


RESEARCH LETTER

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# Improving identification of pulmonary embolism-related out-of-hospital cardiac arrest to optimize thrombolytic therapy during resuscitation

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**Keywords:** Out-of-hospital cardiac arrest, Thrombolytic therapy, Pulmonary embolism, Cardiopulmonary resuscitation

Pulmonary embolism (PE) is responsible for ~3% of Out-of-Hospital Cardiac Arrest (OHCA) and is associated with unfavorable prognoses [1]. We have recently shown that thrombolysis during resuscitation was associated with a better survival in the event of a proven pulmonary embolism [2]. The challenge is thus to identify, from the beginning of resuscitation, PE-related OHCA in order to deliver the proper treatment to the patient. This issue is highlighted by the premature stoppage of the TROICA trial [1], which showed no benefit of using thrombolysis in medical cardiac arrests. Our aim was to identify the factors associated with PE-related OHCA.

We selected adults from the French National OHCA Registry, admitted to the hospital. This registry and the OHCA management by a mobile medical team have been previously described [3]. The present study was approved by the French Advisory Committee on Information Processing in Health Research. It was approved as a

medical assessment registry without a requirement for patient consent.

We assessed characteristics associated with PE-related OHCA with a univariable analysis ( $\chi^2$  test, Fisher's exact test or Student's *t* test). A multivariate logistic regression model was then developed to identify the factors associated with PE with a *P* value < 0.20. Statistical analyses were performed using R software v3.6.1.

From July 2011 to March 2018, 14,253 patients were admitted to the hospital. We excluded OHCA whose cause was obvious from the beginning of the resuscitation (*n* = 2341) or where data was incomplete (*n* = 1150). The final analysis included 10,402 subjects. Two hundred sixty subjects (2%) were diagnosed with PE upon hospital admission by computed tomography pulmonary angiography (CTPA) or echocardiogram. The results of the univariate and multivariate analyses are presented in Table 1. The prevalence of PE was 22% among the population with nonshockable rhythm and history of thromboembolism.

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**Table 1** Factors associated with OHCA caused by PE

	PE-related OHCA (n = 260)	Other etiologies (n = 10,142)	Chi <sup>2</sup> Pearson p	Multivariate logistic regression adjusted odds ratio [95% CI]	p
Female, n (%)	139 (53.5)	3204 (31.6)	< 0.001	2.0 [1.5–2.5]	< 0.001
Age < 50 y, n (%)	67 (25.8)	2101 (20.7)	0.048	1.5 [1.1–2.0]	0.01
Absence of known heart disease, n (%)	170 (65.4)	5790 (57.1)	0.008	1.3 [1.0–1.7]	0.05
History of respiratory disease, n (%)	35 (13.4)	1350 (13.3)	0.94		
History of diabetes, n (%)	34 (13.1)	1407 (13.9)	0.71		
Absence of known comorbidities, n (%)	43 (16.5)	1431 (14.1)	0.27		
History of thromboembolism, n (%)	8 (3.1)	41 (0.4)	< 0.001 <sup>a</sup>	6.4 [2.7–13.5]	< 0.001
History of cancer, n (%)	25 (9.6)	535 (5.3)	0.002	1.6 [1.0–2.3]	0.04
Initial nonshockable, No. (%)	245 (94.2)	5947 (58.6)	< 0.001	10.4 [6.4–18.4]	< 0.001

<sup>a</sup>Fisher’s exact test

PE pulmonary embolism, OHCA out-of-hospital cardiac arrest

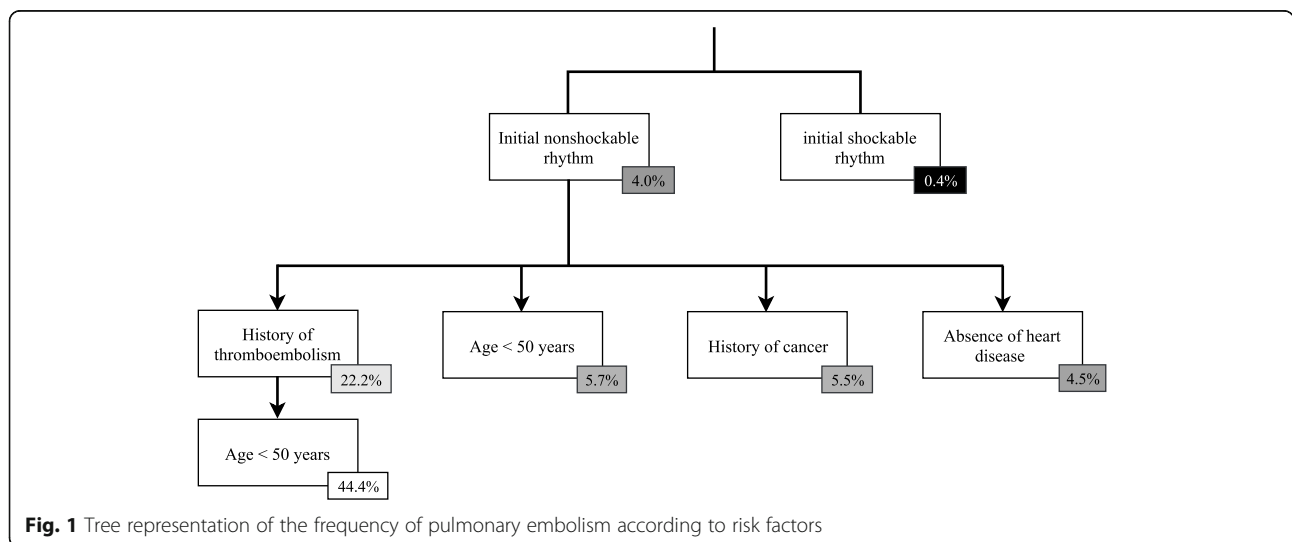
These two factors had a sensitivity of 22% (95% CI [10–39]), a specificity of 98% (95% CI [97–98]) to detect PE. When an age limitation of < 50 years was added to these two factors, the probability of PE was 44% (Fig. 1).

In summary, this study found two factors strongly associated with PE: initial nonshockable rhythm and prior thromboembolism. These factors had already been described by Bouguoin et al. [4] as the two major factors associated with the diagnosis of PE-related OHCA. Moreover, in our study, young age was a risk factor for PE, and this population has a lower risk of major bleeding in the case of thrombolysis, as shown in the PEITHO trial (lower risk if ≤ 75 years) [5].

Our study had some limitations such as the lack of completeness of data which may have resulted in the selection of the population not being completely

exhaustive. Moreover, the method of confirming PE either by CTPA or echocardiogram was not known for each patient, which may have underestimated the number of PE cases due to the lack of sensitivity for the ultrasound. In addition, autopsy results were not included in the data. Finally, we were unable to include subjects who died on site and were not admitted to hospital because of a lack of confirmation of the etiology of OHCA.

In conclusion, we recommend that for cases of OHCA for which a cause is not obvious, suspect a pulmonary embolism if the initial rhythm is nonshockable and there is a medical history of thromboembolism. In accordance with the guidelines of the American Heart Association (AHA) [6], these subjects should be treated by thrombolysis during resuscitation, especially when they are young.



**Fig. 1** Tree representation of the frequency of pulmonary embolism according to risk factors

### Abbreviations

OHCA: Out-of-hospital cardiac arrest; PE: Pulmonary embolism; RéAC: French National OHCA Registry; 95% CI: 95% confidence interval; CTPA: Computed tomography pulmonary angiography; AHA: American Heart Association

### Acknowledgements

We thank all the prehospital emergency medical service units in France investigated in RéAC.

### Authors' contributions

FJ and BL developed the analysis plan. FJ undertook the main analysis with supervision from BL. FJ wrote the first draft of the paper, with all other authors making important critical revisions. All authors have read and approved the final version of the manuscript.

### Funding

The RéAC registry is supported by the French Society of Emergency Medicine (SFMU), a patient foundation—Fédération Française de Cardiologie, the Mutuelle Générale de l'Éducation Nationale (MGEN), the University of Lille, and the Institute of Health Engineering of Lille. The authors declare that the funding sources had no role in the conduct, analysis, interpretation, or writing of this manuscript.

### Availability of data and materials

All data that were collected were listed in an anonymous database. The dataset is not available but can be requested from the corresponding author.

### Ethics approval and consent to participate

The present study was approved by the French Advisory Committee on Information Processing in Health Research and the French National Data Protection Commission (authorization no. 910946). It was approved as a medical assessment registry without a requirement for patient consent.

### Consent for publication

The study was approved as a medical assessment registry without a requirement for patient consent.

### Competing interests

The authors declare that they have no competing interests.

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Received: 4 November 2019 Accepted: 13 November 2019

Published online: 13 December 2019

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