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Point-of-care cardiac assessment using machine learning to guide image acquisition

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Background/Introduction: When used by experienced examiners, the utility of point-of-care (POC) ultrasound for assessing cardiac anatomy and function has been well established. However, in some clinical circumstances (Primary Care offices, Intensive Care Unit, some Emergency Rooms, or in remote settings) in which a rapid assessment of cardiac anatomy and dynamics can facilitate patient care, an examiner experienced at POC scanning may not be immediately available.

Purpose: To help novice users acquire clinically useful standard cardiac views using novel machine learning (ML) software.

Methods: We used an investigational device that employs ML software to provide real-time adaptive guidance of transducer position and orientation to help novice users acquire tomographic views of the heart. We tested the utility of this approach when 4 nurses with no prior training in sonography performed POC studies on 16 subjects (10 healthy, 6 with cardiac abnormalities; 9 men; body mass index normal in 6, overweight in 6, and obese in 4 subjects). Each nurse underwent didactic training and 4 hours of supervised practice using the ML program. Each nurse scanned each study subject using a scanner equipped with ML software to acquire 10 digital two-dimensional image clips, including: parasternal long axis, short axis at the aortic valve, mitral valve, and mid-left ventricle (LV), apical 2-, 4-, and 5-chamber, subcostal 4-chamber, and longitudinal views of the inferior vena cava (IVC). All video clips (n=640) were later reviewed independently by 5 level 3-trained cardiologists who were blinded to subject, scanner, and each other's assessments. The expert readers reviewed each set of 10 clips to determine if the following variables could be assessed qualitatively: LV size and function; right ventricular (RV) size and function; aortic, mitral and tricuspid valves; pericardial effusion; left atrial size; IVC size.

Results: The majority of expert readers concurred, independently, that the sets of images acquired by nurses using ML guidance allowed qualitative assessment of LV size and function in 98%, pericardial effusion in 98%, RV size and function in 92%, and aortic and mitral valve anatomy and dynamics in 94-97% of cases. Qualitative assessment of LA size was feasible in 95%. Images of the IVC were judged as adequate for assessment in 58%.

Conclusion: This preliminary study suggests the potential value of novel ML software by demonstrating that nurses with limited training can acquire tomographic images useful for qualitative assessment of the cardiac chambers and valves in more than 90% of the subjects examined. This approach might be useful when timely POC cardiac assessment is indicated in settings where an experienced examiner is not available. Further refinements in the guiding software are needed to improve the success rate of IVC imaging, since IVC size can
be a useful indicator of volume status.