ASK THE EXPERTS

How Have PE Algorithms Changed Since the Advent of MT and PERTs?

The introduction of mechanical thrombectomy and PERTs has ushered in a new era of pulmonary embolism management, involving standardized, team-based, clinical decision-making pathways; expanded therapeutic options; more risk-stratified and individualized algorithms; and more.

With Kenneth Rosenfield, MD, MHCDS; Krunal H. Patel, MD; Parth Rali, MD; and Patrick Muck, MD

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Pulmonary embolism response teams (PERTs) have completely changed the paradigm and represent a significant advancement in the management of patients with pulmonary embolism (PE). Hospitals and systems with PERTs have implemented improved team-based processes. The concept of urgent, team-based decision-making for the management of PE is now firmly incorporated into hospitals throughout the United States (and even globally) and is recognized as best practice.

Previously, a patient presenting with symptoms of PE would be diagnosed and then referred to a single specialist who would then manage the patient's care however they thought best. In the absence of a solid clinical evidence base upon which to make decisions, the specialist would decide treatment based on personal biases and experience. What has changed as a result of PERT is that clinicians recognize the importance of having input from multiple specialists with expertise in PE and engaging in active discussion about the best treatment plan for that individual patient, given their presentation, risk profile, and prognosis.

A second change since the advent of PERTs is better up-front evaluation of patients with respect to their risk strata. PERTs promote the formal incorporation of risk stratification to drive decision-making for PE management. Such thorough evaluation was not incorporated as formally as it is now.

Along with these process changes, PERTs—supported by the advocacy of The National PERT Consortium—have resulted in an increased awareness of PE as a major cause of morbidity and mortality, highlighting to the medical world that PE is not only the leading cause of cardiovascular death amongst hospitalized patients but is almost as morbid as stroke and myocardial infarction overall. This initiative has also educated all parties about the multiple different ways in which PE can present. I call PE "the great masquerader" because it can look like heart attack, congestive heart failure, flu, pneumonia, asthma, and many other conditions. Heightened awareness of PE means that PE is now more routinely on the differential diagnosis as a potential cause of symptoms. Studies to detect the presence of PE are being ordered (appropriately) more frequently than before PERTs.

The PERT model has also provided a platform to encourage the development and dissemination of more advanced/effective therapies for PE, beyond anticoagulation and systemic thrombolysis. A prime example is that of medium-/large-bore mechanical thrombectomy (MT), which was introduced shortly after the initiation of the PERT concept. The PERT Consortium and its annual scientific meetings provided a forum for demonstrating the effectiveness of this therapy. This forum has facilitated the dissemination of this and other novel and highly effective therapies, such as pharmacomechanical thrombolysis with Bashir catheters (Thrombolex, Inc.) and ultrasound-facilitated thrombolysis with Ekos (Boston Scientific Corporation).

MT has assumed a major role in the treatment of PE and is now one of the most frequently used advanced therapies. Previously, advanced therapies were limited to open surgery, systemic thrombolysis, catheter-directed thrombolysis, and extracorporeal membrane oxygenation (ECMO). The advent of MT provided for a "surgical-like" thrombectomy, extracting clot in bulk but in a less invasive, less morbid manner. This has completely changed the equation for many clinicians, who now see MT as the go-to treatment. Personally, I am a proponent of MT if the patient is a candidate. That said, catheter-directed pharmacomechanical thrombolysis (Bashir) and ultrasound-facilitated thrombolysis (Ekos) have been shown to be highly successful, and I believe there is still a very significant role for these approaches, especially for patients who are not candidates for MT or when MT with experienced operators is not available. It is important to note that, as of the present time, it is yet to be determined which of these advanced therapies is going to be better in any given patient.

Although the algorithms have changed and there are more therapies available, it is imperative that we develop a more extensive evidence base to better inform our decision-making. The way to expand the evidence base is by performing more scientific trials and by collecting real-world evidence. Randomized controlled trials, such as HI-PEITHO, PE-TRACT, and those comparing MT to thrombolysis and to anticoagulation alone, will be essential to determining the role of MT compared to the other available treatments.

Real-world data such as those accrued through The PERT Consortium database will also provide an important scientific basis for decision-making. This database, now in its second iteration and with nearly 20,000 patient entries, is an incredibly powerful tool for analyzing the therapeutic approaches being used in the real world and their effectiveness. These data will inform our future practice and enable best outcomes.

In summary, clinicians now have a wide variety of treatment options to consider when managing a patient with PE. They must consider all the different possibilities and select the strategy that is ideal for the specific patient and their symptoms and prognosis. Therapeutic alternatives are improving rapidly, creating a moving target. Specifically, the field of MT is advancing rapidly, with more flexible, user-friendly devices that likely will prove even more effective and safe. This makes for challenging decision-making regarding optimal treatment, including conservative versus advanced therapy, which advanced therapy is best, and which specific device to utilize.

As noted earlier, PERTs can mitigate the challenge and facilitate decision-making. From my perspective, these all represent "good problems to have," as they indicate rapid progress and a great future for management of patients with PE. I look forward to the next generation of MT devices, which will undoubtedly improve the therapy even further.

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The advent of MT and the development of PERTs have transformed the clinical pathways for acute PE management. Historically, treatment decisions for intermediate- and high-risk PE were fragmented, often driven by individual physician comfort with anticoagulation, thrombolysis, or surgical intervention. At Temple University Hospital, the Department of Thoracic Medicine and Surgery leads PERT discussions for intermediate- and high-risk PE patients. With PERTs, multidisciplinary teams collaborate in real time to rapidly triage patients and tailor therapy based on hemodynamics, right ventricular function, clot burden, and bleeding risk. This shift has helped standardize clinical decision-making at our institution and improve the timeliness and appropriateness of interventions.

MT has expanded our therapeutic options, offering a nonlytic, catheter-based option for patients with contraindications to lytics or at elevated bleeding risk. Its growing adoption has pushed algorithms to more proactively identify patients who may benefit from early invasive therapy—even among intermediate-risk populations. More often than not, patients may transition through severity levels on arrival, requiring real-time changes in decision-making. As registry data and emerging randomized trials (eg, FLARE, FLASH, PEERLESS) continue to shape outcomes, the inclusion of MT in PE care pathways has become more evidence driven. With MT, this

allows us to potentially evaluate high-risk patients early for circulatory support with use of venoarterial ECMO (VA-ECMO). VA-ECMO now can be used as a bridge to MT for more favorable outcomes.

Overall, modern PE algorithms no longer treat MT as rescue therapy; rather, they proactively incorporate it into early decisions for intermediate- and high-risk PE—particularly in multidisciplinary models like PERT. MT is increasingly integrated alongside anticoagulation, thrombolysis, ECMO, and surgical options, with patient selection informed by real-time hemodynamic and imaging data. The utilization of a multidisciplinary team, such as a PERT, can help guide proper therapy. As MT becomes more widespread, not only do treatment algorithms need to change but also the discussion of a "door-to-thrombectomy" time needs to be further studied. Additionally, we are using artificial intelligence (AI)–driven models at Temple to preidentify at-risk patients and support clinical decision-making, further enhancing algorithm responsiveness and accuracy.

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TriHealth Good Samaritan Hospital followed Massachusetts General Hospital's care model and developed a PERT in 2013. Since then, modern PE algorithms have become increasingly risk-stratified and individualized. Clinical tools such as the PE Severity Index (PESI), simplified PESI score, and NEWS2 (National Early Warning Score 2) and Bova scores, coupled with biomarkers (troponin, brain natriuretic peptide), echocardiography, and advanced CT metrics, have become integral to early evaluation. Our PERT, like others, rapidly assesses patients and coordinates across services. We also recently published our experiences with AI (Viz.ai) for rapid PE diagnosis and anticoagulation.[1]

For the first 5 to 6 years, our treatment algorithms were largely binary, relying on anticoagulation alone or ultrasound-assisted thrombolysis with Ekos. Although ultrasound-assisted thrombolysis works well, thrombolytic use will inevitably lead to hemorrhagic complications, including intracranial hemorrhage. MT devices have changed the clinical algorithms guiding PE management by offering single-session therapy with faster, safer, and more targeted removal of the embolus, without the risks of thrombolysis.

Here in Cincinnati, our frontline therapy for intermediate-risk PE—once a therapeutic gray zone—is MT. We are involved in several device trials, but the FlowTriever (Inari Medical) and Lightning Flash 2.0 (Penumbra, Inc.) are the most used at our institution. Both have demonstrated superior outcomes in intermediate–high- and high-risk patients, often on ECMO. These devices have superior safety profiles with excellent embolus removal, minimal blood loss, and minimal complications. Flash 2.0 uses computer-assisted vacuum thrombectomy (CAVT) with both pressure- and flow-based computer algorithms. CAVT selectively aspirates the embolus for minimal to no blood loss, and it has become our mainstay of therapy.

As ongoing trials like STRIKE-PE, STORM-PE, PE-TRACT, PEERLESS, and HI-PEITHO refine our understanding of outcomes, the current algorithms will likely continue evolving. The core elements of our PERT, including timely risk assessment, multidisciplinary input, and procedural readiness, are here to stay. In 2025, it's clear that MT has changed our PE treatment algorithm. ■

1. Shapiro J, Reichard A, Muck PE. New diagnostic tools for pulmonary embolism detection. Methodist Debakey Cardiovasc J. 2024;20:5-12. doi: 10.14797/mdcvj.1342

Disclosures
Dr. Rosenfield: Consultant/scientific advisory board for Abbott Vascular, AngioDynamics, Boston Scientific Corporation, Cordis, Johnson & Johnson, Biosense Webster, Medtronic, NAMSA, Philips; consulting with equity or stock options in Akura, Contego Medical, Fastwave, Imperative Care, Innova Vascular, InspireMD, Jupiter, Magneto, Radiaction, SonoVascular, Vantis Vascular, and Viz.ai.
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