Hidden Markov Models for Activity Detection in Atrial Fibrillation Electrograms

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Objective: To identify activity presence in atrial fibrillation (AF) EGMs using fully unsupervised Hidden Markov Models (HMMs).

Methods: A total of 3780 AF bipolar EGMs of 2500 ms length were acquired from 32 AF patients using a 5 branch PentaRay catheter. Signals exhibited different characteristics such as clean activations, fragmentation, double potentials or no signal (noise). We trained 270 HMMs for different combinations of the number of states, the training EGM lengths and number, and analyzed their AIC/BIC complexity and learning capabilities. The HMM associates the states attaining activity or no activity. We compared the method to the gold-standard NLEO method on a manually annotated 232 EGM database for activity detection: 122210 simulations for the NLEO method and 5670 for the HMMs.

Results: AIC and BIC metrics confirmed that the HMM was able to learn and describe EGM signals. We evaluated the performance of the method on 232 manually annotated EGMs for activity presence. The HMM method performed better than the NLEO in terms of F1Score, 0.960 versus 0.902 respectively for the best parameter combination of each method.

Conclusions: We present a new algorithm for AF EGM activity detection fully unsupervised with no expert training annotation needed nor signal preprocessing. Its implementation in the clinical practice could assess the presence of fragmented atrial areas related to AF maintenance.

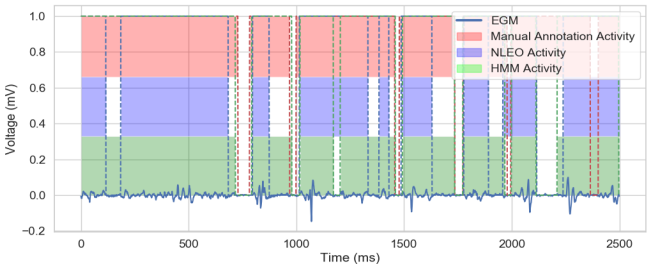

Figure 1. EGM activity detection for HMM, NLEO and manual annotation.