EDITORIAL COMMENT

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Artificial Intelligence and Coronary Artery Calcium Scoring: Enhancing Cardiovascular Risk Assessment

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Coronary artery disease remains one of the leading causes of illness and death worldwide, this highlights the importance of for effective prevention and treatment. Coronary artery calcium (CAC) scoring, obtained through non-contrast computed tomography, measures the amount of calcified plaques in the coronary arteries. The Agatston score is commonly used to quantify this calcification. Higher CAC scores are strongly associated with a greater likelihood of future cardiovascular events. When combined with traditional risk assessment tools such as the Framingham Risk Score, CAC scoring improves the ability to personalize risk predictions.[1,2] However, traditional methods have limitations, including their static nature and potential biases across different ethnic groups.

Recent technological progress has enabled the use of artificial intelligence (AI) to improve CAC scoring. AI algorithms can analyze complex imaging data along with clinical, genetic, and proteomic information to refine cardiovascular risk estimates. Studies have shown that AI-enhanced models outperform conventional scoring methods, offering higher accuracy in predicting major adverse cardiovascular events (Table 1). For example, a 2024 study by the Global CAC Consortium found that incorporating AI increased the model's discrimination ability, with the area under the curve rising from 0.81 to 0.92. AI systems can also identify microcalcifications that may be missed by traditional techniques; these microcalcific foci calcifications are linked to increased plaque vulnerability and higher risk of adverse outcomes. Importantly, AI maintains consistent accuracy across diverse populations, helping to address disparities in risk assessment.[3,4]

Beyond imaging, AI's capabilities extend to integrating genetic risk scores, proteomic biomarkers, and electronic health records. Polygenic risk scores, which combine multiple genetic

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Table 1: Comparison of traditional and AI-enhanced CAC scoring

Feature	Traditional CAC scoring	AI-enhanced CAC scoring
Data type	CT imaging	CT + Clinical + Genetic + Proteomic data
Analytical method	Static, human interpretation	Dynamic, machine learning algorithms
Scoring method	Agatston score	Deep learning risk algorithms
Predictive accuracy (AUC)	~0.81 (as per text)	~0.92 (as per text)
Microcalcification detection	Limited	Enhanced detection capabilities
Bias across populations	Potential for variability	Demonstrated consistency
Sensitivity in ethnic diversity	Limited	High
Multimodal integration	Primarily imaging-based	Seamless integration with omics and EHR data
Temporal sensitivity	Snapshot in time	Potential for real-time monitoring

AI: Artificial intelligence, CAC: Coronary artery calcium, AUC: Area under the curve, EHR: Electronic health record, CT: Computed tomography

Table 2: Applications and benefits of AI in coronary artery calcium scoring

Application area	Description	Benefits
Automated CAC detection	AI algorithms automatically identify and quantify coronary calcifications	Reduces human error, saves time, ensures reproducibility
Risk reclassification	Reclassifies patients into more accurate risk categories based on integrated data	Improves decision-making, reduces under-/over-treatment
Microcalcification analysis	Detects tiny calcifications often missed by human readers	Enables early detection of high-risk plaque
Personalized risk prediction	Combines imaging, genetic, and clinical data for individualized risk scores	Enhances precision medicine and tailored interventions
Workflow integration	Embeds AI tools in radiology and cardiology software platforms	Improves efficiency, supports point-of-care decisions
Population health management	Assists in identifying high-risk individuals across large datasets	Optimizes screening strategies, reduces healthcare disparities

AI: Artificial intelligence

variants, provide insights into inherited susceptibility to cardiovascular disease. When used alongside CAC data, they can improve prediction accuracy, especially in younger or genetically predisposed individuals.[5] Proteomic markers such as interleukin-6 and GDF-15, associated with inflammation and cardiovascular risk, can also be incorporated into AI-driven models to enhance prognostic precision and guide targeted therapies.[6]

Despite these advances, challenges remain. Ethical issues such as transparency of algorithms, mitigation of biases, and equitable access are critical considerations. It is essential to validate AI tools across diverse populations to prevent the widening of healthcare disparities and to ensure clinical acceptability and user confidence through transparent algorithm design and equitable implementation strategies. Additionally, integrating AI into clinical workflows requires careful planning regarding the timing and frequency of testing, as well as patient selection. Currently, CAC screening is most beneficial for individuals at intermediate risk, but AI's capabilities suggest potential benefits in earlier detection among high-risk groups, such as those with familial hypercholesterolemia, and in reducing unnecessary testing in low-risk populations.

Optimal use of AI-enhanced CAC scoring involves strategic timing typically rescreening every 5 to 7 years for individuals with an initial zero CAC score, and every 3 to 5 years for those with higher scores, unless clinical circumstances change. This approach aims to monitor disease progression effectively while minimizing radiation exposure and healthcare costs. Evidence indicates that AI-based risk assessments can improve clinical decision-making, leading to more personalized interventions such as targeted statin therapy and lifestyle modifications. For instance, AI-generated risk scores have been shown to motivate patients to adhere to healthier behaviors, thereby improving health outcomes beyond traditional risk assessments.[7-9]

Looking ahead, integrating AI-driven CAC scoring with data from wearable devices and real-time biometric monitoring could enable continuous risk assessment and early intervention. Large-scale, longitudinal studies are necessary to validate these approaches and determine their impact on clinical outcomes (Table 2). As AI tools become more embedded in clinical guidelines, their role in reducing healthcare disparities, optimizing preventive strategies, and personalizing patient care will likely expand-provided that ethical and logistical challenges are adequately addressed.[10]

In summary, combining AI with CAC scoring represents a significant advancement in cardiovascular risk assessment. This integration moves beyond traditional static models, offering more accurate, equitable, and personalized approaches to prevention. To realize this potential, rigorous validation, transparent algorithms, and efforts to ensure equal access are essential. As these technologies develop, they hold the promise to enable clinicians to identify at-risk individuals earlier and more precisely, ultimately improving cardiovascular health outcomes worldwide.

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