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The voice of residents: satisfaction and benefits of POCUS in cardiology training

La voz de los residentes: satisfacción y beneficios de POCUS en la bormación cardiológica

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Summary

Introduction: Point-of-care ultrasound (POCUS) has emerged as a key tool in clinical practice, particularly in cardiology, due to its ability to improve real-time diagnostic assessment. The inclusion of POCUS in the training of cardiology residents has the potential to improve decision-making and patient management. **Methods**: This descriptive study evaluated a theoretical and practical POCUS course for cardiology residents. The course included theoretical modules, supervised practice, and competency assessment in various ultrasound techniques. Course satisfaction, confidence, and applicability were measured through post-course surveys. **Results**: Residents positively rated the course organization, content, and quality, with a mean score of 9.5/10. 95% of participants felt confident in performing ultrasound assessments independently. Furthermore, residents reported that the knowledge acquired impacted clinical decision-making and patient management. **Conclusions**: The POCUS course improved cardiology residents' ultrasound skills, confidence, and applicability in clinical practice. The early integration of POCUS into academic training represents a crucial advance in medical education and the management of cardiovascular conditions.

Keywords : Focused ultrasound, cardiology residents, clinical decision-making, POCUS

Abstract

Introducción: La ecografía enfocada en el punto de atención (POCUS) ha emergido como una herramienta clave en la práctica clínica, de manera particular en la cardiología, debido a su capacidad para mejorar la evaluación diagnóstica en tiempo real. La inclusión de POCUS en la formación de los residentes de cardiología tiene el potencial de mejorar la toma de decisiones y la gestión de pacientes. **Métodos**: Este estudio descriptivo evaluó un curso teórico-práctico de POCUS para residentes de cardiología. El curso incluyó módulos teóricos, prácticas supervisadas y evaluación de competencias en diversas técnicas ecográficas. La satisfacción, confianza y aplicabilidad del curso fueron medidas mediante encuestas post-curso. **Resultados**: Los residentes valoraron de manera positiva la organización, contenido y calidad del curso, con una calificación media de 9.5/10. El 95% de los participantes se sintieron confiados para realizar valoraciones ecográficas de manera autónoma. Además, los residentes reportaron que los conocimientos adquiridos impactaron en la toma de decisiones clínicas y manejo de pacientes. **Conclusiones**: El

curso de POCUS mejoró las habilidades ecográficas de los residentes de cardiología, así como su confianza y aplicabilidad en la práctica clínica. La integración temprana de POCUS en la formación académica representa un avance crucial en la educación médica y el manejo de condiciones cardiovasculares.

Palabras clave: Ecografía enfocada, residentes de cardiología, toma de decisiones clínicas, POCUS

1. Introduction

Point-of-care focused ultrasound (POCUS) has emerged as an essential tool in clinical practice, impacting the way healthcare professionals approach diagnosis and decision-making in critical situations. This technique allows for real-time ultrasound images at the patient's bedside, complementing and enhancing traditional physical examinations. Its inclusion in clinical evaluation has established itself as a key resource not only in emergencies but also in various medical specialties, including cardiology, where its ability to provide immediate and accurate information is valuable.

Focused Ultrasound: Definition and Basic Principles

POCUS is defined as the use of ultrasound in the patient's clinical setting to answer specific questions and make a rapid diagnosis. Unlike conventional ultrasound, where patients must be referred to a specialized department for more detailed studies, POCUS allows images to be obtained at the time of the clinical evaluation. This real-time diagnostic capability offers significant advantages because it allows physicians to use ultrasound as an extension of the physical examination, thereby increasing the accuracy and speed of evaluating various cardiovascular conditions (1).

Advantages of POCUS as a Complement to Physical Examination

One of the main advantages of POCUS is its ability to provide a more complete evaluation of conditions that are not always evident during conventional physical examination. In cardiology, its usefulness has been highlighted in the diagnosis of heart failure, valvular heart disease, and other diseases that require detailed visualization of the heart and its structures. The use of POCUS also helps differentiate diagnoses with similar symptoms, so that additional diagnostic tests and/or invasive procedures can be chosen more efficiently. Furthermore, in emergency situations, such as trauma or resuscitation, POCUS can detect the presence of hypovolemia, pneumothorax, tamponade, or internal bleeding, which impacts decision-making and patient safety (2).

Improving Clinical Decision-Making

POCUS not only facilitates the initial patient assessment but also optimizes clinical decision-making. Physicians can use this tool to guide interventions such as catheter placement, drainage, or evaluation of the effectiveness of established treatments. By complementing the physical examination, POCUS helps reduce uncertainty and provides a clearer and more detailed view of the patient's condition, which can influence therapeutic management and the need for surgical interventions (3).

Training and Limitations

For physicians to be able to use POCUS effectively, specialized training is essential. Although ultrasound is easy to learn, correct image interpretation and clinical application depend on the practitioner's experience. Currently, the integration of POCUS into medical training is increasingly common, allowing for improved proficiency in its use. However, limitations of this technique include variability in image quality, which can be affected by factors such as operator skill and patient conditions, such as obesity or abdominal gas. Furthermore, although POCUS is useful as a complementary diagnostic tool, it does not replace more complex techniques such as computed tomography or magnetic resonance imaging (4).

Teaching POCUS to Students and Resident Physicians

The teaching of POCUS in medical education has been increasing, and it is considered a fundamental skill in multiple training programs. For cardiology residents, POCUS training is organized into two components: theory and practice. Theory covers the basic principles of ultrasound, its application in clinical practice, and image interpretation, while practice takes place in real or simulated clinical settings, where residents can perform ultrasound examinations under the supervision of experienced instructors (5–6). POCUS training programs have expanded to many universities and hospitals, and early integration of this tool has been shown to significantly improve the diagnostic skills of students and residents. Early exposure to POCUS enables future physicians to make informed decisions more quickly, reducing reliance on invasive procedures and improving patient management (7).

Teaching and Assessment Methods

There are several strategies for teaching POCUS to students and residents. These range from classroom-based theoretical sessions to practical workshops in which students practice using ultrasound on real patients or simulated models. A recent study showed that a combination of theoretical classes and supervised practical training in hospitals improves residents' ability to make accurate diagnoses with POCUS, with a rapid learning curve (8). Assessment of POCUS competency includes direct observation of the procedures performed and interpretation of the images obtained. The use of simulators and technological tools has also facilitated teaching, allowing residents to practice without the need for a real patient. However, continuous feedback from instructors is crucial to ensure that residents develop the competency necessary to use this tool effectively (9).

Challenges and Future of POCUS Teaching

One of the greatest challenges in teaching POCUS is the lack of resources and trained personnel in some medical institutions. The quality of teaching depends on the training of instructors, so their continuous training is essential. Furthermore, some academic programs have not yet integrated POCUS into their curriculum, which limits residents' exposure to this tool from the early stages of their training (10). With the continued advancement of technology and the recognition of the benefits of POCUS, it is expected that more specialized training programs will be implemented in the future, with a more structured approach and the use of online learning platforms that facilitate access to high-quality educational materials and simulators. It is important to mention that " ***you do not find what you do not look for, and you do not look for what you do not know*** "; that is, the application of these techniques must be preceded by an adequate questioning and a thorough physical examination. Without this prior construct, the analysis and interpretation of the images obtained will be incomplete, which impacts their diagnostic performance and the adequate comprehensive patient care process (11).

Study Objectives

To evaluate cardiology residents' satisfaction with POCUS training, as well as their confidence in performing these techniques and the perceived impact on their clinical practice. Our specific objectives were:

- To evaluate the satisfaction of cardiology residents with the training received in the theoretical-practical POCUS course, in terms of content, methodology, and resources used.
- To measure residents' confidence level in performing POCUS techniques in clinical practice, before and after training.
- To determine the impact of the course on the clinical practice of residents by evaluating and analyzing how the acquisition of POCUS skills influences diagnostic and therapeutic decision-making in their professional environment.

- Identify the skills acquired by residents during the course and their application in real-life clinical situations, using feedback provided in evaluation surveys.
- To explore residents' perceptions of the strengths and limitations of the POCUS theoretical and practical course, in order to identify areas for improvement for future editions of the program.

2. Methods

Study Design.

This is a descriptive and evaluative study that analyzes the effectiveness of a theoretical-practical ultrasound course for first-year residents (N=70) at a single educational center. The participants were residents who were part of the academic program of the "Clinical Cardiology" residency at the "Instituto Nacional de Cardiología Ignacio Chávez," a tertiary care university hospital with an uninsured population. The course was held during the academic periods from March 2022 to February 2023 (N=35) and from March 2023 to February 2024 (N=35). First-year residents who did not complete the practical phase of the evaluation and/or did not complete the feedback survey at the end of the course (N=7) were excluded. The practical sessions were held in the classrooms of the Teaching Department of the "Instituto Nacional de Cardiología Ignacio Chávez." The residents had no prior experience in the application of these techniques. Participants were evaluated on their satisfaction, skills acquired, and confidence in the clinical application of ultrasound techniques in critical areas. There was no control group, as all first-year residents took the course during the study period. The topics covered during the course were:

1. Technique, physical principles and modes of ultrasound
2. Echocardiographic approaches and views
3. Quantification
4. Diastolic function
5. Left ventricular function
6. Right ventricular function / pulmonary thromboembolism
7. Pulmonary hemodynamics
8. Valvulopathies
9. Pericardial effusion
10. Lung ultrasound
11. Answer to volume and evaluation of venous congestion

Teaching Methodology.

Theoretical phase. Each resident viewed a prerecorded video (.mp4 format) containing theoretical content related to ultrasound techniques. This material covered basic ultrasound principles, echocardiographic approaches and views, as well as methodologies for quantifying and assessing various cardiac and pulmonary functions. The videos averaged 35 minutes and were recorded by an intensive care cardiologist with expertise in critical care ultrasound (graduate degree in echocardiography and ultrasound in critical care settings).

Practical phase. Residents participated in a one-hour practical session for each topic, with a maximum of eight residents to maximize practice. Healthy models and an intermediate-platform ultrasound (Sonoscape E2 Pro, with a sectorial and linear transducer) were used. The use of ultrasound equipment with advanced software technology was not an absolute requirement. During each practice session, a checklist was used to assess the specific skills residents were expected to acquire in each module (Supplementary Table 1). The practice was coordinated by an intensive care cardiologist with expertise in critical care ultrasound (graduate degree in echocardiography and ultrasound in critical care areas). The ultrasound was connected to a television to facilitate visualization and understanding of the techniques and facilitate interaction

with residents (Figure 1). Images were obtained by the operator using a 2-3 MHz sector transducer from either the patient's right or left side on any platform using the following modes: M-mode, 2D-mode, color, pulsed wave (PW) Doppler, continuous wave (CW) Doppler, and tissue Doppler imaging (TDI). Echocardiographic views and parameters were recorded and measured according to the American Society of Echocardiography guidelines for a complete transthoracic echocardiographic examination in adults and the American Society of Echocardiography and European Association of Cardiovascular Imaging guidelines for quantification of cardiac chambers (12).

- Basic modules.
    - Techniques for turning on the equipment, choosing the appropriate probe, and controlling parameters such as depth, gain, zoom, focus, and ultrasound sector.
    - Ultrasound modes, including: M-mode, two-dimensional, color Doppler, continuous, pulsed and tissue.
- Advanced Modules.
    - Echocardiographic views and approaches: parasternal long-axis view, parasternal short-axis view (at the level of the great vessels and midventricular level), apical 2, 3, 4, and 5-chamber views, and subcostal 4-chamber view
    - Measurement of various structures such as left ventricular diameter, left atrial volume, left ventricular shortening fraction, among others.
    - Evaluation of diastolic function, left ventricular function, and right ventricular function, with special focus on the diagnosis of pulmonary thromboembolism.
    - Analysis of pulmonary hemodynamics, blood pressures, and pulmonary vascular resistance.
    - Evaluation of the heart valves (aortic, mitral, pulmonary, and tricuspid), as well as the calculation of areas and gradients.
    - Analysis of pericardial effusions, with projections and measurements of right ventricle and right atrium collapse.
    - Use of lung ultrasound for the diagnosis of specific syndromes, such as consolidation, pneumothorax, pleural effusion, as well as the evaluation of diaphragmatic excursion and thickness.
    - Evaluation of systemic venous congestion (Venous Excess Ultrasound Score – VexUS protocol).

Final Evaluation.

- Satisfaction and Evaluation Survey: At the end of the course, residents completed a satisfaction survey that covered three key aspects:
    - Overall satisfaction with the training: Evaluation of the theoretical content, the quality of the videos, the effectiveness of the practical learning, and the clarity of the demonstrations.
    - Technique confidence: Measuring residents' self-perception of their ability to perform taught techniques in real-life clinical situations.
    - Impact on clinical practice: Evaluation of how the course learning impacted clinical decision-making, diagnosis, and treatment of patients in daily practice.

3. Results (table 1)

1. Workshop Organization Evaluation: The average rating given to the workshop organization (theoretical content, video quality, effectiveness of practical learning, and clarity of demonstrations) was high, with an overall average of 9.5/10. Participants reported that the workshop structure facilitated learning; they appreciated the quality of the visual presentations and live demonstrations.
2. Evaluation of the content taught: The content taught in the workshop received an average rating of 9.8/10 (effectiveness of practical learning and clarity of demonstrations). This

result reflects the overall perception that the topics covered were relevant and of high quality in their presentation.

3. Usefulness of the topics covered for daily practice: The topics covered during the workshop were highly rated for their applicability to daily clinical practice. The average score obtained was 9.7/10, indicating that participants considered the knowledge acquired had a direct impact on clinical decision-making, diagnosis, and patient treatment.

Figure 1. Graphic example of the practice. The resident can be seen applying the technique during the practice, with the support of the tutor, during the workshop. The echocardiographic images are projected on a high-definition screen.

4. Confidence in performing an independent ultrasound assessment: Regarding confidence in performing ultrasound assessments independently, most participants expressed confidence in their ability to apply the acquired knowledge in real-life clinical situations. Ninety-five percent of respondents responded affirmatively to the question about their ability to perform an independent ultrasound assessment. This high self-perception of confidence reflects the workshop's effectiveness in developing technical skills.
5. Quality of the videos and theoretical content for studying the practical sessions: Regarding the adequacy and suitability of the videos and theoretical content for preparing for the practical sessions, the majority of participants rated the educational resources provided positively. With an average score of 9.9/10, participants expressed that the audiovisual and theoretical material was adequate and useful for understanding and performing the ultrasound techniques.
6. Topic preference and content relevance: Participants highlighted several specific topics that were of greatest interest to them. The most frequently mentioned topics included *volume response/venous congestion* and *left/right ventricular function* . However, there was no consensus regarding the need to omit any topic. In fact, most participants expressed that the topics covered were relevant and appropriate to the workshop objective.

Table 1. Survey results.

Variable	**N=70**	
DEMOGRAPHICS		
Age (years)	28 (+/- 1.9)	
Sex (N%)	Female	11 (15.7)
	Male	59 (84.3)
SURVEY		
Organization	9.5 (+/- 0.3)	
Content	9.8 (+/- 0.37)	
Daily practical utility	9.7 (+/- 0.28)	
Self-assessment, N(%)	Yeah	66 (95)
	No	4 (5)
Quality (theory)	9.9 (+/- 0.07)	
Favorite topics, N (%)	RV/CV	32 (46)
	FVI/D	20 (28.6)
	FVI	12 (17.1)
	HP	4 (5.7)
	Others	2 (2.8)

Data are on a scale of 1-10, mean ± standard deviation. **RV/CV:** Volume Response/Venous Congestion **, LVF/D:** Left/Right Ventricular Function, **LVF:** Left Ventricular Function, **PH:** Pulmonary Hemodynamics

4. Discussion

The incorporation of POCUS into the academic curriculum of cardiology residents represents a significant advance in medical training. This study evaluated the effectiveness of a theoretical and practical POCUS course designed to improve residents' ultrasound skills in real-life clinical situations. The results obtained from satisfaction surveys highlight participants' high ratings of various aspects of the course, reflecting the effectiveness of this tool in the academic training of future cardiologists.

Course Organization and Content

The workshop organization, which combined high-quality theoretical content with supervised practice, received a high average rating (9.5/10), indicating that residents positively perceived both the structure and the methodology employed. The combination of audiovisual resources, such as pre-recorded videos, and live demonstrations during practical sessions appears to have facilitated learning, which is also confirmed by the 9.8/10 rating given to the content taught. This result is consistent with existing literature, which highlights that the integration of theoretical and practical methods is essential for effective POCUS learning in the training of medical residents (6). A key aspect for the workshop's success was the quality of the videos and theoretical content, which were considered adequate and sufficient for preparing for the practical sessions. This educational resource, rated with an average of 9.9/10, allowed residents to acquire a solid foundation before clinical practice, improving their understanding of the techniques and facilitating skill acquisition in a controlled environment. Previous studies show that the use of theoretical content complemented with high-quality videos can improve students' ability to apply learned concepts in practical situations (7).

Impact on Clinical Practice and Decision-Making

The results obtained regarding the applicability of the content in daily clinical practice are relevant. Residents reported that the topics covered had a direct impact on their ability to make clinical decisions, make diagnoses, and adjust treatments. With a mean score of 9.7/10, these results

suggest that the course not only improved the technical competencies of the residents but also favored a better integration of the acquired knowledge in the context of their professional practice. The implementation of POCUS in clinical evaluation allows residents to obtain a more precise and dynamic view of their patients' cardiovascular conditions, which becomes relevant in decision-making in emergency situations and avoids unnecessary invasive procedures (3).

Confidence in the Use of POCUS

One of the most notable findings of this study is the high level of confidence residents demonstrated in their ability to independently perform ultrasound assessments (95% of participants reported feeling confident in applying the techniques taught in real-life clinical situations). This reflects the effectiveness of the course in practical training, which is in line with the literature suggesting that well-structured and supervised training programs increase physicians' self-perception of their technical competence (8). Confidence in using POCUS is essential because it allows residents to integrate ultrasound into their daily clinical practice, which in turn can improve patient diagnosis and treatment outcomes (2).

Relevance of Topics and Areas for Improvement

Regarding the topics covered, residents showed particular interest in areas such as volume response/venous congestion and left/right ventricular function. These topics are fundamental in cardiology because they have a direct impact on the evaluation and management of conditions such as heart failure and other cardiovascular diseases. However, no topic was identified that participants considered unnecessary or that should be omitted, highlighting the relevance of all the content offered in the course. This finding is consistent with previous studies emphasizing the importance of providing comprehensive training that covers a wide range of ultrasound techniques, from basic to advanced, so that residents can confidently apply them in diverse situations (9).

Limitations and Challenges

Although the course results were mostly positive, it is important to acknowledge its limitations. The methodological design, based solely on surveys, suggests the need to incorporate practical assessments for a more comprehensive evaluation. The absence of a control group and the lack of assessment of long-term skill retention are also areas for improvement. The course's delivery by a single instructor underscores the importance of ongoing training to ensure quality teaching by multiple instructors. Furthermore, the variability in ultrasound image quality and differences in anatomical and functional models highlight the need for adequate equipment and trained personnel to overcome the challenges of practical sessions. This study lays the groundwork for future multicenter research with larger sample sizes, practical assessments, and long-term follow-up of acquired skills.

Future of POCUS Teaching in Cardiology

The growing adoption of POCUS in cardiology residency training is a step toward modernizing medical education. It is hoped that in the future, with the advancement of technologies and the implementation of online learning platforms, more accessible and flexible training for residents will be possible, allowing them to access high-quality educational resources and simulators from anywhere. Furthermore, the expansion of POCUS training programs could lead to greater integration of this tool into the clinical practice of cardiologists, resulting in continuous improvement in patient care standards (10).

5. Conclusions

- This study provides strong evidence that POCUS training has a significant impact on the training of cardiology residents, both in terms of technical skills and confidence in the clinical application of ultrasound.
- The results suggest that integrating POCUS into the curriculum is an effective tool for improving the quality of cardiovascular care, with the potential to transform decision-making and patient management.
- However, it is crucial to continue the ongoing evaluation of training programs and overcome barriers related to resources and instructor training to maximize the benefits of this tool in clinical practice.

Take Home Messages:

- POCUS training is highly effective and highly rated by cardiology residents. The satisfaction survey results indicate that residents appreciate the course's organization, content, and quality, reflected in an average rating of 9.5/10.
- The combination of theory and practice is essential for learning POCUS. The course stood out for its combination of high-quality theoretical content with supervised practice, which facilitated the residents' understanding and development of ultrasound skills.
- POCUS improves residents' confidence and skills in clinical decision-making. Course participants felt more confident and prepared to use POCUS in real-life clinical situations, suggesting that this tool has a positive impact on their professional development.

Annex I: Supplementary Table 1: Skills Checklists

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