

# Impact of dedicated outpatient pulmonary follow-up for hospitalized patients with acute pulmonary embolism

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## Abstract

Pulmonary embolism (PE) response teams are the standard of care for the management of acute PE. The complications of PE extend far beyond the initial hospitalization period. In this study, we examined the role and potential benefits of dedicated pulmonary follow-up after hospital discharge for patients with PE.

## KEYWORDS

anticoagulants, complications, pulmonary embolism

Pulmonary embolism (PE) is the third leading cause of cardiovascular mortality behind heart attack and stroke.<sup>1</sup> The advent of pulmonary embolism response teams (PERT) has greatly expanded the landscape of inpatient PE management.<sup>2,3</sup> The effects of acute PE extend far beyond the initial hospitalization period. After discharge, patients often face continued functional limitations, PE-related complications, and adverse reactions to anticoagulation (AC).<sup>3,4</sup> The long-term sequelae of acute PE range from asymptomatic residual pulmonary vascular obstruction (RPVO) to chronic thromboembolic disease (CTED) and chronic thromboembolic pulmonary hypertension (CTEPH). Dedicated follow-up for patients after acute PE is an important component of a PERT program.<sup>3,5</sup> Available guidelines for PE follow-up are limited to the workup of CTEPH, which develops in a very small subset of patients after acute PE.<sup>2</sup> We hypothesize that patients will benefit from early follow-up with a pulmonologist after acute PE. In this study, we report our experience with a dedicated PE follow-up clinic.

## METHODS

After obtaining approval from our Institutional Review Board, a retrospective review of our institution's PERT Registry was performed (review board protocol 26021). All patients who were seen in the PE clinic from August 2017 to November 2020 were included. Primary study outcomes included baseline demographics, European Society of Cardiology risk stratification, time from discharge to initial appointment, and clinic retention rate. Secondary study outcomes included inferior vena cava (IVC) filter retrieval rate, perioperative AC management for patients undergoing surgery, new pulmonary diagnoses and medications, and incidence of RPVO and CTEPH.

## RESULTS

Table 1 presents the patients' baseline demographic characteristics. A total of 90 patients were included in the study. The patients ranged in age from 20 to 93,

**TABLE 1** Baseline demographics

Demographic	Total N = 90
Gender (N, %)	Male: 32 (35.6%) Female: 58 (64.4%)
Race (N, %)	White: 36 (40.0%) Black: 54 (60.0%)
Ethnicity (N, %)	Hispanic: 10 (11.1%) Non-Hispanic: 80 (88.9%)
Age (mean, range)	57 years (20–93)
BMI (mean ± standard deviation)	34.2 ± 8.5
Comorbidities (N, %)	OSA: 7 (7.8%) COPD: 6 (6.7%) Asthma: 8 (8.9%) Pulmonary nodule: 3 (3.3%) Pulmonary embolism: 5 (5.6%) Tobacco use: 11 (12.2%) Diabetes mellitus: 20 (22.2%) Chronic kidney disease: 13 (14.4%) Congestive heart failure: 8 (8.9%) Cancer: 13 (14.4%)
ESC PE risk stratification (N, %)	Low risk: 34 (37.8%) Intermediate risk: 53 (58.9%) High risk: 4 (4.4%)
DVT (N, %)	48 (53.3%)
Inpatient management (N, %)	AC alone: 56 (62.2%) Catheter-based therapy: 25 (27.8%) Systemic thrombolytic: 6 (6.7%) IVC filter: 3 (3.3%)
Anticoagulation (N, %)	DOAC: 75 (83.3%) LMWH: 6 (6.7%) Warfarin: 8 (8.9%) Other: 1 (1.1%)

Abbreviations: AC, anticoagulation; BMI, body mass index; COPD, chronic obstructive pulmonary disease; DOAC, direct oral anticoagulant; DVT, deep venous thrombosis; ESC, European Society of Cardiology; IVC, inferior vena cava; LMWH, low molecular weight heparin; OSA, obstructive sleep apnea.

with a mean age of 57 years. Fifty-four (60%) were Black/African American, 36 (40%) were White, and 10 (11.1%) were Hispanic. For 78 (86.7%) patients, this was their first time seeing an outpatient pulmonologist. The median time from hospital discharge to the first appointment in the PE clinic was 27 days (interquartile range: 5–44). Retention rate, defined by attendance at  $\geq 2$  appointments was 75.6%. During follow-up, 19 (21.1%) patients were newly diagnosed with pulmonary disease (obstructive sleep apnea 11, chronic obstructive pulmonary disease 4, asthma 2, pulmonary sarcoidosis 1, pulmonary mycobacterium avium complex 1). Pulmonary medications were started or adjusted in 20 (22.2%) patients. Of the 54 patients who underwent a VQ scan, 34 (65.4%) were found to have RPVO. The incidence of CTEPH in our population was 2.2%. IVC filter removal rate was 100% for the three patients who had a filter placed. Perioperative AC management for patients undergoing surgery after PE was addressed in 8 (8.9%) cases.

## DISCUSSION

At our center, all patients seen by the inpatient PERT are given a follow-up appointment in the PE clinic. The first visit is focused on identifying risk factors, optimizing AC, facilitating IVC filter retrieval, thrombophilia, and age-appropriate cancer screening.<sup>2,5</sup> Subsequent visits are individualized but generally tailored toward the workup of post PE complications, AC duration and dosing, optimizing comorbid pulmonary disease, and perioperative AC management. After 3 months, patients are sent for individualized diagnostic testing, including echocardiogram, ventilation–perfusion (VQ) scan, pulmonary function testing, sleep testing, 6-min walk test, and lower extremity duplex. Patients who are identified as having RPVO are followed closely for the development of CTEPH.

### Comorbid pulmonary disease

The majority of patients in this cohort had never seen an outpatient pulmonologist before presenting to the PE clinic. We routinely screen for alternative causes of chronic dyspnea. As a result, 21% of patients presenting to our clinic were newly diagnosed with pulmonary disease (with OSA and COPD being most common). Optimization of these diseases may lead to improved functional status and quality of life.

## IVC filter retrieval

IVC filter placement is considered in cases of failed therapeutic AC, if therapeutic AC is contraindicated, or in the presence of a large free-flowing proximal DVT.<sup>5</sup> Longer indwelling times are associated with a greater risk of filter-related complications.<sup>6</sup> The FDA recommends the removal of IVC filters as soon as they are no longer needed.<sup>7</sup> A recent study found that many patients did not fully understand the complications of leaving an IVC filter in place and less than one-quarter of patients had their filters removed.<sup>8</sup> Counseling patients about the risks and benefits of IVC filter retrieval should take place during the first visit. In this study, 100% of IVC filters were retrieved after follow-up. If a filter cannot be retrieved, subsequent PE clinic visits should screen for filter-related complications.

## Long-term PE complications

A recent cohort study found that more than half of patients with acute PE had exercise intolerance compatible with Class II New York Heart Association heart failure 6 months after acute PE.<sup>6</sup> RPVO refers to persistent perfusion abnormalities on imaging after therapeutic AC.<sup>9</sup> CTED is defined by RPVO with functional impairment. CTEPH is characterized by the above with a resting mean pulmonary artery pressure  $\geq 25$  mmHg and pulmonary capillary wedge pressure  $\leq 15$  mmHg.<sup>2,5,10</sup> More than half the patients in our cohort who underwent a follow-up VQ scan were found to have some degree of RPVO. While CTEPH is relatively rare, patients with RPVO are at increased risk and will benefit from the follow-up.<sup>9</sup>

## Anticoagulation

All patients should undergo a discussion of AC duration and dosing during follow-up. We report the added benefit of perioperative AC management. Patients undergoing procedures that require the interruption of AC underwent a discussion of perioperative AC management during follow-up. Having a definitive plan for AC management during the perioperative period is likely to be beneficial.

We report our early results with a dedicated outpatient PE clinic. PE clinic offered patients a definitive follow-up to discuss PE- and AC-related issues. We report the added benefit of optimization of pulmonary comorbidities, perioperative AC management, and IVC filter retrieval. Prospective randomized controlled trials

are needed to show the proven benefit of outpatient PERT programs.

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## CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

## ETHICS STATEMENT

This study received approval from the Temple University Hospital Institutional Review Board (protocol 26021).

## AUTHOR CONTRIBUTIONS

Joseph G. Noto is the guarantor of this manuscript, taking responsibility for the integrity of the data and its interpretation. Joseph G. Noto wrote the manuscript, with input from Parth Rali. Joseph G. Noto performed the data collection and contributed to its analysis. Parth Rali designed the study, contributed to data collection, and its analysis. All authors have reviewed and approved the final version of the manuscript submitted.

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