May 2nd, 12:00 AM

Unveiling the Potential: The Role of AI-Enhanced ECG in Cardiovascular Disease Detection

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BACKGROUND

- Electrocardiogram (ECG) is a ubiquitous, cost-effective, non-invasive cardiac test
- Artificial Intelligence (AI) can transform ECG into a screening tool and predictor of cardiac and non-cardiac diseases, often in asymptomatic individuals [1-5]
- AI's application to standard ECG enables it to diagnose conditions not previously identified by ECG or to do so with greater performance than previously possible [1-5]

OBJECTIVE

This review aims to provide a comprehensive exploration of the utility of AI-powered ECG as a screening tool for early detection of a range of cardiovascular diseases such as low ejection fraction (LEF), atrial fibrillation (AF), aortic valve stenosis (AVS), and cardiac amyloidosis (CA)

METHODS

- **Study Selection**
  - Inclusion/Exclusion criteria: 2018 – 2024, English, full text articles
  - Article types: Randomized control trials, clinical trials
- **Study Strategy**

KEY WORDS	DATABASE	YEARS	DATE ACCESSED	# OF RESULTS
"AI and EKG"	Pubmed	2018-2024	12/19/2023	494
"Artificial Intelligence EKG, Low Ejection Fraction"	Pubmed	2018-2024	12/19/2023	4
	Cochrane library	2018 - 2024	12/19/2023	0
	Web of Science	2018 - 2024	12/19/2023	0
"Artificial Intelligence EKG, Atrial Fibrillation"	Pubmed	2018-2024	12/19/2023	6
	Cochrane library	2018 - 2024	12/19/2023	0
	Web of Science	2018 - 2024	12/19/2023	3
"Artificial Intelligence EKG, Aortic valve stenosis"	Pubmed	2018-2024	12/19/2023	21
	Cochrane library	2018 - 2024	12/19/2023	0
	Web of Science	2018 - 2024	12/19/2023	0
"Artifical Intelligence EKG, Cardiac Amyloidosis"	Pubmed	2018-2024	12/19/2023	6
	Cochrane library	2018 - 2024	12/19/2023	0
	Web of Science	2018 - 2024	12/19/2023	0

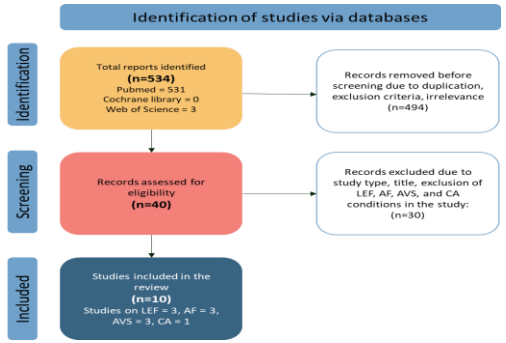

Fig 1: A PRISMA-based flow chart depicts the logic to choosing articles included in this report

RESULTS

Fig 2: Neural Networks

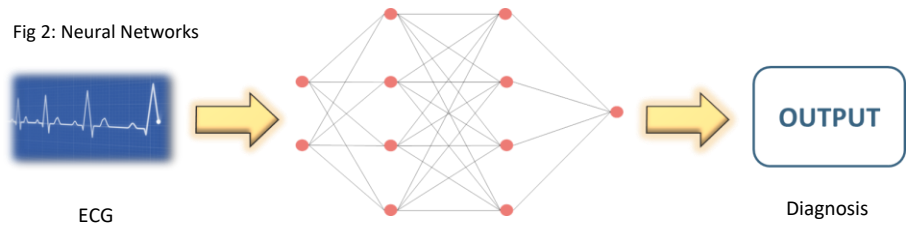

Table 1: Data Analyses

	Author/Group	Cardiac Disease	Sample size	Odds Ratio/Positive Predictive Value	AUC	Specificity	Sensitivity
1.	Yao X, Rushlow DR, Inselman JW, et al. [6]	LEF	22641	Odds ratio: 1.32	-	-	-
2.	Rushlow DR, Croghan IT, Inselman JW, et al. [7]	LEF	11573	Odds ratio: 1.62	-	-	-
3.	Sun JY, Qiu Y, Guo HC, et al. [8]	LEF	26786	-	-	70.50%	69.20%
4.	Noseworthy PA, Attia ZI, Behnken EM, et al. [9]	AF	1003	Odds ratio: 4.98	-	-	-
5.	Fu W, Li R. [10]	AF	114	-	-	100%	88.68%
6.	Gruwez H, Barthels M, Haemers P, et al. [11]	AF	142310	-	0.87	-	-
7.	Cohen-Shelly M, Attia ZI, Friedman PA, et al. [12]	AVS	258607	-	0.87	74%	78%
8.	Elias P, Poterucha TJ, Rajaram V, et al. [13]	AVS	77163	-	0.88	73%	78%
9.	Kwon JM, Lee SY, Jeon KH, et al. [14]	AVS	39371	-	0.88	-	-
10.	Grogan M, Lopez-Jimenez F, Cohen-Shelly M, et al. [15]	CA	2541	Positive predictive value: 0.86	0.91	-	-

LOW EJECTION FRACTION
- AI-powered ECG increases LEF diagnosis overall and in high likelihood cases [6]
- Clinicians following AI recommendation are twice as likely to diagnose LEF [7]

ATRIAL FIBRILLATION
- AI-guided screening increased AF detection compared to usual care over median 9.9 months [9]
- AI-enhanced ECG identified paroxysmal AF during normal sinus rhythm with 78.1% accuracy [10]
- Wearable AI-powered ECG recorder detects AF efficiently in various postures and after exercises [10]

AORTIC VALVE STENOSIS
- False positive AI-ECG doubles risk of moderate/severe AS over 15 years [12]
- Deep learning algorithm achieved high accuracy in detecting significant AS using 12/single-lead ECG [14]
- Deep learning accurately detects aortic stenosis, aortic regurgitation, and mitral valve regurgitation [13]

CARDIAC AMYLOIDOSIS
- The AI model successfully predicted the presence of CA more than 6 months before the clinical diagnosis in 56% of cases [15]

DISCUSSION

- **Validation in practice**
  - ✓ Success relies on clinical adoption of AI-generated recommendations
  - ✓ Comprehensive testing and seamless integration into clinical workflows are crucial
- **Data sharing and privacy**
  - ✓ Sharing data among institutions is essential for algorithmic validation
  - ✓ Unauthorized sharing of identified health data poses ethical concerns and threatens patient trust
- **Treatment decision guidance**
  - ✓ Rigorous evaluation for external validity across population is necessary
- **Risk of bias perpetuation**
  - ✓ AI algorithms may perpetuate bias based on existing clinical practices and outcomes
  - ✓ Mitigation strategies are required to prevent the reinforcement of healthcare disparities
- **Infrastructure challenges**
  - ✓ Integrating AI-ECG results into electronic health records faces significant infrastructure challenges
  - ✓ Widespread implementation necessitates technological advancements and organizational investments

FUTURE IMPLICATIONS & CONCLUSION

- AI's integration with implantable and wearable cardiovascular devices for early detection
- Determining severity and staging of cardiovascular conditions
- AI-powered ECG will enhance prognosis capabilities and facilitate continuous monitoring and enable treatment adjustments
- Identifying high-risk patients for invasive evaluation
- Clinician training is important for the successful integration of AI-ECG into medical practice
- Adding AI-ECG as part of routine check-ups or annual examinations holds potential for early detection

REFERENCES