

● CRITICAL CARE • CARDIOVASCULAR • NGN NCLEX 2026

Hemodynamic *Measurements*

A complete clinical-judgment review of pressures, flows, and resistances measured by central venous and pulmonary artery catheters — what each value means, what it looks like when it goes wrong, and the priority nursing action that follows.

CVP • PAP • PAWP

CO • CI • SVR • PVR

MAP • SVO₂ • SCVO₂

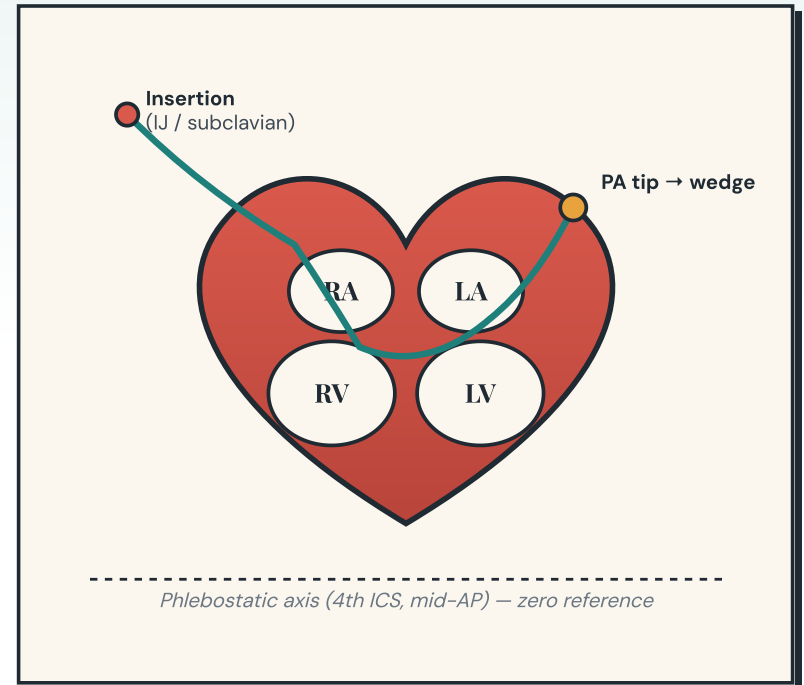
CLINICAL JUDGMENT FOCUS

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DEFINITION / OVERVIEW

What Hemodynamic Monitoring Tells Us

- **Hemodynamics** = the pressures and flows of blood as it moves through the heart and vessels. Direct measurement is done with invasive lines (central venous catheter, pulmonary artery [Swan-Ganz] catheter, arterial line).
- **Why it matters:** these numbers tell the nurse *preload, afterload, contractility, and tissue oxygenation* in real time — essential in shock, heart failure, sepsis, ARDS, and post-cardiac surgery.
- **Nurse's role:** obtain accurate readings (zeroed, leveled at the phlebostatic axis, patient supine $\leq 45^\circ$), trend the values, and act on abnormals using ABC + perfusion priorities.





MASTER REFERENCE

The Hemodynamic Values — Definition • Normal • Abnormal • Priority Action

CVP

Central Venous Pressure

PRELOAD (RIGHT)

Pressure in the superior vena cava / right atrium. Reflects **right-sided preload** and overall fluid status.

NORMAL

2 – 8 mmHg

ABNORMAL

⬆ **overload** / RV failure • ⬇
hypovolemia

NURSE PRIORITY + TEACHING

⬇ CVP:

give fluids, check for bleeding/dehydration.

⬆ CVP:

assess JVD, crackles, edema; slow fluids, prepare for diuretic.

Teach client: lie flat $\leq 45^\circ$ during reading, no Valsalva; report shortness of breath or sudden weight gain.

PAP

Pulmonary Artery Pressure

RIGHT → LUNG

Pressure inside the pulmonary artery — reflects how hard the right ventricle is pushing against the lungs.

NORMAL

Sys 15–25 / Dia 8–15 •
Mean 10–20

ABNORMAL

⬆ **pulm HTN, PE, ARDS, hypoxia, mitral disease**

NURSE PRIORITY + TEACHING

Assess SpO₂, breath sounds, ABGs. Treat hypoxia first (O₂, position upright). Report sudden ⬆ — suspect PE. Teach: avoid smoking, take prescribed pulmonary vasodilators consistently.

PAWP / PCWP

Pulmonary Artery Wedge Pressure

PRELOAD (LEFT)

Balloon-tip "wedged" reading — reflects **left atrial pressure / left ventricular preload**. Best indicator of fluid status of the left heart.

CO

Cardiac Output

PUMP FUNCTION

Liters of blood the heart ejects per minute. **CO = HR × SV**. The bottom-line measure of forward flow.

NORMAL

ABNORMAL

NORMAL

4 – 12 mmHg

ABNORMAL

↑ LV failure, mitral regurg, fluid overload • ↓ hypovolemia

NURSE PRIORITY + TEACHING

SAFETY:

inflate balloon ≤ 1.5 mL, $\leq 8-15$ sec, then deflate passively — leaving inflated → pulmonary infarct. Teach client purpose of the line and report chest pain or hemoptysis immediately.

4 – 8 L/min

↓ shock, MI, HF • ↑ early sepsis, hyperthyroid

NURSE PRIORITY + TEACHING

↓ CO → assess BP, LOC, urine output (<30 mL/hr = poor perfusion). Anticipate inotropes (dobutamine), fluids, or vasopressors. Teach: report dizziness, fatigue, decreased exercise tolerance.

CI

Cardiac Index

CO ÷ BSA

CO adjusted for body size — more accurate measure of pump effectiveness for the individual patient.

NORMAL

2.5 – 4 L/min/m²

ABNORMAL

< 2.2 → cardiogenic shock

NURSE PRIORITY + TEACHING

CI < 2.2 = critical. Notify HCP, prepare inotropic / mechanical support (IABP, ECMO). Teach family about gravity of low CI; clarify that "good number on monitor" depends on patient's body size.

SVR

Systemic Vascular Resistance

LV AFTERLOAD

Resistance the **left ventricle** must pump against — the "tightness" of systemic blood vessels.

NORMAL

800 – 1200 dynes·sec/cm⁵

ABNORMAL

↑ HTN, cardiogenic shock, hypovolemia • ↓ septic / neurogenic / anaphylactic shock

NURSE PRIORITY + TEACHING

↓ SVR (WARM SHOCK):

vasopressors (norepinephrine).

↑ SVR:

vasodilators (nitroprusside). Teach: report flushing, severe headache, or sudden BP changes.

PVR

Pulmonary Vascular Resistance

RV AFTERLOAD

Resistance the **right ventricle** pumps against — the "tightness" of pulmonary vessels.

NORMAL

< 250 dynes·sec/cm⁵ (37–250)

ABNORMAL

↑ PE, ARDS, COPD, hypoxia → cor pulmonale

NURSE PRIORITY + TEACHING

Optimize oxygenation — hypoxia and acidosis raise PVR.
Anticipate pulmonary vasodilators (sildenafil, inhaled NO).
Teach: pace activity, supplemental O₂ as ordered.

MAP

Mean Arterial Pressure

PERFUSION

Average arterial pressure during one cardiac cycle — the number that decides whether organs are being perfused.

NORMAL

70 – 105 mmHg · need ≥ 65 to perfuse organs

ABNORMAL

< 60 → cerebral / renal ischemia · > 110 → ↑ ICP risk

NURSE PRIORITY + TEACHING

MAP < 65 in sepsis → start/titrate vasopressors per protocol; monitor urine output every hour. Teach: change positions slowly, hydrate, report dizziness.

SvO₂

Mixed Venous Oxygen Saturation

O₂ SUPPLY VS DEMAND

% O₂ saturation in pulmonary artery blood — tells you how much oxygen the tissues are pulling out of the blood.

NORMAL

60 – 80 %

ABNORMAL

↓ < 60 % → ↓ demand / ↓ delivery (shock, anemia, fever) · ↑ > 80 % → sepsis, cyanide tox, wedged catheter

NURSE PRIORITY + TEACHING

↓ SvO₂ → optimize the four delivery factors:

ScvO₂

Central Venous O₂ Saturation

SEPSIS BUNDLE

SvO₂'s easier cousin — measured from a central line in the SVC. Used in sepsis/early goal-directed therapy.

NORMAL / GOAL

≥ 70 %

ABNORMAL

< 70 % → poor tissue oxygenation

NURSE PRIORITY + TEACHING

Sepsis bundle: fluids → vasopressors → transfuse PRBCs if Hct < 30 → add inotrope. Teach: importance of finishing antibiotics, monitor for re-infection.

HR, HGB, SAO_2 , CO

. Reduce demand (rest, control fever, sedate, treat pain). Teach family why minimizing stimulation matters.



The Single Most Important Number on the Monitor

MAP $\geq$ 65 mmHg. If MAP drops below this, tissue perfusion fails — kidneys, brain, and gut suffer first. Always cross-check the monitor against a manual cuff before titrating drugs.



PATHOPHYSIOLOGY · SIMPLIFIED

How the Numbers Are Generated

Every hemodynamic value reflects one of four physiologic pillars. Recognizing which pillar is broken tells you which drug, fluid, or intervention is needed.

STEP 1 · PRELOAD

Volume returning to heart

Measured by **CVP** (right) and **PAWP** (left). Low → give fluids. High → diurese.



STEP 2 · CONTRACTILITY

Strength of squeeze

Reflected in **CO / CI**. Low → inotropes (dobutamine). Fix preload first, then strength.



STEP 3 · AFTERLOAD

Resistance to ejection

SVR (left/systemic) and **PVR** (right/pulmonary). High → vasodilate. Low → vasopressors.



STEP 4 · PERFUSION

Result at the tissues

MAP + SvO_2 / $ScvO_2$. End-organ check — urine output, LOC, lactate confirm.

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SIGNS & SYMPTOMS OF HEMODYNAMIC COMPROMISE

Early vs Late — Recognize Before You're Coding



EARLY (Compensated)

- **Restlessness, anxiety** — first sign of hypoperfusion (brain getting less O₂)
- **Tachycardia** — body's first compensation to maintain CO
- **Tachypnea** — blowing off CO₂, trying to correct lactic acidosis
- **Cool, pale extremities** — peripheral vasoconstriction shunts blood to vital organs
- **Narrow pulse pressure** (SBP – DBP) — early sign of hypovolemic / cardiogenic shock
- **Urine output 20–30 mL/hr** — kidneys conserving volume
- BP often *still normal* — don't be fooled



LATE (Decompensated) — RED FLAGS

- **Hypotension** (MAP < 65) — compensation has failed
- **Decreased LOC, confusion** → unresponsive
- **Mottled skin, cyanosis, prolonged cap refill > 3 sec**
- **Urine output < 0.5 mL/kg/hr (or < 30 mL/hr)**
- **Bradycardia** (pre-arrest in late shock)
- **Lactate > 2 mmol/L · metabolic acidosis**
- **Crackles, JVD, frothy sputum** if fluid overload / LV failure
- **Pulseless, apneic** = code blue



NCLEX Pearl — The First Sign Is Almost Always Restlessness

If a question gives you a BP of 110/70 but the patient is "anxious and restless" with a HR of 120 — that is shock until proven otherwise. Hypotension is a *late* finding.

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PRIORITY NURSING INTERVENTIONS

ABC + Perfusion — In Order

1. **Airway & Breathing first.**
1 SpO₂, breath sounds, RR, ABGs. Apply O₂ to maintain SpO₂ ≥ 94 % (≥ 90 % in COPD). Anticipate intubation if LOC declines or PaO₂ stays low.
2. **Zero, level, and verify the line.**
2 Phlebostatic axis (4th ICS, midaxillary). Zero at start of shift and after position change. Patient supine, HOB ≤ 45°. A wrong reading is worse than no reading.
3. **Trend the values — don't react to one number.**
3 Compare MAP, CVP, PAWP, CO/CI, SvO₂ together. One isolated reading rarely changes care; a trend does.
4. **Match the intervention to the broken pillar.**
4 Low preload → fluids. Low contractility → inotropes. Low afterload → vasopressors. High afterload → vasodilators. High preload → diuretics.
5. **Maintain MAP ≥ 65 mmHg.**
5 This is the perfusion goal in sepsis, shock, and post-op cardiac care. Titrate vasoactive drips per HCP order via central line on an infusion pump.
6. **Monitor end-organ perfusion every hour.**
6 Urine output (≥ 0.5 mL/kg/hr), LOC, capillary refill, lactate, mental status. These confirm the numbers are actually working.

7. **PA catheter safety — wedge ≤ 1.5 mL, $\leq 8-15$ sec.**
7 Allow balloon to deflate *passively*. Never leave inflated → pulmonary infarct or rupture. Watch waveform: if "wedged" appears continuously → notify HCP immediately.
8. **Infection prevention — central lines.**
8 Sterile occlusive dressing, change every 7 days (per CLABSI bundle) or PRN if soiled. Scrub the hub. Date all dressings. The #1 problem with central lines is infection.
9. **Air embolism prevention.**
9 If a central line opens accidentally → position patient on **LEFT side, head down (Trendelenburg)**
. Have patient hold breath / Valsalva when changing tubing.

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PHARMACOLOGY · VASOACTIVE DRIPS

Drugs That Move the Numbers

All drugs below are **titrated** on an IV pump, through a **central line**, with continuous BP and rhythm monitoring. Never piggyback. Never bolus. Wean — never abrupt stop.

Norepinephrine (Levophed)

VASOPRESSOR

First-line for septic shock. α -adrenergic $\rightarrow$ vasoconstriction $\rightarrow$ $\uparrow$ SVR $\rightarrow$ $\uparrow$ MAP.

TITRATE TO MAP $\geq$ 65

WATCH

Extravasation $\rightarrow$ tissue necrosis (antidote: phentolamine)

TEACH

Why central line is essential; report any IV-site pain immediately

Dopamine

VASOPRESSOR / INOTROPE

Dose-dependent: low = renal, mid = β ($\uparrow$ CO), high = α ($\uparrow$ SVR). Treats hypotension.

TITRATE TO BP / urine output

WATCH

Tachycardia, dysrhythmias; **nephrotoxic — avoid in CKD**

TEACH

"Dop" hurts the kidneys

Dobutamine (Dobutrex)

INOTROPE

$\beta_1 \rightarrow$ $\uparrow$ contractility $\rightarrow$ $\uparrow$ CO/CI. First choice in cardiogenic shock / HF with low CO.

TITRATE TO BP and urine output

WATCH

Tachycardia, ectopy; *kidney-safe*

TEACH

"DobUt" — the U is good for the Urine

Vasopressin

VASOPRESSOR

Add-on in septic shock when norepi alone isn't holding MAP. V1 receptors $\rightarrow$ vasoconstriction.

TITRATE TO Fixed-dose (0.03 U/min) usually NOT titrated

WATCH

Bradycardia, ischemia (cardiac, mesenteric, digital)

TEACH

Report chest pain, abdominal pain, cold/blue fingers

Nitroprusside / Nitroglycerin

VASODILATOR

Drops afterload (SVR) and preload. Used for hypertensive crisis, HF after MI.

Labetalol

ANTIHYPERTENSIVE

$\alpha + \beta$ blocker $\rightarrow$ $\downarrow$ HR, $\downarrow$ BP. Used in hypertensive emergency.

Hemodynamic Measurements — NGN NCLEX

TITRATE TO	BP; arterial line strongly preferred
WATCH	Hypotension; cyanide toxicity with prolonged nitroprusside
TEACH	Wean slowly; report headache, confusion

TITRATE TO	HR & BP
WATCH	Bradycardia, bronchospasm, heart block
TEACH	Change positions slowly to prevent orthostasis

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NCLEX TEST TRAPS

What Students Get Wrong — And the Right Move

X TRAP

"Patient is hypotensive — bolus fluids." Always reaching for a fluid bolus when BP drops.



✓ CORRECT

Check preload first. If CVP/PAWP are already high (volume overloaded), more fluid worsens it. The answer in cardiogenic shock is *inotrope*, not fluid.

X TRAP

Recording the CVP with the HOB at 60° because the patient is short of breath.



✓ CORRECT

HOB **0–45°** with transducer at the **phlebostatic axis**. Above 45° invalidates the reading.

X TRAP

Inflating the PA balloon and walking away to grab supplies.



✓ CORRECT

Inflate **≤ 1.5 mL for ≤ 8–15 seconds** only, then let it deflate *passively*. Continuous wedge = pulmonary infarct.

X TRAP

Confusing dopamine and dobutamine — picking dopamine for a HF patient with CKD.



✓ CORRECT

"Dop" hurts the kidneys; "Dob**Ut**" — the U is good for the **U**rine. Dobutamine is the inotrope of choice in HF with renal compromise.

X TRAP

Sepsis question with **high SvO₂ (88 %)** and assuming oxygenation is fine.



✓ CORRECT

In **septic shock**, tissues can't extract O₂ — SvO₂ is *falsely elevated*. Look at lactate, MAP, urine output to know real perfusion.

X TRAP

✓ CORRECT

Stopping a vasopressor abruptly when the BP looks "good enough."



Always **wean slowly**. Abrupt discontinuation → rebound hypotension and cardiovascular collapse.

X TRAP

Central line cap pops off → nurse clamps the line and runs for help.



✓ CORRECT

Position client on **LEFT side, head down (Trendelenburg)** first to trap any air in the right atrium, *then* clamp and call. Air embolism is the immediate threat.

X TRAP

"Patient is restless and HR is 122. BP is 118/76 — pt is stable."



✓ CORRECT

Restlessness + tachycardia = **early shock**. BP is the **LAST** thing to drop. Intervene now, don't wait for the number to fall.

7

PATIENT & FAMILY EDUCATION

What to Teach Before, During & After

i Before the Line Is Placed

- Explain purpose: "We are placing a special IV in your neck or chest so we can watch your heart and give medicine quickly."
- Consent obtained by HCP — nurse witnesses and reinforces.
- Patient will lie flat or in **Trendelenburg** for insertion; will need to **turn head away** and may be asked to hold breath / Valsalva.

i While the Line Is In

- Report any **chest pain, shortness of breath, palpitations, or sudden coughing of blood** — these can signal pneumothorax, embolism, or arrhythmia.
- Do not pull, tug, or get the dressing wet.
- Tell the nurse if the dressing loosens, becomes wet, or if there is bleeding/redness at the site.
- Position changes — sit up slowly to prevent dizziness while drips are running.

i Family Teaching

- Why the patient may seem restless or anxious — early sign that the body is compensating; tell the nurse, do not just "calm them down."
- Loud monitor alarms are common; nurses respond — don't silence them.
- Limit the number of visitors, keep the room quiet to reduce O₂ demand (especially with low SvO₂).

i After Removal / Discharge

- Apply pressure for ≥ 5 min; lie flat 30 min; sterile occlusive dressing 24–48 h.
- Report fever > 100.4 °F (38 °C), redness, drainage, or chest pain — late infection or DVT.
- Long-term lifestyle for HF / shock survivors: low-sodium diet, daily weights (call HCP if > 2 lb / 1 kg gain in 24 h or 5 lb in a week), medication adherence, follow-up echo.



NCJMM · CLINICAL JUDGMENT FRAMEWORK

Applied to Hemodynamic Compromise

STEP 1 · RECOGNIZE CUES

What is abnormal?

Restless + HR 124 + MAP 58 + UOP 18 mL/hr + lactate 4.2 + cool mottled skin. Those are cues, not noise.

STEP 2 · ANALYZE CUES

What's it pointing to?

Hypoperfusion + tachycardia + $\uparrow$ lactate $\rightarrow$ *shock*. Now check CVP/PAWP/SVR to determine which type (hypovolemic vs cardiogenic vs distributive).

STEP 3 · PRIORITIZE HYPOTHESES

Most likely + most dangerous?

Low CVP + low PAWP + low SVR = warm/distributive (sepsis). Most life-threatening hypothesis is treated first.

STEP 4 · GENERATE SOLUTIONS

What are options?

30 mL/kg crystalloid bolus $\rightarrow$ reassess MAP $\rightarrow$ start norepinephrine via central line $\rightarrow$ broad-spectrum antibiotics within 1 h $\rightarrow$ trend ScvO₂.

STEP 5 · TAKE ACTION

Implement priority interventions

Apply O₂; start fluids; place central line; initiate norepi; draw lactate, cultures, CBC; titrate to MAP $\geq$ 65 and UOP $\geq$ 0.5 mL/kg/hr.

STEP 6 · EVALUATE OUTCOMES

Did it work?

MAP 72 · HR 96 · UOP 45 mL/hr · lactate trending down · ScvO₂ > 70 % $\rightarrow$ effective. If not improving — re-assess each pillar (preload, contractility, afterload).



MEMORY BOOSTERS · MNEMONICS

Anchor the Numbers

"VIP" — Resuscitation Order



V entilate — airway/breathing first

I nfuse — fluids to fill the tank (preload)

P ump — vasopressors / inotropes after volume is restored

"2 · 8 · 12 · 65"

2–8 = CVP normal (mmHg)

8–12 = PAWP upper limit area

≥ 65 = MAP minimum to perfuse organs

Memorize these three goals — they appear in nearly every shock question.

"DOPA · DOBU"

DOPA mine = bad for the kidneys

DOBU tamine has a **U** = good for the **U** rine

Both raise pressure, but only one is renal-friendly.

"4 D's of Oxygen Delivery"



D rive (HR / rhythm)

D elivery (SaO₂ / lungs)

D raw (Hgb)

D ump (CO / squeeze)

If SvO₂ is low, one of the D's is broken — fix it.

"WET · DRY · LOOSE · TIGHT"

WET (↑ CVP/PAWP) → diurese

DRY (↓ CVP/PAWP) → fluids

LOOSE (↓ SVR) → vasopressor (squeeze)

TIGHT (↑ SVR) → vasodilator (open up)

"Left Side, Head Down"

Central line accidentally **open** ?

Position: **LEFT side** , **Trendelenburg**

Why: traps any air bubble in the right atrium, away from the pulmonary outflow.

Mastery comes from one good rep at a time. ❤️ NGN NCLEX 2026 · Hemodynamic Measurements · Personal Study Library