

Interpreting Pacemaker Mediated Tachycardia (PMT) Episodes at Follow-up

BACKGROUND INFORMATION

In dual-chamber pacing modes (DDD/R and VDD/R), a pulse generator may detect atrial activity resulting from retrograde conduction, causing triggered ventricular pacing rates as high as the Maximum Tracking Rate (MTR). This is known as PMT. Most Boston Scientific ICDs, CRT-Ds, CRT-Ps and pacing systems include a programmable PMT Termination feature to identify and resolve PMT episodes.

ICD: Implantable Cardioverter Defibrillator

CRT-D: Cardiac Resynchronization Therapy Defibrillator

CRT-P: Cardiac Resynchronization Therapy Pacemaker

CRM PRODUCTS REFERENCED*

The following dual-chamber devices: VENTAK PRIZM®, PRIZM HE, PRIZM AVT, PRIZM 2, VITALITY®, VITALITY DS, VITALITY DR, VITALITY DR+, VITALITY EL, VITALITY VR, VITALITY 2, VITALITY 2 EL, VITALITY AVT, CONTAK CD 2, CONTAK RENEWAL®, RENEWAL AVT, RENEWAL 2, RENEWAL 3, RENEWAL 3 HE, RENEWAL 3 AVT, RENEWAL 3 RF, RENEWAL 4, RENEWAL 4 HE, PULSAR®, PULSAR MAX, PULSAR MAX II, DISCOVERY® II, INSIGNIA®, INSIGNIA AVT, INSIGNIA Entra, INSIGNIA Ultra, INSIGNIA Plus, CONTAK RENEWAL TR, RENEWAL TR 2

*Products referenced herein may not be approved in all geographies.

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How PMT occurs

PMT is initiated when ventricular activity is conducted retrograde to the atria, resulting in premature atrial depolarization. The pacemaker senses the retrograde-induced atrial event and paces the ventricle following the programmed A-V Delay. If the ventricular event is again conducted retrograde to the atrium, the cycle may develop into what is known as pacemaker-mediated tachycardia (PMT), which often drives the ventricular rate to the Maximum Tracking Rate (MTR).

Retrograde conduction pathways (and the potential for associated PMT) are often enabled by the loss of A-V synchrony. Loss of A-V synchrony may be caused by premature ventricular contractions, atrial oversensing/undersensing and/or loss of atrial capture.

PMT Termination feature

To minimize time at the MTR in response to tracking of retrograde activity, most Boston Scientific pacing and defibrillation products incorporate a PMT Termination algorithm.

In PULSAR MAX pacemakers, PMT is declared when 16 consecutive paced ventricular events occur at the MTR following tracked atrial events. When declared, PVARP is automatically extended to a fixed value of 500 ms for one cardiac cycle. Extending PVARP causes the retrograde atrial event to fall within PVARP, which avoids triggering of another ventricular event and breaks the PMT (similar to intrinsic AV block).

In all other devices (*listed in the Products Referenced section*), the PMT Termination algorithm also incorporates “V-A interval evaluation,” designed to help discriminate true PMT (stable V-A intervals) from Wenckebach operation due to sinus tachycardia or normal exercise response (less stable V-A intervals). In order for PMT to be detected and terminated in these devices:

1. There must be 16 consecutive ventricular paces at the MTR following atrial sensed events and
2. Each of the 16 consecutive V-A intervals must be “stable,” varying no more than 32 ms from the first measured interval. If any of the 16 measured V-A intervals vary more than 32 ms, then the count starts over and the next V-A interval becomes the new measure against which subsequent V-A intervals are compared. For pacemakers, the first measured interval is that which follows the first ventricular pace at the MTR; for defibrillators, it is the interval prior to the first ventricular pace at the MTR.

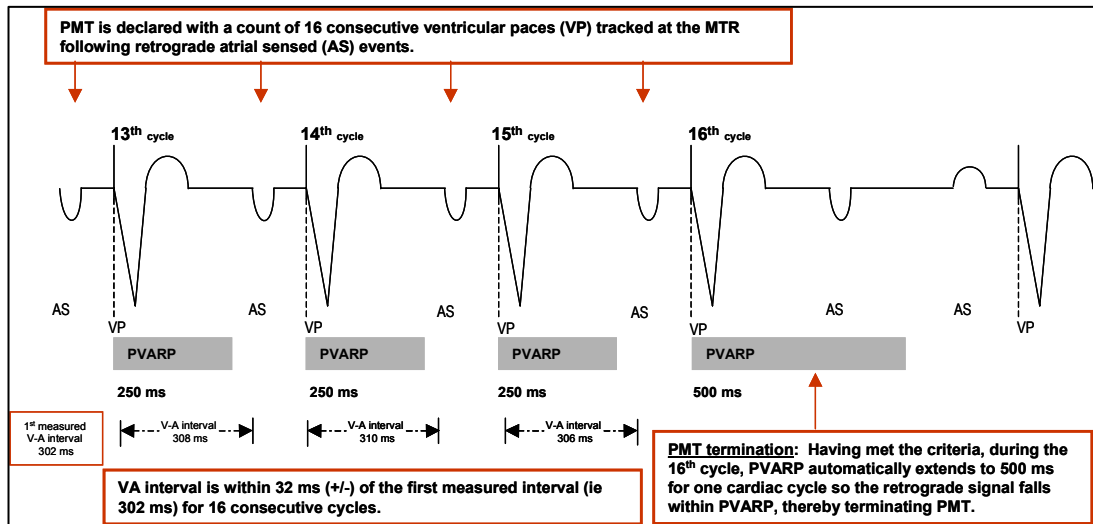


Figure 1. Enhanced PMT algorithm.

Interpreting PMT episodes

PMT starting time and date, the atrial rate at the start of PMT (defibrillators only) and electrograms (pacemakers only) are stored in memory of Boston Scientific devices. Depending on the patient's physiology and device programming, it is possible for the Arrhythmia Logbook to store these data for hundreds of PMT episodes.

The following steps can help determine if the patient's episode was a PMT due to retrograde conduction or simply normal upper rate behavior (exercise response).

Verify appropriate atrial sensing and capture for evidence of situations that may have led to the PMT (for example, loss of A-V synchrony).

1. Check intrinsic amplitude measurement and observe real-time ECG for appropriate sensing.
2. Perform a threshold test to make sure there is atrial capture with an adequate safety margin.

Perform a manual retrograde conduction test and program accordingly

1. In **Temporary** mode, program the device to enable viewing of atrial activity via electrograms and event markers but avoid PMT during the test:
 - a. For pacemakers, temporarily program mode to VDD **and** PVARP to the maximum value allowable for the selected LRL.
 - b. For dual-chamber ICDs and CRT-Ds, temporarily program mode to VVI (which allows viewing of atrial activity and markers but prevents PMT during testing).
2. Temporarily program the **LRL** to different rates (e.g., 90, 100, 110 ppm, etc.) to ensure pacing above the intrinsic atrial rate; retrograde conduction often occurs in a limited rate range only.
3. Start and stop real-time EGM printing as necessary to document retrograde testing.
4. Evaluate for retrograde conduction by looking for retrograde P-waves within PVARP. Measure the time from the ventricular event to completion of the retrograde P-wave, and compare the timing to the programmed PVARP, Dynamic PVARP and PVARP after PVC.
5. If an atrial contraction caused by retrograde conduction time extends beyond the programmed PVARP, reprogram the fixed **PVARP** or minimum **Dynamic PVARP** to ensure the patient's retrograde P-wave falls within PVARP. Similarly, ensure that **PVARP after PVC** is programmed to an appropriate interval. Note: These programmable parameters are located on the Brady Parameters screen under the Refractory submenu.
6. If retrograde P-waves were not identified, the PMT episode was likely due to normal upper rate behavior. In this case, review histograms to determine how often the patient paces at the MTR. Consider raising the MTR, if clinically appropriate.

7. If the Arrhythmia Logbook shows a large number of PMT episodes, consider turning storage of PMT episodes Off; this will help to conserve future space in the logbook, as currently stored PMT episodes cannot be deleted. The PMT counter *still increments* with each PMT episode as long as the PMT algorithm extends PVARP.