Dual-chamber Intracardiac Arrhythmia Analysis

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The need for implantable devices to classify potentially pace-terminable rhythms from those requiring immediate defibrillation has become a necessity in newer generation devices with tiered-therapy protocols. Reports of acceleration of slower tachycardias into faster, more lethal forms upon delivery of initial pacing therapy further emphasizes the need for more critical analysis of the originating tachycardia. Single-chamber analysis employing ventricular electrodes is standard, but this unfortunately ignores concomitant atrial information. This remains the case despite gains in pacing technology over the past two decades, which has led, inevitably, to two-chamber pacemaker implementation.

Our hypothesis is that two-channel analysis is requisite for accurate arrhythmia classification. Moreover, our recent studies have demonstrated that morphological evaluation of the signal can provide improved specificity over rate-based systems. We propose here the first comprehensive rate and morphological classification of two-channel (atrial and ventricular) intracardiac electrograms for the diagnosis of complex arrhythmias. Five distinct features of the two electrograms are employed for initial identification of cardiac cycles: the atrial-atrial interval (AA), the atrioventricular interval (AV), the ventricular-ventricular interval (VV), and two morphological measures: atrial normality (CCa) and ventricular normality (CCv).

We have created an entire taxonomy of possible (observable) cardiac cycles. Each category is a sequence of atrial and ventricular depolarizations, which appear in a particular pattern for a total of 122 possible combinations. This single cardiac-cycle code designation is further classified at a higher level into an AV or ventriculoatrial order to preserve realistic associations between atrial and ventricular depolarizations. At highest rank, contextual analysis is derived from strings of beat codes.

This scheme for two-channel analysis executes in real time and has been tested on 36 passages of two-channel intracardiac signals. Of the 3,417 individual cardiac cycles analyzed, 3,135 (91.7%) were identified correctly. Contextual diagnosis corrected 123 single cycle errors to give an overall performance accuracy of 3,258 out of 3,417 cardiac cycles (95.3%). Using continuous correct contextual diagnosis as indication of successful identification of arrhythmias, the algorithm achieved success in 34 out of 36 cases (94.4%).

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