

Left ventricular ejection fraction – Human vs Artificial Intelligence: Quo vadis?

R. Botan¹, A. Winkler¹, Z. Dindane¹, T. Nowack¹, C. Heitman¹, J. Mierke¹, A.P. Linke¹, K.M. Sveric¹

¹ Technische Universität Dresden, Herzzentrum Dresden UniversitätsKlinik, Dresden, Germany

Background: The measurement of left ventricular (LV) ejection fraction (EF) is central to the clinician's therapeutic decision-making. Two-dimensional echocardiography is a practical method for assessing LVEF in daily practice. However, the interpretation of Echo exams depend on the user's expertise and may vary between different operators.

Therefore, we have evaluated a novel, vendor-neutral artificial intelligence (AI)-based software that performs both, automated evaluation of Echo exams and calculations of biplane LV EF and volumes in a seamless ready-to-use workflow.

Purpose: We sought to assess the ability of the AI to automatically identify appropriate LV 4- and 2-chamber views from routine Echo examinations and compare the resulting biplane EF with conventional hand-tracing biplane Simpson method.

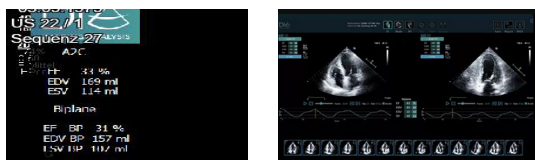


Figure 1 Quantification of LVEF and LV-Volumes with the LvVivo-software

Parameters (N=242)		Mediane quartile (Q1;Q3) or Percentage
Weight (kg)		80 (70;89)
Height (cm)		1.72 (1.65; 1.78)
Age (years)		72(60;81)
BMI kg/m ²		26(24;29)
BSA		1.96(1.80; 2.08)
Sex (male)		0.60 (N=145)
Echocardiographic imaging conditions	poor	0.12 (N=28)
	good	0.59 (N=142)
	moderate	0.30 (N=72)
Indications for Echo examination	valvular heart disease	0.39 (N=121)
	ischemic heart failure	0.31 (N=97)
	non-ischemic heart failure	0.19 (N=59)
	other	0.11 (N=34)

Table 1 Baseline characteristics

Methods We prospectively enrolled 311 patients who underwent clinically indicated Echo exams. Biplane LV EF was determined online with the manual biplane Simpson method by experienced cardiologists (Human). After completion of the exam, the entire echo data set was automatically sent to the AI-based platform, which recognized the optimal LV 4CV and 2CV according to predetermined quality and depth criteria and performed the calculation of biplane EF by endocardial borderline detection without Human's interaction. Spearman's correlation (R) and Bland-Altman analysis with limits of agreement (LOA) were assessed for bias between the two methods. In a subgroup of 20 patients, Echo exams were automatically reanalysed by the AI, and conventional biplane Simpson of LV EF was performed by two cardiologists blinded to previous results to determine intraclass correlation (ICC). Significance was defined as a 2-tailed p value < 0.05.



Figure 2 Example of analysis in the apical 2 chamber view Human vs. AI



Figure 3 Example of analysis of LVEF biplane measured by Human vs. AI

Results: Of the 311 patients who received an Echo, 16 cases did not pass AI's criteria due to poor Echo imaging or impaired acoustic window of patients. In 53 patients either 4CV or 2CV were recognized.

The AI system successfully identified both 4CV and 2CV in 242 patients (overall feasibility 78%). For these, correlation between AI and Human biplane LV EF was $r=0.83$ ($p < 0.001$).

The absolute mean bias between methods was 5.2% ($p < 0.001$) and absolute LOA ranged from -9.0% to +19.4%.

ICC of LV EF by Human was 0.77 ($p < 0.001$). The AI's ability to correctly re-classify 4CV and 2CV was 100% with an ICC of 1 for fully automated LV EF measurements.

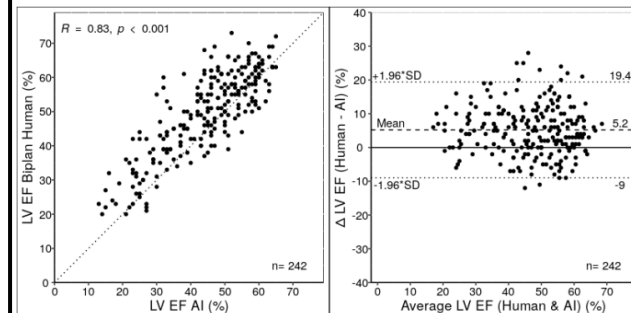


Figure 4 Correlation plot (left) and Bland-Altman plot (right)

Method	biplane LVEF (%)	biplane LVEDV (ml)	biplane LVESV (ml)
AI	46 (34;54)	111 (89;138)	56 (43;83)
Human	51 (42;59)	96 (75;124)	45 (32;70)
P-value	<0.001	<0.001	<0.001

Table 2 Comparative results AI vs Human

Conclusion: The results provided by the AI-based software showed very good capability to identify 4CV and 2CV, especially since patients were not "echocardiographically" preselected. The comparison of LV EF and volumes between AI and Human manual tracings showed excellent correlations. However, the limits of agreement and bias were not negligible and warrant further investigations.