NCLEX-RN 2026 · PHARMACOLOGY · ANTI-INFECTIVES

Aminoglycoside Antibiotics.

Bactericidal · 30S ribosomal inhibitors · Serious gram-negative coverage

SYSTEM
Infectious Disease

RISK TIER
HIGH-ALERT · NARROW THERAPEUTIC INDEX

GENTAMICIN · TOBRAMYCIN · AMIKACIN · STREPTOMYCIN · NEOMYCIN

01 · DRUG OVERVIEW

Why we give it

- **Serious gram-negative infections** — *Pseudomonas, E. coli, Klebsiella, Proteus, Serratia, Enterobacter*
- **Sepsis / septic shock** — when broad, rapid bactericidal coverage is needed
- **Endocarditis** — combined with a penicillin or vancomycin for synergy (gram-positive coverage)
- **Complicated UTIs, intra-abdominal infections, pneumonia**
- ★ **Streptomycin** → tuberculosis, tularemia, plague
- ★ **Neomycin (oral)** → bowel prep pre-op · **hepatic encephalopathy** (↓ ammonia-producing gut flora)
- ★ **Tobramycin (inhaled)** → cystic fibrosis lung infections

KEY CONCEPT

- Reserved for **severe infections** — not first-line due to toxicity profile
- NOT EFFECTIVE against anaerobes (requires O_2 for cell uptake)

02 · MECHANISM OF ACTION

How it kills the bug

Aminoglycoside enters bacterial cell → requires oxygen-dependent active transport
↓
Binds 30S ribosomal subunit (irreversible)
↓
Misreads mRNA → faulty proteins produced
↓
Protein synthesis halted + membrane damage
↓
BACTERICIDAL — bacterial cell death

CLINICAL IMPLICATIONS

- **Concentration-dependent killing** → higher peak = better kill (once-daily "extended-interval" dosing is safer + effective)
- **Post-antibiotic effect** → continues killing even after drug levels fall
- Ineffective against anaerobes → no O_2 = no drug uptake

03 · THERAPEUTIC EFFECTS

Is it working?

- ✓ ↓ **Fever** within 48–72 hrs
- ✓ ↓ **WBC** trending toward normal (4.5–11k)
- ✓ ↓ **Bands** (left shift resolving)
- ✓ **Negative follow-up cultures**
- ✓ ↓ **CRP, procalcitonin, lactate**
- ✓ Hemodynamic stability, improved mentation, resolving organ dysfunction
- ✓ ↑ Energy, appetite, wound healing

TIME TO ASSESS

- Reassess clinical response at **48–72 hrs**
- If no improvement → reconsider organism, dose, source control

04 · SIDE EFFECTS & ADVERSE REACTIONS

The Big 3 Toxicities — memorize these

1 NEPHROTOXICITY

Acute tubular necrosis. **Often reversible** if caught early. Watch: ↑ BUN, ↑ creatinine, ↓ urine output (<30 mL/hr), ↑ trough level.

2 OTOTOXICITY

Often IRREVERSIBLE. Cochlear (hearing loss, tinnitus) + vestibular (vertigo, ataxia, nausea). **Report ringing in ears IMMEDIATELY.**

3 NEUROMUSCULAR BLOCKADE

Potentiates paralytics → **respiratory paralysis**. Avoid in **myasthenia gravis**. Risk ↑ with rapid IV push.

COMMON

- Nausea, vomiting, diarrhea
- Headache, rash
- Injection site pain
- Mild transient renal changes

SERIOUS

- ⚠ **AKI / ATN** (nephrotoxicity)
- ⚠ **Permanent hearing loss / deafness**
- ⚠ **Respiratory paralysis** (esp. w/ anesthesia or MG)
- ⚠ **Superinfection** (C. diff, candidiasis)
- ⚠ **Fetal ototoxicity** — Pregnancy Category D

05 · PRIORITY NURSING CONSIDERATIONS

Assess · Monitor · Hold · Notify

BEFORE GIVING

- ✓ **ASSESS** baseline renal function (BUN, creatinine, GFR)
- ✓ **ASSESS** baseline hearing + balance (especially elderly)
- ✓ **OBTAIN** culture & sensitivity before first dose
- ✓ **VERIFY** no dual nephrotoxin/ototoxin use

DURING THERAPY — MONITOR

- **Peak & trough levels** around 3rd–4th dose (traditional dosing)
- **Daily BUN, creatinine, I&O**
- **Hearing** — ringing, fullness, ↓ acuity
- **Balance / gait** — fall risk
- **Respiratory status** (esp. post-op or with MG)

HOLD AND NOTIFY HCP IF:

- ✕ **Trough is elevated** (gent/tobra >2, amikacin >8 mcg/mL)
- ✕ **Creatinine rising** or urine output <30 mL/hr × 2 hr
- ✕ **Tinnitus, hearing change, vertigo** reported
- ✕ Signs of neuromuscular weakness / respiratory compromise

CONTRAINDICATIONS / CAUTION

- ✕ **Myasthenia gravis** · **Parkinson's** · pre-existing hearing loss
- ✕ Severe renal impairment (dose adjust per CrCl)
- ✕ Pregnancy (Category D) · breastfeeding caution

DRUG INTERACTIONS ⚠

- ⚠ **Loop diuretics** (furosemide) → ↑ **ototoxicity**
- ⚠ **Vancomycin, amphotericin B, cisplatin, NSAIDs, contrast dye** → ↑ **nephrotoxicity**
- ⚠ **Neuromuscular blockers** (succinylcholine, pancuronium) → ↑ paralysis
- ⚠ **Beta-lactams** in same IV line → **inactivate** aminoglycoside (flush between / separate lines)

06 · LABS & DIAGNOSTICS

What to draw, when, and what it means

DRUG	PEAK (GOAL)	TROUGH (GOAL)
Gentamicin	5–10 mcg/mL	< 2 mcg/mL
Tobramycin	5–10 mcg/mL	< 2 mcg/mL
Amikacin	20–30 mcg/mL	< 8 mcg/mL
↑ Trough = toxicity risk → **HOLD & NOTIFY**		

TIMING — MEMORIZE THIS

- **PEAK:** draw **30 min AFTER** IV infusion ends (or 60 min after IM)
- **TROUGH:** draw **30 min BEFORE** next scheduled dose
- Labs usually obtained around the **3rd–4th dose** (steady state)

OTHER CRITICAL LABS

- **Creatinine, BUN, GFR** — daily; ↑ creatinine = nephrotoxicity
- **Urinalysis** — protein, casts = tubular injury
- **CBC with diff** — trend WBC for efficacy
- **Culture & sensitivity** — drawn pre-dose; de-escalate if narrower agent found
- **Audiometry** — baseline + with prolonged therapy

INTERPRETING RESULTS

- **Peak too low** → underdosing, subtherapeutic → resistance risk
- **Peak too high** → toxicity risk → extend interval / ↓ dose
- **Trough too high** → drug accumulating → **kidneys not clearing** → hold, notify

07 · ADMINISTRATION & SAFETY

Route · Timing · High-alert precautions

ROUTE

- **IV** — most common for systemic infection; infuse over **30–60 min** (never IV push)
- **IM** — deep muscle; peak ~60 min
- **PO** (neomycin) — poorly absorbed → used for bowel prep / hepatic encephalopathy
- **Inhaled** (tobramycin) — cystic fibrosis
- **Topical / ophthalmic / otic** — localized infections

SAFETY ESSENTIALS

- ⚠ **HIGH-ALERT** medication — double-check weight-based dose
- ⚠ **NEVER** mix with beta-lactams (penicillins, cephalosporins) in same line or syringe — they **inactivate** each other
- **Infuse slowly** — rapid infusion ↑ neuromuscular blockade risk
- **Extended-interval ("once-daily") dosing** → safer trough, less nephrotoxicity
- **Adequate hydration** — maintain urine output ≥ 0.5 mL/kg/hr to protect kidneys
- **Dose adjustment** in renal impairment — based on CrCl

08 · PATIENT EDUCATION

What the patient MUST know

REPORT IMMEDIATELY

- ⚠ **Ringing in ears, fullness, hearing change** — possible permanent damage
- ⚠ **Dizziness, loss of balance, spinning** — vestibular toxicity
- ⚠ **Decreased urination, dark urine, ankle swelling** — kidney injury
- ⚠ **Muscle weakness, trouble breathing** — neuromuscular effect
- ⚠ Severe or bloody diarrhea (possible C. diff)

DAILY TEACHING

- Drink **plenty of fluids** (unless contraindicated) — protects kidneys
- **Keep all lab appointments** — peak/trough, creatinine
- Avoid loud noise exposure during therapy (↑ ototoxicity)
- Complete **full course** — even if feeling better
- Notify **all providers** (dentist, surgeon) about aminoglycoside use
- Avoid OTC NSAIDs (ibuprofen, naproxen) unless approved
- Report pregnancy immediately — fetal harm risk

09 · NCLEX TEST TRAPS ⚠

Where students lose points

⚠ **"-mycin" confusion** → not all are aminoglycosides!
Macrolides (erythromycin, azithromycin, clarithromycin) are NOT aminoglycosides. Remember: *amino*glycosides sound "mean" → **"mean GNATS"**

⚠ **Peak vs trough timing** — peak AFTER, trough BEFORE. The trap is picking the wrong one under pressure.

⚠ **Trough is the toxicity indicator**, not the peak. A high trough = accumulation = kidneys failing.

⚠ **Neomycin** for hepatic encephalopathy is given PO (we WANT it to stay in the gut). Students think "PO antibiotic = systemic."

⚠ **Furosemide + gentamicin** = deafness trap. Both are ototoxic — increases risk dramatically.

⚠ **Ototoxicity is often PERMANENT**, nephrotoxicity is often reversible. Priority = protect hearing.

⚠ **Anaerobic infection (e.g., abdominal abscess)** → aminoglycoside alone is wrong answer (needs O_2 to work).

⚠ **Myasthenia gravis + aminoglycoside** = respiratory arrest risk. This is a contraindication, not just caution.

⚠ Don't confuse with **Red Man Syndrome** (that's vancomycin, not aminoglycosides).

⚠ "**Tinnitus**" on the exam = stop the drug & call provider — do NOT "continue monitoring."

10 · MEMORY BOOSTERS

Mnemonics & patterns

★ DRUGS IN THE CLASS
"Mean GNATS cannot kill anaerobes"
Gentamicin · **N**eomycin · **A**mikacin · **T**obramycin · **S**treptomycin

★ THE "3 N'S" OF TOXICITY
Nephrotoxicity · **N**eurotoxicity (ototoxic + NM blockade) · **N**eomycin is the most toxic

★ PEAK VS TROUGH
"Peak After, Trough Before" →
Peak **A**fter infusion (30 min post-IV)
Trough **B**efore next dose (30 min prior)

★ "LISTEN & PEE"
Monitor **hearing** (listen) and **urine output** (pee) — the two earliest warning systems.

★ WHAT AMINOGLYCOSIDES DON'T COVER
"No A-A-A" → Anaerobes, **A**typicals, **A**cidic environments (abscesses)

★ PATTERN ACROSS "-TOXIC" DRUGS
Aminoglycosides + **Vancomycin + Loops + Cisplatin + NSAIDs** = shared nephro/ototoxicity. If two are on the MAR, **question it**.

★ MOST TESTED DRUGS IN THIS CLASS

Key differences NCLEX loves to test

DRUG	PRIMARY USE	ROUTE	UNIQUE FEATURE	NCLEX TIP
Gentamicin	Gram-negative sepsis, endocarditis (synergy w/ PCN), UTI	IV / IM / topical / ophthalmic	Most commonly tested aminoglycoside; prototype drug	Classic peak/trough question. Trough <2 mcg/mL.
Tobramycin	Pseudomonas (esp. cystic fibrosis), pneumonia	IV / IM / **inhaled** / ophthalmic	Inhaled form → CF patients for chronic Pseudomonas	Inhaled = think CF. Still systemic toxicity warnings apply.
Amikacin	Resistant gram-negatives (when gent/tobra fail)	IV / IM	Broadest spectrum; reserved for resistant organisms	Different therapeutic range: peak 20–30, trough <8.
Streptomycin	**TB** (2nd line), tularemia, plague	IM primarily	Highest vestibular (balance) toxicity	Think TB + IM. Monitor gait & balance.
Neomycin	**Bowel prep** pre-op · **hepatic encephalopathy** · topical wounds	**PO** (poorly absorbed) / topical	Most toxic if absorbed — stays in gut when given PO	"PO aminoglycoside" = neomycin. Reduces ammonia by killing gut bacteria.

CLINICAL JUDGMENT SNAPSHOT

#1 PRIORITY RISK

What's the most dangerous complication?

Ototoxicity (often **permanent** hearing loss) and **nephrotoxicity** (AKI). Ototoxicity ranks higher because it is irreversible — hearing does not come back.

WHAT HARMS FIRST

What will harm the patient FIRST?

Rising trough level + falling urine output → kidneys stop clearing drug → drug accumulates → ototoxicity & further kidney injury. The kidney is the first organ to signal trouble on labs.

FIRST NURSING ACTION

Patient reports ringing in ears — what do you do FIRST?

HOLD the next dose → NOTIFY the provider → DOCUMENT symptom onset and obtain stat trough + creatinine. Do NOT "continue and monitor" — tinnitus = early ototoxicity, and damage becomes permanent if dosing continues.