

Pulmonary Embolism Response Teams (PERT): Pursuing excellence in the care for venous thromboembolism

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Pulmonary Embolism Response Teams

- Briefly review reperfusion strategies available for PERT
- What is it?
- Who needs it?
- Who should be part of it?
- How is it activated?
- The logistics of a PERT call
- PERT: Collecting data and measuring success/outcomes

Clinical Case Scenario

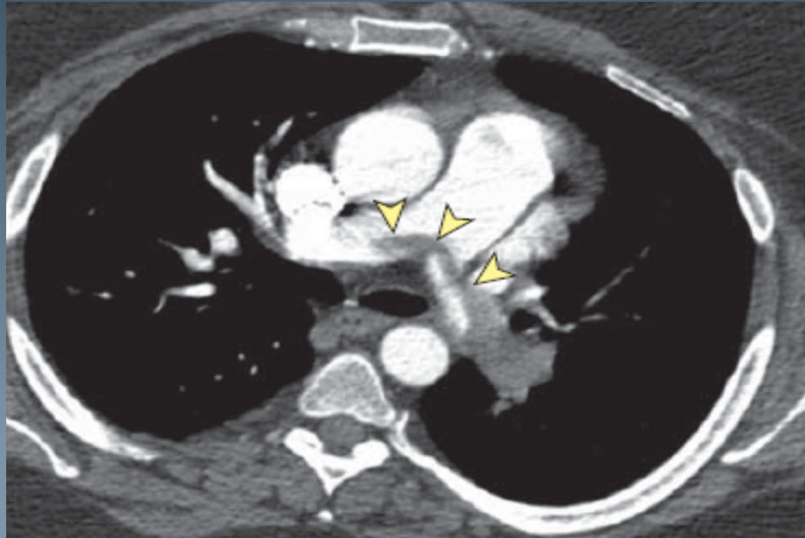
73 y. old female, s/post meningioma removal with L residual hemiparesis 45 days ago, presented to the ER with a 3-day history of acute onset dyspnea, up to the point to be at rest. PE revealed a HR of 128 bpm, BP 105/63 mmHg, RR, 25 x min, O₂Sat at 91% at 5 L/NC. Cardiovascular examination revealed just tachycardia; Left LE with 2+ pitting edema up to the knee, and mild erythematous, warm to touch.

CBC, CMP, coags WNL; initial *trop-I* showed 0.35 ng/ml, and BNP of 700 ng/ml. Acceptable Chest X ray.

ECG: Sinus tachycardia with rightward axis deviation, inverted peak T waves from V1-V3 and complete new onset RBBB.

CT-Angio: End-diastolic RV/LV diameter ratio of 1.8. Venous Doppler of LLE revealed extensive acute femoro-popliteal DVT.

How should this patient be approached?



**Risk Stratification in
acute PE:
Where to start?
Land of confusion
and chaos ??**

Interpreting 3 Sets of Guidelines: Who should get advanced reperfusion strategies?

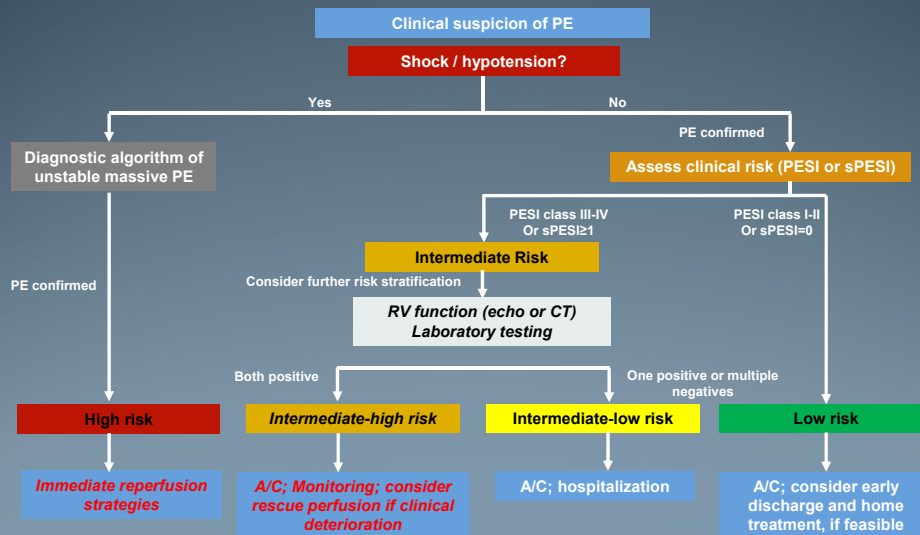
High-risk PE

AHA 2011 ("reasonable")
ACCP 2016 ("suggested")
ESC 2019 ("**recommended**")

Intermediate-high risk PE

- AHA 2011 (severe RV dysfunction **and/or** major biomarker elevation)
- ACCP 2016 (clinical gestalt, Grade 2C)
- ESC 2019 (RV dysfunction **and** biomarker elevation [**intermediate-high risk**] Class IIa, LOE-B)

Risk-adjusted diagnostic/therapeutic strategies in PE



A/C=anticoagulation; CT=computed tomographic pulmonary angiography; PE=pulmonary embolism; PESI=pulmonary embolism severity index; RV=right ventricular; sPESI=simplified pulmonary embolism severity index. Konstantinides SV, et al. *Eur Heart J* 2019;35:3033.

What is the current evidence-based status for reperfusion strategies in acute PE?

THE NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Fibrinolysis for Patients with Intermediate-Risk Pulmonary Embolism

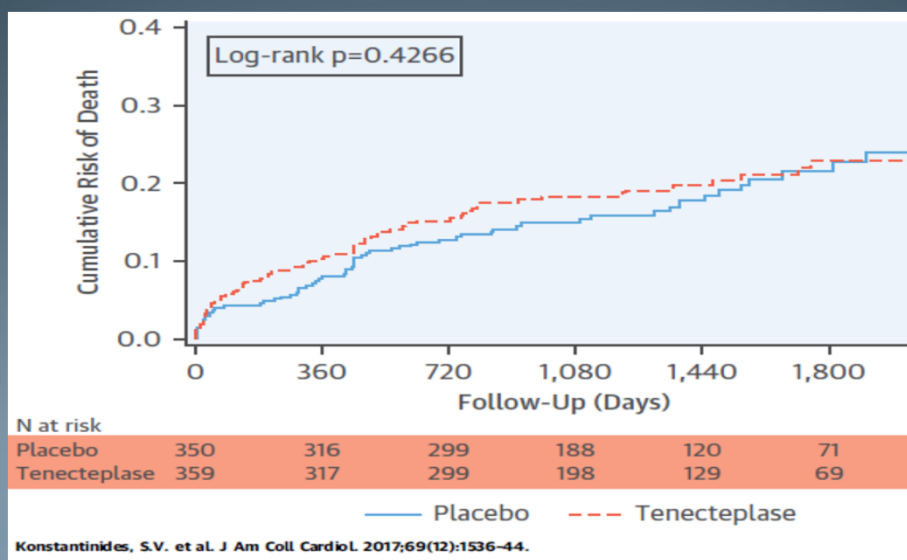
Guy Meyer, M.D., Eric Vicaut, M.D., Thierry Danays, M.D., Giancarlo Agnelli, M.D., Cecilia Becattini, M.D., Jan Beyer-Westendorf, M.D., Erich Bluhmki, M.D., Ph.D., Helene Bouvaist, M.D., Benjamin Brenner, M.D., Francis Couturaud, M.D., Ph.D., Claudia Dellas, M.D., Klaus Empen, M.D., Ana Franca, M.D., Nazzareno Galiè, M.D., Annette Geibel, M.D., Samuel Z. Goldhaber, M.D., David Jimenez, M.D., Ph.D., Matija Kozak, M.D., Christian Kupatt, M.D., Nils Kucher, M.D., Irene M. Lang, M.D., Mareike Lankeit, M.D., Nicolas Meneveau, M.D., Ph.D., Gerard Pacouret, M.D., Massimiliano Palazzini, M.D., Antoniu Petris, M.D., Ph.D., Piotr Pruszczyk, M.D., Matteo Rugolotto, M.D., Aldo Salvi, M.D., Sebastian Schellong, M.D., Mustapha Sebbane, M.D., Bozena Sobkowicz, M.D., Branislav S. Stefanovic, M.D., Ph.D., Holger Thiele, M.D., Adam Torbicki, M.D., Franck Verschuren, M.D., Ph.D., and Stavros V. Konstantinides, M.D., for the PEITHO Investigators*

Take-home messages: *PEITHO*

- Reduction of the primary end-point of death or hemodynamic shock within 7 days of randomization in patients with intermediate-risk PE (1.6 vs 5%; $p=0.002$)
- *PEITHO* represents a great example on how to justify performing early *risk-stratification* in normotensive patients with PE.
- Benefits of systemic thrombolysis came at the high cost of significant increased risk in major, particularly intracranial hemorrhagic stroke (2.4% vs 0.2%; $p=0.003$)

Meyer G, et al. *New Engl J Med* 2014;370:1402-10.

Long-term outcomes: *PEITHO*

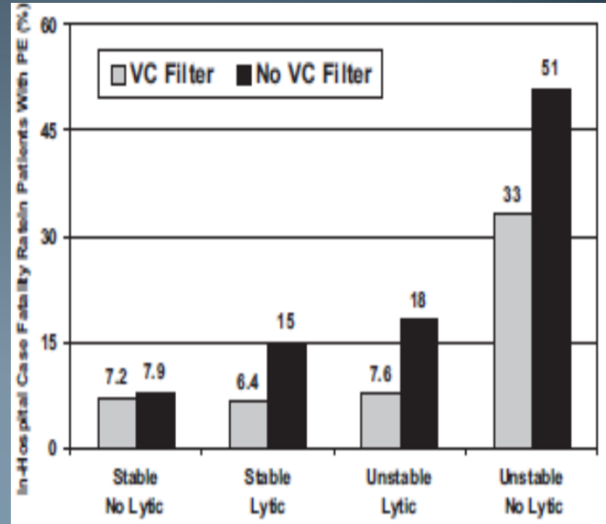


IVC filters in acute PE

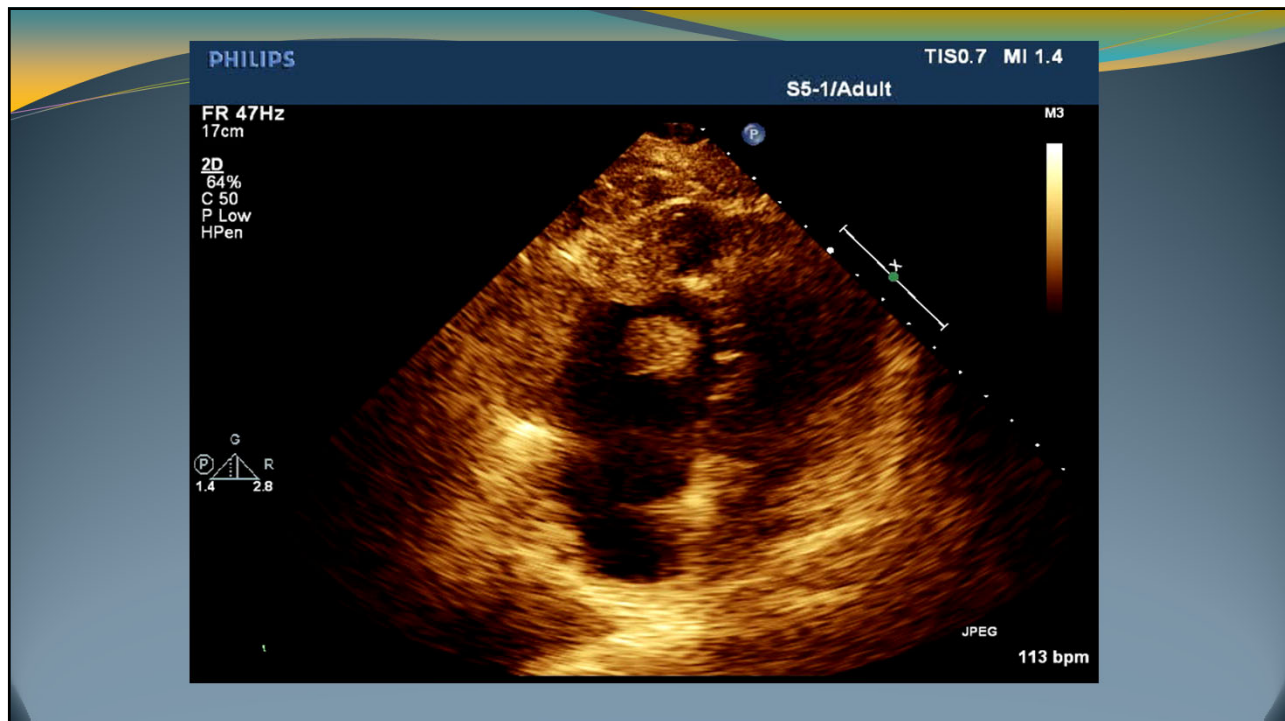
- Why?..... Who?..... How long?

1. Intermediate-high risk PE receiving lytic therapies
2. Recurrent VTE while in optimal AC therapies
3. Emergent pulmonary embolectomy with relative contraindications for systemic lysis
4. Low-risk PE with proximal acute LE DVT
5. Hospitalized cancer pts with solid tumors and > 60 years old ??

Stein PD, Matta F, et al. *Am J Cardiol* 2019;123:1874-78.



Stein PD, et al. *Am J Med* 2012;125:478-84.



Right heart thrombi (*clot in transit*)

- How common? 2.6 to 4.5% of all PEs
- Morphology on Echocardiography: Snake like in 70%
- Mobile (type A) in 85 % of PEs
- More likely to be present in high and intermediate-high risk PE
- Higher mortality in RVD vs controls (17% vs 6%; $p=0.003$)
- Scarce EBM on therapies !!!
- Best papers to read ***RiHTER and RIETE Registries*** from Europe

Koc M, Kostrubiec M, et al. *RiHTER Registry*. ***Eur Respir J*** 2016;47:869.
Barrios D, Rosa-Salazar V, et al. ***Eur Respir J***. 2016;48:1377-85.

Surgical Pulmonary Embolectomy

- Main indications: ***failed thrombolysis or contraindication for lytic therapies (Class I-C, ESC 2019 Guidelines)***
- Retrospective analysis 105 pts (49 unstable; 56 stable)
- Mortality in unstable (10.2%) vs stable (3.2%); ($p=0.247$)
- 1-year survival rates: unstables (68.2%) vs stables (87%); ($p=0.014$)
- Decent survival rates for massive PE and excellent survival rates for intermediate-high risk PE; subgroup of patients undergoing ECMO, higher mortality (50%)

Neely RC, Byrne JG, et al. ***Ann Thorac Surg*** 2015;100:1245.

Risk factors for ICH post systemic lysis: the *PE-CH* score

- Retrospective analysis of 9,703 patients from 2003-2012, received systemic lytic therapies from the nation-wide inpatient sample (NIS) database
- Four independent prognostic factors identified: pre-existing *PVD* (1 point); *age > 65 years old* (1 point); *prior stroke* with residual deficit (5 points); and *prior STEMI* (1 point)
- Clinical scores of 1, 2 and >5 points, associated with 1.9, 2.4 and 17.8% for ICH respectively

Chatterjee S, Weinberg I, et al. *Thromb Haemost* 2017;117:246-251.

Pulmonary Embolism Response Teams (PERT)

Main Objective:

- Conformed by different specialties
- Brings-up different experiences, technical expertise and therapeutic recommendations.
- Optimal care for the complex patient with significant acute PE, with rapid, multidisciplinary approach, mobilizing resources, facilitating further research.

Kabrhel C, Jaff MR, et al. Pulmonary Embolism Response Team. *Chest* 2013;144:1738.

PERTs: Members/Mnemonics

Specialties involved:

- Hospitalist/Internist/Family Medicine/Orthopedics/Gen Surgery (primary care team)
- **P**ulmonary/Critical Care
- **E**ndovascular specialist (invasive cardiologist) and **E**mergency Medicine
- **R**adiology (diagnostic and interventional)
- **T**hrombosis specialist (hematologist) and Vascular Medicine
- **s**: Cardiothoracic and Vascular Surgery

Porres-Aguilar M, et al. *J Thromb Haemost* 2022; (Submitted, Under Review)

PERT: Developing a new paradigm

Mission:

- To advance in diagnostic management and outcomes of patients with severe pulmonary embolism (PE)

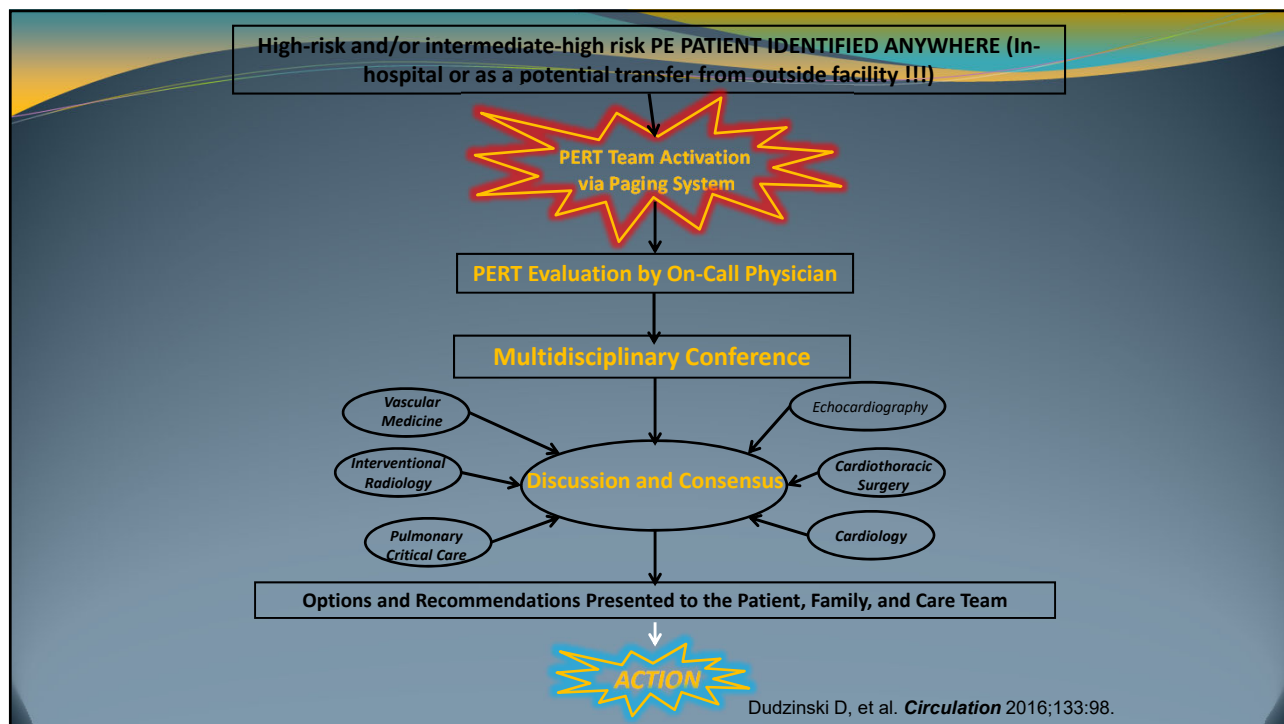
Main Goals:

- Improve patient outcomes using a collaborative, multidisciplinary team-based urgent consult to treat massive and submassive PE

Functionality:

- Modeled on rapid-response concept
- Multidisciplinary team of experts convened via electronic meeting
- Evaluate and offer full range of available treatments

Dudzinsky DM, Piazza G. *Circulation* 2016;133:98.



Original Research Pulmonary Vascular Disease

CHEST

A Multidisciplinary Pulmonary Embolism Response Team

Initial 30-Month Experience With a Novel Approach to Delivery of Care to Patients With Submassive and Massive Pulmonary Embolism

Christopher Kabrhel, MD, MPH; Rachel Rosovsky, MD, MPH; Richard Channick, MD; Michael R. Jaff, DO; Ido Weinberg, MD; Thoralf Sundt, MD; David M. Dudzinski, MD, JD; Josanna Rodriguez-Lopez, MD; Blair A. Parry, CCRC, BA; Savannah Harshbarger, BS; Yuchiao Chang, PhD; and Kenneth Rosenfield, MD

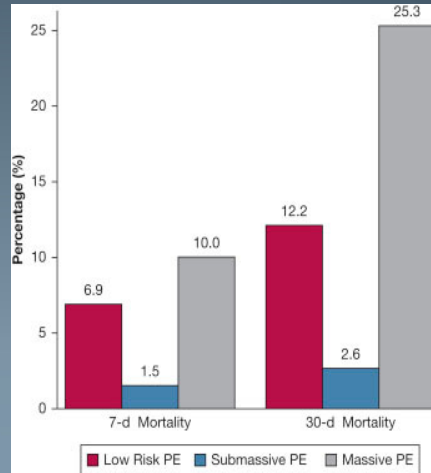
TM

PERT

National Consortium of Pulmonary Embolism Response Teams

PERT OUTCOMES · MGH 30-month experience

- Total: 310 patients
 - Intermediate-risk PE: 143 patients
 - High- risk PE: 80 patients
- **Treatment:**
 - Anticoagulation alone: 205(69%)
 - Catheter-directed thrombolysis in 28 (9%) patients
 - Systemic thrombolysis in 14 (5%)
 - Surgical embolectomy in 8 (3%)
 - Suction/mechanical thrombectomy in 1 (0.3%)



Kahrel C, et al. *Chest* 2016;150:384-9.

PERT Outcomes: Cleveland Clinic

- 134 activations (2014-2016)
- 19% (23) were high-risk (massive) PE; 80% (68) were intermediate-risk (submassive) PE
- 12% received CDT, 5% systemic lysis, 13% ½ doses of rTPA; 5% surgical embolectomy, 3% mechanical thrombectomy.
- 9% mortality rate (11 patients died) during hospitalization; 12% had major bleeding events during hospitalization
- No bleeding events among patients that received rTPA (either full or ½ doses)

Mahar JH, et al. *J Thromb Thrombolysis* 2018; 46:186-92.

PERT Consortium Multicenter Registry (EXPRESS)

- 1st US-based multicenter registry data (8 centers included)
- Main objective: To describe frequency of activations, patterns of therapies and outcomes between 10/2016-10/2017.
- 475 activations; average of 5-13 x month; majority from the ED (approximately **59-69%**); **7-9%** were from outside hospitals; **10-15%** from ICU and medical floors
- Any advanced therapy varied per institution ($p=0.0003$); from 16% to 44%
- VTE recurrence higher in patients receiving advanced therapies: (11% vs AC alone 5%; $p=0.04$)

PERT Consortium EXPRESS Registry

- 18% of PERT activations due to low-risk PE..... why ??
- ***Significant comorbidities, centrally located PE, challenges in management, clot in transit, etc.***
- 20-30% of all the participant institutions considered appropriate to activate PERT in such low-risk subgroup
- Overall mortality rate of 16% (4-44%); major bleeding events of 13%
- ***CONCLUSION: Significant variability among “expert teams” of PERTs in regards frequency, mode of therapies and mortality.***

Schultz J, et al. *Pulm Circ* 2019; Jan 11. doi: 10.1177/2045894018824563. [Epub ahead of print]

VTE- PREVENTION teams at Hospital Zambrano-Hellion: A novel concept in Latin-America

- First PERT well organized and established in Mexico
- PREVENTION-team provides fast, efficient, and time-saving treatment, potentially saving lives and reducing bleeding and -chronic complications in VTE patients
- Provides accelerated care and easy access to best therapeutic tools for the dx and therapies in complex cases of VTE/acute PE (Goal of < 60 min... from door to execution)
- Includes the whole spectrum of VTE= DVT and PE

Toro-Mijares RD, Jerjes-Sánchez C, et al. *Arch Cardiol Mex* 2020;90(1):28-38. doi: 10.24875/ACM.19000276.

Predicting factors for *PERT* activation

- Retrospective analysis from MGH (2013-2017)
- Fifteen percent (56/374) of low-risk PE patients triggered a PERT activation; factors associated were: (1) *vascular disease*, (2) *pulmonary diseases*, (3) *high-risk thrombophilias*, (4) *current use of anticoagulants*, (5) *central extensive PE* and (6) *concurrent proximal extensive DVT*
- Thirty-five percent (110/283) of intermediate/high-risk PE patients did not elicit a PERT activation; main factors included: *incidental asymptomatic PE* and *malignancies*
- Selected patients with low-risk PE may benefit from PERT activations

Mortensen CS, Kramer A, et al. *J Thromb Thrombolysis* 2021; Aug 9. doi: 10.1007/s11239-021-02533-0.

Study	Number of patients	Outcomes
Kabrhel C, <i>et al Chest</i> 2016	394 PERT activations	69% of patients received AC CDT in 9%, ST in 5%
Wright C, <i>et al Am J Cardiol</i> 2021	137 pre/post-PERT	↓6 months mortality rate; ↓LOS
Carroll BJ, <i>et al Am J Med</i> 2020	2042 pre/post-PERT	↑ Risk stratification assessment by cardiac biomarkers and TTE. ↓IVC filters use. No difference in mortality
Chaudhury P, <i>et al Am J Cardiol</i> 2019	769 pre/post-PERT	↓ Rate of bleeding; ↓ Time-to-therapeutic AC; ↓IVC filters; ↓30-day mortality
Araszkiewicz A, <i>et al Kardiol Pol</i> 2021	690 PERT Activations	ST alone in 80.3% of patients 23.3% received advanced therapy: CDT 11.3%, ST 5.3% SPE in 2.4% and ECMO in 0.6%
Annabathula R, <i>et al JTT</i> 2021	530 pre/post-PERT	↓ In-hospital mortality ↓ LOS; ↓ total cost of care
Myc LA, <i>et al. Respirology</i> 2021	554 patients	↓ All-cause mortality Improved outcomes compared to patients who did not receive PERT

Benefits and perks of *PERT*

- Provide fast, efficient, organized, and individualized care in complex cases of PE
- Accurate collection of database, generating high quality of care core measures and clinical research
- Coordinate patient care (inpatient and outpatient), with adequate collaborative team efforts, leveraging each other
- Create a vehicle of education dissemination, for both physicians and patients
- ***Will it represent*** a shifting paradigm and novel standard of care in complex PE?

Porres-Aguilar M, et al. *Arch Cardiol Mex* 2019;89:55-7.

Porres-Aguilar M, et al. *Clin Applied Thromb Hemost* 2018; doi: 10.1177/1076029618812954

Late (chronic) management duties of *PERT*

- Who gets appropriate hypercoagulability work-up as outpatient?
- Assessing functional recovery and RV recovery
- Screen/evaluate for CTEPH and PTS
- Coordinating and ensuring retrieval of IVC filters once contraindication is resolved
- Evaluation for occult malignancy...??

Galmer A, et al. *Tech Interv Vasc Radiol* 2017;20:216.

PERT: Beyond deciding who gets advanced reperfusion therapies !!!

- Peri-operative management of anticoagulation
- Appropriate post-discharge follow up in the post-PE outpatient clinic
- Important to engage acute hospital-nurse practitioners and pharmacists, experts in thrombosis
- *PERT* enables to get things done !!!! (e.g., collection of data, research)
- *PERTs* in perioperative setting: VTE/acute PE, input in major bleeding events

Pros vs Cons post PERTs implementation... an ongoing debate !!!!

FELLOWS-IN-TRAINING & EARLY CAREER SECTION

Pulmonary Embolism Response Team

Additional Call Burden or a Valuable Learning Opportunity?

Yevgeniy Brailovsky, DO, MSc,^a Vladimir Lakhter, DO^b


RESPONSE: Do Pulmonary Embolism Response Teams Result in Improved Outcomes in Patients With Pulmonary Embolism?

Jeffrey W. Olin, DO

Vascular Medicine and Vascular Diagnostic Laboratory, Zena and Michael A. Wiener Cardiovascular Institute and Marie-Josée and Henry R. Kravis Center for Cardiovascular Health, Icahn School of Medicine at Mount Sinai, New York, New York, USA

Review

Impact and role of pulmonary embolism response teams in venous thromboembolism associated with COVID-19

Mateo Porres-Aguilar ¹, Victor F Tapson,² Belinda N Rivera-Lebron ³, Parth M Rali,⁴ David Jiménez ^{5,6}, Mateo Porres-Muñoz,⁷ Sarah Barraza,⁸ Oscar C Muñoz,⁸ Debabrata Mukherjee ⁹

- What is the role of PERTs in current COVID-19 pandemic era?
- PERT could aid in the determination of appropriate thromboprophylaxis strategies in patients with COVID-19 pneumonia
- Who may benefit from therapeutic AC strategies, individualization of case-by-case scenarios?
- Utilization of latest randomized studies (ATTACC, REMAP-CAP and ACTIVE-4a evidence-based literature, RAPID, HEP-COVID trials)

Porres-Aguilar M, et al. *J Investig Med* 2021;69(6):1153-1155. doi: 10.1136/jim-2021-001856.

Unresolved challenges/obstacles for *PERT*

- Lack of interest, commitment, and subsequent failure
- Lack of effective agreement and partnership among specialists
- Significant barriers while advertising and expanding the PERT process
- False perception and misuse of PERT, to increase the use of endovascular procedures
- Engagement of house staff (e.g., residents, fellows, nurses, pharmacists)
- Reimbursement and compensation

Porres-Aguilar M, et al. *Clin Applied Thromb Hemost* 2018 Nov 19; doi: 10.1177/1076029618812954.

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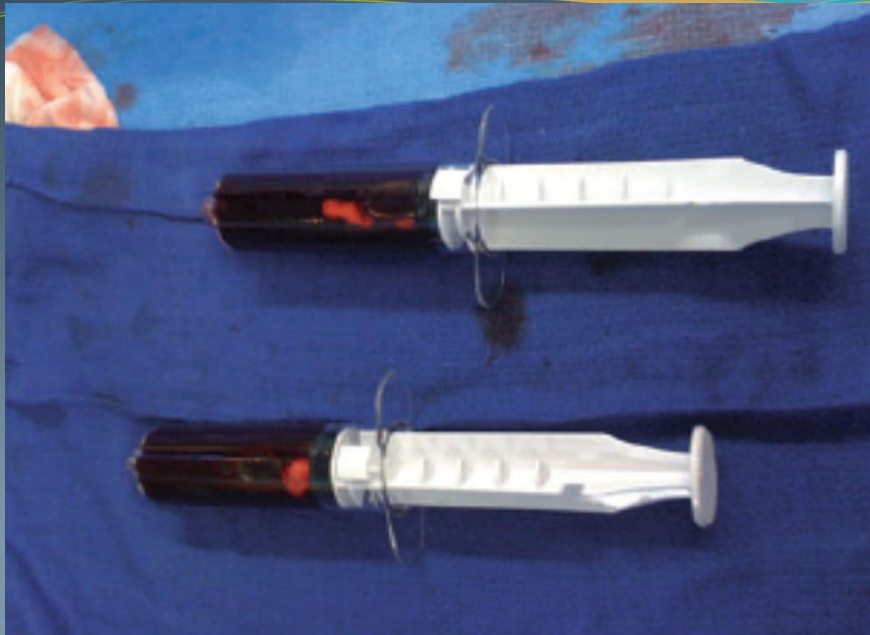
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End-diastolic RV/LV diameter ratio of 1.8. Venous Doppler of LLE revealed *extensive acute femoro-popliteal DVT*.

PESI Score: 125 points; Bova Score at 5 points; sPESI > 1 points + objective evidence of RV dysfunction + elevated biomarkers of myocardial injury !!!!

Cont. Case Scenario (Management decisions)

- Patient with very high PESI score (> 125 points, Class V), high troponins, BNP, concomitant DVT and RV dysfunction by CTA, and Bova score of 5 points (high-risk)
- Categorized as **intermediate-high risk PE**, thus UFH was initiated immediately in the ED.
- **PERT** code activated immediately, and official consult placed
- Given this patient was at particular high risk of bleeding, to undergo with catheter directed therapies, **mechanical thrombectomy with rotational manual maceration and aspiration with PRONTO V3 device, after multidisciplinary consensus**, with immediate clinical, symptomatic and hemodynamic improvements after 12 hours post procedure.
- Adequate post-discharge follow-up in the Post-PE, thrombosis AC multidisciplinary clinic, no bleeding and VTE recurrence in the next 12 months



Take home messages/Key points

- PERT has emerged to provide prompt risk stratification, and to individualize the best therapeutic approach for a complex PE clinical scenario, in a multidisciplinary fashion
- PERT represents a unique, innovative, and continuously evolving concept/process, elevating the care of patients with complex acute PE
- PERT may generate more robust clinical evidence-based data, thus, improving quality of life and survival in patients with complex PE (Ongoing PERT Consortium Registry)
- PERTs will continue to change the paradigm in the care of VTE, achieving excellence and full adoption by clinical-practice guidelines globally

“An ounce of prevention is worth a pound of cure”

Benjamin Franklin

THANK YOU

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