PE in the Real World: Addressing Gaps in Everyday Care

Examining how recent trial data are informing patient selection, treatment pathways, and multidisciplinary care.

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In recent months, a new generation of randomized trials examining the role of pulmonary embolism (PE) intervention has been presented and published, with more results anticipated across a variety of modalities, including the landmark PE-TRACT trial. What are the necessary steps to ensure the results from the completed trials are replicated in real-world settings? What must each center have in place?

The first principle is that centers must reproduce the clinical systems and patient selection processes used in these trials, not simply adopt the devices. HI-PEITHO and STORM-PE are complementary because both directly compared an endovascular strategy plus anticoagulation (AC) with AC alone, but they studied different technologies, populations, and endpoints.

HI-PEITHO evaluated ultrasound-facilitated, catheter-directed fibrinolysis in an enriched intermediate-risk PE population. In addition to right ventricular (RV) dilation and elevated troponin, patients had to exhibit at least two markers of cardiorespiratory distress, such as borderline systolic blood pressure (BP), tachycardia, or tachypnea. Catheter-directed fibrinolysis reduced the 7-day composite of PE-related death, cardiorespiratory decompensation or collapse, or recurrent PE from 10.3% to 4%, primarily by reducing episodes of decompensation or collapse.[1]

STORM-PE evaluated computer-assisted vacuum thrombectomy in normotensive patients with intermediate-high–risk PE, RV/left ventricular (RV/LV) ratio of at least 1.0, and elevated cardiac biomarkers. Mechanical thrombectomy (MT) produced a significantly greater reduction in RV/LV ratio at 48 hours than AC alone (0.52 vs 0.24) and was associated with more rapid normalization of vital signs. Major adverse event rates at 7 days were not significantly different between the groups.[2]

The implementation lesson from both trials is that endovascular treatment should not be triggered by the CT appearance alone. Each center needs a written pathway incorporating:

- Hemodynamic status and clinical trajectory
- Oxygen requirements and respiratory distress
- RV function and cardiac biomarkers
- Baseline cardiopulmonary reserve
- Bleeding risk and contraindications to fibrinolysis
- Evidence of impending or established clinical deterioration
- Availability of different endovascular and surgical rescue options

Centers performing these procedures also need 24-hour access to appropriately credentialed operators, trained procedural personnel, standardized AC and postprocedural monitoring protocols, and pathways for surgical embolectomy or mechanical circulatory support when required. For hospitals without those capabilities, the priority should be a formal tele–PE response team (PERT) and transfer relationship rather than development of a low-volume procedural program.

Finally, centers must measure their own outcomes. These should include death, decompensation, rescue therapy, bleeding, intensive care unit utilization, length of stay, readmission, RV recovery, exercise capacity, return to baseline function, and patient-reported outcomes. Real-world replication requires confirming that locally treated patients resemble those studied in HI-PEITHO and STORM-PE and that comparable benefits are being achieved without an unacceptable safety cost.

If you were to tease out two to three lessons learned by the PE interventional community from this generation of trials—perhaps

aspects of care or study that were not clear until after their completion—what might some examples be?

The first lesson is that intermediate-risk PE is not a single clinical entity. STORM-PE enrolled patients with objective RV strain and myocardial injury, while HI-PEITHO further enriched that phenotype by requiring clinical evidence of cardiorespiratory distress. Both trials support moving beyond a binary classification based only on BP and beyond selecting patients solely because they have a large embolus or an elevated RV/LV ratio.

The patient with RV dysfunction and an elevated biomarker who is comfortable on room air with stable vital signs may have a very different risk/benefit profile from the patient with the same imaging findings who also has tachycardia, tachypnea, increasing oxygen requirements, or borderline BP.

The second lesson is that the benefit of intervention must be evaluated across a continuum of outcomes. STORM-PE demonstrated that MT can produce faster reduction in RV strain, pulmonary artery obstruction, and abnormal vital signs than AC alone. HI-PEITHO moved the field beyond physiologic and imaging endpoints by showing that catheter-directed fibrinolysis can reduce clinically important early deterioration in a carefully selected population.

Those findings should be viewed as complementary. STORM-PE provides randomized evidence that MT accelerates physiologic recovery. HI-PEITHO provides randomized evidence that catheter-directed fibrinolysis can prevent early decompensation. Neither result alone answers every question, but together they substantially strengthen the rationale for selective endovascular treatment.

The third lesson is that we need to interpret both efficacy and safety with precision. HI-PEITHO did not demonstrate a mortality benefit. Its favorable primary result was driven predominantly by less cardiorespiratory decompensation or collapse. Major bleeding was uncommon and there was no intracranial hemorrhage, although bleeding was numerically more frequent with catheter-directed fibrinolysis.

STORM-PE was smaller and was powered for change in RV/LV ratio rather than mortality or major clinical events. Major adverse events were not significantly different, but two PE-related deaths occurred in the MT arm. That finding must be reported transparently even though the deaths were not necessarily attributable to the device or procedure.

The appropriate conclusion is not that every patient with intermediate-high–risk PE should undergo intervention. It is that two different endovascular strategies have now demonstrated benefits over AC alone across different but complementary domains. Our next task is to determine which patient benefits most from which strategy.

PEERLESS remains informative regarding the comparative experience of large-bore thrombectomy and catheter-directed thrombolysis, but it is less central to this question because both study arms received an intervention and there was no AC-only control.

How were these trials informative regarding the patient journey, perhaps specifically regarding the outcomes patients value most? What further study is most needed in understanding and improving patient-reported outcomes?

HI-PEITHO and STORM-PE examine different stages of the patient journey. HI-PEITHO addresses the immediate question: Can an endovascular therapy reduce the risk that a patient who is currently normotensive will deteriorate, require escalating respiratory or circulatory support, or need emergency rescue treatment? Avoiding that progression is inherently meaningful to patients and families.

STORM-PE addresses how quickly the heart and cardiopulmonary physiology begin to recover. It demonstrated faster RV recovery and normalization of physiologic parameters with thrombectomy. The subsequently presented 90-day STORM-PE findings also suggested better 6-minute walk distance (6MWD), a greater likelihood of achieving New York Heart Association functional class I, and a greater return toward pre-PE functional status with thrombectomy.

Together, the trials suggest a potential treatment sequence:

1. Rapid thrombus reduction and RV unloading
2. Reduced early physiologic stress
3. Prevention of clinical deterioration
4. Improved functional recovery

However, the causal connections between those stages still require further study. Patients do not primarily value changes in RV/LV ratio or clot obstruction scores. They want to know:

- When will I breathe normally?
- When can I walk and exercise?
- When can I return to work?
- Will I regain my previous independence?
- Will I develop persistent fatigue or post-PE syndrome?
- Will I remain fearful of recurrence?

Future trials should use a standardized core set of patient-centered outcomes, including dyspnea, fatigue, exercise capacity, return to work, caregiver dependence,

anxiety, quality of life (QOL), and return to pre-PE functional status. These should be collected at 30 days, 90 days, 6 months, and at least 1 year.

The results should be linked to objective measurements such as 6MWD, cardiopulmonary exercise testing, echocardiography, and recurrent health care utilization. PE-TRACT will be particularly important because it places exercise capacity, functional status, and QOL near the center of its assessment.

The next major research question is whether the early benefits demonstrated separately by HI-PEITHO and STORM-PE translate into durable improvements that patients can feel in their daily lives.

In your role as a leading trialist, Society of Interventional Radiology President, and PERT Consortium leader, you have a unique perspective on the global treatment of PE. How is the treatment of PE evolving outside the United States? How can further collaboration between specialties and across international borders affect care in the near future?

The treatment of PE is becoming increasingly multidisciplinary and international. Both STORM-PE and HI-PEITHO demonstrate the value of multinational trial infrastructure. STORM-PE enrolled 100 patients across 22 international sites, while HI-PEITHO enrolled more than 500 patients in a multinational clinical outcomes trial. The successful completion of these studies shows that complex PE trials can be conducted across different health systems, specialties, and procedural environments.

The international importance of these trials is also that they evaluated two fundamentally different approaches. HI-PEITHO studied catheter-directed delivery of a lower-dose fibrinolytic therapy. STORM-PE studied mechanical thrombus extraction without the therapeutic use of a fibrinolytic drug. Those strategies may have different advantages depending on bleeding risk, clot distribution, local expertise, device availability, and the speed with which treatment can be delivered.

Global adoption will not be uniform. Reimbursement, regulatory approval, transfer infrastructure, procedural expertise, and access to critical care resources vary substantially among countries. The appropriate PE system in a large United States tertiary hospital may differ from one in a regional European hospital or in a health system with limited access to advanced intervention.

International collaboration should focus on several priorities. First, we need standardized definitions of intermediate-high–risk PE, cardiorespiratory distress, clinical decompensation, major bleeding, procedural success, and post-PE syndrome. HI-PEITHO and STORM-PE used related but not identical inclusion criteria and endpoints, which makes direct comparison difficult.

Second, future trials should be designed to determine which patient phenotype benefits from MT, catheter-directed fibrinolysis, or AC alone. Neither HI-PEITHO nor STORM-PE establishes that one endovascular modality is superior to the other.

Third, multinational registries should use harmonized data elements and incorporate patient-reported outcomes. This will allow assessment of populations that may be underrepresented in device trials, including older adults, patients with cancer, patients with limited cardiopulmonary reserve, and patients treated in resource-limited systems.

Finally, international tele-PERT networks can help separate access to expertise from physical proximity to a major center. Rapid image exchange, shared protocols, and multidisciplinary consultation can make high-quality PE decision-making less dependent on geography.

Where are the most significant PE care improvements needed at the community hospital level? Rapid acquisition of imaging? Care determination? Transfer to intervention in appropriate cases?

All three are important, but the greatest gap is often what happens after PE has been identified on CT. The community hospital must rapidly translate the imaging diagnosis into a clinical risk profile. That means integrating the RV/LV ratio and clot distribution with BP, heart rate, respiratory rate, oxygen requirement, biomarkers, renal function, bleeding risk, and trajectory.

The two randomized trials provide complementary examples of patients who should generate heightened concern. The STORM-PE phenotype includes a normotensive patient with RV dilation and elevated cardiac biomarkers. These patients have objective evidence that the embolism is affecting the right ventricle even though overt shock has not developed. The HI-PEITHO phenotype adds signs of active cardiorespiratory stress, such as tachycardia, tachypnea, or borderline systolic BP. Those features identify a more clinically stressed subgroup in whom catheter-directed fibrinolysis reduced early deterioration.

The essential community hospital capabilities are therefore:

1. **Rapid diagnosis:** Timely CT pulmonary angiography and reliable recognition of RV strain.
2. **Immediate severity assessment:** Standardized collection of vital signs, oxygen requirements, cardiac biomarkers, RV function, bleeding risk, and evidence of clinical progression.

3. **Prompt AC and stabilization:** Initial treatment should not be unnecessarily delayed while transfer or intervention is being considered.
4. **Rapid access to multidisciplinary expertise:** A regional PERT or tele-PERT should be available through a single-call system.
5. **Defined transfer criteria:** Hospitals should know which patients can remain locally and which require urgent consultation and may benefit from transfer to a center capable of thrombectomy, catheter-directed fibrinolysis, surgery, or extracorporeal support.

Every community hospital does not need to perform pulmonary thrombectomy or catheter-directed fibrinolysis. Every community hospital does need the ability to recognize a STORM-PE–type patient with RV injury and a HI-PEITHO–type patient with additional cardiorespiratory distress before that patient progresses to overt shock.

Will the influence of the recent multisociety guidelines be experienced similarly at all levels? How might this impact differ in community versus tertiary care centers?

The impact will differ because community and tertiary centers have very different resources and responsibilities. At tertiary centers, the 2026 multisociety guideline provides a framework for standardizing PERT activation, applying the new American Heart Association/American College of Cardiology clinical categories and determining when advanced therapy should be considered. It also reinforces that multidisciplinary PERTs should be part of the care system for higher-risk patients.[3]

STORM-PE and HI-PEITHO now add important randomized evidence to that framework. STORM-PE supports the ability of MT to accelerate RV and physiologic recovery compared with AC alone. HI-PEITHO supports the ability of catheter-directed fibrinolysis to reduce early decompensation in a more clinically stressed intermediate-risk population. These trials do not automatically mandate intervention. Rather, they help define the types of patients who should prompt serious multidisciplinary consideration of an endovascular strategy.

At a tertiary center, that discussion may involve choosing among AC, catheter-directed fibrinolysis, MT, surgical embolectomy, or mechanical circulatory support. It also requires matching the treatment to bleeding risk, anatomy, clinical trajectory, and institutional expertise.

At a community hospital, the principal guideline effect is more likely to be organizational. The priority is to establish consistent risk stratification, prompt AC, tele-PERT access, and selective transfer—not to create every advanced procedural capability locally.

HI-PEITHO was published after the guideline itself, and STORM-PE appeared near the end of the guideline development cycle. Therefore, these trials should be understood as important new evidence that will inform implementation, future-focused updates, and subsequent guidelines rather than as evidence already fully embedded in every current recommendation.

The practical message for both settings is the same: Endovascular therapy should be considered based on integrated clinical risk and trajectory, not RV dilation or clot burden in isolation.

Have PE-specific artificial intelligence (AI) identification and triage applications helped improve and democratize the triage and communication of PE patients across a variety of care settings?

AI has helped democratize rapid detection and communication, but the results of HI-PEITHO and STORM-PE demonstrate why identifying the clot is only the first step. An AI application may identify pulmonary arterial filling defects, calculate an RV/LV ratio, and alert the radiologist or PERT. That can reduce delays, particularly overnight or at hospitals without on-site PE expertise.

The next generation of PE decision support should integrate the clinical variables emphasized by both randomized trials. From STORM-PE, that includes RV/LV ratio, proximal embolus location, elevated troponin or BNP, and normotensive but potentially vulnerable physiology. From HI-PEITHO, it additionally includes borderline systolic BP, tachycardia, tachypnea, and other evidence of cardiorespiratory distress.

An effective system should not merely report "PE detected." It should communicate that the patient has RV dysfunction, myocardial injury, and, where present, clinical distress resembling the populations evaluated in randomized trials against AC alone. That information could automatically prompt a local PERT or regional tele-PERT consultation and reduce variation between tertiary and community settings.

AI should not independently determine whether a patient receives MT or catheter-directed fibrinolysis. It cannot fully assess frailty, recent surgery, intracranial disease, cancer, baseline function, goals of care, or the nuances of bleeding risk. Its most valuable current role is accelerated recognition and structured risk assessment and communication, followed by multidisciplinary human decision-making.

How can progress in triage and transfer be further improved? Do you see the potential for local legislative influence in prioritizing trans-

fer of potential PE patients to centers with PERTs in place, for example?

The greatest immediate opportunities are operational. Every region should have:

- A single-call PE consultation and transfer pathway
- Immediate electronic transfer of CT images
- A standardized clinical data and risk assessment checklist
- Tele-PERT consultation while the patient remains at the referring hospital
- Predetermined transfer criteria
- Access to critical care transport
- Feedback to referring hospitals regarding treatment decisions and outcomes

HI-PEITHO and STORM-PE can help refine those transfer criteria. A patient with clinical features similar to patients evaluated in STORM-PE—with RV dilation, elevated biomarkers, and intermediate-high-risk PE—should prompt early expert consultation even if BP remains normal. A patient with clinical features similar to patients evaluated in HI-PEITHO—with RV dilation, elevated biomarkers, and intermediate-high–risk PE plus multiple signs of cardiorespiratory distress—should prompt an even greater sense of urgency because randomized data now indicate that an endovascular strategy can reduce the risk of early deterioration in such patients.

Transfer should nevertheless not be based on clot burden or RV/LV ratio alone, nor should every patient with PE be transferred to a procedural center. Most patients can be treated effectively with AC, and transporting an unstable patient without appropriate stabilization may introduce additional risk.

There may be a role for regional policy or legislation, but it should support the infrastructure rather than dictate a specific procedure. Potential policy priorities include reimbursement for tele-PERT consultations, interoperable image-sharing systems, regional transfer agreements, critical care transportation capacity, standardized PE center designation, and quality reporting and outcomes registries.

A tiered regional system could include PE-ready hospitals, advanced PE centers capable of catheter-based intervention, and comprehensive centers with surgical embolectomy and extracorporeal support. However, a center should not receive advanced designation simply because it owns a thrombectomy device or offers catheter-directed fibrinolysis. Designation should reflect multidisciplinary expertise, 24-hour capability, procedural volume, rescue pathways, follow-up programs, and documented outcomes.

The objective is to identify the right patient early, determine whether AC alone remains appropriate, and transfer the patient only when the receiving center can provide a meaningful additional level of care. HI-PEITHO and STORM-PE give us stronger and complementary evidence for determining which normotensive patients warrant that accelerated pathway. ■

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