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Automated Hemodynamic Profiling from Bedside Ultrasound using EASyExamAI

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Introduction/Background

Point-of-care ultrasound (POCUS) enables rapid hemodynamic and cardiac function assessment but often requires multiple views and expert interpretation. The Echocardiography Assessment using Subcostal-only (EASy) protocol simplifies acquisition to a single subcostal four-chamber view, reducing variability in image acquisition for novice users. While AI has been applied to standard echocardiography, its integration with simplified protocols like EASy remains largely unexplored. To address this gap, we developed EASyExamAI, a deep learning model trained to classify hemodynamic phenotypes from EASy-acquired images, enabling automated interpretation at the bedside, particularly in time-sensitive critical care settings.

Methods/Intervention

We analyzed 588 EASy examinations acquired by novice and experienced clinicians after structured POCUS training. Exams were categorized into three clusters: Cluster 1 (n=361; normal or small ventricular cavity), Cluster 2 (n=174; left ventricular enlargement), and Cluster 3 (n=53; isolated right ventricular enlargement). Frames extracted from videos were labeled and split 80:20 into training and validation sets. Model performance was assessed using accuracy and cross-entropy loss.

Results/Outcome

Training achieved accuracies of 94% for Cluster 1, 80% for Cluster 2, and 100% for Cluster 3, for an overall accuracy of 89% (loss 0.25). Validation accuracy was 75% (loss 0.64) on unseen data. The model demonstrated strong ability to differentiate normal ventricular size, reduced left ventricular function, and isolated right ventricular enlargement, with highest accuracy in detecting RV enlargement.

Conclusion

EASyExamAI demonstrates the feasibility of combining a simplified POCUS protocol with AI to provide real-time, automated hemodynamic profiling from a single subcostal view. While not a substitute for expert judgment, it offers consistent interpretation and decision support in resource-limited and time-sensitive settings.

Statement of Impact

By pairing a standardized acquisition protocol (EASy) with AI-driven analysis, this approach addresses two major challenges in POCUS: variability in image acquisition and interpretive inconsistency requiring expert oversight. EASyExamAI represents the first application of deep learning to an EASy protocol, bridging simplified image capture with automated interpretation to advance scalable bedside imaging.

Keywords

Artificial Intelligence; Point-of-Care Ultrasound (POCUS); Echocardiography; Hemodynamic Profiling; Image Classification