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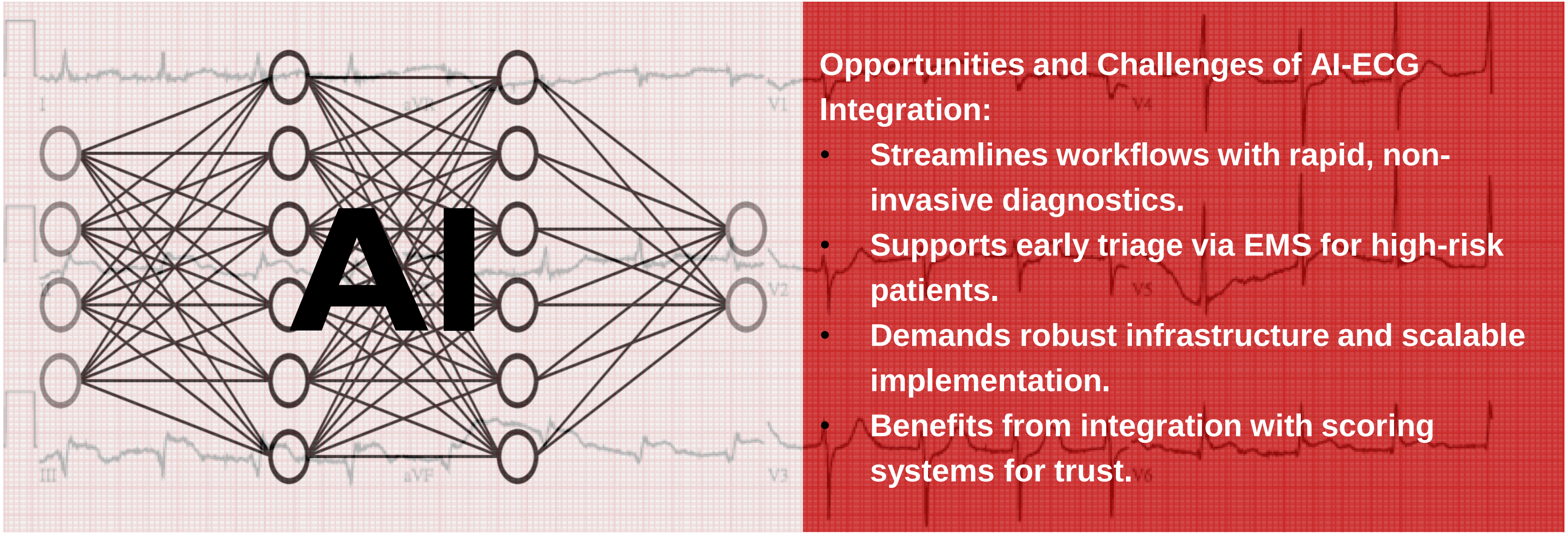
Graphical Abstract



Editorial:

Transforming AMI Diagnosis with AI-ECG Technology

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Accurate and timely interpretation of electrocardiograms (ECGs) is a cornerstone of acute myocardial infarction (AMI) management, enabling early risk stratification and treatment. However, this process remains fraught with challenges. While distinct ECG changes typically characterize ST-segment elevation myocardial infarction (STEMI), interpretation inconsistencies persist even among experts[1]. Non-ST-segment elevation myocardial infarction (NSTEMI) often presents an even greater diagnostic hurdle due to subtle and often ambiguous ECG findings, necessitating additional clinical and laboratory data to augment diagnosis of acute chest pain[2]. These complexities underline the need for innovative tools to enhance diagnostic accuracy and streamline care.

Artificial intelligence (AI)-enabled ECG interpretation offers a promising solution to these challenges. Recent advances in deep learning (DL) have allowed algorithms to extract intricate patterns from raw ECG data that might elude human recognition. Studies have shown that AI-enabled ECG can be used to detect heart failure, hyperkalemia, and anemia, as well as to occult atrial fibrillation and potential future cardiac arrest[3–8]. Despite this promise, real-world evidence supporting the clinical utility of AI-ECG algorithms is still sparse. This gap underscores the importance of rigorous validation studies to assess their performance and applicability.

Summary and strength of the ROMIAE study

The ROMIAE study, featured in this issue, provides evidence by evaluating a AI-ECG algorithm designed to diagnose AMI, including both STEMI and NSTEMI(cite the paper). Built on a residual neural network and trained on 33,000 12-lead ECG waveforrms from multiple hospitals, the algorithm achieved exceptional diagnostic accuracy, with an area under the receiver operating characteristic curve (AUROC) of 0.951 for STEMI and 0.901 for AMI overall. These results demonstrate the algorithm’s technical sophistication and its potential to assist clinicians in making timely, objective diagnoses. Conducted across 18 hospitals in South Korea, this prospective, multicenter study provides critical insights into the real-world performance of AI algorithms. By focusing on emergency departments (EDs), where rapid and accurate risk stratification is essential, the study captures the practical utility of AI-ECG in high-stakes, time-sensitive settings. Its inclusion of adult patients presenting with chest pain—excluding traumatic cases—ensures a clinically relevant cohort reflective of typical ED presentations.

A notable strength of the study is its substantial sample size of 8,493 participants, which enhances the statistical reliability and generalizability of the findings. By incorporating data from multiple hospitals, the study ensures diversity in clinical practice and patient populations, stand the external validity of the results. The study demonstrates the model's consistent diagnostic accuracy, achieving an AUROC of 0.88 in the prospective phase, comparable to its performance of 0.91 in retrospective validation. This consistency underscores the model's reliability across different testing conditions. The study also breaks new ground by exploring the integration of AI-ECG with the HEART score, a widely used clinical risk stratification tool for AMI. This combination achieved a 19.6% net reclassification improvement, highlighting the potential of AI to augment traditional diagnostic frameworks. The enhanced performance demonstrates the synergy between AI-driven insights and established clinical models, offering a pathway to more precise risk stratification.

Challenge of integrating AI into clinical practice

The integration of AI into cardiovascular diagnostics brings both immense opportunities and inherent challenges that transcend individual clinical studies (graphic abstract). AI-ECG models, such as the one highlighted in the ROMIAE study, underscore the transformative potential of these technologies while pointing to broader considerations for their adoption and optimization in real-world clinical settings. A key challenge in adopting new technologies like AI is the integration of AI tools into existing hospital systems. While AI-ECG offers complementary information to clinical presentation and biomarkers like troponin, its implementation relies on robust technological infrastructure. This challenge reflects a broader issue of deploying innovative technologies across diverse healthcare environments, particularly in resource-limited settings. Addressing these logistical barriers, including strategies like cloud-based solutions and scalable deployment frameworks, will be crucial for ensuring equitable access to AI-ECG capabilities globally. AI-ECG's ability to surpass current diagnostic benchmarks is often a key driver for motivating infrastructure innovation in adopting such technologies. However, its performance, which was not superior to traditional indices like the HEART score in this study, warrants consideration and underscores the need for continued refinement of AI algorithms. Improvements in model architecture and the use of more diverse training data could help bridge this diagnostic gap, enabling AI-ECG to better address the complexities of clinical practice.

AI offers a significant opportunity to optimize clinical workflows by providing rapid, non-invasive diagnostic insights. For example, a recent randomized trial demonstrated that an AI-guided workflow reduced the time required for both sonographers and cardiologists to measure left ventricular function in echocardiograms[9]. Similarly, a prior study on AI-ECG technology designed to identify STEMI showed that its use in emergency departments reduced door-to-balloon time, a critical metric in managing acute myocardial infarction[10]. However, the broader implications of these workflow optimizations require careful consideration. Questions remain about whether these efficiencies translate to improved patient outcomes, how they affect overall utilization of medical resources, and whether they might inadvertently introduce additional healthcare costs. In the case of NSTEMI, AI-ECG can help expedite diagnosis by reducing reliance on laboratory tests, potentially shortening the time to clinical intervention. However, recent meta-analyses suggest that early catheterization in NSTEMI patients does not consistently result in improved mortality or morbidity[12]. While these advancements align with the current push to streamline care, further research is essential to fully understand their impact on patient outcomes, healthcare resource allocation, and cost-effectiveness.

Future Directions and Conclusion

The ROMIAE study highlights AI-ECG as a promising innovation for managing AMI, but its full potential in clinical practice requires further evaluation and investigation. Future research should prioritize the integration of AI-ECG into clinical workflows to enhance efficiency and patient outcomes. Randomized controlled trials are essential to evaluate the real-world impact of these advancements on patient outcomes and healthcare efficiency. Beyond the ED, the role of AI-ECG in prehospital care offers exciting possibilities as its integration into emergency medical services systems could allow for early identification and rapid transport of high-risk patients to specialized centers, potentially improving outcomes for AMI cases as well as optimize resource utilization.

Further refinement of AI-ECG algorithms is critical to addressing diagnostic challenges. Integrating AI-ECG with existing clinical scoring systems, such as the HEART score, could enhance its acceptance among clinicians by improving interpretability and trust. This approach leverages the strengths of AI while aligning it with established decision-making frameworks, ensuring a smoother integration into clinical workflows. AI-ECG has the potential to transform cardiovascular diagnostics and care by improving workflows and enabling timely, effective interventions. However, successful implementation requires addressing key challenges, such as infrastructure demands, clinician training, and equitable access. By focusing on these areas and generating robust evidence to support its utility, AI-ECG can evolve into a transformative tool that not only enhances diagnostic precision but also advances precision medicine and equitable healthcare delivery.

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Nothing to declare