UTILIZING POINT-OF-CARE ULTRASOUND (POCUS) FOR DIAGNOSIS IN A RESOURCE-LIMITED SETTING: A CASE REPORT OF PULMONARY EMBOLISM

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Abstract

Introduction: Acute pulmonary embolism (PE) is a common cause of cardiovascular-related deaths and poses diagnostic challenges due to its variable and non-specific symptoms. Computed tomography pulmonary angiography (CTPA) is the gold standard imaging method for PE diagnosis, but its availability is limited in resource-constrained settings. Point-of-care ultrasound (POCUS) has emerged as a valuable tool for emergency physicians, aiding accurate diagnoses, procedural guidance, and resuscitation efforts.

Case Presentation: This case report presents a 76-year-old woman with non-specific symptoms diagnosed with PE using POCUS in the Emergency Department of the Korle Bu Teaching Hospital**.** The POCUS findings included an enlarged right ventricle with a flattened septum (D sign), poor cardiac contractility, thrombi in the right ventricle and a plethoric Inferior Vena Cava (IVC). Prompt diagnosis facilitated timely management, leading to improved patient outcomes.

Conclusion: POCUS has proven to be indispensable in resource-constrained settings where confirmatory diagnostics are limited. Incorporating POCUS training into emergency medicine residency programs and establishing emergency ultrasound fellowships in under-resourced regions like Africa can enhance its utilization and empower clinicians in such environments. Equipping emergency room clinicians with POCUS skills enables timely diagnosis, early interventions, shorter Emergency Department stays, and improved patient outcomes. This approach can contribute to building an African faculty proficient in emergency ultrasound, facilitating the education and training of more clinicians in POCUS, and ultimately enhancing healthcare outcomes in resource-limited environments.

Keywords: Point-of-care ultrasound (POCUS), pulmonary embolism, ultrasound, emergency medicine

Introduction

The occurrence of acute Pulmonary Embolism (PE), which is a serious consequence of Venous Thromboembolic Disease (VTE) is one of the most common causes of cardiovascular-related deaths[1]. It has the potential to result in fatality[2]. Symptoms of PE can be varied and non-specific, often presenting as a diagnostic challenge[1,2,3]. Imaging plays a crucial role in both diagnosing and managing patients with suspected PE with the multi-detector Computed Tomography Pulmonary Angiography (CTPA) being the most frequently utilized imaging method for evaluating PE[1]. Other imaging modalities exist and may be more suitable in certain environments, especially in resource-constrained settings where CTPA is not always readily available[1]. One such modality is the use of Point-of-Care Ultrasound (POCUS) in the Emergency Department (ED). POCUS has become an indispensable tool for emergency physicians, enabling them to obtain accurate diagnoses, assist in various procedures and guide resuscitation efforts[4]. The diagnosis and management of PE necessitate prompt recognition and intervention within the Emergency Department. Implementing POCUS in resource-constrained settings can significantly influence the clinical management of 50-70% of patients[5]. We present a case of a 76-year-old woman who presented to the ED with non-specific symptoms and was diagnosed with PE using POCUS.

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Case Presentation

A 76-year-old Ghanaian woman presented to the Emergency Department of the Korle Bu Teaching Hospital with seizures, which started the day before the presentation. She had a history of hypertension and diabetes and was compliant with her medications. The patient had tonic-clonic seizures at home with a brief post-ictal confusional state. She was taken to a private lab for routine laboratory investigations where she had another episode of the seizures and was immediately rushed to our ED. At the ED, she had another tonic-clonic seizure which self-aborted with no post-ictal confusion. She had had a syncopal attack a month earlier which had been managed on out-patient basis by her primary physician after an initial head CT scan which was ordered showed chronic ischemic disease. She denied headache, fever, chest pain, unilateral leg swelling, recent long travel or a history of malignancy during her interview.

Initial examination revealed an elderly woman, in some respiratory distress receiving oxygen via nasal prongs at 5L/min with SPO_2-93%, Pulse rate-78bpm, RBS-11.8mmol/l, T-35.0C, BP-105/68mmhg, GCS-

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15/15. The respiratory rate was 22cpm with clear lungs. ECG showed sinus rhythm, left axis deviation, right bundle branch block, s1q3t3 pattern, and T wave inversions in V1-V6, with no ST elevation seen. (See Figure 1 for patient's ECG). Point-of-care ultrasound (POCUS) revealed an enlarged right ventricle with a flattened intraventricular septum (D sign), poor cardiac contractility, thrombi in the right ventricle, and a plethoric Inferior Vena Cava (IVC). See Figure 2 showing enlarged right ventricle (thrombi in right ventricle not captured in this image).

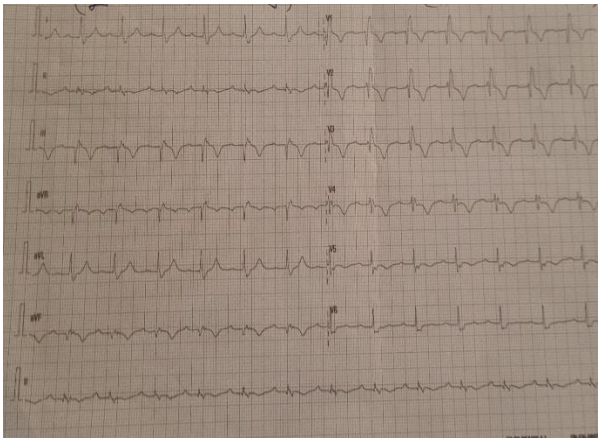

Figure 1 ECG of patient

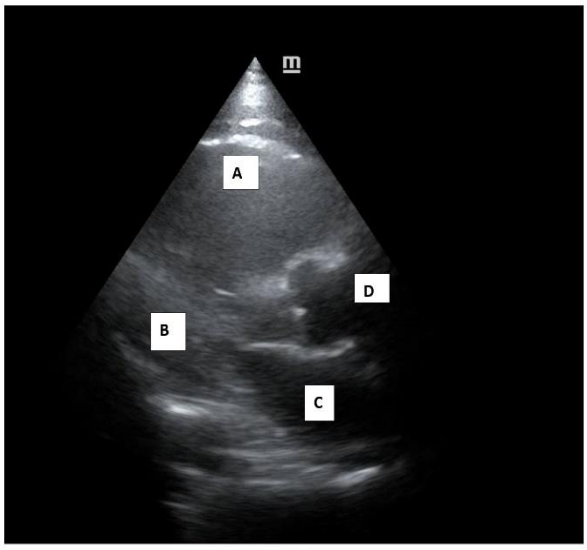

Figure 2. Bedside Echo showing long parasternal axis view. A-Right ventricle, B-Left Ventricle, C-Left atrium D-Ascending Aorta/Aortic outflow tract (thrombi was not captured in this image)

The patient's BP dropped to 70/43mmhg with an increased respiratory rate to 40cpm and she appeared lethargic though conscious. An initial diagnosis of Obstructive Shock secondary to massive pulmonary embolism, seizures due to electrolyte imbalance/ hypoxia was made. Complete blood count and levels of blood glucose, serum electrolytes, blood urea and creatinine and liver function tests and the clotting profile were within normal ranges. A non-contrast enhanced CT scan of the head was unremarkable. The patient received standard thrombolytic treatment with Alteplase. She also received intravenous infusion of normal saline (2 litres) and dobutamine to manage shock and intravenous phenytoin for seizure control. Within 2-3hrs after administration of alteplase, patient's symptoms improved. The patient was transferred to the Medical Ward on day three. A repeat bedside transthoracic echocardiogram on day eight of admission showed no thrombus in the right ventricle. She was discharged the following day on oral rivaroxaban to be followed up by the Cardiology Team on out-patient basis.

Discussion

Pulmonary embolism (PE) is a potentially life-threatening condition[2] that requires prompt recognition and management in the Emergency Department (ED). When a patient presents with symptoms suggestive of PE, the Emergency Department healthcare team must initiate a timely and systematic approach to ensure accurate diagnosis and appropriate treatment. Although CTPA is the gold standard for diagnosing PE, other alternate diagnostic tools such as clinical decision rules based on X-ray findings, patient-specific risk factors like Wells scores and Pulmonary Embolism Rule-out criteria, and D-dimer testing can be used[2]. The use of CTPA is also associated with risks such as exposure to ionizing radiation, the potential for injury from the injection of iodinated intravenous contrast agents and the possibility of nephrotoxicity[2]. Point-of-Care Ultrasound is a readily accessible and cost-effective imaging modality[6].

In the ED, emergency physicians utilize a diverse range of point-of-care ultrasound applications[5]. It helps with the rapid evaluation of the cardiopulmonary function of undifferentiated patients[7], enhances prompt diagnoses of conditions, provides guidance during resuscitation efforts, improves the success of procedures and minimizes complications[5]. Before the onset of POCUS, emergency physicians employed the conventional approach of placing a request for an ultrasound with Radiology and relying on the Radiologist who may not have the full clinical history of the patient to make the clinical interpretation of the results[8]. This often led to delays in conducting the imaging study, in the interpretation of the results and its transmission to the requesting doctor and ultimately the patient receiving definitive care[8].

Currently in the United States (US), POCUS training has been incorporated into the Emergency Medicine Residency programs and is often led by Emergency Ultrasound-trained Faculty aiming to create more leaders in POCUS education[5]. POCUS is now a standard part of Emergency Medicine training as established by the American College of Graduate Medical Education (ACGME) in 190 Emergency Medicine training programs and in the over 95 Emergency Medicine Ultrasonography Fellowship training programs across the US[8]. Additionally, other specialties like Internal

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Medicine, Paediatrics and Critical Care have also begun incorporating POCUS in their training[5]. In many under-resourced regions like Africa, POCUS is usually unavailable in the Emergency Room not to talk about training opportunities like Emergency Ultrasound (EUS) Fellowships in such settings[5]. Challenges such as the cost of the ultrasound machine, lack of training, lack of understanding of the imaging modality and sticking to the traditional way of clinical examination to arrive at a diagnosis exist[9]. In such resource-constrained settings, the establishment of traditional radiology faces numerous challenges, including the availability and maintenance of equipment, the need for trained staff and specialists to interpret imaging, and the associated costs[5]. These obstacles often hinder the development of a robust radiology infrastructure within the Emergency Department, limiting access to essential imaging modalities such as ultrasound services in some of these settings.

In this case report, the PE diagnosis was made via POCUS and this ultimately saved the patient from delays associated with imaging especially when she presented with atypical symptoms of PE such as seizures. Patients with PE often have variable presentations with common symptoms such as chest pain, syncope, palpitations, cough, breathlessness and hemoptysis with up to two-thirds of patients being asymptomatic[1]. Apart from the commonly observed symptoms of chest pain and breathlessness, about 5-8% of patients who present to the ED with pulmonary embolism also exhibit near or full syncope, experience new-onset seizures or convulsion-like activity, or display new-onset confusion[10]. Although our patient had a syncopal episode a month previously, she presented at the ED with recurrent seizures having had another one at a diagnostic facility just before coming to the ED. The use of POCUS in this patient revealed the following: thrombi in the right ventricle, an enlarged right ventricle with a flattened septum (D sign), poor cardiac contractility, and a plethoric Inferior Vena Cava which were all suggestive of PE.

Approximately 30-40% of patients with pulmonary embolism (PE) exhibit specific criteria indicating right ventricular (RV) overload such as the presence of a right-sided cardiac thrombus, a diastolic RV diameter greater than 30 mm, an RV-to-left ventricular (LV) diameter ratio exceeding 1, systolic flattening of the interventricular septum, acceleration time less than 90 ms, or a tricuspid regurgitation gradient higher than 30 mmHg, all of which demonstrate RV involvement in the absence of right ventricular hypertrophy (RVH)[1]. Massive pulmonary embolism (PE) manifests with hypotension, shock, or cardiac arrest. Patients experiencing right heart strain may exhibit electrocardiography (ECG) changes such as the S1Q3 pattern, S1Q3T3 pattern, notched S wave in lead V1, inverted T waves in V1-V4, and right bundle branch block[1]. Sinus tachycardia is thought to be the commonest ECG change in PE[3]. Additionally, T wave inversions are more common in patients with right ventricular dysfunction compared with the S1Q3T3 pattern which is thought not to be specific for PE[3]. In patients with suspected high-risk PE, POCUS can play a crucial role in distinguishing and prioritizing various causes that may lead to hemodynamic instability[1]. POCUS becomes particularly significant in determining the urgency of treatment by revealing RV overload and dysfunction, as well as the presence of right heart thrombi[1]. Our patient was haemodynamically unstable for transport to have the CTPA done outside the Hospital and therefore POCUS played a key role in providing a prompt diagnosis for the patient. The treatment for PE includes anticoagulation which can increase the risk of bleeding[2]. Our patient received intravenous Alteplase after going through the fibrinolytic checklist. She had mild gum bleeding the next day, which was self-limiting, and was attributed to the Alteplase. Clinicians must weigh the risks and benefits associated with thrombolysis in a PE patient.

In resource-limited settings where confirmatory diagnostics are expensive and not always readily available, POCUS becomes an indispensable tool in the clinical management of patients[5]. Emergency physicians trained in POCUS can integrate the findings from POCUS into the management plans of their patients especially because they have full knowledge of the case and its presentation[8]. The implementation of POCUS in resource-limited settings has the potential to significantly influence the clinical management of 50-70% of patients[5].

The growing adoption of POCUS in Emergency Departments has prompted accreditation bodies worldwide to incorporate POCUS training into their educational programs[5]. The International Federation for Emergency Medicine (IFEM) has developed a consensus document outlining a suggested framework for incorporating POCUS into emergency medicine training[11]. Despite the wide use of POCUS in high-income countries, emergency physicians in Africa are limited by various factors such as scarcity of portable ultrasound machines, lack of comprehensive training programs with rigorous standards and accreditation and limited availability of consumables such as gel[12]. It is worth noting that African countries with emergency medicine programs have reported educational initiatives in POCUS but training appears to vary greatly across, both within individual countries and across borders[12]. In Ghana, Emergency Medicine Residency commenced at the Komfo Anokye Teaching Hospital under the leadership of the Ghana College of Physicians and Surgeons and The Ghana Michigan Emergency Medicine Collaborative in 2009. POCUS training has been part of the curriculum since its inception.

With the commencement of another training site at the Emergency Department of the Korle Bu Teaching Hospital (KBTH) in 2022, emergency medicine residents have had POCUS training incorporated into their program as well. The involvement of external

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clinicians with Point-of-Care Ultrasound (POCUS) expertise in resource-limited settings has yielded significant advantages[5]. In KBTH, with support from external faculty, specifically, the Emergency Department of the University of Florida, an ultrasound curriculum has been developed to facilitate context specific POCUS training for emergency medicine residents which includes online lectures as well as in-person practical sessions. In resource-limited settings, numerous POCUS training strategies heavily depend on external expertise and often involves clinicians with extensive POCUS experience, which typically takes years to develop, or foreign Emergency Ultrasound Fellowship-trained faculty[5]. Sadly, in Ghana, and many other African countries there is no established emergency ultrasound fellowship in the emergency medicine residency programs. South Africa stands out as a notable exception, boasting five domestic programs dedicated to POCUS education which follows a curriculum of the Emergency Medicine Society of South Africa, accredited by the College of Emergency Medicine of South Africa[12].

The use of POCUS should not be limited only to emergency physicians and residents. All doctors working in the Emergency Department should have training in POCUS. A systematic review by Abrokwa *et al* focused on task shifting for POCUS in primary healthcare within low- and middle-income countries[6]. Task shifting involves delegating specific responsibilities from highly qualified healthcare professionals to those with shorter training and lower qualifications, aiming to optimize human resources[6,13]. The review found that in three studies assessing the focused abdominal sonography in trauma (FAST) exam, general physicians and non-physician clinicians, including medical students, clinical officers, and community health workers, successfully obtained high-quality ultrasound images and accurately interpreted the results with improvement in diagnostic accuracy following specialist feedback[6]. In another study, the utilization of non-radiologist clinicians for diagnostic breast ultrasound was shown to be both feasible and effective in developing trainees' knowledge and skills and these findings aligned with similar studies in the literature that demonstrate the positive outcomes of such practices[14]. Providing clinicians in the emergency room with Point-of-Care Ultrasound (POCUS) skills can result in prompt diagnosis, early interventions, reduced ED stay and ultimately improved patient outcomes.

Conclusions

To enhance the utilization of Point-of-Care Ultrasound (POCUS) in under-resourced regions like Africa, it is recommended that an emergency ultrasound fellowship program is established as a subspecialty within the field of Emergency Medicine in countries with established residency programs. This initiative would focus on training Fellows who possess specialized expertise in POCUS. By doing so, Africa can cultivate a pool of fellowship-trained faculty in Emergency Ultrasound to educate and generate a greater number of physicians and Emergency Room doctors proficient in POCUS across different African countries. By providing ultrasound machines and imparting POCUS training to Emergency Room doctors in African countries, the potential arises for improved diagnostic accuracy in critically ill patients. Additionally, this approach will enable timely and essential interventions for such patients and can be instrumental in augmenting healthcare outcomes in under-resourced regions.

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