Arterial Line: Waveforms, Square-Wave Test and Nursing Care

Normal waveform, damping and the fast-flush test, leveling and zeroing, MAP vs systolic, complications and site care

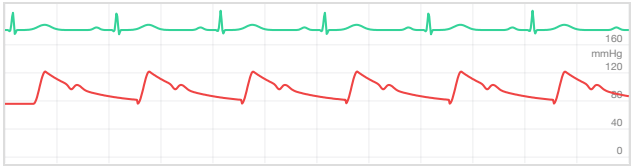
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ARTERIAL LINE NURSING CARE AT A GLANCE

An arterial line is a catheter in an artery, usually the radial, connected to a pressurized transducer that shows blood pressure beat by beat and allows repeated blood sampling. Before you trust the number, level the transducer to the phlebostatic axis, zero it to air, run a square-wave (fast-flush) test and look at the waveform shape.

- Waveform: sharp upstroke, clear dicrotic notch, matches the ECG rate.
- Square-wave test: 1.5 to 2 oscillations after the flush.
- Transducer air-fluid level at the phlebostatic axis; zero after any change.
- Flush bag inflated to 300 mm Hg with fluid left in it.
- Site and hand: color, warmth, cap refill, sensation, no bleeding or swelling.
- Line labeled as arterial, connections tight, alarms on.

NORMAL ARTERIAL LINE WAVEFORM



Normal: brisk upstroke, systolic peak, dicrotic notch (aortic valve closure), diastolic runoff.

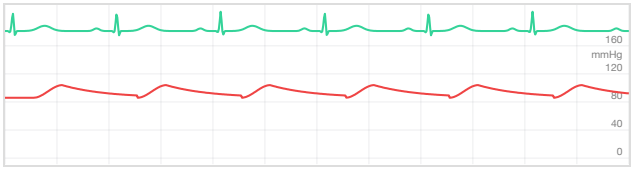
PART	WHAT IT SHOWS
Systolic upstroke	LV ejection; a slow, slurred rise suggests damping or low output
Systolic peak	Systolic pressure
Dicrotic notch	Aortic valve closure, the start of diastole
Diastolic runoff	Pressure falling as blood flows out to the tissues
End-diastole	Diastolic pressure, just before the next upstroke

EXAM TIP Farther from the heart, systolic reads higher, diastolic a little lower, and the notch sits lower and later. A radial and a femoral line on the same patient will not match beat for beat; MAP stays close.

SQUARE-WAVE TEST AND DAMPING

Pull the fast-flush device briefly, release, and watch the trace: it squares off, then rings and settles. Count the oscillations before it returns to the arterial waveform.

RESULT	OSCILLATIONS	READINGS	LOOK FOR
Optimal	1.5–2	Accurate	Nothing to fix
Overdamped	Fewer than 1.5	SBP falsely low, DBP high	Air, clot, kink, loose connection, soft flush bag
Underdamped	More than 2	SBP falsely high, DBP low	Long or added tubing, extra stopcocks, catheter movement, faulty transducer



Overdamped: slurred upstroke, no notch, narrow pulse pressure.



Underdamped: tall narrow spike with ringing; systolic overreads.

SAFETY Never add an air bubble to quiet a ringing line: it lowers the natural frequency and makes the overshoot worse. Check the monitor scale too; a wrong scale can mimic damping.

LEVELING AND ZEROING AT THE PHLEBOSTATIC AXIS

1. Find the phlebostatic axis: fourth intercostal space, mid-axillary line (the level of the right atrium).
2. Put the stopcock open to air at that level, or tape the zero line there.
3. Turn the stopcock off to the patient, open to air, and press zero on the monitor.
4. Close to air, cap it, and confirm the waveform returns.
5. Re-level whenever the bed height or patient position changes; zero per policy and after any disconnection.

SAFETY Every 10 cm of height error shifts all readings by about 7.5 mm Hg. Transducer too low: falsely high. Too high: falsely low. Damping changes the shape; a leveling error moves the whole trace.

MAP VS SYSTOLIC ON AN ARTERIAL LINE

Titrate vasopressors to MAP, not systolic. MAP is the perfusion pressure most targets use, and damping distorts it far less: in one study of 300 radial lines, about 31% were underdamped and overread systolic by 28.5 mm Hg on average compared with the cuff, but MAP by only 7.4.

- Bedside estimate: MAP = (SBP + 2 × DBP) ÷ 3. The monitor measures the area under the curve.
- If the line and cuff disagree, square-wave test first; then level, zero and check the cuff size.

COMPLICATIONS AND SITE CARE

Scheer 2002 and Saugel 2020. Radial: temporary occlusion is common, permanent ischemia rare (about 0.09%).

COMPLICATION	WATCH FOR	ACTION
Hand or limb ischemia	Pale, cool, mottled, painful or numb fingers	Report at once; line usually comes out
Bleeding or disconnection	Blood in the dressing or on the bed, falling pressure	Clamp or close, pressure on the site, call
Hematoma, pseudoaneurysm	Swelling, a pulsatile mass, bruit	Pressure, report; ultrasound
Infection	Redness, drainage, fever	Report; remove; cultures per policy
Air or clot embolism	Sudden distal ischemia; neuro change	Stop flushing, report
Accidental drug injection	Pain, blanching of the hand after a push	Never inject drugs into an arterial line

- Clean the skin with more than 0.5% chlorhexidine in alcohol; change the dressing if damp, loose or soiled.
- Replace transducers every 96 hours with the tubing, flush device and solution; keep the system closed and sterile.
- No dextrose or parenteral nutrition through the pressure circuit.
- Remove the line as soon as it is no longer needed.

ARTERIAL LINE TROUBLESHOOTING

PROBLEM	LIKELY CAUSE	FIRST STEPS
Flat line, no waveform	Stopcock off, disconnection, clot, transducer cable	Check the patient first, then stopcocks, connections, cable
Rounded trace, no notch	Overdamping: air, clot, kink, low bag pressure	Reposition the wrist, aspirate and flush, re-pressurize, remove air
Spiky, ringing trace	Underdamping: extra tubing, stopcocks	Remove extras, use a damping device; trust the MAP
All values shifted	Leveling or zero error	Re-level and re-zero
Blood backing up the tubing	Flush bag soft or empty	Re-inflate to 300 mm Hg, replace the bag
Line won't draw	Tip against the wall, positional, clot	Reposition the wrist; do not force-flush a clot

Sources (5) are listed with links at icubasics.com/sheets/arterial-line.html. For education and exam preparation only. Not medical advice; follow current guidelines and your institution's protocols. ICU Basics is an independent study aid not affiliated with any certifying body.