

The Big Four *Catecholamines*

Norepinephrine • Epinephrine • Dopamine • Dobutamine — four molecules that look alike, behave differently, and decide whether the patient lives or codes.

CARDIOVASCULAR

ADRENERGIC AGONISTS

HIGH-ALERT MEDICATIONS

ICU • ED • CODE BLUE

CENTRAL LINE PREFERRED

01 • VASOPRESSOR

Norepinephrine

Levophed

SEPTIC SHOCK — 1ST LINE

$\alpha_1 \gg \beta_1$. Squeezes vessels to rescue MAP. "Leave 'em dead" if it extravasates.

02 • MIXED ADRENERGIC

Epinephrine

Adrenalin

ANAPHYLAXIS • CARDIAC ARREST

$\alpha_1 + \beta_1 + \beta_2$. The crash-cart catecholamine. Concentration matters: 1:1,000 vs 1:10,000.

03 • DOSE-DEPENDENT

Dopamine

Intropin

SYMPTOMATIC BRADYCARDIA

Receptor switches with the dose. Low = renal, mid = heart, high = squeeze.

04 • INOTROPE

Dobutamine

Dobutrex

CARDIOGENIC SHOCK • ADHF

β_1 pure pump booster. NOT a vasopressor — won't fix vasodilatory hypotension.

01 DRUG OVERVIEW Why we hang it

Each catecholamine has a different "shock signature" — match the drug to the failure.

NOREPINEPHRINE

Vessels won't squeeze

- ▶ **Septic shock** (first-line vasopressor)
- ▶ Neurogenic shock
- ▶ Severe hypotension refractory to fluids
- ▶ Goal: **MAP $\geq$ 65 mmHg**

EPINEPHRINE

Everything is failing

- ▶ **Anaphylaxis** (first-line, IM)
- ▶ **Cardiac arrest** (1 mg IV q3–5 min)
- ▶ Severe asthma / status asthmaticus
- ▶ Croup (racemic, nebulized)

DOPAMINE

Heart is too slow

- ▶ **Symptomatic bradycardia** unresponsive to atropine
- ▶ Cardiac shock (older protocols)
- ▶ Hypotension after ROSC
- ▶ No longer first-line in sepsis ($\uparrow$ arrhythmias)

DOBUTAMINE

Pump is failing

- ▶ **Cardiogenic shock** (low CO + adequate BP)
- ▶ Acute decompensated **HF**
- ▶ Stress echo pharmacologic agent
- ▶ Bridge to transplant / LVAD

02 MECHANISM OF ACTION Receptor $\rightarrow$ Response

Memorize the receptors and the rest writes itself: α_1 = squeeze, β_1 = pump, β_2 = open airways, D_1 = renal flow.

Norepinephrine

α_1 $\rightarrow$ vasoconstriction
 $\rightarrow \uparrow$ SVR $\rightarrow \uparrow$ MAP
 β_1 (mild) $\rightarrow \uparrow$ contractility
HR: minimal change / reflex $\downarrow$

Epinephrine

α_1 $\rightarrow$ vasoconstriction
 β_1 $\rightarrow \uparrow$ HR + contractility
 β_2 $\rightarrow$ bronchodilation
+ stabilizes mast cells

Dopamine

D_1 low (1–3 mcg/kg/min) $\rightarrow$ renal vasodilation
 β_1 mid (3–10) $\rightarrow \uparrow$ HR + CO
 α_1 high (>10) $\rightarrow$ vasoconstriction
"Renal • Cardiac • Vascular"

Dobutamine

β_1 selective $\rightarrow \uparrow$ contractility
 $\rightarrow \uparrow$ Cardiac Output
 β_2 (mild) $\rightarrow$ slight $\downarrow$ SVR
No α_1 $\rightarrow$ does NOT raise BP

RECEPTOR CHEAT-SHEET

α_1 = vasoconstriction (squeeze) • **β_1** = "1 heart" — $\uparrow$ rate & force • **β_2** = "2 lungs" — bronchodilation • **D_1** = renal/mesenteric vasodilation. If you can label the receptor, you can predict every effect and side effect.

03 THERAPEUTIC EFFECTS

What "working" looks like

Titrate to a target — not a number on the bag. Reassess every 5–15 minutes.

NOREPI • GOALS

- ✓ **MAP ≥ 65** mmHg
- ✓ Lactate trending down
- ✓ Urine output ≥ 0.5 mL/kg/hr
- ✓ Warmer extremities, ↑ LOC
- ✓ Cap refill < 3 seconds

EPI • GOALS

- ✓ Anaphylaxis: ↓ stridor, ↓ wheezing, BP recovery
- ✓ Code: ROSC + palpable pulse
- ✓ ↑ HR + ↑ BP within minutes
- ✓ Resolving angioedema

DOPAMINE • GOALS

- ✓ HR ≥ 60 with adequate perfusion
- ✓ SBP ≥ 90 / MAP ≥ 65
- ✓ Resolving symptoms of bradycardia (chest pain, AMS)
- ✓ Adequate urine output

DOBUTAMINE • GOALS

- ✓ ↑ Cardiac Output / CI
- ✓ ↓ PCWP (less pulmonary congestion)
- ✓ Improved end-organ perfusion
- ✓ ↓ dyspnea, ↑ urine output

04 SIDE EFFECTS & ADVERSE REACTIONS

When the drug bites back

Common · Serious 🚑 · Toxic. The α_1 agents share an extravasation horror story.

NOREPINEPHRINE

- ▶ **Common:** headache, anxiety, tremor
- ⚠ Reflex bradycardia (no β_1 to balance α_1)
- ⚠ Peripheral / digital ischemia, cold extremities
- 💀 **EXTRAVASATION** → **tissue necrosis & gangrene**
- 💀 Arrhythmias, MI, cerebral hemorrhage

EPINEPHRINE

- ▶ **Common:** tachycardia, tremor, anxiety, palpitations
- ▶ **Common:** hyperglycemia (β_2 effect)
- ⚠ Severe HTN crisis, headache
- 💀 Tachydysrhythmias, V-fib, MI, stroke
- 💀 Pulmonary edema (severe vasoconstriction)

DOPAMINE

- ▶ **Common:** N/V, headache, palpitations
- ⚠ Tachycardia & tachyarrhythmias (more than norepi)
- ⚠ Angina / myocardial ischemia
- 💀 **EXTRAVASATION** → **necrosis** (high-dose α_1)
- 💀 VT/VF at high doses

DOBUTAMINE

- ▶ **Common:** tachycardia, palpitations, HA
- ⚠ **Hypotension** if patient is hypovolemic (β_2 vasodilation)
- ⚠ ↑ myocardial O_2 demand → angina, MI
- 💀 Tachyarrhythmias, V-tach
- 💀 Tolerance after ≥ 72 hr infusion

EXTRAVASATION ANTIDOTE — MEMORIZE THIS

Phentolamine (α -blocker) is the antidote for norepinephrine and high-dose dopamine extravasation. Inject SC *around* the site within 12 hr. Stop the infusion, do **NOT** remove the IV until aspirated, elevate the limb, and apply **warm** compresses (cold worsens vasoconstriction).

05

PRIORITY NURSING CONSIDERATIONS

Assess • Monitor • Hold • Notify

These are HIGH-ALERT meds. Two RNs, central line, infusion pump, dedicated tubing.

ASSESS & MONITOR — ALL FOUR

- ▶ **Continuous** ECG & arterial line BP
- ▶ MAP, SBP, HR every 5–15 min during titration
- ▶ Urine output hourly (target ≥ 0.5 mL/kg/hr)
- ▶ Cap refill, peripheral pulses, skin temp/color
- ▶ IV site q1h for blanching, pallor, pain → extravasation
- ▶ LOC, lactate, lung sounds

HOLD / NOTIFY PROVIDER IF...

- SBP > 180 or below MAP target
- HR > 130 (esp. dobutamine, dopamine, epi)
- New-onset dysrhythmia (V-tach, SVT)
- Chest pain or new ST changes
- Extravasation, blanching, pain at site
- Urine output < 30 mL/hr $\times 2$ hr

CONTRAINDICATIONS & CAUTIONS

- ⚠ **Hypovolemia:** fluid resuscitate FIRST (esp. dobutamine — it will drop BP further)
- ⚠ Tachyarrhythmias (relative — esp. dopamine, epi)
- ⚠ Pheochromocytoma — already catecholamine-storm
- ⚠ Severe HTN, recent MI
- ⚠ Uncorrected hypoxia or acidosis ($\downarrow$ drug efficacy)

DANGEROUS DRUG INTERACTIONS

- ▶ **MAOIs** + any catecholamine → hypertensive crisis
- ▶ **TCA**s → potentiated pressor effect
- ▶ **Beta-blockers** → blunt epi/dobutamine effect
- ▶ **Phenytoin** + dopamine → severe hypotension & bradycardia
- ▶ **Halothane**/inhaled anesthetics → arrhythmias
- ▶ **Sodium bicarbonate** deactivates catecholamines — flush line!

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LABS & DIAGNOSTICS

Numbers that drive titration

HEMODYNAMICS

- ▶ **MAP:** goal ≥ 65 mmHg (sepsis, shock)
- ▶ **SBP:** ≥ 90 mmHg generally adequate
- ▶ **CVP:** 8–12 mmHg (volume status)
- ▶ **Cardiac Index:** ≥ 2.2 L/min/m²
- ▶ **SVR:** 800–1200 dynes (norepi target)

LABS TO TREND

- ▶ **Lactate:** < 2 mmol/L (perfusion marker)
- ▶ **BUN/Creatinine:** renal perfusion
- ▶ **ABG:** watch metabolic acidosis (catecholamines fail in acidosis)
- ▶ **Glucose:** epi $\rightarrow$ hyperglycemia (β_2)
- ▶ **Troponin / BNP:** with $\uparrow$ MVO₂ demand
- ▶ **K⁺ & Mg²⁺:** low levels $\rightarrow$ arrhythmia risk

CRITICAL VALUE LOGIC

Lactate $\uparrow$ = perfusion still failing $\rightarrow$ titrate up or add agent. **Acidosis** blunts catecholamine response — fix the pH and the BP follows. **Hypokalemia/hypomagnesemia** + epi or dopamine = fast track to V-tach.

07 ADMINISTRATION & SAFETY

High-alert medication protocol

Wrong concentration · wrong line · wrong rate = sentinel event.

NOREPINEPHRINE

- ▶ IV continuous infusion only
- ▶ **Central line preferred**
- ▶ Titrate to MAP $\geq$ 65
- ▶ Dedicated line; flush before/after
- ▶ Wean slowly — abrupt stop → rebound hypotension

EPINEPHRINE

- ▶ **Anaphylaxis:** 1:1,000 — 0.3–0.5 mg **IM lateral thigh**
- ▶ **Cardiac arrest:** 1:10,000 — 1 mg IV q3–5 min
- ▶ EpiPen: adult 0.3 mg, child 0.15 mg
- ▶ Light-protected, refrigerated stock; protect from heat
- ▶ Never give 1:1,000 IV push — fatal

DOPAMINE

- ▶ IV continuous, weight-based mcg/kg/min
- ▶ **Central line preferred** (high-dose α_1)
- ▶ Mix in D5W (NOT bicarb — inactivates)
- ▶ Pump only; titrate q5–10 min
- ▶ Wean gradually

DOBUTAMINE

- ▶ IV continuous, weight-based mcg/kg/min
- ▶ Peripheral OK (no α_1) but central preferred
- ▶ **Volume status FIRST** — won't work if dry
- ▶ Compatible with most fluids; not bicarb
- ▶ Tolerance after ~72 hr

HIGH-ALERT BUNDLE

Two-RN independent verification · Smart pump with drug library · Dedicated IV line · Continuous BP + ECG · Central access for vasopressors · NEVER bolus · Titrate, don't yo-yo · Document every rate change.

08 PATIENT & FAMILY EDUCATION

What they need to hear

WHILE IN THE ICU / ED

- ▶ "You're on a powerful heart and blood pressure medicine — that's why we check vitals so often."
- ▶ Report any pain, burning, or coldness at the IV site immediately
- ▶ Report chest pain, palpitations, or feeling "like your heart is racing"
- ▶ Activity is limited; we'll wean the medication as you improve

EPIPEN / AUTO-INJECTOR TEACHING

- ▶ Carry **two** auto-injectors at all times
- ▶ Inject into **outer mid-thigh**, hold 3 seconds (Auvi-Q: 2 sec)
- ▶ Can give through clothing in an emergency
- ▶ Call 911 **after** injection — symptoms can rebound
- ▶ Replace before expiration; protect from heat & light
- ▶ Wear medical alert bracelet

09

NCLEX TEST TRAPS ⚠️ Where students lose points

If you only memorize one section — this is it.

Trap 01

"The patient is hypotensive and in heart failure — start dobutamine."

❌ **Dobutamine is NOT a vasopressor.** It can drop BP further (β_2 vasodilation). If patient is hypotensive, pair with norepinephrine OR fluid-resuscitate first. Dobutamine alone needs a "good enough" BP.

Trap 02

Anaphylaxis epi route?

✓ **IM into the lateral mid-thigh** (vastus lateralis) — fastest absorption. Subcut is too slow; IV is for cardiac arrest only. Use the 1:1,000 concentration IM, never IV.

Trap 03

Epi 1:1,000 vs 1:10,000?

✓ **1:1,000 = IM** (anaphylaxis). **1:10,000 = IV** (cardiac arrest). Giving 1:1,000 IV push is fatal — instant hypertensive crisis & V-fib. This *will* show up on the exam.

Trap 04

IV site is blanched, painful, cold — what FIRST?

✓ **STOP the infusion** first. Then aspirate residual drug through the IV (don't remove yet), notify provider, give **phentolamine** SC around the site, elevate, warm compresses.

Trap 05

"Low-dose dopamine for renal protection."

❌ Old teaching, **not evidence-based**. "Renal-dose dopamine" does NOT protect kidneys. Choose answer options that reflect current practice — dopamine is reserved for symptomatic bradycardia, not renal rescue.

Trap 06

Septic shock — first-line vasopressor?

✓ **Norepinephrine** — after adequate fluid resuscitation (30 mL/kg crystalloid). NOT dopamine (more arrhythmias) and NOT dobutamine (not a pressor).

Trap 07

Patient on norepi suddenly bradycardic — why?

✓ **Reflex bradycardia** from intense α_1 vasoconstriction (baroreceptor response). It's expected, not a reason to stop unless symptomatic. Don't confuse with dopamine, which causes tachycardia.

Trap 08

Catecholamine drip and bicarb running together?

❌ **Sodium bicarbonate inactivates catecholamines.** Run in separate lines. If the same line must be used in a code, flush thoroughly between drugs.

Trap 09

Stop the drip when BP normalizes?

❌ **Wean — never stop abruptly.** Sudden cessation → rebound profound hypotension. Titrate down by small increments while monitoring MAP.

Trap 10

Tachycardia ranking: which catecholamine causes the most?

✓ **Epi > Dopamine > Dobutamine > Norepi.** Norepi has minimal HR effect (α -dominant). If exam says "least tachycardia," pick norepinephrine.

10 MEMORY BOOSTERS

Mnemonics & pattern recognition

"NEAD" — pick the right pressor

- N** Norepi → **N**ot enough squeeze (sepsis, distributive shock)
- E** Epi → **E**verything's failing (anaphylaxis, arrest)
- A** dopAmine → **A**trial bradycardia (slow heart)
- D** Dobutamine → **D**ying pump (cardiogenic shock, ADHF)

Receptors made simple

- α_1 = **1 vessel** → squeeze
- β_1 = **1 heart** → faster & stronger
- β_2 = **2 lungs** → bronchodilation
- D_1 = **kiDney flow**

"Dopamine is Dose-Dependent"

Low (1–3) → renal · **Mid** (3–10) → muscle of the heart · **High** (>10) → muscle of the vessels.

"Renal · Cardiac · Vascular" — climb the dose, climb the receptor.

"Levo Leaves them Lifeless"

Levophed (norepinephrine) extravasation = tissue death. **Phentolamine** is the antidote (Phen for Phlesh saved). Stop infusion, aspirate, inject around site, warm compresses.

Epi concentrations: "Skin or Stick"

1:1,000 = strong (skin / IM) — anaphylaxis
1:10,000 = dilute (stick / IV) — cardiac arrest
 More zeros = more dilute = IV. Mix these up = code blue.

"DoBUTamine BUTs the heart, not the vessels"

β_1 only → contractility ↑ but NO vasoconstriction. Won't fix BP if vessels are dilated.
 Volume + dobutamine = good · Empty tank + dobutamine = worse.

+ MOST-TESTED DRUG CLASS COMPARISON

The grid that decides the question

Read horizontally — every NCLEX vasopressor question can be answered from this grid.

	NOREPINEPHRINE	EPINEPHRINE	DOPAMINE	DOBUTAMINE
BRAND	Levophed	Adrenalin	Intropin	Dobutrex
CLASS	Vasopressor	Mixed adrenergic	Dose-dependent	Inotrope
RECEPTORS	α_1 *** β_1 *	α_1 ** β_1 *** β_2 **	D_1 low β_1 mid α_1 high	β_1 *** β_2 mild
1ST-LINE FOR	Septic shock, neurogenic shock	Anaphylaxis, cardiac arrest	Symptomatic bradycardia	Cardiogenic shock, ADHF
BP EFFECT	↑ ↑ ↑ SVR/MAP	↑ ↑ BP	↑ BP (dose-dep)	↔ / slight ↓
HR EFFECT	↔ / reflex ↓	↑ ↑ ↑	↑ ↑	↑
CONTRACTILITY	↑ mild	↑ ↑ ↑	↑ ↑	↑ ↑ ↑
CARDIAC OUTPUT	↑ slight	↑ ↑	↑ ↑	↑ ↑ ↑
BIG RISK	Extravasation necrosis, reflex bradycardia	HTN crisis, V-fib, hyperglycemia	Tachyarrhythmias, extravasation	Hypotension if hypovolemic, V-tach
ROUTE	IV continuous · central line	IM (1:1k) · IV (1:10k) · ETT	IV continuous · central	IV continuous · central preferred
ANTIDOTE (EXTRAV.)	Phentolamine	Phentolamine	Phentolamine	Not typically — minimal α_1
NCLEX PEARL	"Vasopressor" by default in shock answers	1:1,000 IM thigh for anaphylaxis	NOT for "renal protection"	NEEDS volume — not a pressor

NCJMM

Clinical Judgment *Snapshot*

NCJMM priority-action reasoning · the three questions the NCLEX is actually asking.

1

#1 PRIORITY RISK

Extravasation → tissue necrosis for α_1 -active drugs (norepi, dopamine, epi). Combined with arrhythmias from β_1/β_2 stimulation, these are the catecholamine killers.

α_1 vasoconstriction at the IV site cuts off blood flow to skin and digits. Within hours: blanching → mottling → necrosis → amputation. This is why **central line** is the standard.

2

WHAT HARMS FIRST?

The IV site (extravasation) and **the rhythm** (tachydysrhythmias / V-tach). Both can occur within minutes of starting or titrating up.

Long before MI, stroke, or organ failure show up, you'll see: blanched/painful site OR ECG changes (PVCs → VT). Catch either early and you save the patient.

3

FIRST NURSING ACTION

If extravasation: **STOP the infusion**, leave IV in place, aspirate, notify provider, give **phentolamine** around site, elevate, warm compresses.

If new arrhythmia: **assess perfusion** (BP, pulse, LOC) → notify provider → prepare to titrate down.

"Stop the infusion" is almost always the right first answer when a vasopressor goes wrong. Then assess, then call. Never "remove the IV first" — you need to aspirate the residual drug.