

# Troubleshooting the Malfunctioning Pacemaker: A Systematic Approach

Karoly Kaszala, MD, PhD, FHRS

## KEYWORDS

• Pacemaker • Troubleshooting • Capture • Sensing • Noise • Lead fracture • Pacemaker algorithm

## KEY POINTS

- Pacemaker troubleshooting requires an integrated approach with special emphasis on clinical history, physical examination, and device interrogation.
- Successful patient management requires an in-depth understanding of the basics of pacing and device features.
- If an abnormal device function is suspected, a wide differential diagnosis should be established and a didactic approach used to uncover the final diagnosis.

## INTRODUCTION

Expectations for a pacing system are high. Pacemaker leads should withstand the hostile intravascular environment for decades, characterized by excessive chemical and mechanical stress. Pacemaker generators are expected to operate on a single battery without a flaw for 10+ years and appropriately react to cardiac signals without being affected by noise from the neighboring environment. Over the 60-year history of cardiac pacing, as technology continued to evolve, many lessons have been learned and, as a result, the reliability of modern pacemaker systems has reached an exceptional level.<sup>1</sup> In spite of these achievements, an occasional problem with device components continues to occur.<sup>2</sup> More frequently, abnormalities or pseudoabnormalities may be encountered, caused by complexities in device programming and algorithms. Differentiation between these is important in order to ensure proper management and safe patient care. An approach to pacemaker troubleshooting is discussed here.

## PATIENT EVALUATION (CLINICAL HISTORY, PHYSICAL EXAMINATION, STUDIES/TESTING)

In all aspects of medicine, a systematic approach for evaluation of a clinical problem minimizes the chance of overlooking the correct diagnosis, and this is also true during pacemaker troubleshooting. Although a complete evaluation is the goal, the extent of initial investigations should be determined by the urgency of the problem. A focused clinical history, physical examination, and ancillary testing should be performed in most cases. The troubleshooting process is significantly enhanced with meticulous record keeping during the implantation procedure and routine device follow-up visits.

### *Clinical History*

The first step is to identify the presence and circumstances of symptoms that may direct attention to specific problems (**Table 1**). Focused questions should also be directed to screen for specific abnormalities in select patient groups (such as

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Cardiac Electrophysiology Laboratory, Hunter Holmes McGuire Veterans Affairs Medical Center and Virginia Commonwealth University, 1201 Broad Rock Boulevard, Room 111(J3), Richmond, VA 23249, USA

E-mail address: [karoly.kaszala@va.gov](mailto:karoly.kaszala@va.gov)

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**Table 1**  
**Differential diagnosis of symptoms related to pacemaker system malfunction**

Clinical Event or Symptom	Possible Abnormality	Causes
Fatigue, dizziness, chest pain, palpitation, syncope	Pacemaker syndrome	Loss of atrial pacing or capture; nontracking pacing mode; VVI pacing caused by ERI; inadequate AV delay, RV pacing Inadequate rate support
Chest pain (pleuritic)	Lead perforation; pneumothorax, pulmonary embolization	RA or RV lead perforation, perioperative lung injury, DVT
Palpitations	Failed mode switching, inappropriate mode switching, PMT, RNRVAS Upper rate behavior, loss of capture or sensing, intermittent operation of special algorithms Inaccurate sensor rate pacing New arrhythmia	Failed mode switch algorithm caused by undersensing Mode switch is turned off; suboptimal programming of refractory periods or mechanical complication Suboptimal programming of rate sensor or special algorithms
Hiccup/diaphragmatic stimulation	Lead dislodgement, positional change in phrenic nerve and pacer lead proximity	Atrial lead dislodgement or lateral lead positioning LV lead dislodgement/movement
Muscle twitching	Pectoral stimulation	Insulation defect, loose lead pin, unipolar pacing and pocket stimulation
Chest wall stimulation	Perforation, thin body habitus	Lead perforation, far-field capture of skeletal muscle
Heart failure	New heart failure symptoms	Switched A and V lead pin, high % RV pacing, suboptimal AV or VV delay, frequent rapid pacing
Cardiac surgery	Heart manipulation, electrocautery	Lead dislodgement, EMI, device compromise
Other surgery	Electrocautery	EMI
Cardioversion	High electric current	EMI, device compromise, threshold change
Radiofrequency ablation	Local heat production Electric current	EMI, threshold change, lead dislodgement
Therapeutic radiation	Radiation injury	Device reset, circuitry damage

*Abbreviations:* A, atrial; AV, atrioventricular; DVT, deep vein thrombosis; EMI, electromagnetic interference; ERI, elective replacement indicator; PMT, pacemaker-mediated tachycardia; RA, right atrial; RNRVAS, repetitive nonreentrant ventriculoatrial synchrony; RV, right ventricular; V, ventricular; VVI, ventricular pacing and sensing with inhibition.

pacemaker-dependent patients, patients with biventricular devices). Certain symptoms may be intermittent or the patient may not relate those to the pacemaker. Indications for device therapy and symptoms before device implantation should be queried. In the medical history, recent interventions such as surgeries (EMI [electromagnetic interference] noise, circuitry damage), cardioversions (increased threshold, circuitry damage), ablation procedures (lead dislodgement, increased threshold), or therapeutic radiation (device reset and memory problems; rarely damage to the circuitry and decreased battery life) should be noted. New diagnoses such as renal failure, heart failure, myocardial infarction, or new medication prescriptions should be recorded.

Implant and device clinic data should be reviewed with special attention to the implant report. Lead and device type and serial numbers, access site, pacemaker pocket location, any procedural difficulties, or problems during follow-up should be noted. The timeline in relation to device implantation and symptoms may also provide clues for specific causes. Examples are listed in **Box 1**.

### **Physical Examination**

Focused physical examination is an important part of device troubleshooting and follow-up. The device site should be inspected and palpated to ensure proper healing and to rule out erosion or impending erosion. Presence of muscle twitching

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