time (PT, sec)	21 ± 1.9	16.7 ± 2	14.5 ± 2.1	13.9 ± 2
International normalized ratio (INR)	1.7 ± 0.2	1.4 ± 0.2	1.2 ± 0.2	1.2 ± 0.2
Activated partial thromboplastin time (aPTT, sec)	63.8 ± 7.9	39.2 ± 8.3	43 ± 8.7	39.4 ± 8.3
Thrombin time (TT, sec)	83 ± 18.7	44.3 ± 19.4	66.6 ± 20.3	43.4 ± 19.4
Fibrinogen (mg/dL)	381.6 ± 58.8	336.5 ± 61.2	338.6 ± 63.6	342.9 ± 61.2
FXIII (%)	85.8 ± 20.5	58.1 ± 21.9	54.7 ± 18.1	58.8 ± 15.9
Antithrombin III (ATIII, %)	53.3 ± 4.9	48 ± 5.1	46.8 ± 5.2	53.7 ± 5.2
Protein C (%)	52.6 ± 6.5	46.8 ± 6.6	47.2 ± 6.8	62.9 ± 6.8
Protein S (%)	54.2 ± 4.9	48.6 ± 5.1	51.5 ± 5.3	61.7 ± 5.3
vWF parameters				
vWF:CB/vWF:Ag ratio	0.8 ± 0.1	0.6 ± 0.1	0.5 ± 0.1	0.7 ± 0.1
vWF:CB (%)	248.8 ± 23.4	197.4 ± 23.8	180.3 ± 24.1	218.2 ± 24.1
vWF:Ag (%)	393.2 ± 55.4	394.1 ± 56.6	433.3 ± 57.8	383.6 ± 57.8
vWF:Rco (%)	289.8 ± 33.8	240.5 ± 34.3	232.7 ± 34.6	254.5 ± 34.6



CONCLUSION

AVWS and FXIII deficiency are observed in 64% and 33% in this study and occurs within 24 hours after initiate ECMO. However, it's reversible after discontinuation of ECMO. Findings from this study highlight the need for monitoring of VWF and FXIII activity in patients with ECMO support, especially bleeding patients. Understanding the hemostatic alterations and their implications can help in developing strategies to mitigate bleeding and thrombotic risks during ECMO.