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AI-enabled opportunistic left ventricular volumetry in coronary artery calcium scans predicts heart failure comparably to cardiac MRI: An AI-CVD study with the Multi-Ethnic Study of Atherosclerosis (MESA)

Artificial intelligence applied to coronary artery calcium (CAC) scans can provide information beyond what is currently reported. The AI-CVD initiative aims to opportunistically extract all actionable information from CAC scans and lung scans. We have recently shown that AI-CVD opportunistic screening for enlarged cardiac chambers particularly left atrium (LA) and left ventricle, and increased left ventricular (LV) mass in CAC scans predicts future atrial fibrillation (AF) and heart failure (HF)[1–4]. In this study, we compare the AI-measured LV volume in CAC scans with the LV volume measured by human experts using semi-automated software in cardiac magnetic resonance imaging (MRI).

We analyzed 4177 asymptomatic participants (ages 62.2 ± 10.3 years; 52.3 % female) in the Multi-Ethnic Study of Atherosclerosis (MESA) who underwent both non-contrast CT for CAC scoring and cardiac MRI at baseline (2000–2002). The AI-CVD tool used for automated cardiac chambers volumetry in this report is AutoChamber™ (HeartLung.AI, Houston, TX), an FDA cleared deep learning model that segments each of the four cardiac chambers and assesses LV mass (Figure, Panel A). LV volume is computed by segmenting the chamber on each axial slice and summing the cross-sectional areas multiplied by the slice thickness. Cardiac MRI end-diastolic LV volume was previously measured by the MESA MRI reading center using end-diastolic volume. 2839 cases at MESA centers: Wake Forest University, University of Minnesota, Johns Hopkins University were scanned with multidetector CT (MDCT) using ECG-gating at 50 % R–R interval, and 2990 cases at Northwestern University, Columbia University, and University of California Los Angeles with electron beam CT (EBCT) using ECG-gating at 80 % R–R interval.[5] HF events were adjudicated over 15 years of follow-up; however, HF subtypes (e.g., HFrEF vs. HFpEF) were not delineated in the MESA cohort. Time-dependent receiver operating characteristic (ROC) analysis was used to compute areas under the curve (AUC) for AI-CVD AutoChamber versus cardiac MRI for HF prediction.

During a mean follow-up of 12.2 years, 171 participants developed heart failure, corresponding to an incidence rate of 0.33 events per 100 person-years. In this cohort, mean LV volume was 102.5 ± 25.4 mL by AutoChamber AI in CAC scans versus 127.2 ± 30.7 mL by cardiac MRI. The difference between AI-measured LV volume in CAC scans and MRI is attributed to the difference in timing of each measurement during a cardiac cycle where the MRI measurement is done at the time of maximum LV relaxation (end diastole) whereas the LV volume in CAC scans was from early (MDCT) to mid diastole (EBCT). The LV volume in MDCT and EBCT were not significantly different (102.0 cc vs 103.1 cc, respectively, p = 0.11). Time-dependent ROC AUCs for incident HF prediction were 0.797 (95 % CI 0.766–0.828) for AutoChamber LV volume and 0.810 (0.780–0.840) for cardiac MRI LV volume (p = 0.67). Cumulative incidence curves stratified by quartiles showed substantial overlap between AutoChamber and cardiac MRI derived LV volumes, with the highest quartile of each method experiencing 10.7 % and 9.8 % heart failure incidence over 15 years, respectively. (Figure, Panel B). Examples of two asymptomatic individuals who were classified as low risk, with CAC zero and less than five percent 10-year ASCVD risk by the Pooled Cohorts Equation (PCE) but were flagged with high LV volume have been provided (Figure, Panel C).

To our knowledge this is the first report comparing cardiac MRI LV measurements performed by human experts to AI-enabled opportunistic LV volumetry in CAC scans for incident HF prediction over 15 years. In our study AI-measured automated LV volumetry from routine non-contrast CAC scans provided prognostic performance for incident HF equivalent to cardiac MRI. Despite the differences in estimated LV volumes due to differences in the cardiac cycle, the strikingly similar ROC AUC for HF prediction highlights the accuracy of the deep learning model compared to the gold standard (cardiac MRI). Our study demonstrates the feasibility of using an opportunistic AI to extract actionable for HF prediction that takes on average 20 seconds per case as an add-on to a CAC scan versus cardiac MRI which is more expensive and less available. AI-enabled cardiac chambers volumetry in chest CT scans can run in the background of radiology PACS and alert providers to cases with enlarged cardiac chambers and cardiomegaly that put patients at risk of HF, AF, and stroke. Today many high-risk patients are undetected, therefore untreated until it is too late. Early detection of these cases can open a new window of opportunity for intensive treatment of high-risk patients to prevent progression from subclinical to clinically overt HF. Our findings have some limitations-baseline CT scans in MESA Exam 1 (2000–2002) were performed on earlier-generation EBCT and multidetector CT scanners, and cardiac MRI used FGRE pulse sequences no longer standard today. However, these factors would have affected both AutoChamber and cardiac MRI measurements similarly and are unlikely to bias the comparative findings.

In a large, community-based cohort of asymptomatic individuals who were followed for 15 years, AI-enabled opportunistic measurement of LV volume in CAC scans and human measured LV volume in cardiac MRI demonstrated similar performances in predicting incident HF. These results encourage further investigations under the AI-CVD initiative to opportunistically extract all actionable information from CAC and other chest CT scans. Clinical trials are warranted to demonstrate

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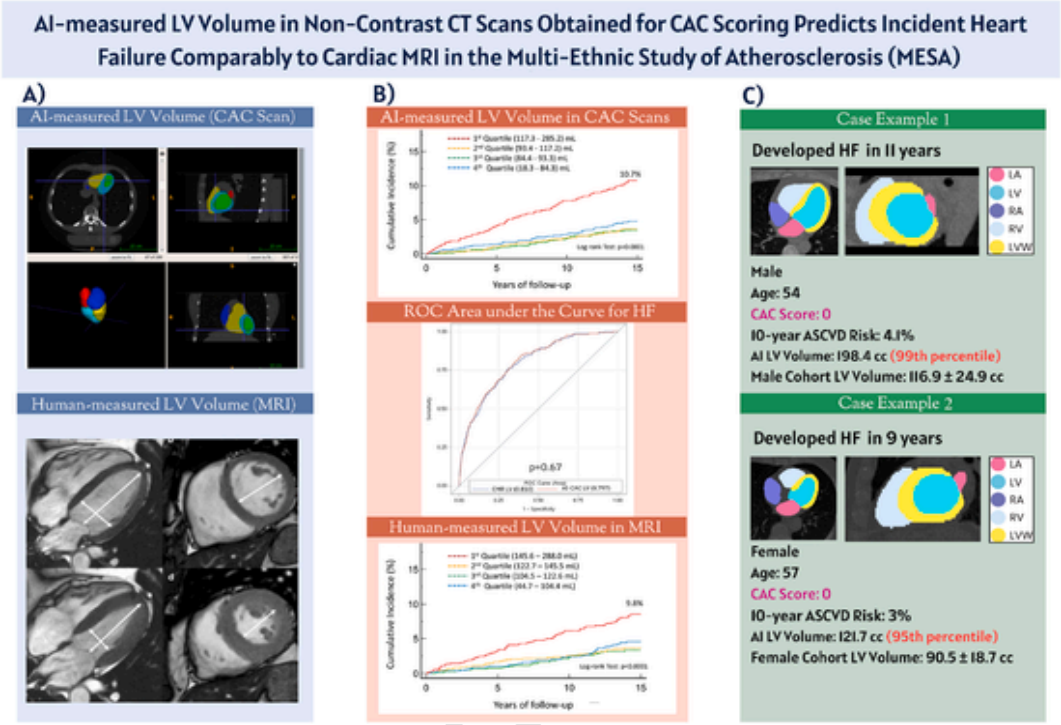


Fig. 1. AI-measured left ventricular (LV) volume from non-contrast coronary artery calcium (CAC) scans predicts incident heart failure comparably to cardiac magnetic resonance imaging (MRI) in MESA.
A) LV volume was measured from non-contrast CAC scans using AutoChamber AI and compared against cardiac MRI LV volume measured by human experts using semi-automated software (bottom). Segmented cardiac chambers include the left atrium (LA), left ventricle , right atrium (RA), right ventricle (RV), and LV wall (LVW).
B) Top: Kaplan–Meier curves showing cumulative incidence of incident heart failure stratified by quartiles of AI-derived LV volume from non-contrast CAC scans (Log-rank p < 0.0001). Middle: Receiver operating characteristic (ROC) curve showing comparable performance of AutoChamber AI LV volume (AUC = 0.797 [95 % CI 0.766–0.828]) vs. cardiac MRI LV volume (AUC = 0.810 [0.780–0.840]), p = 0.67. Bottom: Kaplan–Meier curves showing cumulative incidence stratified by quartiles of MRI-derived LV volume. Log-rank p < 0.0001.
C) Case examples of individuals high LV volumes despite low ASCVD risk and zero CAC score who developed heart failure during follow-up. Top: 54-year-old male with an AI-derived LV volume of 198.4 cc (99th percentile vs sex-specific cohort mean of 116.9 ± 24.9 cc). Bottom: 57-year-old female with an AI-derived LV volume of 121.7 cc (95th percentile vs sex-specific cohort mean of 90.5 ± 18.7 cc).
Abbreviations: ASCVD = atherosclerotic cardiovascular disease; AUC = Area under the Curve; CAC = coronary artery calcium; HF = heart failure; LA = left atrium; LV = left ventricular; LVW = left ventricular wall; MRI = magnetic resonance imaging; RA = right atrium; ROC = receiver operating characteristic; RV = right ventricle.

the positive impact of such opportunistic screening information for CVD risk reduction.

Declaration of competing interest

Several members of the writing group are inventors of the AI tool mentioned in this paper. Dr. Naghavi is the founder of HeartLung.AI. Dr. Reeves, Dr. Atlas, Dr. Yankelevitz, Dr. Wong, and are advisors to HeartLung.AI. Chenyu Zhang is an AI engineer for HeartLung.AI. Kyle Atlas is a data scientist for HeartLung.AI. The remaining authors declare no competing interests.

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References

1. Naghavi M., Reeves A., Atlas K., et al. AI-Enabled cardiac chambers volumetry in CT scans predicts atrial fibrillation and stroke comparably to MRI. *JACC Adv*. 2024;3:101300.
2. Naghavi M., Yankelevitz D., Reeves A.P., et al. AI-enabled left atrial volumetry in coronary artery calcium scans predicts atrial fibrillation as early as one year, improves CHARGE-AF, and outperforms NT-proBNP: the multi-ethnic study of atherosclerosis. *J Cardiovasc Comput Tomogr*. 2024;18(4):383–391. https://doi.org/10.1016/j.jcct.2024.04.005.
3. Naghavi M., Reeves A., Budoff M., et al. AI-enabled cardiac chambers volumetry in coronary artery calcium scans predicts heart failure and outperforms NT-proBNP: the multi-ethnic study of Atherosclerosis. *J Cardiovasc Comput Tomogr*. 2024;18(4):392–400. https://doi.org/10.1016/j.jcct.2024.04.006.
4. Naghavi M., Reeves A.P., Atlas K., et al. Artificial intelligence applied to coronary artery calcium scans (AI-CAC) significantly improves cardiovascular events prediction. *npj Digit Med*. 2024;7(1):309. https://doi.org/10.1038/s41746-024-01308-0.
5. Carr J.J., Nelson J.C., Wong N.D., et al. Calcified coronary artery plaque measurement with cardiac CT in population-based studies: standardized protocol of Multi-Ethnic Study of Atherosclerosis (MESA) and Coronary Artery Risk Development in Young Adults (CARDIA) study. *Radiology*. 2005;234(1):35–43. https://doi.org/10.1148/radiol.2341040439.

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