Enhanced Atrial Fibrillation Detection in ICU: Leveraging Novel ECG-Derived Features with Machine Learning

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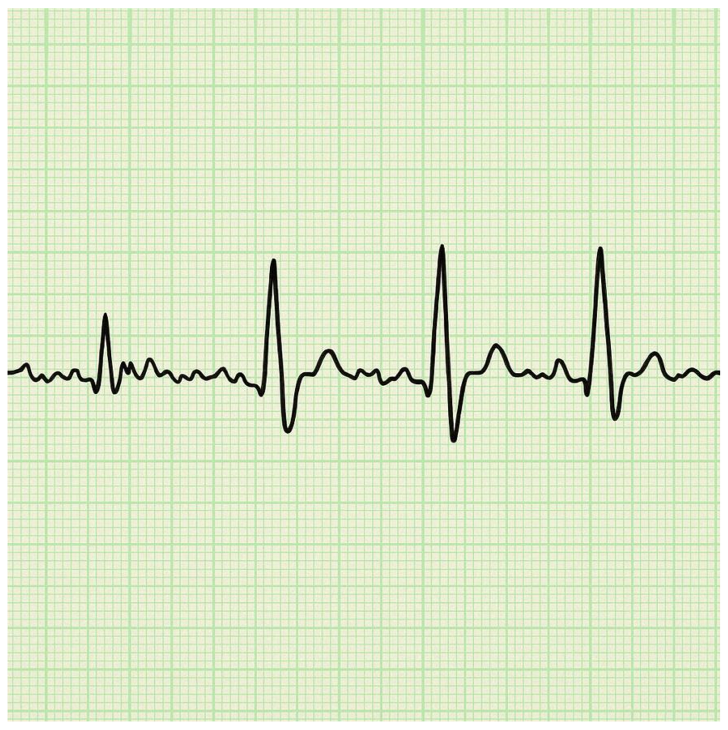
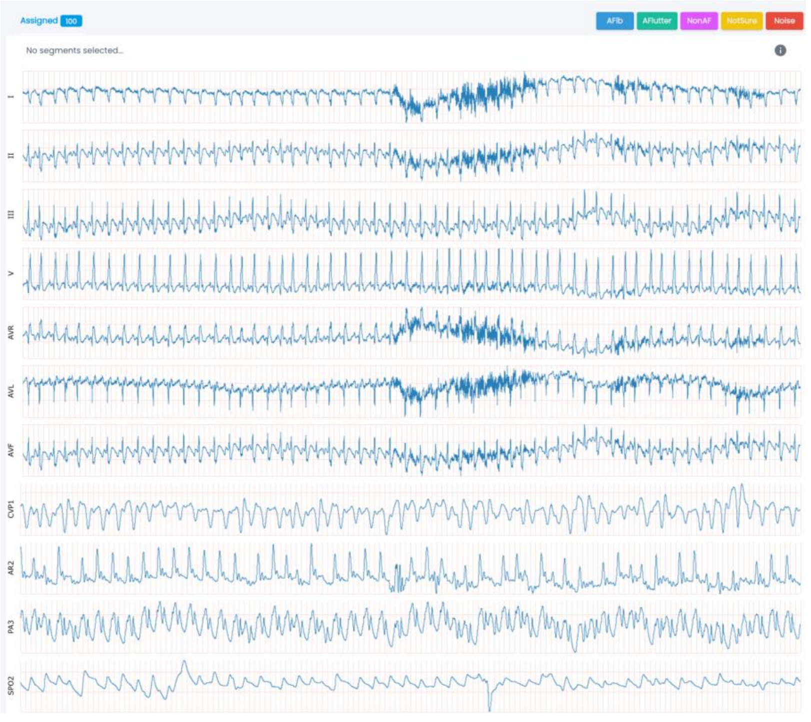
Background



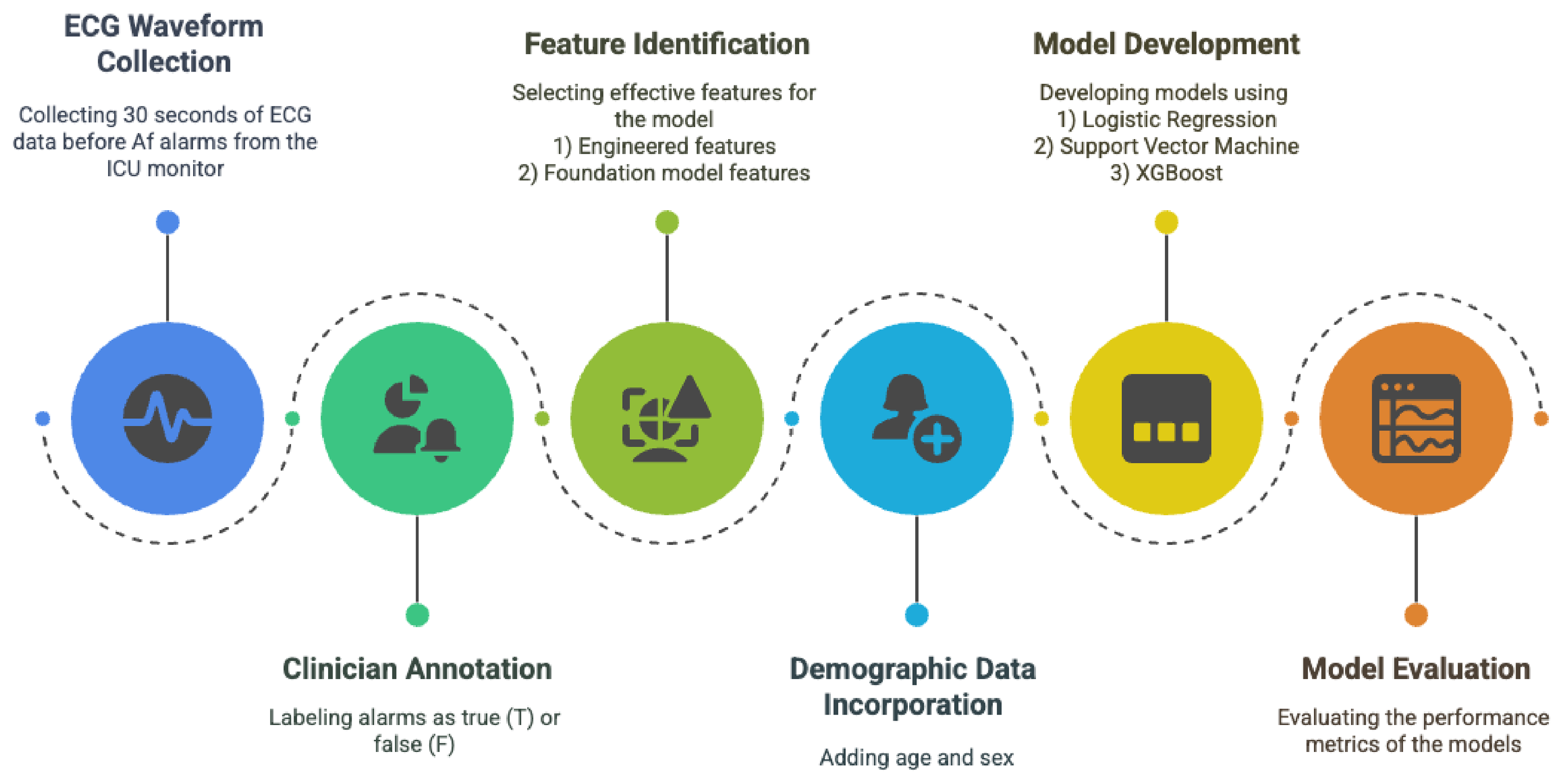


Atrial fibrillation (AF) is a prevalent cardiac condition associated with significant morbidity, particularly due to its contributions to stroke and heart failure. In intensive care units (ICU), bedside patient monitors continuously record electrocardiogram (ECG) and send out an alarm if AF is detected. However, current monitor software lacks precision for accurate AF detection resulting in false alarms, contributing the issue of alarm fatigue. We explore and evaluate a machine learning based predictive model for AF detection and effective patient management.

Aim

To develop robust AF detection models to enhance alarm reliability, improve patient management in ICU settings, and reduce the clinical burden associated with false alarms.

Methods [1, 2, 3]



Results

Table 1. Performance comparison between engineered features and foundation model (FM) embeddings.

		Logistic Regression	Support Vector Machine	XGBoost
		AUROC (Mean ± STD)	AUROC (Mean ± STD)	AUROC (Mean ± STD)
Engineered Features	ECG-only	83.76 ± 10.45%	82.45 ± 12.55%	83.81 ± 11.41%
	ECG + demographics	84.71 ± 9.47%	83.62 ± 10.19%	82.84 ± 11.52%
FM Embeddings	ECG-only	87.45 ± 6.07%	83.98 ± 8.22%	85.16 ± 7.81%
	ECG + demographics	87.37 ± 6.13%	84.33 ± 2.63%	85.20 ± 8.50%

Table 2. False alarm rate of machine learning models using engineered and foundation model features

In our ICU dataset, the baseline false alarm rate was 22.27%.

		False Alarm Rate@90% Sensitivity		
		Logistic Regression	Support Vector Machine	XGBoost
Engineered Features	ECG-only	26.42%	22.64%	20.75%
	ECG + demographics	16.98%	26.42%	20.75%
FM Embeddings	ECG-only	14.29%	28.57%	23.81%
	ECG + demographics	14.29%	52.38%	19.05%

Discussion

- An interesting observation from our results is that adding demographic information did not further enhance performance when using FM features. One possible explanation is that foundation models capture nuanced ECG features that inherently reflect demographic characteristics, such as age and sex.
- Our study uniquely addresses this critical gap by focusing on the tougher task of distinguishing AF from AF-mimicking rhythms rather than merely separating AF from normal sinus rhythms.
- Clinically, our study highlights the feasibility and efficacy of employing foundation model features to mitigate the prevalent issue of false alarms in ICU settings, thus potentially reducing unnecessary interventions and improving patient management outcomes.

Conclusion

Our results demonstrate that through machine learning and ECG features combined with patient demographics, a more precise detection model can be obtained for detecting AF in ICU setting.

Implication

This approach has the potential to reduce false AF alarms in ICU setting while maintain a high sensitivity in detecting true AF event.

Reference

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