A novel programming language to reduce energy consumption by arrhythmia monitoring algorithms in implantable cardioverter-defibrillators
Background:

Arrhythmia Detection Algorithms (ADA) employed by devices such as Implantable Cardioverter Defibrillators (ICD) and Implantable Loop Recorders continuously monitor the rhythm to detect arrhythmias. ADAs are a major consumer of battery power. For a given hardware, power consumption depends on the Programming Language (PL) used to code the ADA. The present PL approach, which utilizes a database of electrograms to estimate maximum power consumption, is unreliable and not very flexible.

Objective:

To introduce a novel PL which allows estimation of ADA maximum power consumption early in the device design process. We hypothesize that this approach should minimize power consumption without compromising detection ability.

Methods:

We used QRE, which is a PL that can process large amounts of data in a small amount of time, to code ADAs. Using QRE, guaranteed estimates of maximum power consumption can be obtained. We coded three variations of an ADA from a single ICD vendor (Boston Scientific) in the QRE language: Baseline version, a version without the Onset discriminator (NoOnset), and a version with Duration set to 1sec (ShortD). We computed estimates of maximum power consumption for the three versions by running the code on a standard laptop. Each version was run a 100 times.

Results:

ADA Baseline has the highest power consumption ($3.37e^{-5}$ Joules per calculation), and ShortD the lowest ($1.1337e^{-5}$ Joules per calculation, p-value of difference = 0.01). NoOnset has almost identical power consumption to Baseline ($3.2637e^{-5}$ Joules per calculation, p-value of difference with Baseline = 0.45).

Conclusion:

A novel programming language for ADAs allows reliable and early comparison of maximum power consumption between ADAs. Results suggest that patients who might benefit from the Onset discriminator should have it turned on by default with minimal loss in device longevity. Shortening the Duration increases longevity significantly but is known to increase the rate of inappropriate therapy. The QRE language lets engineers make these power comparisons early to better improve battery lifetime.