Morphology Discrimination and ICD Programming: Can we do better?

rahul doshi[1]

[1]HonorHealth

April 28, 2020

Abstract

Editorial commentary for "Electrogram Morphology Discriminators in Implantable Cardioverter Defibrillators: a comparative evaluation".

Morphology Discrimination and ICD Programming: Can we do better?

Rahul N. Doshi, M.D., F.H.R.S., F.A.C.C.

Address for Correspondence:

Rahul N. Doshi, M.D., F.H.R.S., F.A.C.C.

Pillar Chief, Electrophysiology and Complex Arrhythmia Management

Cardiovascular Center of Excellence

HonorHealth

Scottsdale, AZ

Email rdoshi@honorhealth.com

Keywords: Defibrillator, ICD, Discriminators, Morphology

Word Count: 1521

"Do the best you can until you know better. Then when you know better, do better"—Maya Angelou

There was a time when defibrillators were not programmable. As a last-ditch effort to provide protection for a patient with recurrent ventricular tachycardia, you called your industry partner, prescribed an implantable cardioverter defibrillator (ICD) with a particular therapy rate, and after receiving a device prescribed for your particular patient, saw to its implantation. While individualized for a particular patient, our options were limited to choosing a rate for detection. Certainly, the emphasis of ICD treatment was the sensitivity to detect a life-threatening arrhythmia. In addition, the lack of stored electrograms made it difficult to accurately adjudicate appropriate versus inappropriate therapy. As ICD therapy matured, we began to appreciate that inappropriate shocks occur, and they are associated with poor outcomes including the frightening realization that they are adversely associated with mortality[1].

As such, measures such as empiric anti-tachycardia pacing (ATP), higher detection rates, and prolonged detection times have led to decreased rates of inappropriate therapy. In addition, currently available ICDs are increasingly programmable. The 2015 HRS/EHRA/APHRS/SOLAECE expert consensus statement on optimal implantable cardioverter-defibrillator programming and testing provides straightforward guidelines

on ideal device programming.[2] This document provides general information regarding the use of multiple zones, different methods of supraventricular tachycardia (SVT) versus ventricular tachycardia (VT) discriminators, including atria-ventricular (A-V) relationship, sudden onset, stability, and morphology. Given the differences between manufacturers, the 2019 HRS/EHRA/APHRS/LAHRS focused update to 2015 expert consensus statement on optimal implantable cardioverter-defibrillator programming and testing provide some manufacturer specific recommendations for programming[3].

However, it is important to note that there is a paucity of data comparing different devices and their respective discriminators. Given fundamental differences in algorithms and device-specific programming parameters, it is difficult to compare clinical results across defibrillator brands. Moreover, while all device companies have changed default programming values to increase detection times and rate detection parameters, "out of the box" programming may not be ideal for al ICD recipients. While the decrease in inappropriate therapy employing these programming-strategies is well demonstrated[4], there are still many (if not most) devices that remain in initial factory settings. This suggests that most of us feel that this is simply good enough. For the photography enthusiasts out there—when was the last time you adjusted the exposure time on your camera? Or changed a lens? Most of us are content enough to click away with our smartphone because it's already pretty darn good. But this begs the question—can we or should we do better?

Of all the potential programming optimization possible in the current ICD, morphology discrimination might be the most taken for granted (though I suspect defibrillation waveforms might be a very close second). Different devices collect morphology templates in different ways (all proprietary), creating a "black box" for the practicing clinician. What does percentage match refer to? Can I program the percentage match to an acquired template? What are the number of beats that fulfil criteria and out of how many? How much variation in an acquired template is seen normally? How much does aberrant conduction affect this? More importantly, does it matter? One would assume (correctly) that device manufacturers make seemingly Herculean efforts to validate their respective technologies. However, this type of evaluation does limit the type of comparisons that can be made across different devices using agnostic and standardized parameters that are analyzing actual arrhythmic events—data which is more relevant to the clinician electrophysiologist.

In this issue of the journal, Frontera and colleagues[5]present a detailed evaluation of morphology discriminators for three device manufacturers, comparing the Far Field MD (Abbott Medical, Abbott, Il, USA), RhythmID (Boston Scientific, Nattick, MA, USA) and Wavelet (Medtronic, Minneapolis, MN, USA) algorithms. They compared SVT and VT episodes from ICDs with an atrial lead placed obtained from their respective remote monitoring platforms. After adjudicating the episodes by independent review of intracardiac electrograms using the atrial channel from dual chamber and cardiac resynchronization defibrillators, they looked solely at the morphology discriminator algorithms and determined the sensitivity and specificity for a range of template match percentage values after constructing receiving operating characteristics (ROC) curves. They found some statistically significant differences between manufacturers in both sensitivity and specificity results at default programming, most notably poor specificity for the RhythmID and Wavelet algorithms compared to the Far Field morphology discriminators. Perhaps more importantly, "optimal" settings corresponding to the highest number of correctly classified episodes could be achieved with programming changes. The Abbott algorithm default is essentially already set to the optimal setting in this analysis, and while further optimization could be achieved it falls outside of allowed programming parameters. Significant improvements could be made with programmable changes for the Boston Scientific and Medtronic devices from default settings. The authors do report that these findings are somewhat different from prior reports that are possibly related to study design[6-8]. However, this study does amount to the first investigation of morphology discriminators with real-world episodes for three different vendors.

Firstly, the authors should be congratulated on their elegant work, allowing the reader to gain real insight into morphology discrimination and programming options for improving accuracy. Perhaps more importantly, it brings to the light the importance of programming considerations for the type of device and clinical setting. It is important to realize that the results of this study are only applied to the morphology discriminators and does not reflect real time therapy using all potential components of any full device detection algorithms. The

authors themselves state that it would make sense to employ different thresholds for morphology detection depending whether or not the algorithm was functioning as a sole determinant to withhold therapy in a single chamber ICD as compared to part of a decision tree as is the case in dual chamber and cardiac resynchronization devices.

In order to strive for doing better, we should not be satisfied with simply implanting another widget with no further thought given to what we are doing when we prescribe this therapy. Sure, we are decreasing the risk of sudden cardiac death by implanting a defibrillator for accepted indications, but I think the relative ease of doing so and our relative success demonstrated in our landmark clinical trials has allowed us to overlook the dangers of inappropriate therapy and strive for what we can do better. When it comes to avoiding inappropriate therapy, I would remind everyone the first tenet of medicine: "*primum non nocere*".

References:

1. Daubert JP, Zareba W, Cannom DS, McNitt S, Rosero SZ, Wang P, Schuger C, Steinberg JS, Higgins SL, Wilber DJ, Klein H, Andrews ML, Hall WJ, Moss AJ. Inappropriate Implantable Cardioverter-Defibrillator Shocks in MADIT II. J. Am. Coll. Cardiol. 2008;51:1357–1365.
2. Wilkoff BL, Fauchier L, Stiles MK, Morillo CA, Al-Khatib SM, Almendral J, Aguinaga L, Berger RD, Cuesta A, Daubert JP, Dubner S, Ellenbogen KA, Mark Estes NA, Fenelon G, Garcia FC, Gasparini M, Haines DE, Healey JS, Hurtwitz JL, Keegan R, Kolb C, Kuck K-H, Marinskis G, Martinelli M, McGuire M, Molina LG, Okumura K, Proclemer A, Russo AM, Singh JP, Swerdlow CD, Teo WS, Uribe W, Viskin S, Wang C-C, Zhang S. 2015. HRS/EHRA/APHRS/SOLAECE expert consensus statement on optimal implantable cardioverter-defibrillator programming and testing. Heart Rhythm 2016;13:e50-86.
3. Stiles MK, Fauchier L, Morillo CA, Wilkoff BL. 2019 HRS/EHRA/APHRS/LAHRS focused update to 2015 expert consensus statement on optimal implantable cardioverter-defibrillator programming and testing. J Arrhythm. 2019 May 14;35(3):485-493. doi: 10.1002/joa3.12178. eCollection 2019 Jun.PMID: 31293697.
4. Sedláček K, Ruwald AC, Kutyifa V, McNitt S, Thomsen PEB, Klein H, Stockburger M, Wichterle D, Merkely B, DE LA Concha JF, Swissa M, Zareba W, Moss AJ, Kautzner J, Ruwald MH; MADIT-RIT Investigators. The Effect of ICD Programming on Inappropriate and Appropriate ICD Therapies in Ischemic and Nonischemic Cardiomyopathy: The MADIT-RIT Trial. J Cardiovasc Electrophysiol, Vol. 26, pp. 424-433, April 2015)
5. Frontera A, Strik M, Eschalier R, Biffi M, Pereira B, Weite N, Chauvel R, Mondoly P, Laborderie J, Bernis JP, Clementy N, Reuter S, Garrigue S, Deplagne A, Vernooy K, Pillois X, Haissaguerre M, Dubois R, Ritter P, Bordachar P, Ploux S. Electrogram Morphology Discriminators in Implantable Cardioverter Defibrillators: a comparative evaluation. J of Cardiovasc Electrophysiol *in press* .
6. Klein GJ, Gillberg JM, Tang A, Inbar S, Sharma A, Unterberg-Buchwald C, Dorian P, Moore H, Duru F, Rooney E, Becker D, Schaaf K, Benditt D, Worldwide Wave Investigators. Improving SVT discrimination in single-chamber ICDs: a new electrogram morphology-based algorithm. J. Cardiovasc. Electrophysiol. 2006;17:1310–1319.
7. Theuns DAMJ, Rivero-Ayerza M, Goedhart DM, van der Perk R, Jordaens LJ. Evaluation of morphology discrimination for ventricular tachycardia diagnosis in implantable cardioverter-defibrillators. Heart Rhythm 2006;3:1332–1338.
8. Gold MR, Ahmad S, Browne K, Berg KC, Thackeray L, Berger RD. Prospective comparison of discrimination algorithms to prevent inappropriate ICD therapy: primary results of theRhythm ID Going Head to Head Trial. Heart Rhythm 2012;9:370–377.