Atrial Fibrillation (AF) is a significant clinical problem and the complications of cardiovascular postoperative AF often lead to longer hospital stays and higher health 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. We created a neuro-fuzzy network that was able to classify the patients into the control and AF groups with the performances: 99.42% sensitivity, 99.89% specificity, and 99.74% accuracy for 30 minutes just before AF onset.

Method

We hypothesize that the limitations of statistics-based attempts to predict AF occurrence may be overcome using a hybrid neuro-fuzzy prediction model.

Neuro-fuzzy network

• 43 AF vs. 55 control patients
• Pairs of ECG inputs and known outputs use to build the network: for AF patients ECG parameters for 30 minutes prior to AF onset as inputs and the output is 1 (AF), for control group 30 minutes before the end of the registration and the output is 0 (no AF)
• 2654 data pairs to develop the network

Fuzzy Rule based Layer

• 25 IF-THEN fuzzy rules determined by a fuzzy c-means clustering algorithm
• Optimization trade: compactness within and separation between clusters

Sensitivity

Specificity

Accuracy

Results

- Optimization algorithms: BP 3000 epochs
- Testing data: 3,974 at 1 hour to 40,949 at 9 hours prior to AF onset
- Training data set: 99.42% sensitivity, 99.89% specificity, and 99.74% accuracy
- sufficient information for the neuro-fuzzy model to classify 30 minutes prior to clinical diagnosis
- 9 hours prior AF onset, classify with 93.99% accuracy (88.98% sensitivity, 97.48% specificity)

Summary & Next Steps

- A novel neuro-fuzzy network using 15 ECG parameters differentiates AF prone and control patients
- 2654 data pairs, network of 25 rules. The neuro-fuzzy classification model has all metrics > 60% to 9 hours prior to onset of AF
- Refinement of the network, testing on an existing database, and an observational clinical trial

FIGURE 1: The architecture of the proposed neuro-fuzzy model

FIGURE 2: Gaussian membership functions for NN parameter of HRV associate to the 4th and 24th clusters

FIGURE 3: Historical Neuro-Fuzzy Classification Performances

FIGURE 4: An overview of the proposed clinical monitoring system.