COMMENTARY

Algorithms and programming matters: implantable cardioverter defibrillator therapy in Biotronik and Abbott devices

Arwa Younis[1] · Bruce L. Wilkoff[1,2]

Implantable cardioverter defibrillators (ICDs) are considered the gold standard for the prevention of sudden cardiac death in high-risk individuals. Treating an episode of sustained malignant ventricular arrhythmia (ventricular tachycardia [VT] or ventricular fibrillation [VF]) with anti-tachycardia pacing (ATP) or electrical shocks is the only option for restoring viable hemodynamics. On the other hand, the latest guidelines recommendations, based on numerous randomized trials, suggest the need to avoid treating slower and organized ventricular arrhythmias too prematurely or too aggressively, and to avoid the treatment of non-ventricular tachyarrhythmias [1]. VT/VF therapies can save a life when applied correctly, but it is also associated with a deleterious effect, a reduction in quality of life, and increased mortality on its own and should therefore be avoided whenever possible, especially when spontaneous termination is expected or when a less aggressive therapy can be effective [2].

ICD therapy is a strategic therapy to prolong life. This is especially so in primary prevention patients in whom there had been no prior VT/VF events to calculate the best detection parameters where the only choice is to strategically choose the programmed parameters most likely to prolong life and improve quality of life by avoiding unnecessary appropriate and inappropriate therapies. In 2019, the Heart Rhythm Society released a focused update to the 2015 expert consensus statement on optimal ICD programming and testing recommendations among the different manufacturers [3]. Specific recommendations of how to optimally program ICDs from each manufacturer were provided, and notably distinct, reflecting manufacturer-specific detection algorithms. A direct consequence of strategic programming for every manufacturer is that some patients' arrhythmias will sometimes fall on the better side and some on the worse side of every choice.

For Biotronik™ ICDs, the counting method differs completely between the VT zone (up/down counter) and the VF zone (probabilistic counter), which is not the case for the ICDs of competing manufacturers (except Medtronic™). Importantly, an interval classified as VS in conjunction with undersensing of a VF event does not reset the VT counter to zero (distinct from Medtronic™) but decrements the latter only by one; intermittent undersensing (VF or polymorphic VT) thus delays but does not prevent detection. Abbott™ ICDs use continuous counters that classify the intervals based on the RR interval and the average of the last 4 cycles and then groups each RR intervals into bins. Similar to Biotronik™ devices, an interval binned in the higher zone (VF) does not necessarily increment the counter of a slower treatment zone (VT). This feature is also true in the redetection of tachyarrhythmias — for example if ATP accelerates a VT to the VF zone — the full VF counter must be met to deliver therapy. In both Biotronik™ and Abbott™ ICDs, SVT discriminators are not utilized in the VF zone.

In the present edition of the *Journal of Interventional Cardiac Electrophysiology*, Oesterle and colleagues [4] share the findings of 120 Patients with Biotronik ($N = 52$) and Abbott ($N = 68$) ICDs receiving care at a US center. Patient information and device tracings for patients with any ICD therapies were examined to assess for possible delayed tachycardia detection.

In 52 patients with Biotronik™ ICDs, over a median follow-up of 29 months, eight (15%) patients experienced at least one appropriate ICD therapy and 3 of the 8 patients (38%) who received appropriate therapy experienced some

---

Editorial to the following article: Ventricular Arrhythmia Detection for Contemporary Biotronik and Abbott Implantable Cardioverter Defibrillators with Markedly Prolonged Detection in Biotronik Devices.

This comment refers to the article available at https://doi.org/10.1007/s10840-023-01498-9.

✉ Bruce L. Wilkoff
  wilkoffb@ccf.org

1 Cardiac Electrophysiology and Pacing Section, Department of Cardiovascular Medicine, Cleveland Clinic, 9500 Euclid Avenue Desk J2-2, Cleveland, OH 44195, USA

2 Cleveland Clinic Lerner College of Medicine of Case Western Reserve University, Cleveland, OH 44195, USA

delay in VT/VF detection due to the oscillation in the tachy-cardia cycle length between the VT and VF treatment zones. In 68 patients with Abbott™ ICDs, over a median follow-up of 83 months, 26 (38%) patients experienced at least one appropriate ICD therapy and 4 of the 26 patients (15%) who received appropriate therapy experienced some delay in VT/VF detection due to the oscillation in the tachycardia cycle length between the VT and VF treatment zones. Three of the eight Biotronik and one of the four Abbott patients had symptoms, but we don't know how many patients without detection delays had symptoms, which were principally syncope.

The authors should be congratulated for their efforts, which included detailed presentations and interpretations of numerous interrogations of the affected patients. The current study discusses the incidence and clinical consequences of delayed detection and therapies for VT/VF in Biotronik™ and Abbott™ ICDs in a comprehensive fashion. It is impor-tant to understand that delays in detection can occur and that there may be clinical consequences. This retrospective, observational analysis is limited due to a small number of events and patients in a population of primary and second-ary prevention patients with non-standardized programming, absence of reports on inappropriate therapies, no measure-ments of quality of life and absence of a control population. Since the analysis only looked for delays in tachyarrhythmia detection, we don't know how often the detection algorithms prevented inappropriate detections and therapies.

It is important to remember that delays in detection and delivery of appropriate ICD therapies are not only a condition seen with Biotronik™ and Abbott™ ICDs, but rather a situation that can occur with any other manufac-turer's device. Comparative data on the incidence of these events in patients with any manufacturer's ICD remains very limited. However, the data that has been collected shows that on average, when detection duration is prolonged and tachycardia cycle length is increased, there are both fewer therapies, appropriate and inappropriate, and reduced mor-tality. However when, in a specific patient, a behavior of delayed detection occurs and there are negative clinical consequences, using the understanding of the manufacturer specific detection algorithm and how to recalculate the opti-mal programming for this individual patient is often quite valuable.

Although there were relatively few events in this report, these data show that delayed detection occurs, can be associ-ated with potentially preventable symptoms, and is related to the specific characteristics of the manufacturer's specific detection algorithms and the programming choices made by the physician. Care should be taken to balance the desire to treat every VT/VF appropriately with the need to limit other symptomatic events, such as avoidable and inappropriate therapies. Optimal ICD programming requires additional data.

Declarations

References

1. Al-Khatib SM, Stevenson WG, Ackerman MJ, et al. 2017 AHA/ACC/HRS guideline for management of patients with ventricular arrhythmias and the prevention of sudden cardiac death: executive summary: a report of the American College of Cardiology/Ameri-can Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society. Heart Rhythm. 2018;15:e190–252.
2. Aktaş MK, Younis A, Zareba W, Kutyifa V, Klein H, Daubert JP, Estes M, McNitt S, Polonsky B, Goldenberg I. Survival after implantable cardioverter-defibrillator shocks. J Am Coll Cardiol. 2021;77:2453–62.
3. Stiles MK, Fauchier L, Morillo CA, Wilkoff BL. 2019 HRS/EHRA/APHRS/LAHRS focused update to 2015 expert consen-sus statement on optimal implantable cardioverter-defibrillator programming and testing. Heart Rhythm. 2020;17:e220–8.
4. Oesterle A, Dhruva SS, Pellegrini CN, et al. Ventricular arrhyth-mia detection for contemporary Biotronik and Abbott implantable cardioverter defibrillators with markedly prolonged detection in Biotronik devices. J Interv Card Electrophysiol. 2023. https://doi.org/10.1007/s10840-023-01498-9.