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MULTIDISCIPLINARY APPROACHES TO RAPID ASSESSMENT AND TREATMENT OF PULMONARY EMBOLISM; ACUTE CARE MANAGEMENT

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Abstract
This research investigates the execution and consequences of Pulmonary Embolism Response Teams (PERTs) in Pakistan, which aim to improve the prompt evaluation and management of pulmonary embolism (PE). Pulmonary embolism (PE) is a severe cardiovascular disorder marked by the presence of blood clots that block the pulmonary arteries. This condition presents considerable difficulties in terms of diagnosis and treatment. The establishment of PERTs, consisting of a variety of medical experts, seeks to offer a comprehensive and interdisciplinary strategy for controlling PE. The study investigates the actions and results of PERTs at four specialized facilities in Pakistan, analyzing data from 680 patients with proven pulmonary embolism (PE). The main results show that doctors are better at diagnosing problems, that advanced treatments like catheter-directed thrombolysis (CDT) and extracorporeal membrane oxygenation (ECMO) are being used more, and that the death rate in hospitals has gone down significantly. The findings indicate that a well-coordinated and interdisciplinary approach greatly improves patient outcomes and maximizes the efficient use of resources in the therapy of acute pulmonary embolism (PE).

Introduction
Pulmonary embolism is a serious potentially deadly disorder which in a blood clot, typically originating from one of the larger strains in the pelvis or legs, obstructs a few arteries in the lungs. This leads to reduced flow blood and elevated the pressure in the upper accurate ventricle of the heart. Pulmonary embolism and cavernous vein clotting are dual different expressions of the similar

medical problem known as venous thromboembolism. Industrialized nations rank this ailment as the third most prevalent cardiovascular disorder (Gaziano, 2010). The diagnosis of PE is challenging due to the non-specific symptoms and the vast range of clinical presentations observed in patients, ranging from asymptomatic individuals to persons in cardiac arrest. In October 2011, the Association Interdisciplinary aimed at Investigation in Lung Infection formed a Force Duty to address the identification and organization of (PE). The Force Mission consisted of a diverse group of medical professionals, with 3 pulmonologists, 3 internists, 2 imperative care doctors, 1 radiologist, 1 cardiologist, and 1 radiation therapy surgeon. The memberships of the mission group must collaborated on projects interdisciplinary related to PE diagnostic techniques and treatment. We structured the current Task Force in an interdisciplinary manner to facilitate an integrated strategy for the initial detection of the virus. We instructed the Force Task to organize its recommendations on PE diagnosis using a multidisciplinary approach that can adjust in real-time to accommodate the fast-paced and individualized healthcare delivery within an organized structure. During meetings and conference calls, the Task Power studied the deliberated and literature on therapeutic procedures in Italy. The Task Force did not attempt to evaluate the quality of the evidence or offer recommendations. This page covers the guidelines established by the Task Force, which are based on consensus (Garritty, 2021).

The prevalence of pulmonary embolism acute is 1–2 cases per 1,000 persons annually. The diagnosis is multifaceted, with varying degrees of severity. The diagnosis can range from a minor PE, accidentally discovered and lacking clinical significance, to a major PE, potentially leading to death. There have been minimal changes in the treatment approaches for PE over the last 50 years. Recently, researchers have developed several new technologies and tactics to mitigate the severe health consequences and death rates commonly associated with severe PE. Newer surgical thrombectomy methods, catheter-directed thrombolysis, thrombectomy devices and percutaneous thrombus aspiration, and better use of extracorporeal membrane oxygenation (ECMO) have all been shown to help treat and maintenance for pulmonary embolism high-risk patients better. Currently, the safety medical and effectiveness of numerous techniques are under evaluation. Even though this field is growing quickly, many decisions about how to treat acute pulmonary embolism (PE) are made based on expert opinion rather than rigorously tested scientific standards (Giri, 2019).

METHODS

The pulmonary embolism response teams Logistics

We previously discussed the framework and structure of Pulmonary Embolism Response Team in point (Moghadam, 2020). Simply put, physicians initiate the activation of pulmonary embolism response teams by calling a Pulmonary Embolism Response Team manager using a receiver number that 24 hours a day is available, week in 7 days. Afterwards, the PERT members, who are primarily cardiologists, cardiac surgeons, interventional cardiologists, and other authorities unknown needed, discuss the important radiological images and medical data patient's. They then provide a consensus opinion and treatment suggestions to the referring doctor within a 30-minute timeframe (Cohn, 2021). If necessary, the patient can receive treatment and observation at a referral center or undergo admission to a Pulmonary Embolism Response Team (PERT) midpoint, where mobilized equipment and operate can provide advanced therapies such as VCF, ECMO, SE, and CDT, implantation.

Data collection

We conducted the investigation from 2018, June 1, to 2020 July 31. We gathered all activations of PERT during this time frame as part of a excellence declaration endeavor. We included all sequential with the patients acute pulmonary embolism who received consultation or admission to 4 distinct centers in Pakistan, home to specialized Pulmonary Embolism Response Teams (PERTs). The following centers follows were as:

• CELZAT—Central Aga Khan University Hospital, Karachi, Pakistan

• DJ-PERT— Shifa International Hospital, Islamabad, Pakistan
• JP2-PERT— Pakistan Institute of Medical Sciences (PIMS), Islamabad
• PERT-POZ— Lady Reading Hospital, Peshawar, Pakistan

We included all patients over the age of 18, seen by any of the aforementioned teams, who provided consent informed to contribute in the local office. The sole criterion for elimination was the absence of knowledgeable permission to take part in the education. All patients provided informed consent to take part in the archive. We obtained therapeutic approval from the patients' family members in cases where they were not coherent. The study protocol received approval from the institution's bioethics group (KBE No. 271/2021). The ClinicalTrials database also recorded the trial (NCT04879069). We looked at these things: (1) How often and where each Pulmonary Embolism Response Team (PERT) activation happened; (2) The patient's symptoms, risk factors, and other health problems; (3) How bad the pulmonary embolism (PE) was; (4) The treatments that were given; and (5) The outcomes, especially the death rate in the hospital. We identified all accompanying disorders according to the present criteria of the related global associations, and documented the required treatment in health chronicles to confirm the diagnosis of a specific ailment. Previous studies have thoroughly explained the makeup and functioning of PERTs.

The severity of pulmonary embolism

All patients had their PE diagnosis clinically confirmed using a computerized tomography pulmonary angiogram. The PERT members also evaluated the localization and amount of embolic load. The Pulmonary Embolism Scale then the reduced Pulmonary Embolism Severity Index were first computed for every patient normotensive diagnosed with pulmonary embolism (PE) (Donadini, 2024). We used imaging investigations, specifically transthoracic ultrasound and/or computerized tomography and pulmonary angiography, to identify RV dysfunction. We used institution-specific cut-offs to define an elevated concentration of cardiac troponin.

Outcomes and Treatment strategies

ESC guidelines indicated a specific therapeutic method based on the patients' projected mortality risk. Treatment options included the use of anticoagulation alone or in combination with advanced therapies such as surgical thrombectomy (ST), endovascular thrombectomy (SE), catheter-directed thrombolysis (CDT), local thrombolytic therapy (CDF), a combination of catheter-directed thrombolysis and local thrombolysis (CDThl + CDF), the installation of an inferior vena cava filter (VCF), or extracorporeal membrane oxygenation (ECMO). Other sources previously reported the specific requirements for qualifying for percutaneous procedures (Moran, 2022). We suggest CDT with high-risk pulmonary embolism for patients who cannot undergo systemic thrombolysis due to contraindications or if it has failed, leading to refractory circulatory collapse. We also recommend it for patients with intermediate-high-risk pulmonary embolism who still exhibit right ventricular dysfunction factors after 24 hours at least of anticoagulation, or in cases of clinical deterioration. We documented the suggestions from each PERT and the subsequent clinical progress. The in-hospital outcomes assessed were death, hemodynamic dysfunction, distal systemic embolism, respiratory distress, shock, cardiac arrest, and minor or severe bleeding. The Worldwide Society on Thrombosis and Hemoglobin set the criteria that determined these outcomes. Postmortem examinations or information from death certificates determined the precise causes of death. At each location, we inputted pertinent clinical information into databases and then condensed it to ensure patient confidentiality. We then sent the data to the organizing center for statistical analysis (Botvinik-Nezer, 2020).

RESULTS

Characteristics of patients and PERT activations

The four universities recorded a total of 688 distinct Pulmonary Embolism Response Team (PERT) activations. We ultimately confirmed the diagnosis of PE in 680 individuals, accounting for 98.8%

of the total cases. We used imaging tests to exclude the presence of non-confirmed pulmonary embolism in 8 individuals, representing 1.2% of the total. There was no notable disparity in the number of familiar PERT beginnings among the contributing universities (P=0.4). Table 1 displays the specific information regarding the PERT activations in each institution. Emergency departments, specifically the ER, initiated the majority of activations, accounting for 44.9% (305) of the total. The lasting stimulation devised from within medicine elements (31.1%; 212), surgery or physical therapy (9.1%; 62), oncology (6.3%; 43), medical centers (6.0%; 41), and other divisions, including neurology (2.5%; 17). The source of activation differed considerably among the institutions (P <0.001). Figure 1 displays the origin of PERT starts. Table 2 displays the concomitant disorders, demographics, and risk factors for pulmonary embolism (PE) of patients who underwent PERT activations. The median age for all PERT activations was 60 years, with an interquartile choice of 18 to 95 years. The representation of both sexes was equal, with 50.6% females and 49.4% males. The majority of PERT cases involved patients with intermediate-high-risk pulmonary embolism (292 out of 680; 42.9%), while a lesser percentage were high-risk PE patients (69 out of 680; 10.1%). However, there was a considerable variation in the severity of PE across PERTs (P <0.001). Figure 2 presents comprehensive data. Central pulmonary embolism was present in the overwhelming majority of patients (560 out of 680; 82.4%). Notably, 79.7% (55 out of 69) of the patients high-risk and(126 out of 155) 81.3% of the low-risk patients had central pulmonary embolism (PE). Within the intermediate-risk category, the prevalence of central pulmonary embolism (PE) was 382 out of 459 cases, accounting for 83.2%. Table 3 shows the percentage of people who had a essential pulmonary embolism (in the heart, saddle, major pulmonary artery [PA], right/left PA, or lobar) versus a distal pulmonary embolism (segmental) when imaging showed they had a PE.

Patients Treatment with PE

Effects of Anticoagulation alone were the predominant treatment indicated for 546 out of 680 patients with PE, accounting for 80.3% of the cases. In total, 158 out of 680 patients (23.2%) had advanced therapies, such as CDT (77/680; 11.3%), SE (16; 2.4%), VCF implantation (25/680; 3.7%), ECMO (4; 0.6%) and ST (36/680; 5.3%). There remained no notable variations in the treatment methods used across different institutions (P = 0.57). Figure 3 displays the therapies administered to PERT patients, categorized by institution. Additional Material, Figure S1, outlines the specific properties and frequency of initial anticoagulant administration by different PERTs. There was a notable disparity observed in the kinds of functional CDT in PERTs, with a statistical significance of P <0.01. PERT-POZ primarily used CDThro in 80% of invasive procedures, while JP2-PERT primarily used CDF in 91% of invasive procedures (P = 0.017 in post-hoc analysis). Pharmaco-mechanical treatment, specifically CDThro and CDF, was the prevailing treatment method in DJ-PERT, accounting for 57.8% of cases. Figure 4 displays the exact data.

Table 1. Participating institutions across the Number of PERT activations

Institution	P-(value)	N (%)	Number of PERT month/ activations/1000 hospitalizations
All	0.4	680(100)	1.1
PERT-POZ		145(21.3)	1.5
JP2-PERT		113(16.6)	0.6
DJ-PERT		282(41.5)	1.9
CELZAT		140(20.6)	0.8

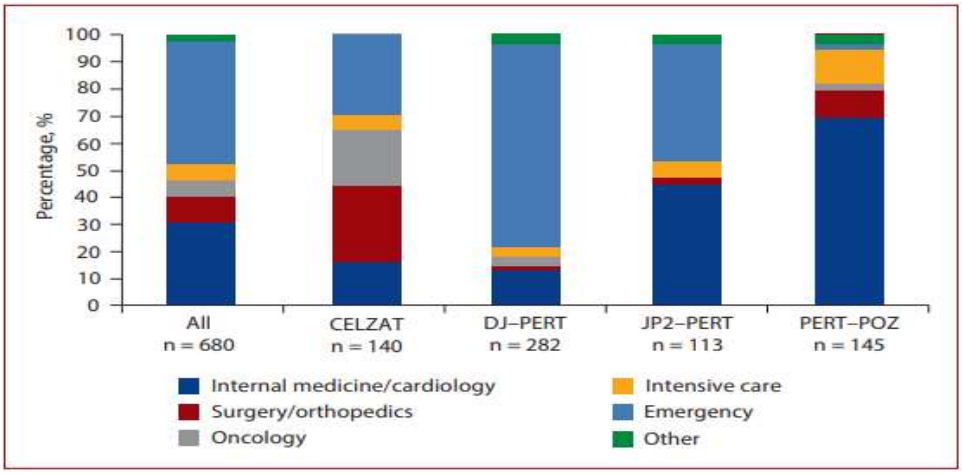

Figure 1. Origin of all PERT activations stratified

Table 2. Basic characteristics, comorbidities, and risk factors among all PERT patients

Characteristic	CELZAT(n=140)	DJ-PERT(n= 282)	JP2- PERT (n = 113)	PERT-POZ (n = 145)	P-value	All (n = 680)
years,Age,median (IQR)	62 (18–92)	58 (18–93)	65(24–95)	62 (18–92)	0.2	60(18–95)
Sex male/female,n (%)	79/61(56.4/ 43.6)	142/140 (50.3/49.7)	45/68 (40.2/59.8)	70/75 (48.3/51.7)	0.18	336/344 (49.4/50.6)
Concomitant diseases:						
Chronic obstructive pulmonary disease, n (%)	19 (13.6)	25 (8.9)	5 (4.5)	8 (5.5)	0.03	57 (8.4)
Chronic coronary syndrome, n (%)	25(17.4)	30(10.6)	16 (14.3)	15 (10.3)	0.14	86 (12.6)
Diabetes mellitus, n (%)	13(9.3)	45(16)	13(11.6)	24(16.6)	0.18	95 (14)
Arterial hypertension, n (%)	50(35.7)	91(32.3)	33(29.5)	55(37.9)	0.44	229(33.7)
Obesity, n (%)	11(7.9)	70 (24.8)	11 (9.8)	37 (25.5)	<.0001	129 (19)
Previous stroke, n (%)	4(2.9)	8(2.8)	12(10.7)	6 (4.1)	0.43	30 (4.4)
Chronic kidney disease, n (%)	12 (8.6)	22 (7.8)	13 (11.6)	15 (10.3)	0.57	62 (9.1)
Cigarette smoking, n (%)	39 (28)	40 (14.2)	3 (2.7)	8 (5.5)	<0.001	90 (13.2)
Prothrombotic risk factors:						
Mobility limitation, n (%)	35 (25)	123(43.6)	13 (11.6)	68 (46.9)	<.001	239 (35.1)
Recent surgical procedures, n (%)	22 (15.7)	28 (9.9)	3 (2.7)	14(9.7)	<.001	84 (12.4)
Recent hospitalization, n (%)	36 (25.7)	54 (19.1)	7 (6.3)	28 (19.3)	<.001	125 (18.4)
Recent trauma, n (%)	18 (12.9)	25 (8.9)	9 (8)	16(11)	0.05	68 (10)
Previous DVT, n (%)	11 (7.9)	24 (7)	13 (11.6)	12(8.3)	0.74	60 (8.8)
Previous PE, n (%)	5 (3.6)	29 (10.3)	2 (1.8)	16(11)	0.003	52 (7.6)
Hormonal therapy, n (%)	17 (12.1)	10 (3.5)	6 (5.4)	5(3.4)	0.002	38 (5.6)
Neoplastic disease, n (%)	53 (37.9)	38 (13.5)	24 (2.1)	29(20)	<0.001	144 (21.2)

Abbreviations: DVT, deep vein thrombosis; IQR, interquartile range; PE, pulmonary embolism.

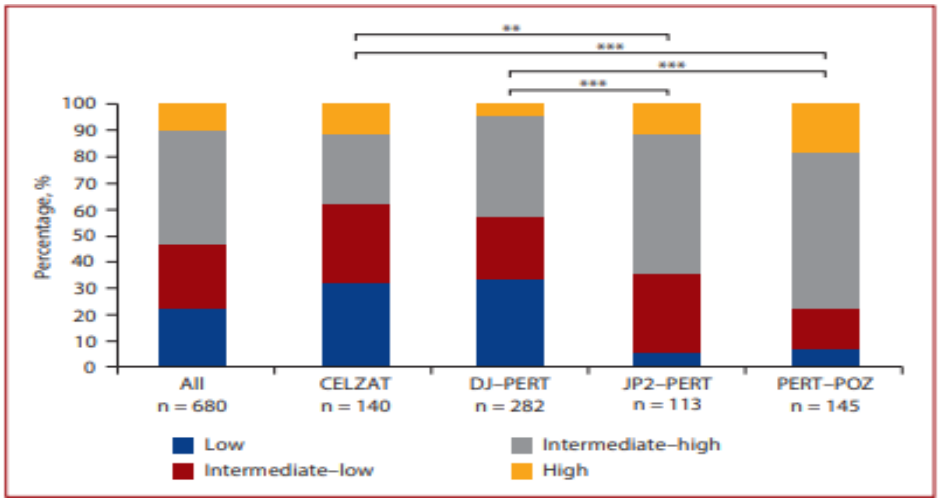

Figure 2. Risk stratification of patients with confirmed pulmonary embolism
**P <0.001; ***P <0.0001

Table 3. PERT patients among Accumulation localizations

Institution	Another central (main or right/left, or lobar pulmonary artery), n (%)	Segmental(%)	Saddle,n(%)	Unknown,n(%)
All(n=680)	405 (59.6)	119 (17.5)	155 (22.8)	1 (0.15)
PERT-POZ(n=145)	75 (51.7)	22 (15.2)	48 (33.1)	—
CELZAT(n=140)	72 (51.4)	46 (32.9)	22 (15.7)	—
DJ-PERT(n=282)	182(64.5)	43 (15.25)	57 (20.2)	—
JP2-PERT(n= 113)	76 (67.3)	8 (7.1)	28 (24.8)	1 (0.9)

Outcomes of PE with patients

The general in-hospital blood amount was 3.8%, and 26 out of 680 patients experienced bleeding. Among the patients, 1.4% (10 out of 680) experienced major bleeding, whereas 2.4% (16 out of 680) had minor bleeding. Four patients, representing 0.6% of the total study group, experienced stroke. Table 4 contains the supplied details. The study found that the overall death rate of patients during their hospital stay was 5.1% (35 out of 680). The death rate varied considerably among different organizations (P=.011). The CELZAT PERT death rate was 7.9%, PERT-POZ 6.2% and JP2-PERT, and just 2.8% in DJ-PERT. The most common cause of death among all patients undergoing Pulmonary Embolism Response Team (PERT) treatment was acute right ventricular failure associated with pulmonary embolism (PE), accounting for 2.8% (19 out of 680) of cases. Supplementary Substances, Table S1, provides the precise reasons for mortality among PERT patients, along with their full characteristics.

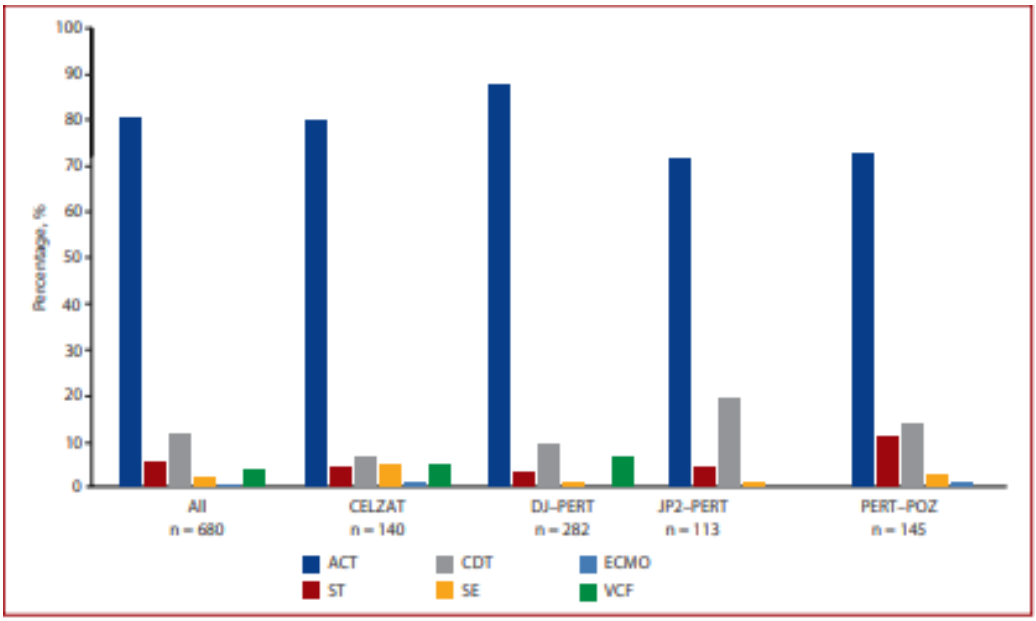

Figure 3. Therapies administered using PERTs to individuals with PE Abbreviations: ACT refers to anticoagulant analysis alone; CDT refers to catheter-directed therapies; ECMO stands for extra-corporeal circuit oxygenation; PE stands for pulmonary embolism; SE refers to surgical embolectomy; ST refers to systemic thrombolysis; VCF refers to inferior vena cava filter.

Table 4. PERT patient's outcomes in-hospital

	CELZAT (n=140)	**DJ-PERT (n=282)**	**JP2-PERT(n=113)**	**PERT-POZ(n=145)**	**All (n=680)**	**P-value**
Stroke, n (%)	2 (1.4)	0 (0)	0 (0)	2 (1.3)	4 (0.6)	0.43
Mortality,n(%	11(7.9)	8 (2.8)	7 (6.2)	9 (6.2)	35 (5.1)	0.011
Minor bleeding,n(%)	8 (5.7)	5 (1.8)	0 (0)	3 (2)	16 (2.4	0.018
Major bleeding,n %)	5 (3.6)	1 (0.4)	3 (2.7)	1 (0.7)	10 (1.4)	0.038
All bleedings, n (%)	13 (9.3)	6 (2.2)	3 (2.7)	4 (2.8)	26 (3.8)	0.002

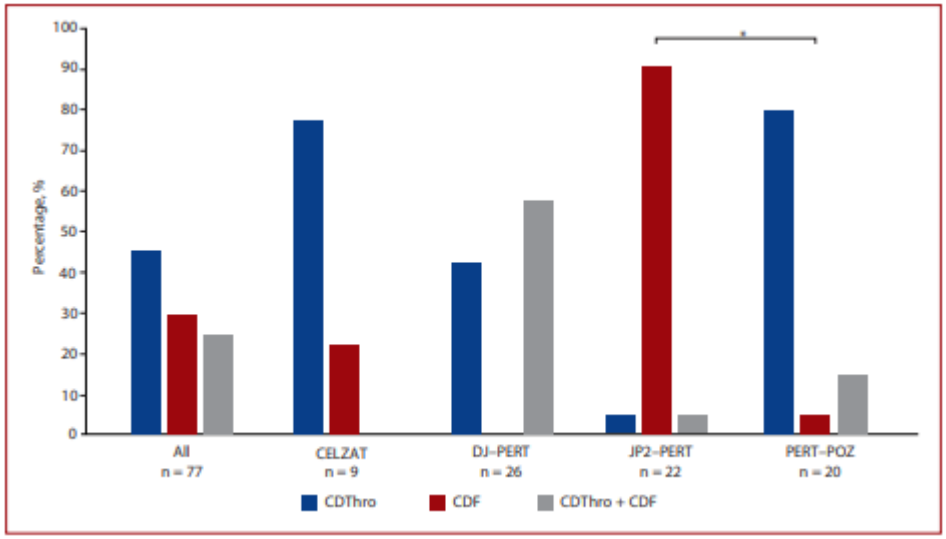

Figure 4. Dissemination of different catheter-directed treatments *P = 0.017 (post-hoc analysis) Abbreviations: CDThro, catheter-directed thrombectomy; CDF, catheter-directed thrombolysis.

DISCUSSION

We looked at the activity of pancreatic enzyme replacement therapy Pulmonary Embolism Response Team (PERT) at four institutions in Pakistan, looking at a total of 680 different PERT recommendations (Cencioni, 2022). This survey study, as far as we know, the first documentation of the operations of systematized PERTs provides in Pakistan. This training revealed that there was a comparable frequency of multidisciplinary team activations and the use of therapeutic modalities. Still, there were big differences between institutions in the types of patients, the severity of the pulmonary embolism, the use of catheter-directed thrombolysis (CDT), and the overall results. The findings of our study align with the outcomes obtained by PERT Consortium the Pakistan, which reported the practices of eight centers (Senman, 2024).

Demonstrated significant differences among institutions regarding the organization of centers, frequency of activations, severity of pulmonary embolism (PE), therapies administered, and in-hospital death rates. However, we also observed notable variations in the frequency activations of PERT and the specific therapy administered type (Deadmon, 2017). These disparities may be due to the expertise of patients' risk profiles and PERT squads. The majority of activations PERT in our data originated from the emergency room, accounting for 45% of the total. This is consistent with prior findings. The PERT Consortium reports that the emergency room initiated nearly 60% of PERT activations, albeit with notable variations across different sites. Our analysis revealed that patients from the internal medicine and cardiology departments received a significant number of consultations, a trend not typically observed in the recommendations documented in the American office. We have observed disparities among institutions, indicating notable variations in their organization and structure. There was no clear, observable pattern indicating a decrease in fatality rate in institutions with a higher number of emergency room activations (Wilde, 2013).

This could be due to factors such as a shorter time period between the diagnosis of pulmonary embolism and the decision to initiate pulmonary embolism response team (PERT) treatment (Jen, 2020). The majority of examined cases likely had intermediate-risk pulmonary embolism (PE). In these patients, the importance of prompt interventional treatment doesn't seem as crucial when compared to high-risk patients or PE with ST-elevation myocardial infarction. So, in managing pulmonary embolism, the result to start PERT usually follows diagnosis and an initial attempt to stabilize the patient's clinical condition in the hospital zone. The outcomes of this training show that putting in place PERT institutional made advanced treatments like SE, CDT, VCF, and ECMO, implantation much easier to get .Our investigation utilized percutaneous therapies in 11% of patients. The PERT at Massachusetts Overall Hospital reported similar findings (Deadmon, 2017).

Researchers observed that the introduction of PERT caused in a more than tenfold increase in CDT usage incidence compared to the era before its deployment. The development of PERT may facilitate the widespread adoption of CDT utilization, especially in the current era of rapid advancements in transcatheter procedures. Generally, the hospital experienced a relatively low death rate, especially when using PERTs to manage more complex cases of pulmonary embolism. On the other hand, the CELZAT and DJ-PERT clinics classified a significant percentage of consulted patients as low-risk patients. Nevertheless, the majority of individuals exhibited central pulmonary embolism (PE), which raised concerns among referring physicians and led them to seek advice from PERT members. Further insights can be derived from an in-depth examination carried out by (Carcary, 2011) .

Conclusion

The introduction of Pulmonary Embolism Response Teams in Pakistan has greatly enhanced the treatment and results for individuals suffering from acute pulmonary embolism (PE). The use of a multidisciplinary strategy, which incorporates experts from many medical disciplines, ensures prompt identification and tailored therapeutic approaches for each individual. The study shows that PERTs make advanced treatments like catheter-directed thrombolysis (CDT), surgical thrombectomy (ST), and extracorporeal membrane oxygenation more likely to be used. These treatments are very important for high-risk patients. When compared to conventional treatment approaches, the analysis of data from the four collaborating hospitals reveals a significant decrease in in-hospital mortality rates. The results show how effective Pulmonary Embolism Response Teams (PERTs) are at providing the best care for patients and allocating resources, emphasizing how important it is to work together when dealing with pulmonary embolism (PE). In the future, it will be crucial to continuously assess the performance and outcomes of PERTs in order to improve protocols and increase their effectiveness. It is recommended that future studies focus on looking at longer-term patient outcomes and how to use new technologies to maintain and improve the high standards of care set by PERTs.

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