RESEARCH LETTER

Point-of-Care Ultrasound for Evaluation of Systolic Heart Function in Outpatient Hemodialysis Units

To the Editor:

Heart failure with reduced ejection fraction is a significant cause of morbidity and mortality in patients receiving hemodialysis.[1,2] Interdialytic volume overload results in increased preload and afterload, increasing ventricular chamber size, elevating filling pressures, and worsening diastolic dysfunction.[2] Guidelines recommend evaluating ejection fraction at the time of dialysis initiation, when patients reach dry weight, and then every 3 years.[1] However, echocardiography is infrequently performed at these intervals, limiting the timely detection of asymptomatic left ventricular (LV) dysfunction.[3,4] There is growing interest from nephrologists to learn and use point-of-care ultrasound (POCUS) to assess cardiac function.[5] In this study, we sought to determine whether focused cardiac POCUS can successfully ascertain ejection fraction in patients undergoing outpatient hemodialysis without interfering with dialysis clinic operations.

We conducted a cross-sectional study at 2 outpatient hemodialysis clinics from September to November 2018 (Fig S1; IRB00132750). We trained a nephrology fellow (S.L.) and a third-year medical student (S.A.; "operators") to obtain POCUS-derived cardiac parasternal long-axis views using a Vscan device (maximum depth, 24 cm; GE healthcare).[5,6] We obtained the images in the first 30 minutes of hemodialysis to avoid the risk for misinterpretation due to the potential for myocardial stunning with intradialytic hypotension. We also abstracted information from dialysis and health records. We calculated ejection fraction from the cardiac parasternal long-axis view using the E-point septal separation method[7-9] and categorized patients into ejection fraction < 45% or ejection fraction ≥ 45% groups (Fig S2). All images were interpreted by the POCUS operator, followed by a blinded review by an echocardiographer with 30 years of experience (C.M.). A cardiologist (S.Z.) then reviewed all abnormal results and an additional 10% of random images. We compared ejection fraction assessment by the operator (index test) versus echocardiographer (reference standard) and calculated 95% CIs for the performance metrics using bootstrapping (10,000 resamples).

We completed POCUS on 57 participants; all studies were performed in the first 30 minutes of hemodialysis without interrupting patient-care tasks. Of the 57 patients, 52 (93%) had satisfactory images for interpretation and comprised the analytic cohort. The 5 patients with unsatisfactory images were due to obesity (n = 3), mitral stenosis (n = 1), and errors in saving images (n = 1). Mean age was 65 ± 13 years, 96% were Black, and 44% were women (Table 1). The average time to obtain images was 3.2 ± 1.7 minutes. Image interpretation concordance was 64% between the operator and echocardiographer and 100% between the echocardiographer and cardiologist. Operator-assessed low ejection fraction (<45%) was 93% sensitive and 51% specific, with a positive predictive value of 44% and negative predictive value of 95% (Fig 1). Among the 15 participants with low ejection fraction, 40% did not have a prior heart failure diagnosis and 53% were not receiving renin-angiotensin system–blocking medications. Fifty participants had undergone formal echocardiography in the prior 3 years (Table S1). Notably, 42 had an ejection fraction ≥ 45%, and of those, 8 (19%) had a low ejection fraction detected using POCUS evaluation.

The results of our study support the use of focused cardiac POCUS in patients undergoing hemodialysis in the outpatient setting. In most patients, POCUS can quickly obtain diagnostic images to screen for low ejection fraction without burdening patients or hindering care. Initial POCUS interpretation by the operator was reasonably reliable in excluding significant LV dysfunction; however, <50% of patients with abnormal findings were noted to have a low ejection fraction by the echocardiographer and cardiologist. Thus, our findings suggest that operator interpretation of POCUS is a useful screening tool for low ejection fraction, but a formal review of abnormal findings is necessary before initiating further diagnostics and cardiac treatments. Of note, POCUS imaging is helpful for more than just determining ejection fraction. It can also be used to obtain a limited echocardiogram (Current Procedural Terminology code 93308) in the hemodialysis clinic to provide information on chamber size, aortic root diameter, LV hypertrophy, pericardial and pleural effusions, and inferior vena cava. Therefore, there may be even more utility in considering POCUS in the outpatient dialysis setting, with careful oversight from

Table 1. Baseline Characteristics of the 52 Participants

Characteristic	Results
No. of patients	52
Age, y	64.8 ± 13.0
Race, African American	50 (96.2%)
Sex, female	23 (44.2%)
Body mass index, kg/m^2	28.9 ± 7.9
Weight, kg	83.7 ± 27.3
Duration of dialysis, mo	34.3 [11.3-56.3]
Clinical diagnosis of heart failure	20 (38.5%)
β-Blockers	38 (73.1%)
ACEi/ARB	16 (30.8%)
Both β-blockers and ACEi/ARB	12 (23.1%)
Day of scan	
Monday or Tuesday	27 (51.9%)
Wednesday or Thursday	18 (34.6%)
Friday or Saturday	7 (13.5%)

Note: Data are mean ± standard deviation, median [25th-75th percentile], or number (percent), with percentages based on the total number in the corresponding column.
Abbreviations: ACEi, angiotensin-converting enzyme inhibitor, ARB, angiotensin receptor blocker.

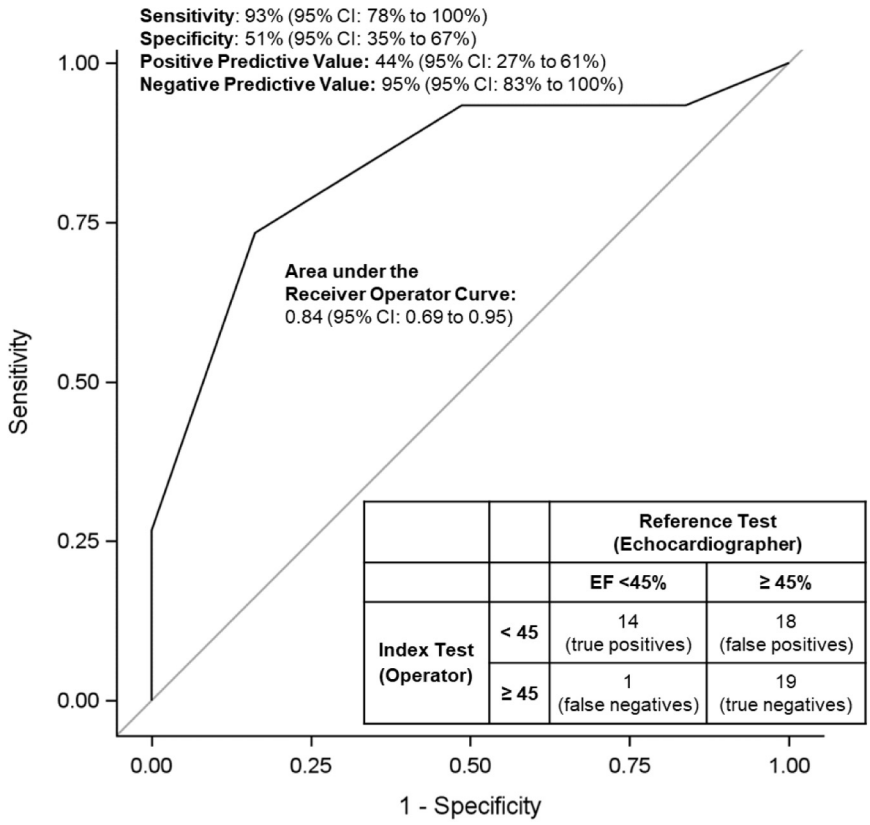

Figure 1. Performance of point-of-care ultrasound (POCUS) ejection fraction estimation by the operator compared to echocardiographer. Receiver operator curve compares sensitivity to 1 − specificity of ejection fraction (EF) calculation by the operator (index test) to the echocardiographer (reference test). EF estimation by echocardiographer and cardiologist were 100% concordant.

echocardiographers and imaging cardiologists. Our pilot study was potentially limited by the use of POCUS on varied days of the week, which can affect imaging parameters depending on the amount of interdialytic intravascular congestion. In addition, we used the E-point septal separation method for ejection fraction estimation, which is not accurate in the presence of mitral stenosis, aortic regurgitation, or atrial fibrillation and is less accurate than ejection fraction assessment using traditional echocardiographic parameters. Despite these limitations, our study demonstrates the potential to bring cardiac POCUS to the dialysis clinic, help detect low ejection fraction, and guide medical care in this high-risk population.

In summary, our study suggests that focused cardiac POCUS is feasible in US dialysis clinics and can be used to screen for low ejection fraction and guide management. Further studies are needed to evaluate large-scale implementation strategies and whether timely imaging can improve outcomes for patients treated with hemodialysis.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Figure S1: Flow diagram illustrates participant selection

Figure S2: Method of ejection fraction (EF) estimation with E-point septal separation (EPSS) on cardiac PLAX view

Table S1: Changes in ejection fraction since the last formal echocardiogram

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Authors' Contributions: Research idea and study design: TS, SL, SA; data acquisition: SL, SA; data analysis/interpretation: SL, SA, CM, SZ; statistical analysis: SH; supervision or mentorship: TS, BJ, SMS. Each author contributed important intellectual content during manuscript drafting or revision and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved.

Support: This work was supported by the Johns Hopkins Center for Innovative Medicine (CIM), United States. Dr Shafi was a CIM Scholar. The funder of this study did not have any role in study design; collection, analysis, and interpretation of data; writing the report; and the decision to submit the report for publication.

Financial Disclosure: The authors declare that they have no relevant financial interests.

Acknowledgements: The authors thank the patients, staff, and physicians of DaVita dialysis clinics and the Nephrology Center of Maryland for their support.

Prior Presentation: Parts of this work were presented at the National Kidney Foundation 2019 Spring Clinical Meeting, May 8–12, 2019, Boston, MA.

Peer Review: Received June 12, 2020. Evaluated by 1 external peer reviewer, with direct editorial input from the Statistical Editor, an Associate Editor, and the Editor-in-Chief. Accepted in revised form November 21, 2020.

 Published online February 10, 2021 with doi 10.1016/j.xkme.2020.11.018

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