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Interpreting the ECG of a Patient with a Pacemaker

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INTERPRETING ECGS

Interpreting the ECG of a patient with a pacemaker

James F. Ginter, MPAS, PA-C, Patrick Loftis, PA-C, MPAS, RN June 14, 2011

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Originally developed for the treatment of symptomatic bradyarrhythmias, artificial cardiac pacemakers (PMs) consist of a battery and electrical circuits that are encased in a sealed container. PMs deliver electrical stimuli over leads that are connected to the right atrium, right ventricle, or both right-sided chambers.



HISTORY

The first pacemakers were classified as atrial, ventricular, or dual-chamber devices. A single-chamber atrial PM has a generator and an electrode that is placed in the right atrium. A ventricular PM has a generator and an electrode that is placed in the right ventricle. A dual-chamber PM has two separate electrodes: one that is placed in the right atrium and one that is placed in the right ventricle.

The earliest pacemakers were capable of stimulating the heart at a fixed rate only. They could not recognize or sense the recipient's spontaneous rhythm. To avoid competition between the PM and the patient's own rhythm, second-generation devices were equipped with the capability to sense the intrinsic atrial or ventricular impulse. Whenever a spontaneous atrial or ventricular impulse was detected, the PM was inhibited from delivering an impulse. These devices were called demand pacemakers.

As pacemakers became more advanced, a coding system evolved to identify the different functions a PM was capable of performing. The first universally accepted coding system was developed by the Intersociety

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Commission on Heart Disease Resources in 1974.¹ This system consisted of three characters that identified the type and basic function of the PM. The first character indicated the chamber that was being paced: A for atrium, V for ventricle, or D for dual (both atrium and ventricle). The second character indicated which chamber was being sensed: A for atrium, V for ventricle, D for dual (both atrium and ventricle), or the number 0 for none. The third character described the response of the PM to a sensed event: I for inhibit, T for trigger, D for dual (atrial inhibition followed by ventricular triggering), or 0 for no response. This system applied to a PM's antibradyarrhythmia function only.

In 1981, the North American Society of Pacing and Electrophysiology (NASPE) and the British Pacing and Electrophysiology Group (BPEG) developed a five-function coding system known as the NBG code for pacing nomenclature.² The first three characters are the same as the original coding system. The fourth character is R or 0; R refers to the pacemaker's ability to adjust its programmed paced rate based upon patient activity, and 0 indicates that the PM has no such ability. The fifth character identifies the location or absence of multisite pacing, defined as stimulation sites in both atria, both ventricles, and more than one stimulation site in any single chamber. The number 0 signifies no multisite pacing, A indicates multisite pacing in the atria, V indicates multisite pacing in the ventricles, and D indicates dual multisite pacing in both atria and ventricles. The most common presentation of multisite pacing is biventricular pacing for the management of heart failure. A pacemaker in such a patient could be identified as a VVTRV pacemaker.

PACEMAKER'S EFFECT ON AN ECG

A paced rhythm is easy to recognize. When a pacemaker fires, a small spike is seen on the ECG. An atrial pacemaker will generate a spike followed by a P wave and a normal QRS complex. **Figure 1** shows the ECG of a patient with an atrial pacemaker that was placed to address a problem in the sinoatrial (SA) node. Once the electrical cycle is started, it proceeds through the atrioventricular (AV) node and continues distally as normal.

With a ventricular pacemaker, a spike is seen before the QRS complex. In **Figure 2**, a normal P wave is followed by a pacemaker spike in front of a wide QRS complex. In this patient, the electrical cycle started normally in the SA node but was blocked at the AV node. The electrode was placed in the right ventricle, which depolarized first, followed by the left ventricle. This placement generates a wide QRS complex similar to that seen in left bundle branch block.

A sequential pacemaker stimulates the atrium first and then the ventricle. With a sequential PM, two spikes are seen, one before the P wave and the other before the QRS complex.

ECG CHALLENGE

A PA student asks for help interpreting an ECG (**Figure 3**), saying that it does not look right. You take him through the step-by-step process for evaluating ECGs.

- (1) Is the rhythm **regular**? Use your calipers and march out the QRS complexes. It is a regular rhythm.
- (2) Now look at the **heart rate**.

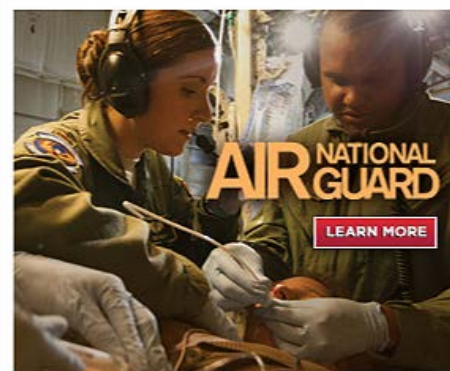
Method A: Assign each big box between QRS complexes a number as follows: 300, 150, 100, 75. The second QRS appears at about 75, so you can estimate the rate at 75 beats per minute.

Method B: Count the number of QRS complexes in 6 seconds (30 boxes), and multiply by 10. $7.5 \times 10 = 75$ beats per minute.

Method C: Count the number of large boxes between QRS complexes, and then divide 300 by that number. $300 \text{ divided by } 4 = 75$ beats per minute.

- (3) Is there a **P wave** before every QRS? Do all the P waves look the same? The answer to both questions is yes. We also see a pacer spike before the P wave. This is an atrial paced rhythm.
- (4) Is the **PR interval** greater than 3 small boxes and less than one large box? Yes. Therefore, the patient's heartbeat is in sinus rhythm.

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I agree with David. So another David will say thank you very much for the kind words for my profession. Dave

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Dave Mittman, PA

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(5) Does the **QRS complex** span fewer than 3 small boxes? No. We also see a pacer spike before the QRS complex. This is a ventricular paced rhythm causing a left bundle branch block appearance in the QRS complexes

(6) Is the **ST segment** neutral, elevated, or depressed? The ST segment cannot be interpreted in a ventricular paced rhythm.

(7) The **T waves** are normal.

(8) There are no **U waves**.

You tell the student that this ECG indicates an atrial/ventricular-paced rhythm at a rate of 75 beats per minute.

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REFERENCES

1. Parsonnet V, Furman S, Smyth NP. Implantable cardiac pacemakers status report and resource guideline. Pacemaker Study Group. *Circulation*. 1974;50(4):A21-A35.
2. Bernstein AD, Daubert JC, Fletcher RD, et al. The revised NASPE/BPEG generic code for antibradycardia, adaptive-rate, and multisite pacing. North American Society of Pacing and Electrophysiology/British Pacing and Electrophysiology Group. *Pacing Clin Electrophysiol*. 2002;25(2):260-264.

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David Bunnell

Thank-you to Dr. Furnary for your continuing support and thoughtful commentary.

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community on **DISQUS**

This is a nice review/explanation. For 15 years I worked with Seymour Furman, who developed the first transvenous pacemaker. It was good to see him in the bibliography. I also know the others mentioned in the credits. I was a member of NASPE, and helped found the organization for paraprofessionals working in pacing and electrophysiology and took the first board certification offered in this field.

1 year ago

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Gina Spino-Rogers

Figure 1 is AP VP. Figure 3 is sensing in V...Not APVP. Must have scanned in backwards

1 year ago

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