ADVANCED RIGHT VENTRICULAR HEMODYNAMICS IN INTERMEDIATE- AND HIGH-RISK PULMONARY EMBOLISM

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INTRODUCTION

Acute pulmonary embolism (PE) is cardiovascular disorder that can lead to right ventricular (RV) failure leading to hemodynamic instability and death. The development of catheter directed therapy (CDT) has provided novel therapeutic strategies for rapid reperfusion, as well as the routine intraprocedural measurement of invasive hemodynamics. An important determinant of RV function is RV to pulmonary artery (PA) coupling. However, invasive surrogates for RV-PA coupling have not been thoroughly investigated.

AIM

To investigate advanced invasive right ventricular (RV) hemodynamics, including RV cardiac power output (CPO), pulmonary artery (PA) pulsatility index (PAPi), and RV myocardial performance score (MPS) in patients with intermediate- and high-risk (IR and HR) pulmonary embolism (PE).

METHODS

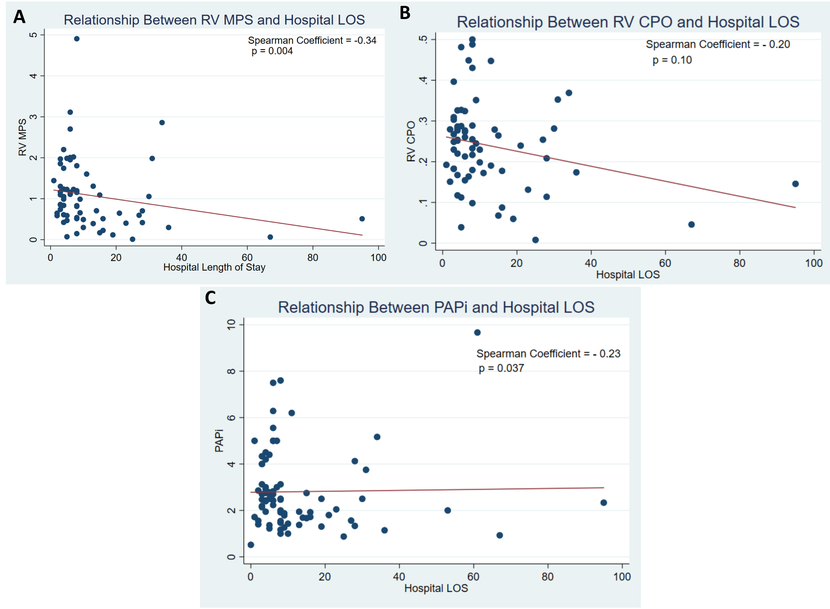
- Retrospective single-center cohort study of consecutive patients with intermediate- or high-risk PE who underwent invasive hemodynamics during CDT from 2022 to 2024
- RV CPO was calculated using mean PA pressure (mPAP), right atrial pressure (RAP), and cardiac output in the following equation: $\frac{(mPAP-RAP)\times CO)}{451}$
- PAPi was calculated as $\frac{PASP-PADP}{RA}$
- RV MPS was calculated as RV CPO x PAPi x 1.5
- Patients with intermediate-risk PE were compared with high-risk PE.
- RV CPO, PAPi, and RV MPS were correlated with hospital length-of-stay using Spearman correlation rank test

RESULTS

Table 1: Baseline Patient Characteristics by PE Risk Status

	All Patients N = 81	Intermediate Risk N = 65	High Risk N = 16	P Value
Age, median (IQR)	62 (51, 70)	61 (50, 70)	63 (55, 78)	0.19
Female Sex, N (%)	39 (48.1)	27 (41.5)	12 (75.0)	0.024
Race, N (%)				0.48
White	10 (12.3)	8 (12.3)	2 (12.5)	
Black	67 (82.7)	55 (84.6)	12 (75.0)	
Hispanic	2 (2.5)	1 (1.5)	1 (6.3)	
Other/Unknown	2 (2.5)	1 (1.5)	1 (6.3)	
BMI, median (IQR)	32.3 (26.0, 38.7)	32.7 (26.8, 38.5)	31.7 (24.8, 39.2)	0.61
Co-Morbidities				
Hypertension	44 (54.3)	33 (50.8)	11 (68.8)	0.26
Diabetes	24 (29.6)	18 (27.7)	6 (37.5)	0.44
Current or Former Smoking	29 (35.8)	25 (38.5)	4 (25.0)	0.39
CKD	10 (12.3)	9 (13.8)	1 (6.3)	0.68
Heart Failure	18 (22.2)	13 (20.0)	5 (31.3)	0.33
Prior Stroke	5 (6.2)	4 (6.2)	1 (6.3)	0.99
Atrial Fibrillation	7 (8.6)	5 (7.7)	2 (12.5)	0.62
Prior VTE	23 (28.4)	20 (30.8)	3 (18.8)	0.54
Prior PE	17 (21.3)	14 (21.9)	3 (18.8)	0.99
Chronic Lung Disease	11 (13.9)	10 (15.9)	1 (6.3)	0.45
History of Cancer	19 (23.5)	11 (16.9)	8 (50.0)	0.005
sPESI score, median (IQR)	2 (1, 3)	1 (1, 2)	3 (2, 4)	< 0.001
PE Treatment, N (%)				
Anticoagulation	76 (93.8)	62 (95.4)	14 (87.5)	0.25
Systemic Thrombolysis	2 (2.5)	0	2 (12.5)	0.037
Catheter-Directed Therapy	75 (92.6)	61 (93.8)	14 (87.5)	0.34
Cardiac Arrest Prior to Therapy	4 (5.1)	0	4 (26.7)	< 0.001
Vasopressor	15 (19.0)	4 (6.3)	11 (68.8)	< 0.001
Mechanical Ventilation	14 (17.4)	4 (6.3)	10 (62.5)	< 0.001
ECMO	5 (6.3)	0	5 (31.3)	< 0.001
Vitals and Labs on admission, median (IQR)				
Heart Rate, bpm	105 (90, 118)	105 (90, 117)	113 (88, 130)	< 0.001
MAP, mmHg	91 (76, 107)	98 (84, 110)	72 (64, 86)	< 0.001
BNP, pg/mL	1447 (406, 4624)	1353 (394, 4137)	2891 (450, 6409)	0.14
Hs-Troponin-T peak, ng/L	83 (35, 151)	74 (35, 137)	100 (35, 234)	0.21
Lactic acid, mmol/L	2.5 (1.6, 3.9)	2.1 (1.5, 2.8)	4 (2.1, 7.4)	0.002

Figure 1: Relationship Between Invasive Hemodynamics and Length of Stay



Relationship between RV MPS (A), RV CPO (B), and PAPi (C) with hospital length of stay among patients with intermediate- or high-risk pulmonary embolism

Table 2: Invasive Hemodynamics and Outcomes by PE Risk Status

	Intermediate Risk N = 65	High Risk N = 16	P Value
Pressures, median mmHg (IQR)			
RA	10 (7, 15)	17 (14, 22)	0.002
PASP	50 (43, 60)	57 (49, 66)	0.13
PADP	24 (19, 28)	25 (20, 31)	0.22
mPAP	32 (26, 37)	37 (31, 42)	0.096
PCWP	16 (12, 22)	20 (16, 20)	0.61
Fick CO	5.2 (4.0, 6.4)	4.5 (3.4, 6.0)	0.19
Fick CI	2.5 (1.9, 2.8)	2.0 (1.5, 2.7)	0.24
PVR, WU	2.2 (1.6, 3.3)	4.9 (3.7, 6.5)	0.021
RA/PCWP	0.64 (0.44, 0.75)	1.05 (0.90, 1.25)	0.003
PAPi	2.7 (1.8, 4.0)	1.8 (1.4, 2.1)	0.013
RV CPO	0.23 (0.15, 0.28)	0.06 (0.0, 0.23)	0.006
RV MPS	1.05 (0.59, 1.60)	0.49 (0.23, 0.84)	0.017
API	3.5 (2.4, 5.0)	2.8 (2.3, 3.2)	0.28
LV CPO	1.03 (0.70, 1.38)	0.59 (0, 0.97)	0.001
LV MPS	2.60 (1.32, 3.61)	1.48 (0.95, 2.33)	0.28
Outcomes, N (%)			
Death, Cardiac Arrest or HF Hospitalization	8 (12.3)	8 (50.0)	0.001
Death	4 (6.1)	6 (37.5)	0.001
Hospital LOS, median days (IQR)	6 (4, 11)	13 (5, 26)	0.085
ICU LOS, median (IQR)	2 (1, 3)	5 (2, 11)	0.003

CONCLUSIONS

- Among patients with intermediate- or high-risk PE with invasive hemodynamics, patients with high-risk PE were more likely to have markers of RV-PA decoupling including lower RV MPS, RV CPO, and PAPi while cardiac output was not different between the two groups.
- RV MPS and PAPi were associated with hospital LOS
- Further research is needed to investigate the utility of advanced RV hemodynamics in informing prognosis of pulmonary embolism

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