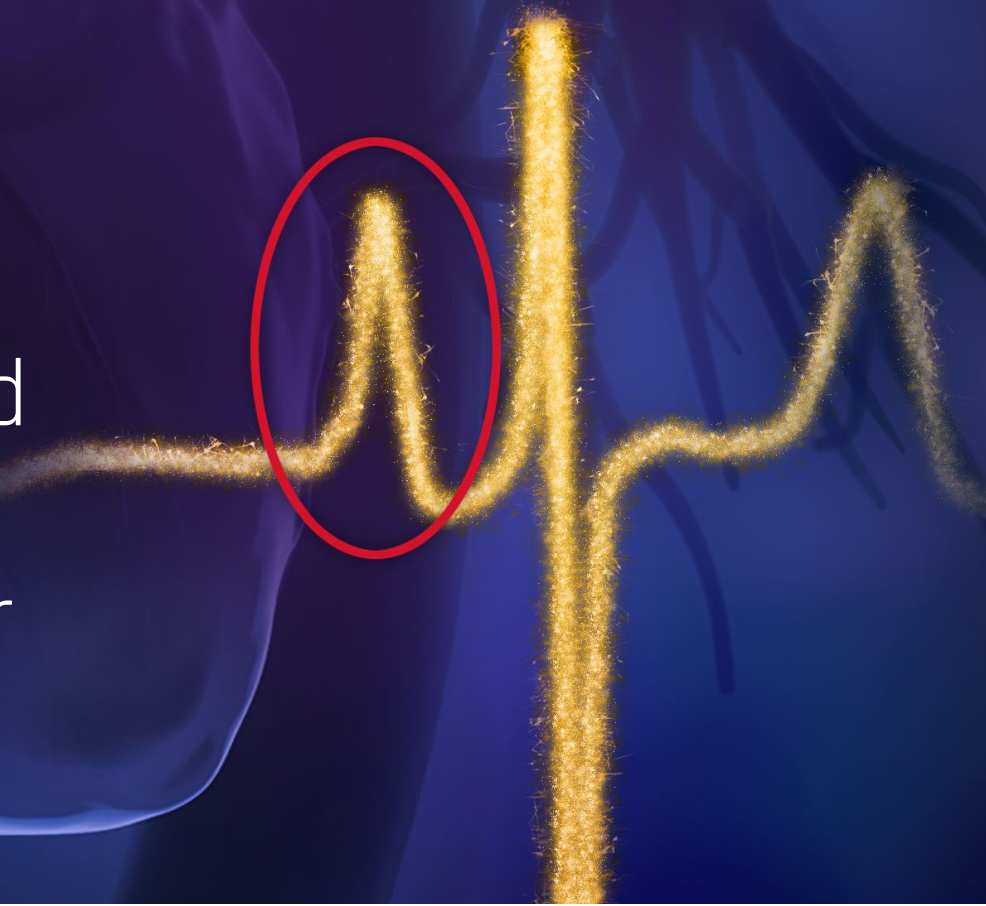# AI for AF Detection

Generate superior diagnostic yield with a P-wave centric monitor

Published Poster Summary

Atrial signal clarity and rhythm specificity are critical when developing artificial intelligence (AI) to distinguish atrial fibrillation (AF) from rhythms that mimic AF.

Authors: Dan Paris, MSCS; Rodney Boleyn, MSEE; Ezra Dreisbach, BSCS; Chuck Dulken, BSEE; Susan Blancher, NP; Melinda Wang, BSN; and Gust H. Bardy, MD from Bardy Diagnostics, Inc. – Seattle, WA

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Background

The identification of atrial fibrillation (AF) using artificial intelligence (AI), either with medically prescribed ECG monitors or non-prescription devices such as watches, is not to be taken lightly. Little focus has been placed on the cost, anxiety and potential therapeutic consequences of a false positive diagnosis. The potential value of AI in AF diagnostics is not debated here, but if it is to be used, the ECG used to determine the truth set should be capable of sorting AF from its various mimickers. Many current methods are limited by the duration of the ECG and the fidelity of the P-wave as well as by the validation process details. These limitations can lead to misdiagnosis of other arrhythmias with R-R interval variability as AF by the AI engine.

Objective

Our objective was to build an AI to detect AF with better than 90% sensitivity and 90% specificity capable of identifying the onset and offset of episodic AF events, without conflating other atrial (or ventricular) arrhythmias that mimic AF with R-R interval variability.

Methods

For this work, we built a convolutional neural network (CNN) that would analyze the Carnation Ambulatory Monitor (CAM™) (Bardy Diagnostics, Inc., Seattle, WA) ECG and its associated R-R interval data to produce an AF yes/no output for every half-second of ECG data. Training of the CNN was done with CAM ECG recordings from 1227 patients, 474 with paroxysmal or persistent AF, and 753 without AF. Included in the 753 patients were 148 patients with dense atrial or ventricular ectopy, and both atrial flutter (AFL) and sustained atrial tachycardia (AT) with variable conduction. This distinction is pertinent to diagnostic and therapeutic medical and procedural management, and for assessing stroke risk should these disorders be diagnosed as AF.

Shown above is the training population vs. the whole (general) patient population of Bardy Diagnostics

Our validation was comprised of two-hour excerpts of CAM ECG data chosen at random from 50 AF-positive patients and 50 AF-negative patients (200 hours total). AF was diagnosed if variable P-wave morphology was present for at least 30 seconds. AF presence and duration were confirmed by a team of experienced cardiac electrophysiology clinicians. Disagreements between the three validating electrophysiology clinicians were adjudicated at weekly review meetings.

Results

In the validation cohort, there were 58 patients presenting with normal sinus rhythm (NSR), 27 with atrial flutter (AFL), 24 with ventricular tachycardia (VT), 9 with atrioventricular blocks (AVB), and all patients exhibited AT. The AI differentiates AF not only from NSR but also from myriad other arrhythmias, including those that have R-R interval variability such as AFL and AT. Our results were 96.82% sensitive and 99.86% specific with a positive predictivity of 99.79% for detecting 30 seconds of AF or longer.

Conclusions

Our P-wave centric continuous ECG monitoring technology allows our neural network, or AI, to differentiate between AF and a host of rhythms that mimic AF. AI systems that do not make these distinctions may mislead both patients and clinicians.

The CAM patch AI uses low-amplitude, low-frequency content to distinguish AF not just from normal sinus, but from other arrhythmias that mimic AF.

This includes arrhythmias that have R-R variability like atrial flutter with variable conduction, atrial tachycardia with variable conduction, bigeminy, trigeminy, quadrigeminy, and the various types of heart blocks.

Atrial Flutter with Variable Conduction
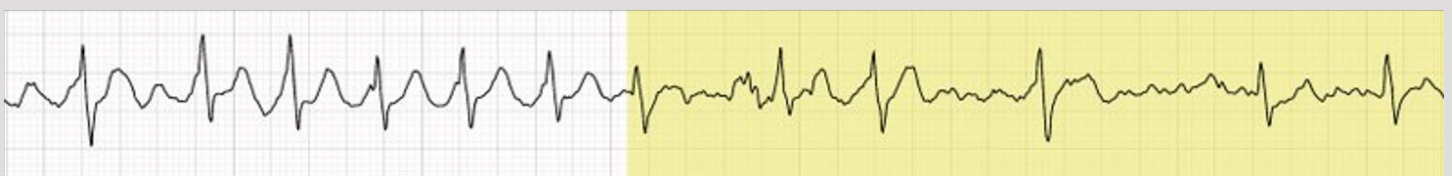
Atrial Tachycardia to Atrial Fibrillation

Rhythm specificity matters

The difference between a patient **actually having AF** and having an arrhythmia that **mimics AF** can play out in medical and procedural management and stroke risk. **Gain confidence in AF detection with high signal fidelity and low-amplitude, low-frequency P-wave clarity.**

One AI output every half second

| AF | AF | AF | AF | AF | AF | AF | AF | Not AF | Not AF | Not AF | Not AF | Not AF | Not AF | Not AF | Not AF |

CAM patch AI is engineered to give an output for every half second of recording, identifying if a patient has AF and showing where AF starts and stops.

Accuracy vs. validation datasets

For AF episodes of 30 seconds or longer

Sensitivity	Specificity	Positive predictivity
96.82%	**99.86%**	**99.79%**

Carnation
Ambulatory Monitor™

To view the 5-min poster presentation, visit
https://info.bardydx.com/AFYND

For more clinical evidence, go to www.bardydx.com

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