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Classificiation of Atrial Fibrillation Prone Patients Using Electrocardiographic Parameters in Neuro-Fuzzy Modeling,

Mirela Ovreiu
Cleveland Clinic Foundation, ovreium@ccf.org

Marc Petre
Cleveland Clinic Foundation, petrem@ccf.org

Daniel J. Simon
Cleveland State University, d.j.simon@csuohio.edu

Daniel Sessler
Cleveland Clinic Foundation, sessled@ccf.org

C Allen Bashour
Cleveland Clinic Foundation, bashoua@ccf.org

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Classification of Atrial Fibrillation prone Patients using Electrocardiographic Parameters in Neuro-Fuzzy Modeling

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INTRODUCTION

ATRIAL FIBRILLATION (AF) is a significant clinical problem as it can degenerate into its chronic manifestation, create hemodynamic instability and increase the risk for stroke. Moreover, the complications of cardiovascular postoperative AF often lead to longer hospital stays and higher heath care costs.

The literature showed that AF may be preceded by changes in electrocardiogram (ECG) characteristics such as premature atrial activity, heart rate variability (HRV), and P-wave morphology. We hypothesize that the limitations of statistics-based attempts to predict AF occurrence may be overcome using a hybrid neuro-fuzzy prediction model that is better capable of uncovering complex, non-linear interactions between ECG parameters.

MATERIALS AND METHODS

A database of long duration ECG signals was collected and the demographics are presented in TABLE1. The inclusion criteria were no preoperative chronic AF and no perioperative pacing.

TABLE 1 – DEMOGRAFICS OF DATABASE

		AF	control
gender	male	28	32
	female	15	23
age	average	70	59
(years)	range	46-88	23-88

ECG parameters describing PACs, HRV, and P-wave morphology were computed for every minute of data recording for all of the 98 patients of the training data set according to standards evocated by the Writing Group in [1]. The following 15 crisp valued parameters were considered for neuro-fuzzy classification: 1)Premature Atrial Complexes/min, 2) HRV: Mean, Standard Deviation, Root Mean Square, Total Power, High Frequency, Low Frequency, Low/High Frequency, Low Frequency normalized, Approximate Entropy, and 3) P-wave morphology: duration, amplitude, shape, inflection point, energy ratio. The details of ECG parameter computation are provided in [2].

During network development, pairs of ECG inputs and known outputs were required to train the network. For AF patients parameters computed for 30 minutes prior to AF onset were used as inputs and the outcome was set to 1. While for control group the 30 minute interval was selected before the end of the registration and outcome was zero. A total of 2654 data pairs were used in the training step.

The training model was based on a Sugeno inference system with five layers [3]. Membership functions were Gaussians with parameters computed by the class separation process and the total of 25 clusters. Multiple optimization algorithms were tried and Back Propagation over 3000 epochs was selected as the most appropriate.

RESULTS

The preliminary neuro-fuzzy model was able to classify the training data set with the following performances: 99.42% sensitivity, 99.89% specificity, and 99.74% accuracy see Fig. 1. The results confirm that there is sufficient information for a model to distinguish between control and AF patients 30 minutes prior the AF event to clinical diagnosis.

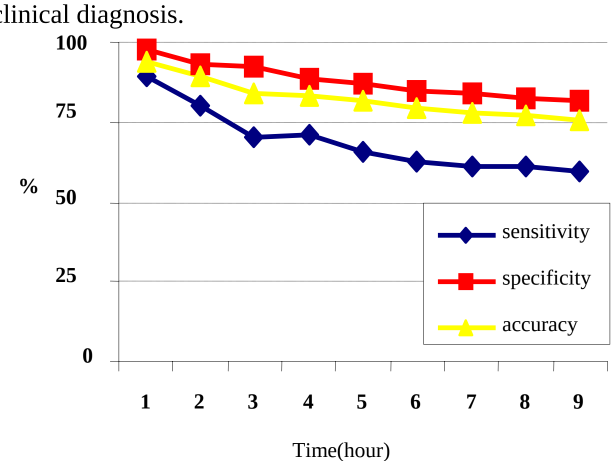

Fig. 1. Classification Performances over 9 hours

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Mirela Ovreiu is with Cleveland Clinic, Cleveland, OH 44195 USA, ovreium@ccf.org
Marc Petre is with Cleveland Clinic, Cleveland, OH 44195 USA, petrem@ccf.org
Daniel Simon is with Cleveland State University, Cleveland, OH 44115 USA, d.j.sinom@csuohio.edu
Daniel Sessler is with Cleveland Clinic, Cleveland, OH 44195 USA, sessled@ccf.org
C Allen Bashour is with Cleveland Clinic, Cleveland, OH 44195 USA, bashoua@ccf.org