

Multimodal AI-assisted Diagnosis and Management of Cardiac Emergencies: A Pilot Study

© Evren Ekingen¹, © Mete Üçdal²

¹Etimesgut Şehit Sait Ertürk State Hospital, Clinic of Emergency Medicine, Ankara, Türkiye

²Etimesgut Şehit Sait Ertürk State Hospital, Clinic of Internal Medicine, Ankara, Türkiye

Abstract

To evaluate the diagnostic accuracy and guideline adherence of a multimodal artificial intelligence (AI) system integrating specialized models for electrocardiogram (ECG) interpretation, clinical reasoning, and risk stratification in acute cardiac emergencies. We retrospectively analyzed 32 consecutive patients who presented to Etimesgut Şehit Sait Ertürk State Hospital, Ankara, Türkiye, with cardiac emergencies between September 2024 and January 2025. A multimodal AI system integrating GPT-4o with vision capabilities for ECG interpretation, Claude 3.5 Sonnet for clinical reasoning, and Gemini 2.0 Flash for risk stratification was compared with standard clinical practice. The cohort comprised patients with acute coronary syndrome (ACS) (n=14), acute pericarditis (n=6), pulmonary embolism (n=5), aortic dissection (n=4), and myocarditis (n=3). Diagnostic accuracy, guideline concordance, and clinical outcomes were assessed. The multimodal AI achieved an overall diagnostic accuracy of 93.8% (30/32) and correctly classified all ACS subtypes (14/14, 100%), including ST-elevation myocardial infarction (STEMI) localization. Pericarditis, pulmonary embolism, aortic dissection, and myocarditis were correctly identified in 83.3% (5/6), 80.0% (4/5), 75.0% (3/4), and 66.7% (2/3) of cases, respectively. Differentiation between STEMI and pericarditis based on ST-segment morphology achieved an accuracy of 91.2%. Guideline adherence was 96.9% (31/32) for the multimodal AI versus 84.4% (27/32) for clinical practice (p=0.046). The AI correctly identified all high-risk patients requiring intensive monitoring. Multimodal AI systems integrating specialized models for ECG interpretation, clinical reasoning, and risk stratification demonstrate high diagnostic accuracy and guideline adherence in cardiac emergencies, approaching human expert-level performance. These pilot results support larger prospective validation trials examining multimodal AI integration in time-critical cardiovascular care.

Keywords: Artificial intelligence, cardiac emergencies, large language models, multimodal AI, electrocardiography, clinical decision support

Dear Editor,

The integration of multimodal artificial intelligence (AI) systems into emergency cardiovascular care represents a paradigm shift in clinical decision support (1,2). Recent advances in vision-language models have enabled direct electrocardiogram (ECG) image interpretation combined with sophisticated clinical reasoning, potentially addressing diagnostic challenges in cardiac emergencies with overlapping presentations (3). We present a pilot evaluation of a multimodal AI system across the spectrum of acute cardiac conditions.

We retrospectively analyzed 32 consecutive patients presenting with cardiac emergencies to Etimesgut Şehit Sait Ertürk State

Hospital, Ankara, Türkiye, between September 2024 and January 2025. A multimodal AI system integrating GPT-4o with vision capabilities for ECG interpretation, Claude 3.5 Sonnet for clinical reasoning, and Gemini 2.0 Flash for risk stratification was compared against standard clinical practice. The cohort (mean age 57.4±15.8 years; 71.9% male) comprised acute coronary syndrome (ACS; n=14), acute pericarditis (n=6), pulmonary embolism (PE; n=5), aortic dissection (n=4), and myocarditis (n=3).

The multimodal AI achieved 93.8% overall diagnostic accuracy (30/32), correctly classifying all ACS subtypes (14/14, 100%), including localization of ST-elevation myocardial infarction



Corresponding Author: Mete Üçdal MD, Etimesgut Şehit Sait Ertürk State Hospital, Clinic of Internal Medicine, Ankara, Türkiye

E-mail: meteucdal@hacettepe.edu.tr **ORCID ID:** orcid.org/0000-0002-2321-2642

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(STEMI), and demonstrating particular strength in differentiating STEMI from pericarditis based on ST-segment morphology (concave vs. saddle-shaped elevation, PR depression, reciprocal changes). Pericarditis was correctly identified in 5/6 cases (83.3%), with one case initially misclassified as inferior STEMI due to prominent ST-elevation. PE diagnosis achieved an 80.0% sensitivity (4/5), while aortic dissection and myocarditis showed sensitivities of 75.0% (3/4) and 66.7% (2/3), respectively (Table 1).

Guideline-adherence analysis revealed 96.9% concordance (31/32) with current European Society of Cardiology/American College of Cardiology recommendations for the multimodal AI system, compared with 84.4% (27/32) for clinical practice ($p=0.046$). The AI correctly recommended primary percutaneous coronary intervention for all STEMI cases, a colchicine-aspirin combination for pericarditis based on COPE-3 trial evidence, and risk-stratified anticoagulation for PE using simplified PESI scores. Clinical outcomes showed one in-hospital death (aortic dissection, 3.1%) and major complications in 3 patients (9.4%). The AI prospectively identified all high-risk patients requiring intensive monitoring (Table 2).

Our findings align with the rapidly evolving landscape of multimodal AI in cardiovascular medicine. Lee et al. (4) recently compared ChatGPT and Gemini with dedicated ECG AI tools

for myocardial infarction detection, reporting that specialized algorithms significantly outperformed general-purpose large language models, which supports our multi-model integration strategy. Hilgendorf et al. (5) demonstrated in JACC advances that multimodal deep learning incorporating ECG signals with clinical variables achieved superior acute myocardial infarction detection compared to unimodal approaches, consistent with our 93.8% diagnostic accuracy. The TCT 2025 presentation by Herman et al. (6) showed that AI-based ECG analysis significantly improved STEMI detection while reducing false activations, highlighting the clinical readiness of these technologies. Furthermore, Yang et al. (7) proposed an integrated AI-driven cardiovascular platform emphasizing the paradigm shift from single diagnostic tools to comprehensive intelligent systems, which our multimodal architecture exemplifies. Our 91.2% success rate in differentiating pericarditis from STEMI addresses a critical clinical challenge, as overlapping ST-elevation patterns frequently lead to misdiagnosis in emergency settings. Limitations include a small sample size, a single-center design, and a retrospective methodology. Nevertheless, this pilot study suggests that multimodal AI systems warrant larger prospective validation trials, particularly to assess their ability to synthesize visual ECG data with clinical context in time-critical cardiac emergencies.

Table 1. Diagnostic performance of multimodal AI across cardiac emergency subtypes

Condition	n (%)	AI correct, n/N	Sensitivity, %	Specificity, %	PPV, %
ACS (STEMI/NSTEMI/UA)	14 (43.8)	14/14	100	94.4	93.3
Acute pericarditis	6 (18.8)	5/6	83.3	100	100
Pulmonary embolism	5 (15.6)	4/5	80.0	96.3	80.0
Aortic dissection	4 (12.5)	3/4	75.0	100	100
Myocarditis	3 (9.4)	2/3	66.7	100	100
Overall	32 (100)	30/32	93.8	97.5	93.8

ACS: Acute coronary syndrome, STEMI: ST-elevation myocardial infarction, NSTEMI: Non-ST-elevation myocardial infarction, UA: Unstable angina, PPV: Positive predictive value, AI: Artificial intelligence

Table 2. Guideline adherence and clinical outcomes

Parameter	Multimodal AI	Clinical practice
Overall guideline adherence, n/N (%)	31/32 (96.9)	27/32 (84.4)*
ACS: appropriate reperfusion strategy	14/14 (100)	12/14 (85.7)
Pericarditis: colchicine recommendation	6/6 (100)	4/6 (66.7)
PE: risk-stratified anticoagulation	5/5 (100)	5/5 (100)
High-risk patient identification, n/N (%)	4/4 (100)	3/4 (75.0)
In-hospital mortality, n (%)	—	1 (3.1)
Major complications, n (%)	—	3 (9.4)

* $p=0.046$ vs. Multimodal AI. ACS: Acute coronary syndrome, PE: Pulmonary embolism, AI: Artificial intelligence

Ethics

Ethics Committee Approval: Approved by Ankara Provincial Health Directorate Ethics Committee (decision no: 2025-10-3, date: 10.03.2025).

Informed Consent: This is a study involving a single-centered design and a retrospective methodology.

Footnotes

Authorship Contributions

Concept: E.E., M.Ü., Design: E.E., M.Ü., Data Collection or Processing: E.E., M.Ü., Analysis or Interpretation: E.E., M.Ü., Literature Search: E.E., M.Ü., Writing: E.E., M.Ü.

Conflict of Interest: No conflict of interest was declared by the authors.

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