

⚡ CARDIOLOGY

CARDIAC RHYTHM DEVICES

PHARMACOLOGY

NGN NCLEX 2026

Pacemakers

An electrical device that delivers impulses to stimulate the heart when the natural conduction system fails — covering nursing care, malfunction recognition, and patient teaching.



1 Definition & Overview

- ▶ **Pacemaker** = battery-powered electronic device that delivers electrical impulses through leads to stimulate myocardial contraction when the heart's intrinsic conduction is too slow, blocked, or unreliable.
- ▶ **Components:** pulse generator (battery + circuitry) + one or more lead wires + electrode tip in contact with the myocardium.
- ▶ **Why it matters:** restores adequate cardiac output and perfusion; prevents syncope, heart failure, and sudden cardiac death from severe bradyarrhythmias.

Types of Pacemakers

PERMANENT

Implanted (PPM)

Surgically placed under the skin in the upper chest (pectoral pocket); leads threaded via subclavian vein into the heart. Battery lasts **8–10 years**.

TEMPORARY

Short-term Support

Transcutaneous (external pads — emergency), **Transvenous** (lead via vein to RV), or **Epicardial** (wires placed during cardiac surgery).

Common Indications

Symptomatic bradycardia

HR too low to perfuse → dizziness, syncope.

2nd & 3rd-degree AV block

Mobitz II & complete heart block.

Sick Sinus Syndrome

Tachy-brady; SA node dysfunction.

Asystole

Emergency transcutaneous pacing.

Post-cardiac surgery

Epicardial wires used temporarily.

Drug-induced bradycardia

Refractory to atropine.

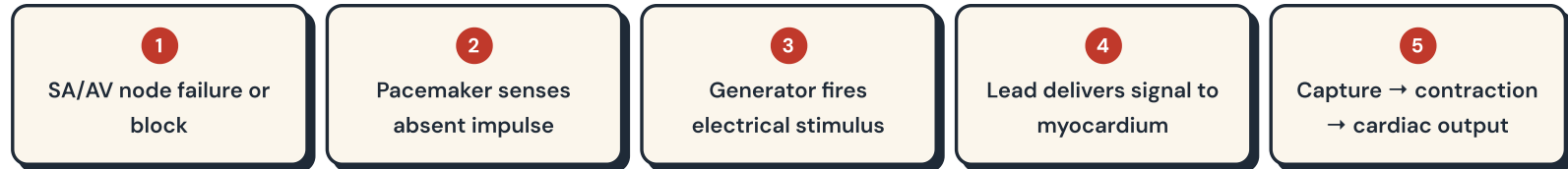
Goal HR: usually set 60–80 bpm

Battery life: 8–10 yrs

Lead position: RA, RV, or both

2 Pathophysiology & How It Works

The pacemaker continuously **senses** the heart's electrical activity. If the heart fails to fire on its own at the preset rate, the pulse generator delivers an electrical impulse that **captures** the myocardium → depolarization → contraction.



Pacemaker Code (NBG) — First 3 Letters

Position	Meaning	Common Letters
1st letter	Chamber Paced	A = atrium · V = ventricle · D = dual
2nd letter	Chamber Sensed	A · V · D · O (none)
3rd letter	Response to Sensing	I = inhibit · T = trigger · D = dual

DDD (most common) = paces both chambers, senses both, dual response. VVI = paces & senses ventricle, inhibited by intrinsic beat.

Pacing Modes

DEMAND (SYNCHRONOUS)

Fires only when needed

Senses intrinsic rhythm; fires *only* when HR drops below the set rate. Most common & safest mode.

FIXED (ASYNCHRONOUS)

Fires at preset rate

Paces continuously regardless of intrinsic rhythm. Risk of **R-on-T** → **V-fib**. Rarely used long-term.

3 Signs & Symptoms — Malfunction Patterns

When something goes wrong, identify the **type of malfunction** from the ECG strip and the patient's symptoms. The three core failures are *capture*, *sense*, and *pace*.

Malfunction	ECG Finding	Cause	Patient Cues
Failure to CAPTURE	Pacemaker spike present but no QRS follows	Lead displacement, low battery, fibrosis at electrode tip, electrolyte imbalance	Bradycardia, dizziness, syncope, ↓BP
Failure to SENSE	Spike fires at wrong time (during T-wave or normal beat)	Lead displacement, sensitivity setting too low, battery depletion	Palpitations; risk of R-on-T → V-fib
Failure to PACE	No spike when one is expected	Battery depletion, broken lead, generator failure	Bradycardia returns, syncope, hypotension

Patient Signs of Malfunction

- ▶ **Hiccups (intractable)** — diaphragmatic stimulation = lead displacement 🚩
- ▶ Dizziness, lightheadedness, syncope
- ▶ Pulse rate *below* the preset pacemaker rate
- ▶ Chest muscle twitching at generator site
- ▶ Palpitations or "skipped beats"
- ▶ Shortness of breath, fatigue
- ▶ Hypotension; cool, pale skin (poor perfusion)
- ▶ Hematoma, redness, drainage at insertion site

🚩 RED FLAG: Hiccups = Lead Displacement

Persistent hiccups, twitching of the chest wall or diaphragm, or a pulse *below* the pacemaker's set rate signal a displaced lead or capture failure — notify the provider immediately and prepare for repositioning.

4 Priority Nursing Interventions

A · B · C

Airway, Breathing, Circulation

Monitor continuous ECG, HR, BP, and SpO₂. Compare apical pulse to set rate every shift. Assess perfusion (LOC, skin, urine output).

SITE CARE

Insertion-Site Assessment

Assess for bleeding, hematoma, swelling, redness, warmth, drainage. Keep dressing dry & intact. Report sudden swelling or fever.

ACTIVITY

Limit Operative-Side Movement

Restrict arm on operative side: no raising above shoulder × 4–8 weeks; no lifting > 5 lb; immobilize per protocol to prevent lead dislodgement.

SAFETY

Electrical & MRI Safety

Avoid MRI (unless device is MRI-conditional), strong magnets, arc welders, and large running motors. Cell phone ≥ 6 in / opposite side.

TEMP PACING

Transcutaneous / Transvenous

Provide sedation/analgesia (painful!). Verify capture: every spike followed by QRS & palpable pulse. Keep external generator secured & battery checked.

DOCUMENTATION

Strip + Settings

Document rhythm strip, pacing mode, set rate, output (mA), sensitivity, and capture status every shift and with any changes.

⚡ Priority Action Sequence (Suspected Malfunction)

1) Assess patient (LOC, pulse, BP) → 2) Obtain ECG strip → 3) Position on

LEFT side

if lead displacement suspected → 4) Notify provider → 5) Prepare for chest x-ray & possible repositioning → 6) Have transcutaneous pacing pads & emergency drugs ready.

5 Pharmacology

Drugs are used *before, around, and after* pacemaker placement — to manage bradycardia until pacing begins, support perfusion, and prevent thromboembolism.

Atropine

ANTICHOLINERGIC · 1ST-LINE BRADYCARDIA

Mechanism: Blocks vagal tone → ↑ SA node firing & AV conduction → ↑ HR.

Dose: 0.5–1 mg IV push, may repeat to 3 mg max. **Side effects:** tachycardia, dry mouth, urinary retention, blurred vision, confusion (elderly).

Nursing: Use while preparing transcutaneous pacing for symptomatic bradycardia. Ineffective in 2nd-degree Mobitz II & 3rd-degree block — **pace, don't wait.**

Epinephrine

SYMPATHOMIMETIC / ADRENERGIC

Mechanism: α + β agonist → ↑ HR, contractility, BP.

Side effects: tachydysrhythmias, hypertension, anxiety, tremor, ↑ myocardial O₂ demand.

Nursing: IV infusion 2–10 mcg/min for refractory bradycardia bridging to pacing. Continuous BP & ECG monitoring; central line preferred.

Dopamine

INOTROPE · VASOPRESSOR

Mechanism: Dose-dependent. At 5–20 mcg/kg/min → ↑ HR, contractility, BP.

Side effects: tachycardia, ectopy, ischemia, extravasation tissue necrosis.

Nursing: Titrate per BP/HR; central line preferred. Caution in CKD. Have phentolamine on hand for extravasation.

Isoproterenol

B1 + B2 AGONIST

Mechanism: Pure β agonist → ↑ HR, contractility, vasodilation.

Use: Bradycardia bridging to pacemaker (less common today).

Nursing: Monitor for tachydysrhythmias, ischemic chest pain, hypotension.

Anticoagulants (Heparin / DOACs / Warfarin)

POST-IMPLANT PROPHYLAXIS WHEN INDICATED

Mechanism: Prevent thrombus formation around leads & in atria (especially with concurrent AFib).

Nursing: Monitor PT/INR or aPTT, signs of bleeding at site & systemically. Hold prior to lead extraction or revision per protocol.

Prophylactic Antibiotics

PERI-PROCEDURAL INFECTION PREVENTION

Use: Given pre-implant (e.g., cefazolin) to prevent pocket infection & endocarditis.

Nursing: Verify allergies; administer within 60 min of incision; monitor for signs of infection post-op.

Analgesia / Mild Sedation

PROCEDURAL COMFORT

Examples: Acetaminophen post-op; midazolam for transcutaneous pacing (extremely uncomfortable).

Nursing: Avoid heavy sedation that masks neuro changes; monitor respirations.

6 NCLEX Test Traps ⚠️

✗ Trap: "The microwave will damage the pacemaker."

✓ **Truth:** Modern microwaves are **safe**. Patients can use household appliances normally.

✗ Trap: Confusing failure to *capture* with failure to *sense*.

✓ **Truth:** Capture = spike with NO QRS after. Sense = spike fires at the WRONG time. Different problems, different ECG findings.

✗ Trap: Choosing "give atropine" for a complete (3rd-degree) heart block.

✓ **Truth:** Atropine is **ineffective** in 3rd-degree AV block — go straight to **transcutaneous pacing**.

✗ Trap: "Hiccups are a normal post-op finding."

✓ **Truth:** Persistent hiccups = **lead displacement / diaphragmatic pacing**. NOTIFY HCP — never normalize.

✗ Trap: "All MRIs are absolutely contraindicated."

✓ **Truth:** Older devices = contraindicated. Many newer devices are **MRI-conditional** — verify make/model and follow protocol.

✗ Trap: "Pulse below the set rate is acceptable as long as the patient feels fine."

✓ **Truth:** Pulse **lower** than the pacemaker's set rate is **always abnormal** — indicates malfunction, requires intervention.

✗ Trap: "Resume full activity right after discharge."

✓ **Truth:** No lifting > 5 lb and no raising the operative arm above the shoulder for **4–8 weeks** to allow lead fixation.

✗ Trap: Choosing "place on right side" if a lead displaces.

✓ **Truth:** Position the patient on the **LEFT side** — gravity helps reposition a floating ventricular lead against the RV wall.

✗ Trap: "Cell phones must never be used near a pacemaker."

✓ **Truth:** Phones are safe when held to the **opposite ear** and kept ≥ 6 inches from the generator. No carrying in the chest pocket over the device.

7 NCJMM — Clinical Judgment Framework

Scenario: A 72-year-old, day-1 post pacemaker insertion, develops persistent hiccups and reports "feeling weak." HR 48, BP 92/58.

STEP 1

Recognize Cues

Persistent hiccups, HR 48 (below set rate of 70), hypotension, fatigue, post-op day 1.

STEP 2

Analyze Cues

Hiccups + HR < set rate suggest **lead displacement** with failure to capture; hypotension reflects ↓ cardiac output.

STEP 3

Prioritize Hypotheses

#1 Lead displacement / failure to capture ·
#2 Battery failure · #3 Surgical complication (hematoma, pneumothorax).

STEP 4

Generate Solutions

Continuous ECG, position on left side, notify provider, prepare for CXR & possible repositioning, ready transcutaneous pacing.

STEP 5

Take Action

Apply transcutaneous pads at bedside, start IV NS, give O₂ as needed, document strip, hold operative-arm movement, escalate.

STEP 6

Evaluate Outcomes

HR ≥ set rate, BP normalized, hiccups resolved, capture restored on ECG, perfusion intact (warm skin, alert LOC, urine output).

8 Patient & Family Education

✓ Daily Routines & Self-Monitoring

✓ Take **pulse daily** at the same time. Report rate *below* the set rate.

✓ Carry your **pacemaker ID card** at all times.

✓ Wear a **medical alert bracelet** identifying the device.

✓ Keep all follow-up appointments — generator interrogation every 3–6 mo.

✓ Wear loose clothing over the site initially; avoid tight bra straps.

✓ Battery will eventually need replacement (~8–10 years) — usually outpatient.

⚡ Electromagnetic Safety

✓ **Microwaves are safe** — use normally.

✓ **Cell phone** ≥ 6 in away; use opposite ear; do *not* carry in chest pocket over the generator.

✓ **Avoid:** MRI (unless MRI-conditional), arc welders, large running motors, strong magnets, tasers.

✓ **Airport security:** notify TSA, request hand-wand; metal detectors won't damage the device but may alarm.

✓ Anti-theft store gates: walk through normally — don't linger near them.

✓ Tell every healthcare provider (including dentists) you have a pacemaker before any procedure.

🏃 Activity Restrictions (First 4–8 Weeks)

✓ **No lifting** > 5 lb with operative arm.

✓ Do **not raise operative arm above shoulder**.

✓ Avoid contact sports indefinitely (football, martial arts).

✓ No driving for **1–2 weeks** or per provider; longer if syncope.



Sexual activity may resume when comfortable, usually 1–2 weeks.



Walking and gentle range-of-motion to the affected shoulder are encouraged to prevent "frozen shoulder."



Call 911 / Provider Immediately If...

Dizziness, fainting, persistent hiccups, palpitations, chest pain, shortness of breath, swelling/redness/drainage at site, fever, or pulse below the set rate.

9 Memory Boosters & Mnemonics

PACED — Daily Living After a Pacemaker

- P** **Pulse** daily — report rate below the set rate.
- A** **Avoid** MRI & strong magnets unless device is MRI-conditional.
- C** **Carry** pacemaker ID card & wear medical alert.
- E** **Electronics** caution — phone opposite side, ≥ 6 in from generator.
- D** **Don't** raise arm above shoulder or lift $> 5 \text{ lb} \times 4\text{--}8$ weeks.

3 F's of Pacemaker Malfunction

- F** **Failure to Capture** — spike with no QRS.
- F** **Failure to Sense** — spike at the wrong time (R-on-T risk).
- F** **Failure to Pace** — no spike when one is expected.

HICCUP = HELP! 🚨

HICcups, twitching, or pulse below set rate = **HELP** — likely **lead displacement**. Position on **LEFT side**, notify provider, prepare for CXR & repositioning.

Pattern Recognition: ECG Spike Quick Read

- ◆ Spike + QRS = working ✅
- ◆ Spike - QRS = **Failure to Capture**
- ◆ Spike at the wrong moment = **Failure to Sense**
- ◆ No spike when expected = **Failure to Pace**

"Always Verify Capture"

For every pacemaker spike, verify a **QRS complex AND a palpable pulse**. Electrical capture without mechanical capture is still inadequate cardiac output.