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INPLASY

Artificial Intelligence-based Electrocardiogram Diagnosis and Disease Prediction: A Systematic Review and Meta analysis

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Cheng, YL

Corresponding author:
Yonggang Cheng

chengyonglang666@163.com

Author Affiliation:
West China Hospital, Sichuan University.

ADMINISTRATIVE INFORMATION

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Review stage at the time of initial registration - Data analysis.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY2026110026

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 8 November 2026 and was last updated on 8 November 2026.

INTRODUCTION

Review question / Objective In this scoping review, we aim to systematically assess the performance of AI-ECG across diverse diagnostic and predictive tasks. This involves assessing the various AI-ECG models used; diseases, conditions, and populations studied; types of AI approaches considered; the different scenarios, and geographic representation of global countries to help guide future applications. Additionally, we identify shortcomings of current applications and future opportunities for health applications, research priorities, and policy innovations in AI-ECG. Our findings would help decisionmakers and researchers recognize the opportunities and possibilities for using these digital tools for equitable access to quality health care and address challenges that impede their use.

Rationale We reported this protocol using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA) 2020 checklist.

Condition being studied Artificial intelligence-enabled electrocardiography (AI-ECG) is proposed as a scalable digital biomarker, yet evidence across diagnostic and prognostic tasks has not been mapped. In this scoping review, we used Joanna Briggs Institute methodology and PRISMA-ScR reporting, searching PubMed, Web of Science and the Cochrane Library from inception to March 2026. We included 119 studies reporting 428 AI-ECG models and pooled discrimination for 50 clinical outcomes. Pooled AUCs averaged 0.84 (range 0.64–0.98), highest for hypertrophic cardiomyopathy (0.98) and sustained ventricular tachycardia (0.95), and reached 0.89 for cardiac amyloidosis and 0.85 for heart failure. Diagnostic models slightly outperformed prognostic models

(0.839 vs 0.818), and pooled performance rose with sample size (0.789 to 0.847), suggesting small-study overestimation. Applications span pre-hospital triage, in-hospital diagnosis, outpatient and community screening, and long-term risk prediction, extending to non-cardiovascular conditions. Evidence remains largely retrospective and heterogeneous; prospective validation with hard outcomes, interpretability, fairness and workflow integration are priorities.

METHODS

Search strategy Databases searched: PubMed, Web of Science (All Databases), and the Cochrane Library. Last search date: March 29, 2026. Searches were restricted to human studies; the Preprint Citation Index was excluded in Web of Science.

1. PubMed (via NCBI; search date: March 29, 2026)

#1 Artificial Intelligence[MeSH Terms] OR Artificial Intelligence[Title/Abstract] OR Intelligence, Artificial[Title/Abstract] OR Computer Reasoning[Title/Abstract] OR Reasoning, Computer[Title/Abstract] OR AI (Artificial Intelligence)[Title/Abstract] OR Machine Intelligence[Title/Abstract] OR Intelligence, Machine[Title/Abstract] OR Computational Intelligence[Title/Abstract] OR Intelligence, Computational[Title/Abstract] OR Computer Vision Systems[Title/Abstract] OR Computer Vision System[Title/Abstract] OR System, Computer Vision[Title/Abstract] OR Systems, Computer Vision[Title/Abstract] OR Vision System, Computer[Title/Abstract] OR Vision Systems, Computer[Title/Abstract] OR Knowledge Acquisition (Computer)[Title/Abstract] OR Acquisition, Knowledge (Computer)[Title/Abstract] OR Knowledge Representation (Computer)[Title/Abstract] OR Knowledge Representations (Computer)[Title/Abstract] OR Representation, Knowledge (Computer)[Title/Abstract] (n = 293,752)

#2 Machine Learning[MeSH Terms] OR Machine Learning[Title/Abstract] OR Learning, Machine[Title/Abstract] OR Transfer Learning[Title/Abstract] OR Learning, Transfer[Title/Abstract] (n = 178,186)

#3 Neural Networks, Computer[MeSH Terms] OR Neural Networks, Computer[Title/Abstract] OR Computer Neural Network[Title/Abstract] OR Computer Neural Networks[Title/Abstract] OR Network, Computer Neural[Title/Abstract] OR Networks, Computer Neural[Title/Abstract] OR Neural Network, Computer[Title/Abstract] OR Models, Neural Network[Title/Abstract] OR Model, Neural Network[Title/Abstract] OR Network Model, Neural[Title/Abstract] OR Network Models, Neural[Title/Abstract] OR Neural Network Model[Title/Abstract] OR Neural Network Models[Title/Abstract] OR Connectionist Models[Title/Abstract] OR Connectionist Model[Title/Abstract] OR Model, Connectionist[Title/Abstract] OR Models, Connectionist[Title/Abstract] OR Perceptrons[Title/Abstract] OR Perceptron[Title/Abstract] OR Computational Neural Networks[Title/Abstract] OR Computational Neural Network[Title/Abstract] OR Network, Computational Neural[Title/Abstract] OR Networks, Computational Neural[Title/Abstract] OR Neural Network, Computational[Title/Abstract] OR Neural Networks, Computational[Title/Abstract] OR Neural Networks (Computer)[Title/Abstract] OR Network, Neural (Computer)[Title/Abstract] OR Networks, Neural (Computer)[Title/Abstract] OR Neural Network (Computer)[Title/Abstract] (n = 98,978)

#4 #1 OR #2 OR #3 (n = 383,001)

#5 Electrocardiography[MeSH Terms] OR Electrocardiography[Title/Abstract] OR ECG[Title/Abstract] OR EKG[Title/Abstract] OR Cardiography[Title/Abstract] OR Cardiographies[Title/Abstract] OR Electrocardiogram[Title/Abstract] OR Electrocardiograms[Title/Abstract] OR Electrocardiograph[Title/Abstract] OR Electrocardiographs[Title/Abstract] OR 12-Lead ECG[Title/Abstract] OR 12 Lead ECG[Title/Abstract] OR 12-Lead ECGs[Title/Abstract] OR ECG, 12-Lead[Title/Abstract] OR 12-Lead EKG[Title/Abstract] OR 12 Lead EKG[Title/Abstract] OR 12-Lead EKGs[Title/Abstract] OR EKG, 12-Lead[Title/Abstract] OR 12-Lead Electrocardiography[Title/Abstract] OR 12-Lead Electrocardiographies[Title/Abstract] OR 12 Lead Electrocardiography[Title/Abstract] OR Electrocardiographies, 12-Lead[Title/Abstract] OR Electrocardiography, 12-Lead[Title/Abstract] (n = 280,374)

#6 #4 AND #5 (n = 4,769)

#7 Diagnosis[MeSH Terms] OR Diagnosis[Title/Abstract] OR Diagnoses[Title/Abstract] OR Diagnose[Title/Abstract] OR Diagnoses Examinations[Title/Abstract] OR Examination Diagnoses[Title/Abstract] OR Antemortem Diagnosis[Title/Abstract] OR Antemortem Diagnoses[Title/Abstract] OR Diagnoses, Antemortem[Title/Abstract] OR Diagnosis, Antemortem[Title/Abstract] OR Postmortem Diagnosis[Title/Abstract] OR Diagnoses, Postmortem[Title/Abstract] OR Diagnosis, Postmortem[Title/Abstract] OR Postmortem Diagnoses[Title/Abstract] (n = 12,049,147)

#8 Prognosis[MeSH Terms] OR Prognosis[Title/Abstract] OR Prognoses[Title/Abstract] OR

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Prognostic Factors[Title/Abstract] OR Prognostic Factor[Title/Abstract] OR Factor, Prognostic[Title/Abstract] OR Factors, Prognostic[Title/Abstract] (n = 2,403,480)
#9 #7 OR #8 (n = 12,241,132)
#10 #6 AND #9 (n = 4,061)
#11 #6 AND #9, filtered by publication type: Adaptive Clinical Trial, Clinical Study, Clinical Trial (Phase I-IV), Observational Study, Randomized Controlled Trial (n = 163)
2. Web of Science (All Databases; search date: March 29, 2026)
#1 TS=("Artificial Intelligence" OR "Deep Learning" OR "Machine Learning" OR "Feature Extraction" OR "Reinforcement Learning" OR "Task Analysis" OR "Transfer Learning" OR "Convolutional Neural Network" OR "Convolutional Neural Networks" OR "Neural Networks") (n = 3,164,117)
#2 TS=(Electrocardiography OR ECG OR Electrocardiogram OR Arrhythmia OR "Atrial Fibrillation" OR "Electrocardiogram ECG" OR "Brugada Syndrome") (n = 701,188)
#3 #1 AND #2 (n = 25,164)
#4 TS=(Diagnosis OR "Early Diagnosis" OR Clinical OR Diagnostic OR "Diagnosis Design Evaluation") (n = 20,642,520)
#5 TS=(Prediction OR "Outcome Prediction" OR "Prediction Model" OR "Risk Prediction" OR "Behavior Prediction" OR "Predictive Models") (n = 2,993,492)
#6 #4 OR #5 (n = 23,143,072)
#7 #3 AND #6 (n = 16,760)
#8 TS=("Observational Study" OR "Observational Studies" OR "Longitudinal Observational Study") (n = 460,761)
#9 #7 AND #8 (n = 300)
3. Cochrane Library (CENTRAL; search date: March 29, 2026)
#1 MeSH descriptor: [Artificial Intelligence] this term only (n = 720)
#2 Knowledge Acquisition (Computer) OR Acquisition, Knowledge (Computer) OR Systems, Computer Vision OR Computer Vision Systems OR Vision System, Computer OR Vision Systems, Computer OR Computer Vision System OR System, Computer Vision OR Intelligence, Machine OR Computational Intelligence OR Reasoning, Computer OR AI (Artificial Intelligence) OR Intelligence, Computational OR Intelligence, Artificial OR Machine Intelligence OR Computer Reasoning OR Knowledge Representation (Computer) OR Representation, Knowledge (Computer) OR Knowledge Representations (Computer) (n = 4,626)
#3 #1 OR #2 (n = 4,626)
#4 MeSH descriptor: [Machine Learning] this term only (n = 670)
#5 Learning, Machine OR Transfer Learning OR Learning, Transfer (n = 5,440)
#6 #4 OR #5 (n = 5,440)
#7 MeSH descriptor: [Deep Learning] this term only (n = 355)
#8 Learning, Deep OR Learning, Hierarchical OR Hierarchical Learning (n = 2,259)
#9 #7 OR #8 (n = 2,259)
#10 MeSH descriptor: [Neural Networks, Computer] this term only (n = 357)
#11 Connectionist Model OR Computer Neural Networks OR Neural Network Model OR Connectionist Models OR Neural Network, Computer OR Networks, Computer Neural OR Neural Network (Computer) OR Neural Network Models OR Models, Connectionist OR Neural Network, Computational OR Perceptrons OR Networks, Computational Neural OR Network, Computational Neural OR Networks, Neural (Computer) OR Network, Computer Neural OR Model, Connectionist OR Neural Networks, Computational OR Computer Neural Network OR Neural Networks (Computer) OR Network Models, Neural OR Computational Neural Networks OR Network, Neural (Computer) OR Model, Neural Network OR Computational Neural Network OR Models, Neural Network OR Network Model, Neural OR Perceptron (n = 1,866)
#12 #10 OR #11 (n = 1,866)
#13 #3 OR #6 OR #9 OR #12 (n = 11,833)
#14 MeSH descriptor: [Electrocardiography] this term only (n = 9,427)
#15 Electrocardiograms OR ECG (n = 20,641)
#16 #14 OR #15 (n = 27,424)
#17 #13 AND #16 (n = 241)
Note: n values are the number of records retrieved at each step as recorded on the search date. Records from the three databases were exported and deduplicated in reference management software before screening.

Participant or population Not applicable.

Intervention Not applicable.

Comparator Not applicable.

Study designs to be included The method of identifying relevant studies will include two stages of screening. First, two reviewers will independently analyze the titles and abstracts using eligibility criteria. If a consensus cannot be achieved, the two reviewers will discuss their differences and consult with a third member of the study team. During the full-text review stage, two reviewers will independently assess the papers to see if they meet the inclusion criteria: Studies on human; AI-enhanced ECG as a diagnostic or

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predictive indicator; Construct diagnostic or prognostic models based on algorithms such as Machine.

Eligibility criteria Not applicable.

Information sources PubMed、Web of Science、Cochrane library.

Main outcome(s) This study followed the PRISMA guidelines for literature retrieval and screening. A systematic search was conducted across three databases, including PubMed (n=163), Web of Science (n=300), and Cochrane Library (n=241). Ultimately, 109 studies were included in the qualitative synthesis, of which 83 studies providing complete effect size data were further included in the quantitative meta-analysis.

Data management Use Excel to record the data and conduct data analysis using Stata.

Quality assessment / Risk of bias analysis The quality of included studies was assessed using appropriate checklists based on study design. For diagnostic accuracy studies, the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) tool was employed to evaluate risk of bias across four domains: patient selection, index test, reference standard, and flow and timing. For prognostic studies, the Quality in Prognosis Studies (QUIPS) tool was utilized. Risk of bias was categorized as low, unclear, or high for each domain.

Strategy of data synthesis Since most of the included diagnostic or prediction model studies only reported the C-statistic (i.e., AUC) and total sample size (N) without providing standard errors or raw contingency table data, we employed the Hanley-McNeil method to estimate standard errors for meta-analysis. This method assumes an equal distribution between case and control groups (1:1 ratio), with standard errors calculated using the following formula, where Pooled effect estimates were obtained using a random-effects model (DerSimonian-Laird method) to account for clinical and methodological heterogeneity across studies. All analyses were conducted using Stata 15.0, with results reported as pooled AUC and corresponding 95% confidence intervals. Heterogeneity was quantified using the I2 statistic, with values less than 25% considered low, 25-50% moderate, and greater than 50% high heterogeneity. Publication bias was assessed using Egger's test and visual inspection of funnel plots. Sensitivity analyses were performed to examine the robustness of our findings, including exclusion of small studies, subgroup analyses by outcome type, and comparison of fixed-effect versus random-effects models.

Subgroup analysis Not applicable.

Sensitivity analysis Not applicable.

Language restriction No language restrictions.

Country(ies) involved China.

Keywords electrocardiography; artificial intelligence; disease diagnosis; risk prediction.

Dissemination plans Publicly published achievements.

Contributions of each author

Author 1 - Yonggang Cheng - Manuscript writing.
Email: chengyonglang666@163.com

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