Improving Rapid and Appropriate Pulmonary Embolism Treatment at the SFVAMC

Reginald Conley*[1], Kristen Enriquez*[1], Stephanie Hu*[1], Christian Jimenez*[1], Yimeng Li*[1], Erika Price, MD, MPH[1,2]
*Contributed equally
[1]UCSF School of Medicine, San Francisco, CA
[2]San Francisco VA Medical Center, San Francisco, CA

Background

The San Francisco VA Medical Center (SFVAMC) formed a pulmonary embolism response team (PERT) in 2018. As part of an ongoing effort to optimize the PERT team's function and overall treatment of pulmonary embolism (PE) at SFVAMC, we identified two specific areas for improvement:

- Prolonged time between diagnosis and treatment
- Frequent use of unfractionated heparin (UFH) as first-line therapy when low molecular-weight heparin (LMWH) or a direct oral anticoagulant (DOAC) would be more appropriate

The goal of our project was to clarify and improve the PERT workflow while increasing concordance with guideline-directed therapy and shortening the time between diagnosis and treatment.

Methods

- A **structured A3 framework** guided this quality improvement project.
- A **chart review** of PE diagnoses from March 2022 to August 2023 was performed to assess current conditions.
- **Interviews with key stakeholders** (2 nurses, 5 attendings, 3 pharmacists) at the SFVAMC were used in a formal gap analysis to assess PE patient treatment workflow and potential causes for delays in treatment.
- A **survey** (17 trainees and attendings) was conducted to evaluate awareness of the PERT at the SFVAMC.
- **Gap analysis,** including a fishbone diagram, was used to outline root causes and potential interventions for closing the gaps in PE patient care. A review of PE diagnoses from September 2023 to August 2024 was conducted to evaluate the effects of our interventions.

Results

An audit of electronic medical records (EMRs) of SFVAMC patients presenting with PE between March 2022 to August 2023 showed that the median time from CT scan to first dose of anticoagulant was 176 minutes. This number is much higher than what has been reported in the literature, with numbers as low as 76 minutes.[5]

Stakeholder interviews identified complex workflow between PE diagnosis and treatment initiation (Figure 1), providing many opportunities for delays to be introduced. Gap analysis revealed several factors key contributing to prolonged diagnosis-to-treatment, including:

- **Protocols:** Due to unclear understanding of the PERT's role in PE treatment workflows, care teams who called the PERT waited for input before initiating anticoagulation, which can pose a risk if immediate anticoagulation is indicated. In fact, of the survey respondents who called the PERT, 89% indicated that they sometimes waited for PERT recommendation prior to treatment. Unfortunately, there is currently no formal institutional protocol for when/how to contact the PERT.

- **Education:** A lack of formal training about the PERT for incoming care teams results in new members remaining unaware about institutional PE treatment protocols and PERT contact information/availability.

- **Order sets:** No anticoagulant order set exists at the SFVAMC to simplify the ordering process, which can be complex depending on the medication. The order set for UFH drip was found to be particularly confusing and time-consuming, often requiring corrections and clarifications from pharmacy before the physician is able to sign off on the order. All respondents in our survey expressed interest in an order set guide for initial anticoagulant treatment.

- **Personnel & staffing:** PERT availability during nights and weekends is currently unclear. Additionally, frequent turnover in trainees contributes to limited awareness about local PE management policies and the PERT. Availability of pharmacy staff to prepare and/or deliver medications to the inpatient unit can sometimes also contribute to delays in medication administration, as well as a lack of alerts to nurses for when the requested medications have been delivered to the unit (Figure 1). This means that they are sometimes unaware that they can begin administering anticoagulation immediately.

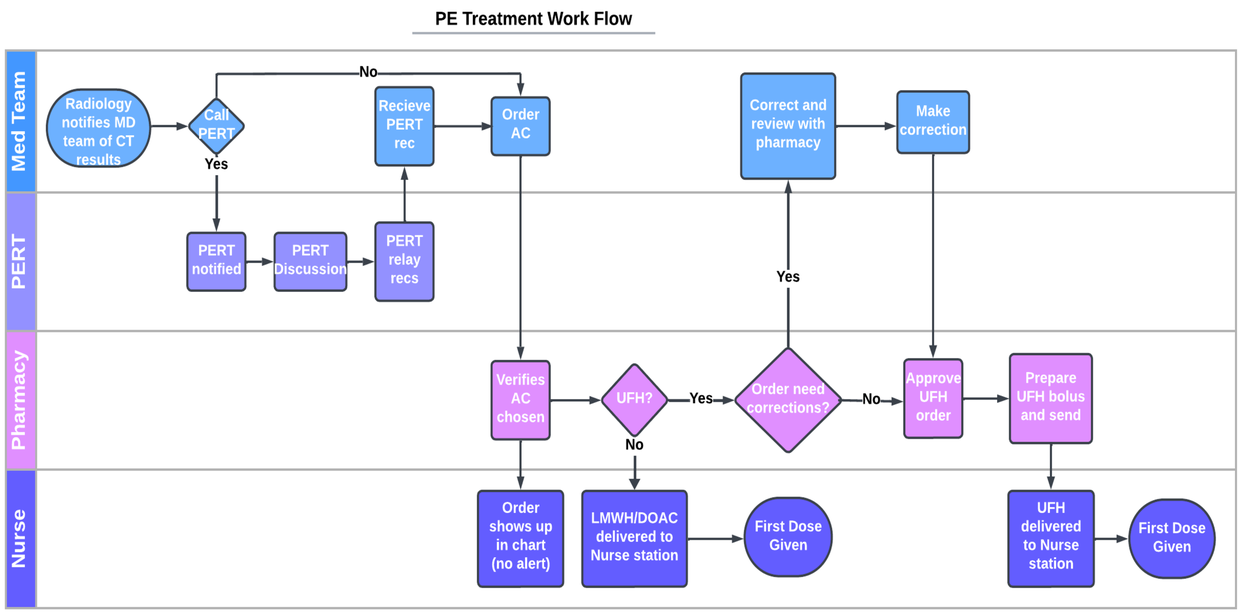

Figure 1. *Swim lane diagram illustrating the current workflow for initiating and processing PE treatment at the SFVAMC.*

Based on our gap analysis, we aimed to clarify and improve the PERT workflow, while also increasing concordance with enoxaparin guideline-directed therapy and shortening the time to initiating first-line treatment.

Four interventions were chosen to address the root causes of decreased PERT awareness and delays in medication administration from multiple angles. These included:

1. Educational outreach to the emergency department via email reminding providers they can treat patient while waiting for PERT recommendations
2. A flyer with key guidelines for PE management, including when to call the PERT
3. An order set in the EMR for DVT/PE
4. A written PERT standard operating procedure (SOP) outlining workflows within the PERT

In Figure 2, we report a timeline of key milestones that were (or are being) executed for the successful implementation of our proposed interventions.

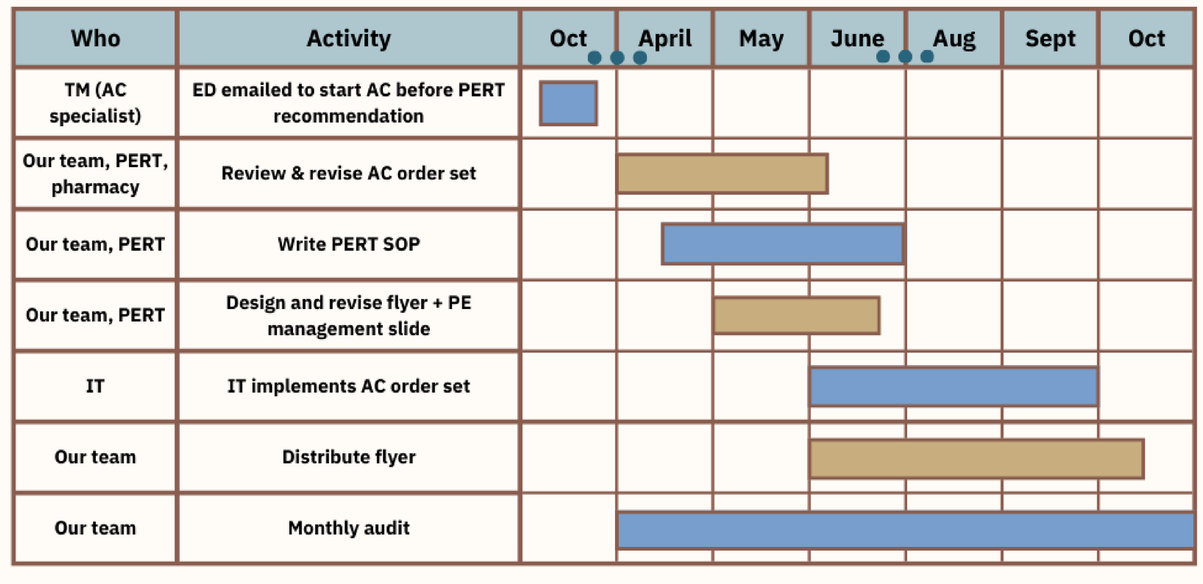

Figure 2. *Implementation timeline for proposed interventions.*

To evaluate the incremental effects of our interventions, we conducted a follow-up audit of PE cases for patients admitted to the SFVAMC between September 2023 and August 2024. We found that average diagnosis-to-treatment time decreased to 155 minutes, although subgroup analysis of data of the most recent 6 months showed that this number further decreased to 129 minutes.

176 Min → 155 Min → 129 Min

We also assessed choice of first-line anticoagulant therapy among PE patients receiving treatment and found the following (Figure 3):

- From March 2022 to August 2023 over 60% of our pilot cohort received UFH, which was indicated in only 41%

- Over the course of this QI intervention UFH use decreased to 40%, of which 79% had an appropriate indication

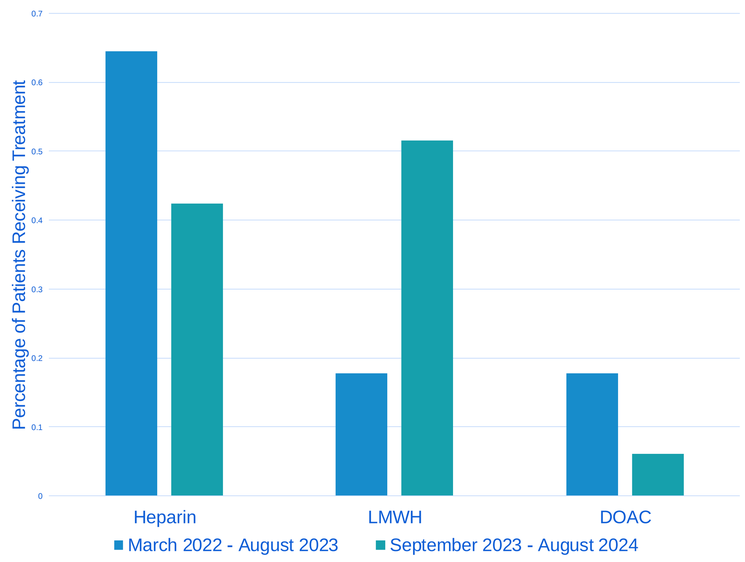

Figure 3. *Choice of first-line therapy by anticoagulant class.*

Conclusions

- We observed an increase in alignment with guideline-directed therapy and a modest decrease in diagnosis-to-treatment time compared to our pilot data.
- Awareness of the PERT and guideline-directed therapies were the major causes identified from interviews with multiple stakeholders and the PERT awareness survey.
- The structured A3 framework can guide quality improvement projects in PE response.
- Future work includes implementing the developed anticoagulant order set to aid clinician selection of anticoagulant treatment and streamline order placement.

References

1. Kahn SR, de Wit K. (2022). Pulmonary Embolism. *The New England journal of medicine*, *387*(1), 45–57. https://doi.org/10.1056/NEJMcp2116489
2. Lehnert P, Lange T, Møller CH, Olsen PS, Carlsen J. (2018). Acute Pulmonary Embolism in a National Danish Cohort: Increasing Incidence and Decreasing Mortality. Thrombosis and haemostasis, 118(3), 539–546. https://doi.org/10.1160/TH17-08-0531.
3. Bunte MC, Gosch K, Elkaryoni A, Noman A, Johnson E, Jones P, Indaram MB, Vupputuri S. (2021). Bleeding, death, and costs of care during hospitalization for acute pulmonary embolism: Insights from the Saint Luke's Outcomes of Pulmonary Embolism (SLOPE) study. *Vascular medicine (London, England)*, *26*(1), 28–37. https://doi.org/10.1177/1358863X20967415
4. Hobohm L, Farmakis IT, Keller K, Scibior B, Mavromanoli AC, Sagoschen I, Münzel T, Ahrens I, Konstantinides S. (2023). Pulmonary embolism response team (PERT) implementation and its clinical value across countries: a scoping review and meta-analysis. *Clinical research in cardiology : official journal of the German Cardiac Society*, *112*(10), 1351–1361. https://doi.org/10.1007/s00392-022-02077-0
5. Saif K, Kevane B, Ní Áinle F, Rosovsky RP. The role of the PERT team in 2021. *Thrombosis Update*, 6 (2022), p. 100092
6. Prucnal CK, Jansson PS, Deadmon E, Rosovsky RP, Zheng H, Kabrhel C. Analysis of Partial Thromboplastin Times in Patients With Pulmonary Embolism During the First 48 Hours of Anticoagulation With Unfractionated Heparin. *Acad Emerg Med.* 2020 Feb;27(2):117-127. doi: 10.1111/acem.13872. Epub 2019 Nov 24. PMID: 31625654.
7. Robertson L, Jones LE. Fixed dose subcutaneous low molecular weight heparins versus adjusted dose unfractionated heparin for the initial treatment of venous thromboembolism. *Cochrane Database Syst Rev.* 2017 Feb 9;2(2):CD001100. doi: 10.1002/14651858.CD001100.pub4. PMID: 28182249; PMCID: PMC6464611.