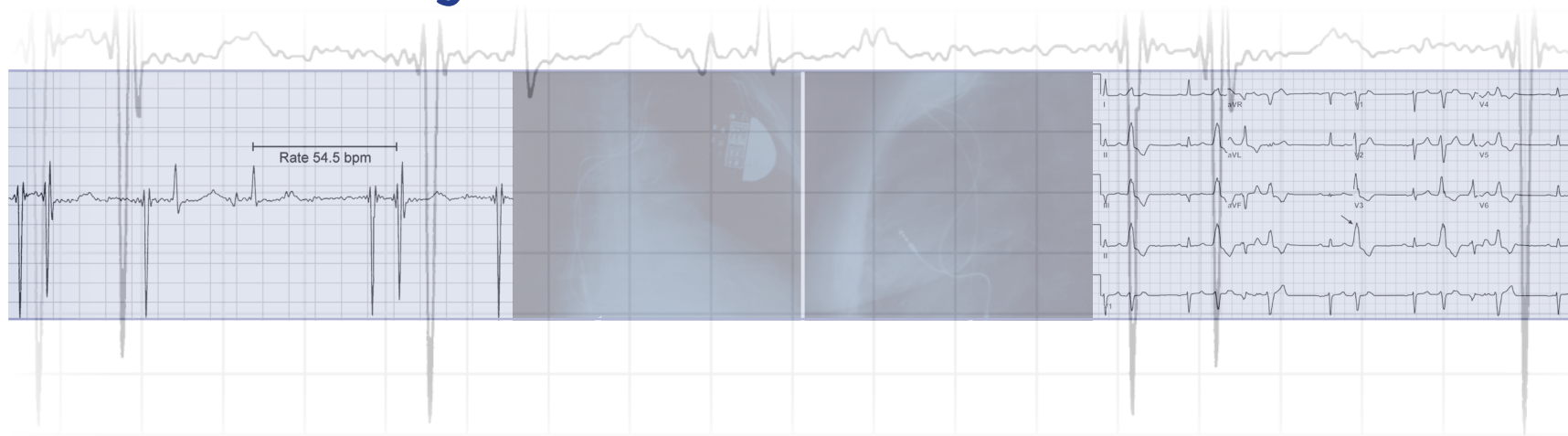


A Case-Based Approach TO Pacemakers, ICDs, AND Cardiac Resynchronization

Volume 1



Questions for Examination Review and Clinical Practice

Edited by

Paul A. Friedman MD, FACC, FHRS | Melissa A. Rott RN

Anita Wokhlu MD | Samuel J. Asirvatham MD, FACC, FHRS

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Editors and Other Contributors

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Editors

Paul A. Friedman MD, FACC, FHRS

Consultant, Division of Cardiovascular Diseases
Mayo Clinic, Rochester, Minnesota
Professor of Medicine
College of Medicine, Mayo Clinic

Melissa A. Rott RN

Heart Rhythm Services
Division of Cardiovascular Diseases
Mayo Clinic, Rochester, Minnesota

Anita Wokhlu MD

Fellow in Electrophysiology, Mayo School of Graduate
Medical Education
College of Medicine, Mayo Clinic, Rochester, Minnesota
Assistant Professor of Medicine, College of Medicine,
Mayo Clinic

Samuel J. Asirvatham MD, FACC, FHRS

Consultant, Divisions of Cardiovascular Diseases
and Pediatric Cardiology
Mayo Clinic, Rochester, Minnesota
Professor of Medicine and of Pediatrics
College of Medicine, Mayo Clinic

David L. Hayes MD, FACC, FHRS

Consultant, Division of Cardiovascular Diseases
Mayo Clinic, Rochester, Minnesota
Professor of Medicine
College of Medicine, Mayo Clinic

Contributors

Craig S. Cameron MD, FACC, Oklahoma Heart Institute, Tulsa, Oklahoma (Cases 52 and 53)

Gregory A. Cogert MD, FACC, Oklahoma Heart Institute, Tulsa, Oklahoma (Cases 52 and 53)

Connie M. Dalzell RN, Mayo Clinic, Rochester, Minnesota

Joseph J. Gard MD, College of Medicine, Mayo Clinic, Rochester, Minnesota

Michael Glikson MD, FACC, FESC, Leviev Heart Center, Sheba Medical Center, Tel Hashomer, Israel (Case 54)

Michael J. Hillestad RN, Mayo Clinic, Rochester, Minnesota

Nancy Y. Lexvold RN, Mayo Clinic, Rochester, Minnesota

Madhavan Malini MBBS, College of Medicine, Mayo Clinic, Rochester, Minnesota

Marjorie L. Martin RN, Mayo Clinic, Rochester, Minnesota

David A. Sandler MD, FACC, FHRS, Oklahoma Heart Institute, Tulsa, Oklahoma (Cases 52 and 53)

Matthew J. Swale MBBS, College of Medicine, Mayo Clinic, Rochester, Minnesota

K. L. Venkatachalam MD, Mayo Clinic, Jacksonville, Florida

Tracy L. Webster RN, Mayo Clinic, Rochester, Minnesota

Preface

The book that you hold in your hands, *A Case-Based Approach to Pacemakers, ICDs, and Cardiac Resynchronization: Questions for Examination Review and Clinical Practice*, is a compilation of our favorite teaching cases that were seen at or sent to Mayo Clinic. As our device practice has grown, we have found that one of the best ways to remain current and to educate incoming physicians and nurses is the review of interesting “unknown” clinical cases. Consequently, we established a morning conference in 2008 for the purpose of presenting and discussing interesting or uniquely educational cases. Since learners ranged from cardiology fellows who were new to the device practice to experienced nurses and physicians, group discussion brought out facets of interest at all levels. Cases for this book were selected based on clinical relevance and their usefulness for illustrating general principles, practical tips, or interesting findings in device practice. Occasionally, manufacturer-specific features are discussed, but always with a goal of advancing general concepts in device management.

The cases in this book are presented as a case history, an image when pertinent, and a multiple-choice question. The answer and a detailed explanation is presented on subsequent pages. We’ve adopted this format to encourage the reader to think through the differential diagnosis and approach the clinical problem based on the information

presented. In light of the growing use of pacemakers, defibrillators, and resynchronization devices, we are confident that readers will find this practical means of self-assessment and education useful. Although the questions are designed in a multiple-choice format that may be particularly useful for self-assessment for test-takers, they are not formally validated board questions. This book is for any individual who sees patients with implantable devices, or who will be taking an examination related to device management.

How to Use This Book

The cases generally progress from simpler to more complex, understanding that there will be individual variation in what constitutes a difficult case.

There is no table of contents because the case numbers are clearly marked at the top of each page and we specifically did not want to include in the beginning of the book a listing of the “diagnosis” for each case and therefore limit the ability for the reader to approach the cases as unknowns.

For the reader interested in reviewing a specific type of case (such as “T-wave oversensing” or “inappropriate shock”), two resources are offered. An appendix is provided that identifies the major diagnostic

dilemma presented by each case, and the index will direct the reader to cases and discussions focusing on specific issues. However, we encourage readers to progress sequentially through cases as unknowns to maximize learning and interest.

This book is one of two volumes. The first volume includes introductory and intermediate cases. The second volume includes additional intermediate cases as well as advanced cases. There are more multipart cases in volume 2, to delve more deeply into important concepts.

In various electronic versions of this book, hypertext links and linked indices have been added to facilitate navigation. Also, a combined index that covers both volumes is available at www.cardiotextpublishing.com/titles/detail/9781935395812.

This text includes a collective wisdom of numerous physicians, nurses, technicians, educators, and practitioners. We are indebted to the entire Heart Rhythm services team at Mayo Clinic for identifying and discussing cases, and educating us with them. We have also benefitted

greatly from friends and colleagues at other institutions who have kindly shared interesting cases with us, and permitted us to include them in this work. We are grateful for their generosity. If you come across an interesting case that you would like included in a future edition of this book, we would love to discuss it with you. E-mail addresses are listed below for that purpose. Please enjoy the cases! We look forward to your feedback and future contribution.

—Paul Friedman MD and David Hayes MD

Samuel Asirvatham: asirvatham.samuel@mayo.edu

Paul Friedman: friedman.paul@mayo.edu

David Hayes: dhayes@mayo.edu

Melissa Rott: rott.melissa@mayo.edu

Anita Wokhlu: woklhu.anita@mayo.edu

Abbreviations

A	atrial	EP	electrophysiological	PVC	premature ventricular contraction
AF	atrial fibrillation	FFRW	far-field R wave	RAO	right anterior oblique
APC	atrial premature contraction	ICD	implantable cardioverter-defibrillator	RBBB	right bundle branch block
AS	atrial sensed	IV	intravenous	RV	right ventricle; right ventricular
ASD	atrial septal defect	J	Joules	RVOT	right ventricular outflow tract
AT	atrial tachycardia	LAO	left anterior oblique	SVT	supraventricular tachycardia
ATP	antitachycardia pacing	LBBB	left bundle branch block	TARP	total atrial refractory period
AV	atrioventricular	LV	left ventricle; left ventricular	TENS	transcutaneous electrical nerve stimulation
AVNRT	atrioventricular nodal reentrant tachycardia	LVEF	left ventricular ejection fraction	V	ventricular
BBB	bundle branch block	MRI	magnetic resonance imaging	VA	ventriculoatrial
CI	confidence interval	OR	odds ratio	VF	ventricular fibrillation
CRT	cardiac resynchronization therapy	PA	pulmonary artery	VRR	ventricular rate regulation
CT	computed tomographic	PAC	premature atrial contraction	VS	ventricular sensed
ECG	electrocardiogram	PMT	pacemaker-mediated tachycardia	VSD	ventricular septal defect
EGM	electrogram	PVARB	postventricular atrial blanking period	VT	ventricular tachycardia
EMI	electromagnetic interference	PVARP	postventricular atrial refractory period		

A Case-Based Approach
TO Pacemakers, ICDs, AND
Cardiac Resynchronization

Volume 1

Questions for Examination Review and Clinical Practice

Case 1

2

A 67-year-old male received a dual-chamber ICD for inducible ventricular tachycardia in the presence of ischemic heart disease. Four years later he received his first shock during a visit to his chiropractor. He had sought chiropractic treatment due to chronic shoulder discomfort.

Device settings:

- Mode: DDD
- Mode switch: on
- Pacing rate: 40 bpm (lower rate), 120 bpm (upper rate)
- Amplitude: 2.6 V (right ventricular), 2.0 V (atrial)
- Pulse width: 0.50 ms (right ventricular), 0.40 ms (atrial)
- Sensitivity: 0.18 mV (right ventricular), 0.18 mV (atrial)
- Dynamic AV: off
- Refractory after pace: 250 ms
- Antitachycardia therapies: initial burst ATP followed by 33-J shock

Upon interrogation the tracing in Figure 1.1 was obtained.

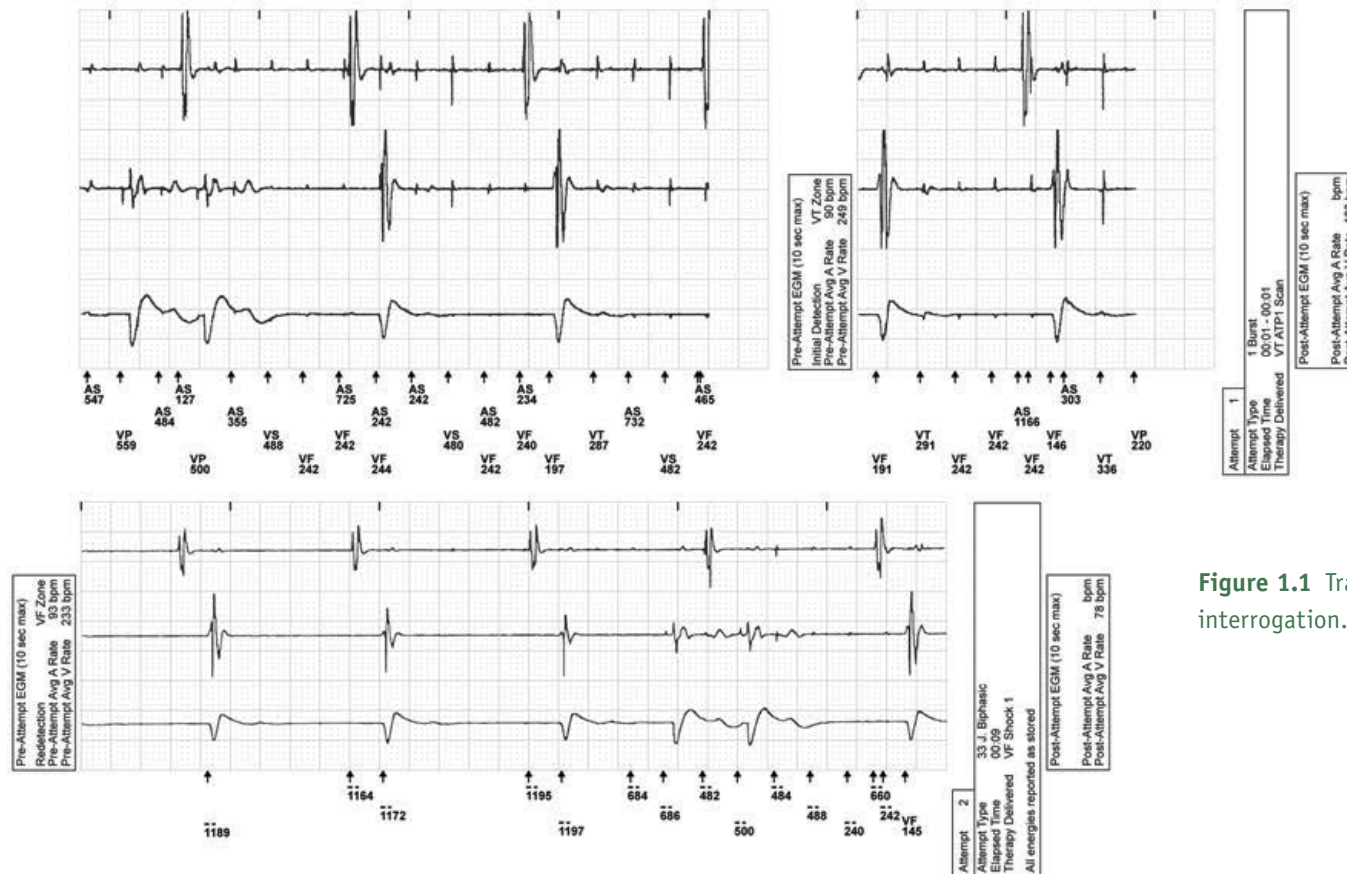


Figure 1.1 Tracing upon interrogation.

Q

As a result of the EGMs and therapies delivered, what would be your next step?

1. Initiate new or additional antiarrhythmic medications
2. Consider ablation of the ventricular ectopic focus
3. Reprogram ventricular sensitivity
4. Look for source of EMI

1

4. Look for source of EMI

The tracing reveals sinus rhythm with a rate of approximately 52 bpm. However, other signals are present on the EGMs, often occurring at a regular cycle length of approximately 220 ms, which, if consistent, would be equivalent to a rate of approximately 272 bpm. These signals are sensed as ventricular events and labeled as VF or VT. Burst ATP therapy is delivered at the end of the first strip and a 33-J shock is delivered after the second tracing. Postshock tracing is shown in Figure 1.2. The signals that were occurring at a cycle length of 220 ms are no longer present. Note that the tracing includes both AS-VP cycles as well as VS events that appear to be premature ventricular contractions.

The appearance of very regular signals without any corresponding intrinsic events on the EGM or surface recording suggests electromagnetic noise or interference. In this example, the patient was receiving a treatment with diathermy. When the shock was delivered the diathermy

was stopped and no further noise is noted. Diathermy is a method of physical therapy that involves generating local heat in body tissues by high-frequency electromagnetic currents.

A question could arise as to whether a problem with ventricular lead integrity was responsible for this appearance. When oversensing occurs as a result of loss of lead integrity, the VV intervals would most likely be shorter and more irregular.

Any circumstance in which a device patient is going to be subjected to any equipment with known potential for electromagnetic interference should be carefully assessed prior to initiating therapy.

Answers 1 and 2 are incorrect because the abnormality noted is due to external EMI, not an intrinsic rhythm disturbance. Answer 3 is incorrect because ventricular sensing is fine in the absence of the EMI.

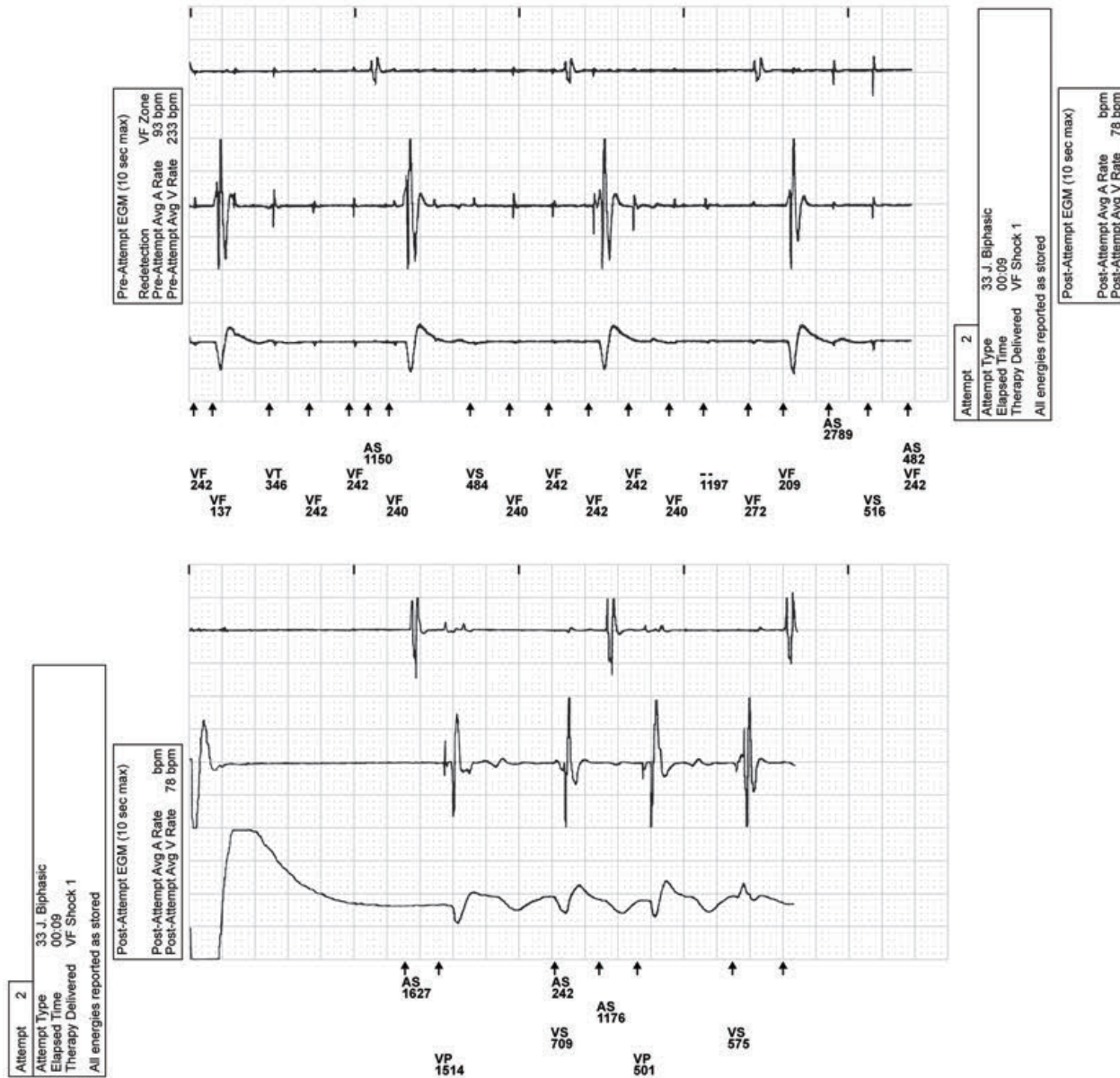


Figure 1.2 Postshock tracing.

Case 17

70

PACEMAKERS, ICDs AND CARDIAC
RESYNCHRONIZATION

The same 73-year-old man from case 16, with a history of single-chamber defibrillator implantation, has a RV pace-sense lead added because of T-wave oversensing on his defibrillator lead, which was causing inappropriate shocks. One month later, the patient receives another defibrillator shock and remotely transmits his data. The patient is currently in sinus rhythm. Figure 17.1 shows the shock episode.

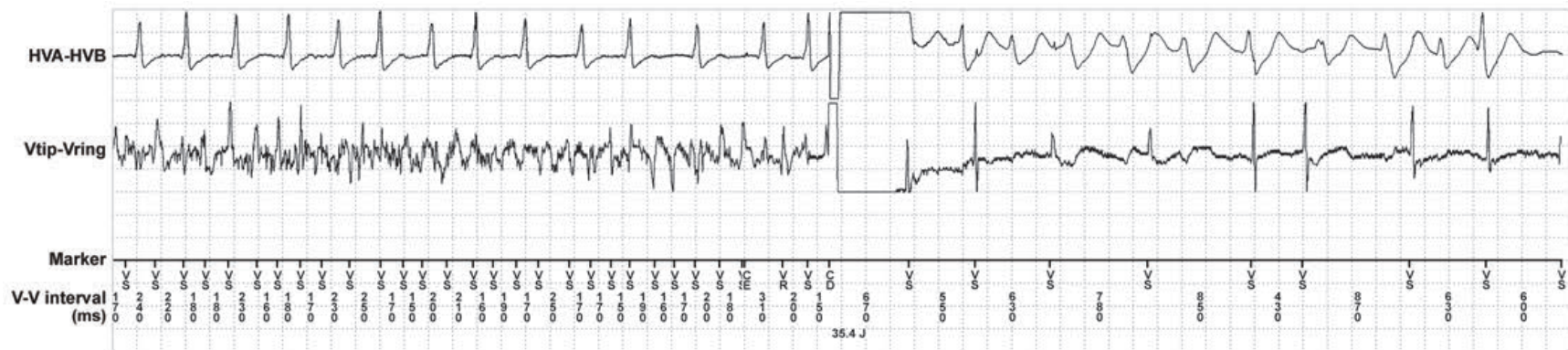


Figure 17.1 Arrhythmia episode. The top row demonstrates far-field signal derived from the high-voltage EGM (shock). The bottom row demonstrates near-field signal derived from a separate RV sense-pace lead.

Q:

What is the most likely cause of the shock episode?

1. Lead dislodgment
2. Dual atrial and ventricular tachycardias
3. Electromagnetic interference
4. Oversensing of diaphragmatic myopotentials

time EGM that was transmitted following the shock. The ventricular EGMs on the near-field channel correspond to P waves rather than QRS complexes, indicating that the ventricular pace-sense lead was dislodged to the atrium. The smaller, dedicated pace-sense lead may be more prone to dislodgment into the atrium than a defibrillator's lead.

Oversensing of atrial signals on the ventricular lead can occur with dislodgment of the ventricular lead to the annulus or to the atrium (as in the present case). Integrated bipolar leads, particularly with proximally placed leads or in children, may also lead to oversensing of atrial EGMs since the large distal coil is part of the sensing circuit. If it is placed at or near the level of the tricuspid valve annulus, it may record atrial and

ventricular signals. Atrial arrhythmias, in particular, may be sensed incorrectly as ventricular arrhythmias.

There is no ventricular tachycardia present, making answer 2 incorrect. Electromagnetic interference (answer 3) is incorrect because it would be present, and typically larger in amplitude, on the far-field EGM as well as the near-field EGM. Answer 4 is incorrect because diaphragmatic myopotentials, although also near-field, present as bursts of lower-amplitude, high-frequency noise that varies with respiration and occur most commonly after pacing or long diastolic intervals. The pattern should be similar after a shock.

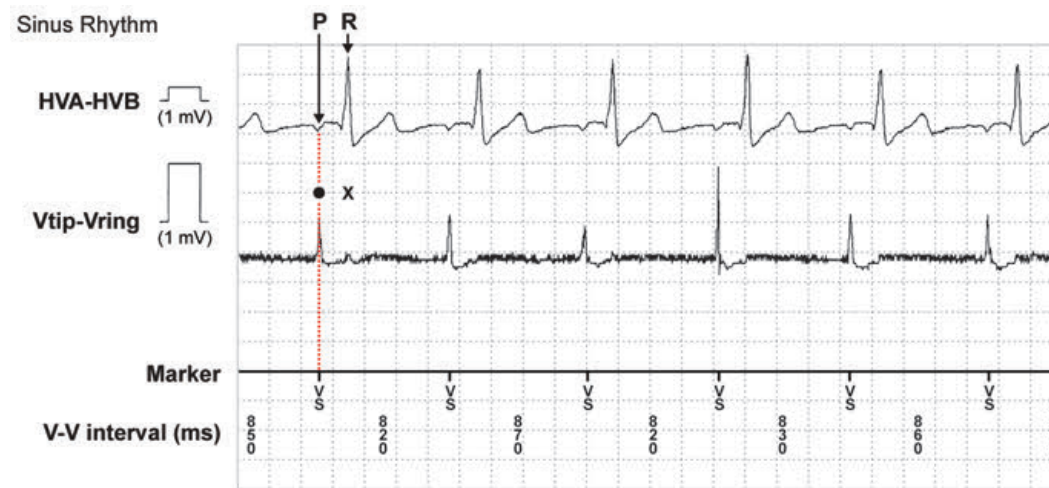


Figure 17.3 Real-time EGM.

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