Journal Reading

12-Lead ECG Findings of Pulmonary Hypertension Occur More Frequently In Emergent Department Patients With Pulmonary Embolism Than in Patients Without pulmonary Embolism

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PICO

- P: Patients with pulmonary embolism
- I: ECG findings
- C: objective diagnostic testing (D-dimer, CTPA, V/Q scan, venous US)
- O: Diagnosis and treatment

Introduction

- Acute pulmonary embolism increases the pulmonary arterial pressure and causes right ventricular strain.
- ECG findings: S1Q3T3 pattern, precordial T-wave inversions, tachycardia, incomplete or complete RBBB.
- Is ECG specific enough to be useful in diagnosis or treatment?

Study Design

- Secondary analysis of prospective cohort of patients who were evaluated for pulmonary embolism. From 2003.07.01~2006.11.30.
- Objective diagnostic testings were ordered.
- Patients were asked to report any cardiopulmonary disease.

Table 1. Comparison of patients with and without an ECG.*

Characteristic	ECG Obtained, n=6,049	No ECG Obtained, n=943
Age, y, ±SD	49±17	43±18
Sex, No. (%)		
Male	1,959 (32)	252 (27)
Female	4,090 (68)	691 (73)
Race, No. (%)		
Black	2,057 (34)	407 (43)
White	3,479 (58)	438 (47)
Hispanic, No. (%)	362 (6)	68 (7)
Asian	46 (1)	13 (1)
Other	105 (2)	17 (2)
Previous VTE, No. (%)	616 (10)	116 (12)
CHF, No. (%)	443 (7)	46 (5)
COPD, No. (%)	421 (7)	44 (5)
CAD, No. (%)	639 (11)	49 (5)
PE diagnosis within 45 days, No. (%)	354 (5.9)	62 (7)
Death within 45 days, No. (%)	73 (1)	12 (1)

VTE, Venous thromboembolism; *CHF*, congestive heart failure; *COPD*, chronic obstructive pulmonary disease; *CAD*, coronary artery disease; *PE*, pulmonary embolism.
*Previous VTE, CHF, COPD, and CAD were reported by the patient. Patients with incomplete ECG interpretation data were excluded from analysis.

Likelihood Ratio	Interpretation
>10	Strong evidence to rule in disease
5–10	Moderate evidence to rule in disease
2–5	Weak evidence to rule in disease
0.5–2.0	No significant change in the likelihood
0.2–0.5	Weak evidence to rule out disease
0.1–0.2	Moderate evidence to rule out disease
<0.1	Strong evidence to rule out disease

PE:354 ; DVT:43

PE:196

Table 2. ECG findings among all patients and those with no preexisting cardiopulmonary disease.*

ECG Feature	All Patients (n=6,049) N	Sensitivity, %	Specificity, %	LR+ (95% CI)	OR (95% CI)	Patients With No Preexisting Cardiopulmonary Disease (n=1,836) N	Sensitivity, %	Specificity, %	LR+ (95% CI)	OR (95% CI)
Non-sinus rhythm	1,030	23.5	83.4	1.4 (1.2–1.7)	1.5 (1.2–2.0)	577	24.5	85.5	1.7 (1.3–2.2)	1.9 (1.3–2.7)
Tachycardia	994	28.8	84.3	1.8 (1.5–2.2)	2.2 (1.7–2.8)	550	28.6	86.4	2.1 (1.7–2.6)	2.5 (1.8–3.6)
Incomplete RBBB	179	4.8	97.2	1.7 (1.0–2.7)	1.7 (1.0–2.9)	97	4.6	97.6	1.9 (1.0–3.6)	1.9 (0.8–3.9)
Complete RBBB	141	3.1	97.7	1.4 (0.8–2.5)	1.4 (0.7–2.6)	68	3.1	98.3	1.8 (0.8–4.0)	1.8 (0.8–4.3)
S wave in lead I	903	22.3	85.5	1.5 (1.3–1.8)	1.7 (1.3–2.2)	560	25.5	86.0	1.8 (1.4–2.3)	2.1 (1.5–3.0)
Q wave in lead III	898	24.6	85.8	1.7 (1.4–2.1)	2.0 (1.5–2.5)	524	23.5	86.9	1.8 (1.4–2.3)	2.0 (1.4–2.9)
Inverted T in lead III	1,081	30.5	82.9	1.8 (1.5–2.1)	2.1 (1.7–2.7)	674	35.2	83.4	2.1 (1.7–2.6)	2.7 (2.0–3.7)
S1Q3T3	190	8.5	97.7	3.7 (2.5–5.4)	4.0 (2.5–6.0)	95	8.7	97.8	4.0 (2.4–6.5)	4.3 (2.3–7.9)
ST-segment changes	455	9.3	92.6	1.3 (0.9–1.8)	1.3 (0.9–1.9)	262	9.7	93.3	1.5 (0.9–2.2)	1.5 (0.9–2.5)
Inverted T in V1	2,073	37.9	66.0	1.1 (1.0–1.3)	1.2 (0.9–1.5)	1,364	37.2	64.5	1.1 (0.9–1.3)	1.1 (0.8–1.5)
Inverted T in V1-V2	515	14.4	91.9	1.8 (1.3–2.3)	1.9 (1.4–2.6)	286	11.7	92.8	1.6 (1.1–2.4)	1.7 (1.0–2.7)
Inverted T in V1-V3	266	10.5	96.0	2.6 (1.9–3.6)	2.8 (1.9–4.0)	131	8.7	96.9	2.8 (1.7–4.5)	2.9 (1.6–5.0)
Inverted T in V1-V4	140	7.3	98.0	3.7 (2.4–5.5)	3.9 (2.4–6.3)	69	6.6	98.1	3.5 (2.0–6.2)	3.6 (2.0–6.6)

RBBB, Right bundle branch block.
*Preexisting cardiopulmonary disease included any patient-reported history of venous thromboembolism, coronary artery disease, congestive heart failure, chronic obstructive pulmonary disease, asthma, or other lung disease. Tachycardia was defined as a pulse rate greater than 100 beats/min captured on the ECG. Inverted T refers to a T-wave inversion of any depth in the lead noted.

Table 3. Results of multivariate logistic regression of ECG findings, D-dimer, and troponin for the diagnosis of PE.*

Variable	OR (95% CI)
S1Q3T3 pattern	4.9 (2.4–10.3)
T-wave inversions in leads V1–V4	3.1 (1.4–6.9)
Tachycardia	1.8 (1.1–2.9)
Any positive D-dimer level	17.7 (9.5–33.2)
Any troponin-level increase	3.0 (1.5–5.7)
Non–sinus rhythm	1.2 (0.7–2.0)
Incomplete RBBB	1.3 (0.5–3.7)
RBBB	0.7 (0.2–2.1)
ST-segment changes	0.7 (0.4–1.4)

*Tachycardia was defined as any pulse rate greater than 100 beats/min captured on the ECG. D-dimer increase was defined as a positive D-dimer level for those who had a qualitative D-dimer test ordered or any value above the reference range for those who had a quantitative D-dimer test ordered. Troponin increase was defined as any borderline or positive troponin-level measurement.

Limitation

- 1. No record of the depth of T-waves inversions.
- 2. Lack of an estimate of pulmonary arterial pressure.
- 3. No validation of ECG interpretation was performed.
- 4. No attemp to determine whether the ECG findings were new of preexisting.

Conclusion

- 1. S1Q3T3 and precordial T-wave inversions: Highest LR(+) values with lower-limit 95% CI.
- 2. Independent predictors
- 3. The sensitivities for the diagnosis of pulmonary embolism were low!

(+): in symptomatic ED patients: possibility↑

(-) : should not decrease the suspicion

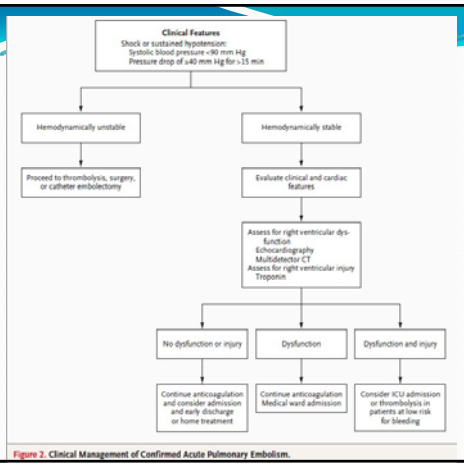
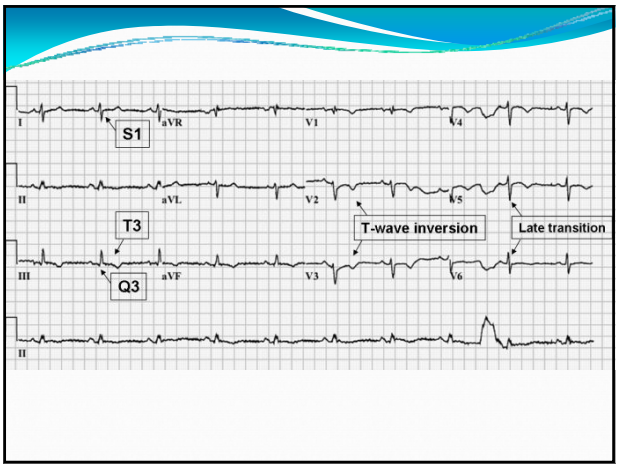


Figure 2. Clinical Management of Confirmed Acute Pulmonary Embolism.

Thank you for listening!


I
aVR
V1
V4
S1
II
aVL
V2
V5
T3
T-wave inversion
Late transition
III
aVF
V3
V6
Q3
II