EXPLORING THE EFFECTIVENESS OF POINT-OF-CARE ULTRASOUND FOR CARDIOVASCULAR DISEASE DIAGNOSIS: AN IN-DEPTH INVESTIGATION

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ABSTRACT:
Objective: This article conducts a retrospective, qualitative, and cross-sectional analysis to examine the utility of Point-of-Care Ultrasound (POCUS) in the context of cardiovascular changes, with a particular focus on its role during the COVID-19 pandemic.
Methods: The study relies on a literature review sourced from the Regional Portal of the Virtual Health Library and PubMed. The data collection process involves the assessment of studies showcasing the application of POCUS in identifying cardiovascular changes, particularly in the context of the SARS-CoV-2 virus.
Results: All reviewed studies consistently demonstrate that POCUS can effectively identify cardiovascular changes at an early stage. Its application has proven instrumental in containing SARS-CoV-2 infections during the pandemic. Notably, the majority of articles highlight the usefulness of POCUS in detecting potentially reversible causes of cardiovascular issues. Furthermore, POCUS emerges as a valuable tool in aiding medical decisions for critically ill patients in emergency and intensive care settings.
Conclusion: The findings underscore the essential role of bedside ultrasound, specifically POCUS, as a diagnostic tool for cardiovascular diseases, even amidst the challenges posed by the COVID-19 pandemic. Its use enables swift and accurate diagnoses of potentially reversible pathologies, offering an active and non-invasive diagnostic test for emergency and intensive care scenarios.

Keywords: POCUS; Cardiovascular; Diagnosis; Analyzes.

INTRODUCTION:

Since the 1940s, ultrasound has been widely used as a diagnostic imaging tool for various pathologies, and from the 1950s onward, its use has become more specific for cardiovascular disorders. As demonstrated by Yamada H, it was only in the 2000s that portable ultrasound was launched on the market to be used in emergency and intensive care settings to add bedside information to patients' clinical picture critics. Therefore, thanks to advances in Point-of-Care Ultrasound (POCUS) technology, it is increasingly common to introduce this rapid and easy-to-use imaging method into the hospital setting (Pachiyannan et al., 2024; Suvankulovich & Zafarjonovich, 2024).

Furthermore, as highlighted by Yamada H, POCUS is an ultrasound device that doctors not specialized in imaging diagnosis can use at the patient's bedside, requiring a course to train in the correct use of the portable device and for interpretation of the images he produced. For doctors who are not specialists in ultrasound, there are protocols and guidelines to follow for the diagnosis of pathologies that affect different and large areas of the human body, such as the visualization of intra-abdominal organs, heart and blood vessels, and lungs and their appendages (Gargani, 2024).

Regarding cardiovascular diseases, POCUS is mainly used in the emergency room and intensive care unit as a tool that integrates physical examination and clinical evaluation of patients with acute heart failure and aortic dissection, among other pathologies. The use of POCUS is particularly advantageous due to its speed of evaluation, which allows an immediate interpretation of the clinical state of the patient in bed, as well as not involving radiation exposure, not requiring the patient to move to the imaging and examination areas. as it is not an invasive test, as highlighted by Di Vilio A (Feng et al., 2024; Karthikeyan, 2024).

Focused cardiac ultrasound (CFU) is a POCUS diagnostic protocol that allows a more accurate diagnosis of possibly reversible cardiovascular manifestations, such as cardiogenic shock, cardiac tamponade, heart valve changes and hypovolemic shock (Ejaz, Thyyib, Ibrahim, Nishat, & Malay, 2024).

Regarding cardiovascular disease, POCUS is primarily used in the emergency room and intensive care unit as a tool that integrates physical examination and clinical evaluation of patients with acute heart failure and aortic dissection, among other pathologies. Speed of assessment, which allows immediate interpretation of the patient's clinical status in bed, as well as not involving radiation exposure, not requiring the patient to move to the imaging examination areas and because an invasive examination is not envisaged, as highlighted by Di Vilio A (Montelaro, Ibrahim, Thames, & Mehta, 2024; Parashar, Chaudhary, & Pandey, 2024).

Focused cardiac ultrasound (CFU) is a POCUS diagnostic protocol that allows for a more accurate diagnosis of possibly reversible cardiovascular manifestations, such as cardiogenic shock, cardiac tamponade, heart valve abnormalities, and hypovolemic shock. Furthermore, Persson JN highlights that CFU can be used to reassess the patient's clinical status during therapeutic management (Pakhare & Anjankar, 2024).

The use of portable ultrasound in patients with cardiac and vascular disorders is gaining more and more space in managing critically ill and hemodynamically unstable patients in emergency rooms and pediatric and adult intensive care units due to its rapid assessment, promoting greater diagnostic ease. Therefore, the objective of this work was to analyze how POCUS is used in the management and diagnosis of cardiovascular conditions in critically ill patients in a hospital setting (Grenar, Nový, Mědílek, & Jakl, 2024; Gudigar et al., 2024).

METHODOLOGY:

The present study consists of a qualitative, cross-sectional and retrospective analysis based on an integrative review of the literature in February 2023. The following databases were used for this research: the National Library of Medicine (Pub Med) and the Regional Medicine Portal Virtual Health Library. The descriptors applied in both data sources were "Point-of-care systems", "Ultrasound", and "Cardiology" with the Boolean operator "AND" between the respective words (Jin, Kim, Song, Park, & Kang, 2024).

The inclusion criteria were freely available articles, fully available articles, those published in the last 5 years, types of articles, including review and systematic review, and filtering by topic on the topic of cardiology and ultrasound was also included. Articles unrelated to this research's main topic were excluded (Cai et al., 2024; Liu, Chen, & Cheng, 2024).

RESULTS:

After searching with the descriptors "Point-of-Care Systems," "Ultrasound," and "Cardiology," 1,193 articles were found. Of this total, 218 articles were found in the Regional Portal of the Virtual Health Library (PRBV) database and 975 articles in the National Library of Medicine (Pub Med) database. In both databases, the inclusion criteria were used: fully available articles, free articles and articles published in the last five years and only one exclusion criterion (articles that deviate from the main topic) (Huang et al., 2024; Scafa Udriște, Burdușel, Niculescu, Rădulescu, & Grumezescu, 2024).

Only in the Regional Portal of the Virtual Health Library were the following inclusion criteria used: subjects in cardiology and ultrasound. Only in Pub Med was an additional inclusion criterion used: types of articles (review and systematic review) (Stankovic & Cardim, 2024).

About the inclusion criteria of complete and freely available articles, 176 articles in PRBV and 425 articles in Pub Med were filtered. Including articles published in the last 5 years, 74 remained in PRBV and 293 in Pub Med. After inclusion by topic in the PRVC, 12 articles remained. Using the inclusion criteria by type of articles (review and systematic review) in Pub Med, 56 articles were selected. Regarding the exclusion criterion of topic avoidance, only 1 article in PRBV and 14 articles in Pub Med were selected, as shown in Figure 1 (Kumar & Kumar, 2024).
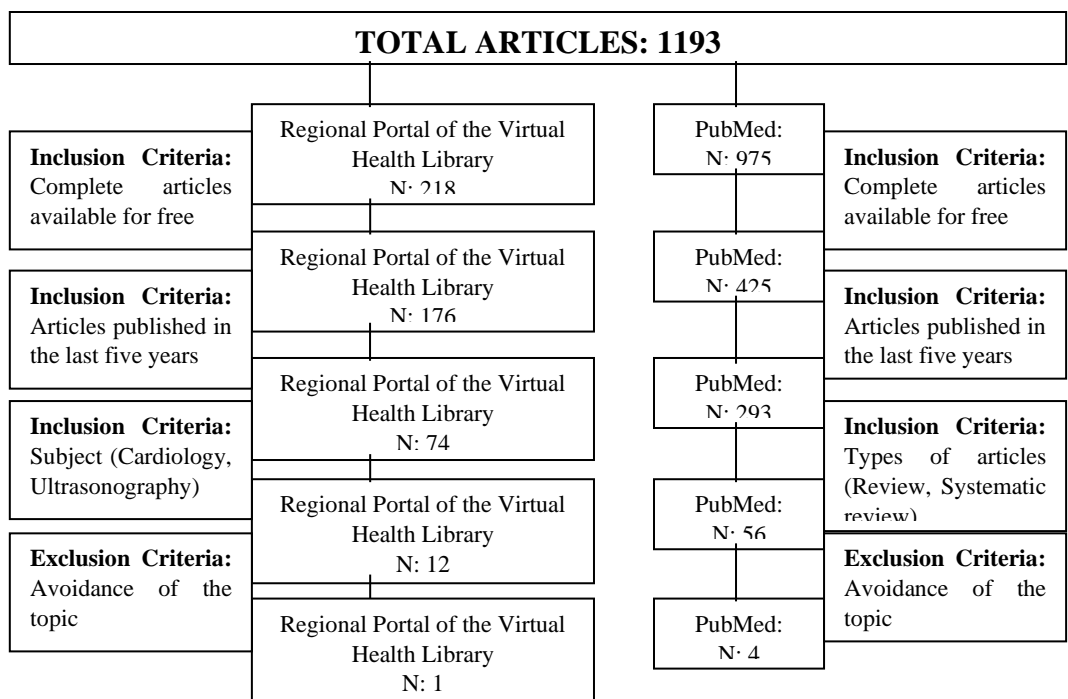
***Figure 1**. Flowchart for the recognition of selected articles in the databases of the Regional Portal of the Virtual Health Library and Pub Med*

Regarding recommendations for the use of POCUS during cardiopulmonary resuscitation (CPR), 11 articles do not address the topic. However, 3 articles demonstrated that POCUS should not be used if it would delay the onset of chest compressions. 1 article demonstrated that POCUS should be used with caution, and 1 other article demonstrated that its use is more appropriate during rapid assessment after CPR manoeuvres (Lee, Park, & Lee, 2024).

Furthermore, 9 articles did not comment that POCUS serves as a basis for immediate changes in medical conduct, 5 articles showed that this technology works as a parameter for immediate changes

at the bedside, and 1 article denied this claim. However, 9 articles demonstrated that this technology serves as a guide for the choice of medical conduct; 6 articles did not address the topic, and none denied this information (Santos-Moreno et al., 2024; Tang, Shi, Ji, Zhu, & Gu, 2024).

11 of the 15 articles demonstrated that POCUS helps identify potentially reversible causes, while 4 articles did not mention the topic, and no articles denied this information. Regarding the accuracy of cardiovascular system assessment with POCUS, 13 articles confirm the information and 2 articles do not address the topic. All articles demonstrated that POCUS allows for the early identification of cardiovascular conditions and complements the patient's physical examination findings (Kaffas, Vo-Phamhi, Griffin IV, & Hoyt, 2024).

All articles that have commented on the use of POCUS during the time of the COVID-19 pandemic confirm that its use has been beneficial. According to Tables 1 and 2, 11 articles do not comment on POCUS during the pandemic (Lindor et al., 2024).

Article	Early Identification Of CV Conditions	Complements The Physical Examination	Immediate Change Of Conduct	Recommendations During CPR
D'ANDREA A, et al. (2023)	Yes	Yes	-	Use cautiously
DAVE JK, et al. (2018)	Yes	Yes	Yes	-
DI VILIO A, et al. (2021)	Yes	Yes	No	-
DUDEK M, et al. (2021)	Yes	Yes	-	-
HACKETT I, WARD RP. (2020)	Yes	Yes	-	-
Hammadah M, et al. (2020)	Yes	Yes	-	-
ISKANDER J, et al. (2022)	Yes	Yes	-	-
JARMAN RD, et al. (2023)	Yes	Yes	-	-
JENKINS S, et al. (2022)	Yes	Yes	-	-
LEE LC DECARA, JM. (2020)	Yes	Yes	Yes	Do not delay compressions
PANEBIANCO N, et al. (2021)	Yes	Yes	Yes	-
PERSON JN, et al. (2023)	Yes	Yes	Yes	Do not delay compressions
RUBEN M, et al. (2023)	Yes	Yes	-	-
SPENCER KT; FLACHSKAMPF, FA. (2019)	Yes	Yes	Yes	You should not delay compressions. It is best for rapid post-PCR assessment.
Yamada H, et al. (2022)	Yes	Yes	-	-

Graph 1. *Explanation of the results obtained by author, year of publication and main analyzes on the use of POCUS in cardiovascular diseases.*

Article	Identification of Potentially Reversible Causes	Accurate Assessment of the CV System	Guide for Choosing Medical Management	Positive use of POCUS during the COVID-19 Pandemic
D'ANDREA A, et al. (2023)	Yes	Yes	Yes	Yes
DAVE JK, et al. (2018)	Yes	Yes	-	-
DI VILIO A, et al. (2021)	Yes	Yes	-	-
DUDEK M, et al. (2021)	Yes	Yes	-	-
HACKETT I, WARD RP. (2020)	-	-	Yes	-
Hammadah M, et al. (2020)	-	-	-	-
ISKANDER J, et al. (2022)	Yes	Yes	Yes	Yes
JARMAN RD, et al. (2023)	Yes	Yes	Yes	-
JENKINS S, et al. (2022)	Yes	Yes	-	Yes
LEE LC DECARA, JM. (2020)	Yes	Yes	Yes	Yes

PANEBIANCO N, et al. (2021)	Yes	Yes	-	Yes
PERSON JN, et al. (2023)	-	Yes	Yes	-
RUBEN M, et al. (2023)	Yes	Yes	Yes	-
SPENCER KT; FLACHSKAMPF, FA. (2019)	Yes	Yes	-	-
Yamada H, et al. (2022)	-	Yes	Yes	Yes

Table 2. *Explanation of the results obtained by author, year of publication and primary analysis on the use of POCUS in cardiovascular diseases*

DISCUSSION:

Point-of-care ultrasound (POCUS) is a widely used tool in various fields of medicine to investigate diseases. According to a recent study by Di Vilio, POCUS has proven to be a fundamental tool in medical practice, especially in the emergency room, for the diagnosis of cardiovascular diseases. The study by Dudeck M (2021) highlights the great importance of qualified professional training for the effective use of POCUS as a method of recognizing cardiac and vascular pathologies (Cavero-Redondo, Saz-Lara, Martínez-García, Otero-Luis, & Martínez-Rodrigo, 2024; Cipriani et al., 2024). Recently, Ruben M highlighted the high accuracy of POCUS in treating acute heart failure, especially in patients in cardiogenic shock, ensuring a higher quality of treatment. Furthermore, the study by Hackett highlights the importance of POCUS in accelerating the diagnostic process, reducing investigation times, and allowing faster and more precise approaches to the heart and blood vessels. The study by Iskander J underlines the importance of the ultrasound method as the non-invasive and instantaneous approach, proving to be of high value for its practicality, defining the exam as the "future stethoscope" (Jobling et al., 2024).

The focused cardiac ultrasound technique can be applied by doctors of different specialities who need to evaluate patients with cardiac symptoms and who have the necessary skills to acquire and interpret the images. However, it is essential to highlight that although some studies have suggested using focused cardiac ultrasound as an alternative to regular ultrasound, most patients presenting with cardiac symptoms or signs require a more extensive and accurate ultrasound evaluation. Therefore, it is essential that doctors carefully evaluate each case to determine which technique is best suited to each patient (Sing, 2024; Yang et al., 2024).

In emergencies, especially concerning cardiorespiratory arrest (CPA), a rapid approach by healthcare professionals is necessary. Therefore, to facilitate this approach, the use of POCUS in such situations was evaluated. A favourable odds ratio for restoration of spontaneous circulation was established in those patients in whom cardiac movements could previously be visualized. Of those without cardiac contractility, 94% did not survive resuscitation manoeuvres. However, it is necessary to use this method with caution once the existence of damage in the case of cardiac massage has proven to be precarious in qualitative terms due to poor execution of the resuscitation manoeuvre (Zhao et al., 2024).

Still, regarding the auxiliary use during PCR, the effectiveness of ultrasound was verified during the investigation of the potential cause. POCUS can provide the practising practitioner with a qualitative assessment of cardiac compression, investigate the cause, and differentiate pulseless electrical activity (PEA) from pseudo pulseless electrical activity. Therefore, this imaging method is vital in diagnosing reversible and non-reversible causes, offering great prognostic utility. It is worth underlining the careful use of this tool, as reported in the European Resuscitation Council manual (Teira Calderón et al., 2024).

In the early care of those patients in whom cardiovascular circulation is reestablished after CRA, the test can assist in the post-arrest investigation of the possible cause of cardiac compromise. In this way, it is possible to evaluate some alterations, such as the systolic function of the left ventricle, the

dimensions of the left ventricle and the pericardial effusion, helping guided management (Suriani, Bouwman, Mischi, & Lau, 2024).

According to Jarman RD, POCUS is becoming an emerging and promising method for analyzing the cardiovascular system. Precise assessment of changes in such a device is essential for diagnosing and treating various cardiac diseases in a critically ill patient scenario. This imaging method allows simple and rapid echocardiography for accurate real-time assessment of several aspects of cardiac function, such as ventricular and atrial contractility, the presence of pericardial tamponade, and assessment of heart valve function (Zhang, He, Wu, Chen, & Lyu, 2024).

In addition to accurate evaluation, PCOUS has been increasingly helpful in helping determine appropriate medical management for patients with cardiovascular disorders. This is because its use provides an immediate evaluation of the response to drug therapy, allowing the individualization of therapy and reducing the risk of adverse effects. POCUS can be used as a guide for therapeutic procedures such as, for example, ultrasound-guided pericardial drainage in cases of pericardial effusion (Hou et al., 2024).

During the COVID-19 pandemic in the United States, bedside ultrasound has emerged as the gold standard for cardiac visualization in patients suspected of having the disease. To minimize the risk of contagion for doctors on the front line of combat, a multidisciplinary committee and a specific laboratory have been created, which brings together ultrasound images and professionals specialized in their interpretation. This initiative minimized the number of professionals exposed to the SARS-CoV-22 viral infection and improved infection control by adequately monitoring the need for echocardiography, as reported by Panebianco N (Serai et al., 2024).

Furthermore, POCUS is also very useful in pediatric use, especially in pediatric intensive care units (ICU), where myocardial dysfunction is joint. Current diagnostic tests for this condition, such as MRI and cardiac catheterization, require more extensive protocols and the availability of a specialized professional. In the case of catheterization, the patient is also exposed to an invasive technique with intravenous contracture and ionizing radiation. On the other hand, bedside ultrasound has been studied in this scenario, and its use has proven effective. With brief training, cardiac assessment of child patients is comparable to that performed by specialized pediatric cardiologists, as highlighted by Persson JN (Almeida et al., 2024).

For Point of Care ultrasound to be an accurate and efficient diagnostic method, adequate criteria must be respected together with quality professional preparation. This ensures better accuracy in managing systemic diseases, especially cardiovascular diseases. Therefore, given the perceived need for training of the professionals who use it, a protocol was created that provides six hours of training in echocardiography in a service centre with specialized sonographers and members of the American Society of Echocardiography (Gorgone, Bartholow, & Maximous, 2024).

In addition to adequate professional technical training, POCUS requires consistent telecommunication so that images generated at the bedside can be used multispecialty in patient care. One option is cloud storage networks, which have proven effective for consultation and interpretation of images by other professionals, as Lee LC and Decara JM reported. Therefore, the level of technology associated with the ultrasound examination is of great importance and represents an advance in the clinical and hospital management of critically ill patients (Defrançais, Mansour, & Bressollette, 2024).

FINAL CONSIDERATIONS:

Studies have shown that point-of-care ultrasound is a critical diagnostic tool in medical practice, particularly for cardiovascular disease in emergency and intensive care settings. During the critical period of the COVID-19 pandemic, this exam was of great value. It helped combat the virus as protocols were established for the appropriate use and sharing of images to avoid perpetuating viral contamination. In addition to the general adult population, pediatric patients benefit from the increased use of this ultrasound modality, which is already replacing conventional diagnostic methods. Since its introduction on the market, POCUS has allowed a more rapid assessment of the patient's clinical status without the need for exposure to radiation or invasive imaging tests, as well as

reducing the need for medical specialists and the time needed to diagnose and treat various pathologies.

Furthermore, of great importance is the evolution and diagnostic speed of cardiovascular pathologies that may be reversible with the immediate re-evaluation of the patient's hemodynamic status. In intensive care scenarios, the effectiveness of its use has been demonstrated when there is specific technical training for this. Today, POCUS is an increasingly used test in the hospital medical field. It brings significant progress in the use of rapid and accurate diagnoses associated with more effective treatments. As regards the field of cardiology, studies have shown that this tool is currently of fundamental importance in the medical scenario since, with the development of the technology, a gain is also achieved in terms of effectiveness, quality and speed in treating the sick patient.

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