EKG TECH BASICS · ONE-PAGER

Pacemakers and Implanted Devices on the ECG

The pacemaker code, atrial, ventricular, dual-chamber and biventricular pacing, capture and sensing problems, magnets, ICD shocks, and filters that hide or fake spikes

17 sources + more detail
ekgtechbasics.com/sheets/ekg-pacemakers-devices.html
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1 The pacemaker code (NBG)

LETTER	MEANS	CHOICES
1st	Chamber paced	A atrium, V ventricle, D both
2nd	Chamber sensed	A, V, D, O
3rd	Response to a sensed beat	I inhibit, T trigger, D both, O none
4th	Rate response	R raises the rate with activity, O none
5th	Multisite pacing	For example both ventricles; O none

VVIR: paces and senses the ventricle, holds back when it senses a beat, speeds up with activity. DDD is the most common mode. AOO, VOO and DOO pace at a fixed rate and sense nothing (asynchronous).

2 What paced beats look like

PACING	ON THE STRIP
Spike	Narrow vertical line, about 2 ms; tiny with bipolar leads, so check every lead
Atrial	Spike, then a P wave; the patient's own QRS follows
Ventricular (RV lead)	Spike, then a wide QRS shaped like LBBB, ST-T opposite the QRS
Dual-chamber	Spikes before the P only, the QRS only, or both, depending on the patient's own beats
Biventricular (CRT)	Paced QRS often upright in V1; two ventricular spikes may show as one
Fusion	Spike on a QRS that is a hybrid of paced and native; normal function
No spikes	Own rhythm is fast enough: a demand pacemaker waits and senses



Dual-chamber pacing: atrial spike and P wave, a set delay, then a ventricular spike and wide QRS. Ventricular pacing alone, failure to capture and failure to sense are drawn in the Rhythm Gallery.

EXAM TIP A normal ECG does not rule out a pacemaker. Ask about devices, note the device on the tracing, and tell the reader, so a paced QRS is not read as a new bundle branch block.

3 Naming the problem

PROBLEM	ON THE STRIP	COMMON CAUSES
Failure to capture	Spike with no P wave or QRS after it	Lead moved or broken, battery, threshold rise; electrolytes, drugs, MI
Undersensing (failure to sense)	Spikes ignore the patient's own beats; can land on a T wave	Lead problem, small native signals
Oversensing	Pause with no spike when one is due; often with muscle noise	T waves, muscle activity or interference read as beats
Failure to pace	No spikes; rate falls below the programmed rate	Oversensing, battery or generator, poor lead contact
Paced rate too fast	Paced rate faster than expected, up to the device's upper rate	Tracking a fast atrial rhythm, PMT, activity sensor

SAFETY A spike on a T wave (R on T) can trigger VT, torsades or VF: report it promptly even if the patient feels fine. Pauses, lost capture or dizziness: stay with the patient and tell the nurse now. Unresponsive and not breathing normally: call the code team and start CPR.

4 Magnets and ICDs

DEVICE	MAGNET ON (STOPS WHEN IT IS LIFTED)
Most pacemakers	Fixed-rate pacing at the maker's magnet rate; spikes march through the patient's own beats
Transvenous ICD	Shocks and antitachycardia pacing suspended; no fixed-rate pacing
Micra leadless pacemaker	No magnet response

- Placing a magnet is the provider's decision; record and report what the strip shows.
- An ICD also paces, so its spikes look like a pacemaker's. Antitachycardia pacing is a short burst of fast paced beats that can stop VT without a shock.
- Shock, patient awake: stay, tell the nurse, save the strip and the time. Several shocks or symptoms: urgent.
- Shock, patient unresponsive: code team, CPR, AED with the pad off the device. Touching a patient during an ICD shock is not harmful.

5 Filters, monitors and look-alikes

- Record first at the diagnostic setting (to 150 Hz); a 40 Hz filter can blunt, hide or distort spikes. Label any filter.
- Many monitors find spikes only with their pacer setting on and then draw their own marker; with it off, paced beats can alarm as a ventricular rhythm.
- Fake spikes: static from clothing, loose or broken wires, nerve stimulators (fixed-rate spikes unrelated to the P or QRS).

6 Exam pearls

EXAM TIP Spike, no QRS: failure to capture. Spikes among the patient's own beats: undersensing. Pause with no spike: oversensing or failure to pace. Two spikes per beat: dual-chamber. Wide LBBB-like QRS after each spike: RV pacing. No spikes with a normal rhythm: demand pacing, not failure. Magnet: fixed-rate pacing, expected. Paced 'LBBB' on the computer read: note the device.

MORE Spikes: why they are small, missing or fake

A pacing stimulus is very brief, so on paper it is a thin vertical line, usually about 2 ms wide (LITFL). Its height depends on where the lead sits and what kind of lead it is: bipolar leads make much smaller spikes than unipolar leads, and epicardial leads make smaller spikes than leads inside the heart. A spike that is obvious in one lead may be invisible in the next, which is why CanadiEM advises checking every lead before deciding a beat is not paced.

Machines have to work to see them. In one study of electrocardiographs, pacer spike detection from the ordinary 500-samples-per-second data stream found 77.5% of spikes, while a detector sampling at 32,000 per second found 99.5% (Luo 2008). The same study notes that a slow data stream can show only one spike when two ventricular leads fire close together, as in biventricular pacing. Stored ECGs are usually compressed, and SCST warns that compression changes short, sharp signals such as pacemaker spikes more than it changes the ST segment, so an archived copy may not match the original.

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