SECTION 1

Calculations and Conversions

Basic medication dose conversion and calculation skills are essential to providing safe nursing care. Standard conversions are used to solve dosage calculation problems. Nurses are responsible for the administration of the correct amount of medication based on the type of medication being administered.

A. **Standard Conversion Factors**

1. 1 mg = 1,000 mcg
2. 1 g = 1,000 mg
3. 1 kg = 1,000 g
4. 1 kg = 2.2 lb
5. 60 mg = 1 gr
6. 30 mL = 1 oz
7. 1 L = 1,000 mL
8. 5 mL = 1 tsp
9. 15 mL = 1 tbsp
10. 1 tbsp = 3 tsp

B. **Temperature Conversions**

1. 37.0° C = 98.6° F
2. °C = (°F − 32)×(5/9)
3. °F = (°C × 9/5) + 32

C. **Calculations for IV Administration**

1. Number of hours = total volume/mL/hr
2. gtt per min = total volume × gtt/mL in administration set/total number of minutes

D. **Calculations for Dosage**

1. Dosage on hand (H)/mL = Dosage desired (D)/mL

PRACTICE TEST QUESTIONS

1. A client has the following food for lunch: 8 oz ice chips, 1 cup tea, 1 cup coffee, and 240 mL milk. The client eats the ice chips, and drinks all of the tea, coffee, and half of the milk. The total intake for lunch is ____.
2. A client has a prescription for 0.25 mg digoxin. The dose on hand is 0.5 mg tablets of digoxin. How many tablets will the client receive?
3. A client's IV infusion rate is 75 mL/hr. How many hours will it take for a 500 mL bag of IV fluid to infuse?
4. The IV rate is 100 mL/hr and the administration set is 15 drops/mL. How many drops per minute will deliver the required fluids?
5. A client has a prescription for heparin sodium 7,000 units IV. The vial contains 10,000 units/mL. How many milliliters of heparin will the nurse administer?
6. A nurse is preparing 300,000 units of procaine penicillin. The vial contains 1,500,000 units/2 mL. How many milliliters will the nurse administer?
7. A client weighs 180 lb and has a prescription for 0.5 mL of medication per kilogram of body weight. How many milliliters of medication will the client receive?
8. A client is receiving dextrose 5% in water at 50 mL/hr in one IV and D_5W 75 mL/hr in another IV. The client also receives IV piggyback medication every 8 hr prepared in 100 mL of fluid. What is the total amount of IV fluid the client will receive in 8 hr?
9. The IV administration set delivers 10 drops/mL. The rate of flow in drops/min for 1,000 mL dextrose 5% in water to infuse in 8 hr is ____.
10. When measuring a client's output, the nurse records 300 mL of urine at 0800, 450 mL of liquid stool at 1130, 225 mL of urine at 1300, and 35 mL of emesis at 1430. What is the client's total output for this shift?
11. A client receiving an IV infusion has a prescription for 1,000 mL in 12 hr. Using a microdrip system that delivers 60 microdrops/mL, the nurse should regulate the infusion for how many drops per minute?
    A. 45
    B. 68
    C. 83
    D. 96
12. A client's temperature is 100° F. What is this temperature in degrees centigrade?
13. A nurse has available meperidine 50 mg/mL. The prescription is to administer meperidine 35 mg. How many milliliters will the nurse safely administer?
14. A nurse is preparing an IV antibiotic in 100 mL dextrose 5% in water to infuse over 20 min. The infusion set is calibrated for 10 drops/mL. What drip rate should the nurse use?

Answer Key: 1. 720; 2. 0.5, 3. 6.7, 4. 25; 5. 0.7; 6. 0.4; 7. 41; 8. 1,100; 9. 21, 10. 1,010, 11. C (83); 12. 37.8; 13. 0.7; 14. 50

SECTION 2

Medication Therapies

I Medication Actions, Interactions, and Reactions

A. **Medication properties (pharmacokinetics):** The absorption, distribution, metabolism, and excretion of a medication; describes the onset of action, peak level, duration of action, and bioavailability

B. **Medication interaction:** When a medication is given with another medication and alters the effect of either or both medications

C. **Adverse reactions:** Negative effects experienced by a client as the result of a specific medication; may be hazardous, tolerated, or subside with continued use

II Pharmacotherapy Across the Life Span

A. **Medications and pregnancy:** A majority of medications cross the placental barrier, thereby increasing the risk of teratogenicity. All medications should be given with extreme caution to ensure safety to the developing fetus.

B. **Medications and breastfeeding:** Most medications taken by a mother who is breastfeeding appear in breast milk. Medication levels tend to be the highest in the newborn immediately after the medication is administered to the mother. Mothers who are breastfeeding are advised to breastfeed before taking the medication. For additional guidelines, review Unit 8.

C. **Medication in children:** Pharmacokinetics are influenced by a child's age, size, and maturity of the targeted organ. To reduce the risk of toxicity, these factors must be considered: safe calculation of the child's dosage (mg/kg/day), medication that is age-appropriate, monitoring of IV medications to prevent fluid overload (smaller solution containers should be used to avoid infusing too much fluid), and the administration of inhalants using a metered-space device. For additional guidelines, review Unit 9.

D. **Medication in older adults:** Age-related changes affect therapeutic effects of medications in older adult clients. Older adult clients experience more adverse effects than younger adults due to aging body systems. Confusion, lethargy, falls, and weakness may be mistaken for senility, rather than adverse reactions. If the adverse reaction is not identified, unnecessary medication may be prescribed to treat complications caused by the medication. As the client continues to receive medications, the risk for toxicity increases, especially in cases of polypharmacy. Toxicity in older adults is a greater risk when taking diuretics, antihypertensives, digoxin, steroids, anticoagulants, hypnotics, and over-the-counter medications.

III Safe Medication Administration

A. **The RN is prepared to administer medications using the enteral, parenteral, and transcutaneous routes.**

B. **The RN must assess the client's:**

1. Allergies and adverse effects
2. Current medication regimen for potential interactions
3. Physiologic status compared to baseline assessment data

C. **The RN follows the six rights of medication administration** (i.e., right client, right drug, right dose, right route, right time, right documentation) to protect the safety of the client and follow the scope of practice to maintain professional licensure.

IV Laboratory Profiles in Pharmacology

Laboratory testing may be indicated for specific medications. The nurse is accountable for collaborating with the health care provider in ensuring client safety when laboratory testing is prescribed.

A. **Therapeutic Drug Monitoring**

1. Measures blood drug levels to determine effective medication dosages and prevent medication toxicity. The test may also be used to identify noncompliance with medication regimens.
2. Blood testing is preferred because it provides information about current therapeutic levels, whereas urine levels reflect the presence of a drug over several days.

B. **Peak levels reflect the highest concentration.**

AVERAGE TIMES FOR DRAWING PEAK LEVELS

ROUTE OF ADMINISTRATION	TIME SPECIMEN IS DRAWN AFTER ADMINISTRATION
Oral intake	1 to 2 hr
Intramuscular	1 hr
Intravenous	30 min

C. **Trough levels** reflect the lowest concentration or residual level and are usually obtained within 15 min prior to administration of the next scheduled dose. The scheduled dose of medication should not be administered until the trough level is confirmed.

NOTE: The timing for drawing a peak and trough level varies based on the half-life (time required for the body to decrease the medication blood level by 50%) for the medication.

D. **Culture and Sensitivity:** Cultures are obtained to detect the presence of pathogens within the specimen collected. If a culture produces organisms, testing is performed in the laboratory to identify the appropriate antibiotic therapy (sensitivity). Begin antibiotic therapy after obtaining lab sample.

NOTE: When prescribed, cultures should be obtained prior to initiating antibiotic therapy (definitive therapy). When cultures cannot be drawn prior, the provider will prescribe a broad-spectrum antibiotic (empirical therapy). Monitoring culture results is imperative to ensure proper antimicrobial treatment.

v Intravenous Therapy

Administration of fluids via an intravenous catheter (peripheral or central vein access) for the purpose of providing medication, fluid, electrolyte, or nutrient replacement

A. **Guidelines for Safe IV Administration**

1. Review medication guidelines for precautions related to IV administration for compatibility, rate of administration, necessity of infusion pump, and serious adverse reactions.
2. Never administer medications through tubing being used for blood administration.
3. Implement standard precautions and follow policies related to IV site changes.
4. Fluids should be infused within 24 hr (discard unused portion) to prevent infection.
5. Maintain patency of IV access.

B. **Types of IV Access**

1. Peripheral vein
2. Central venous catheters
   a. PICC (peripherally inserted central catheter)
   b. Nontunneled percutaneous central venous catheter
   c. Tunneled central venous catheter (Hickman, Groshong)
   d. Implanted port

C. **Prevent complications associated with IV infusion.**

COMPLICATIONS ASSOCIATED WITH IV INFUSION

COMPLICATION	NURSING INTERVENTIONS
Infiltration	**Prevention:** Use smallest catheter for prescribed therapy, stabilize port-access, assess blood return. **Treatment:** Stop infusion, remove peripheral catheters, apply cold compress, elevate extremity, insert new catheter in opposite extremity.
Extravasation	**Prevention:** Know vesicant potential before giving medication. **Treatment:** Stop infusion, discontinue administration set, aspirate drug if possible, apply cold compress, document condition of site (may photograph).
Phlebitis/ thrombophlebitis	**Prevention:** Rotate sites every 72 to 96 hr, secure catheter, use aseptic technique; for PICCs, avoid excessive activity with the extremity. **Treatment:** Stop infusion, remove peripheral IV catheters, apply heat compress, insert new catheter in opposite extremity.
Hematoma	**Prevention:** Avoid veins not easily seen or palpated; obtain hemostasis after insertion. **Treatment:** Remove IV device and apply light pressure if bleeding; monitor for signs of phlebitis and treat.
Catheter embolus	**Prevention:** Do not reinsert stylet needle into catheter. **Treatment:** Immediately apply tourniquet high on extremity to limit venous flow. Prepare for removal under x-ray.

D. **Complications Associated with Central Venous Catheters**

COMPLICATIONS OF CENTRAL VENOUS CATHETERS

COMPLICATION	NURSING INTERVENTIONS
Pneumothorax (during insertion)	**Prevention:** Use ultrasound to locate veins, avoid subclavian insertion when possible. **Treatment:** Administer oxygen, assist provider with chest tube insertion.
Air embolism	**Prevention:** Have client lie flat when changing administration set or needleless connectors, ask client to perform Valsalva maneuver if possible. **Treatment:** Place client in left lateral Trendelenburg, administer oxygen.
Lumen occlusion	**Prevention:** Flush promptly with NS between, before, and after each medication. **Treatment:** Use 10 mL syringe with a pulsing motion.
Bloodstream infection	**Prevention:** Maintain sterile technique. **Treatment:** Change entire infusion system, notify provider, obtain cultures, and administer antibiotics.

E. **Complications Associated with PICC Line**

COMPLICATIONS ASSOCIATED WITH PICC LINE

COMPLICATION	NURSING INTERVENTIONS
Catheter occlusions	Prevent kinks, reposition arm, confirm blood return, flush catheter between medications, administer approved antithrombolytic.
Catheter dislodges	Assess blood return, discomfort in jaw, chest, or ear, contact provider.
Phlebitis	Apply low degree heat, discontinue if not resolved.
Catheter embolism	Secure catheter, avoid pulling, follow safe practices for catheter removal.
Infection	Use aseptic technique, keep dressing clean and dry, intervene immediately for any sign of infection.

vi Total Parenteral Nutrition (TPN)

Hypertonic solution containing dextrose, proteins, electrolytes, minerals, trace elements, and insulin prescribed according to the client's needs and administered via central venous device (PICC line, subclavian, or internal jugular vein)

A. **Care and Maintenance of TPN**

1. Before administering, verify prescription and solution with another nurse.
2. Administer via infusion pump.
3. Monitor weight daily.
4. Monitor and record I&O, noting fluid balance.
5. Monitor serum glucose levels every 4 to 6 hr.
6. Monitor for signs of infection.
7. Change dressing every 48 to 72 hr per facility protocol.
8. Change IV tubing and fluid every 24 hr.
9. If TPN solution is temporarily unavailable, administer dextrose 10% in water to prevent hypoglycemia.

vii Antidote/Reversal Agents

A. **Acetaminophen:** acetylcysteine
B. **Benzodiazepine:** flumazenil
C. **Curare:** edrophonium
D. **Cyanide poisoning:** methylene blue
E. **Digitalis:** digoxin immune FAB
F. **Ethylene poisoning:** fomepizole
G. **Heparin and enoxaparin:** protamine sulfate
H. **Iron:** deferoxamine
I. **Lead:** succimer
J. **Magnesium sulfate:** calcium gluconate 10%
K. **Narcotics:** naloxone
L. **Warfarin:** phytonadione (vitamin K)

viii Therapeutic Drug Levels

A. **Aminophylline:** 10 to 20 mcg/mL
B. **Carbamazepine:** 5 to 12 mcg/mL
C. **Digoxin:** 0.8 to 2.0 ng/mL
D. **Gentamicin:** 5 to 10 mcg/mL
E. **Lidocaine:** 1.5 to 5.0 mcg/mL
F. **Lithium:** 0.4 to 1.4 mEq/L
G. **Magnesium sulfate:** 4 to 8 mg/dL
H. **Phenobarbital:** 10 to 40 mcg/mL
I. **Phenytoin:** 10 to 20 mcg/mL
J. **Salicylate:** 100 to 250 mcg/mL
K. **Theophylline:** 10 to 20 mcg/mL
L. **Tobramycin:** 5 to 10 mcg/mL
M. **Trough Drug Levels**
   1. Gentamicin: 1 to 2 mcg/mL
   2. Tobramycin: 1 to 2 mcg/mL
   3. Vancomycin: 15–20 mcg/mL

ix Toxic Drug Levels

A. **Acetaminophen:** greater than 250 mcg/mL
B. **Aminophylline:** greater than 20 mcg/mL
C. **Amitriptyline:** greater than 500 ng/mL
D. **Digoxin:** greater than 2.4 ng/mL
E. **Lidocaine:** greater than 5 mcg/mL
F. **Lithium:** greater than 2.0 mEq/L
G. **Magnesium sulfate:** greater than 9 mg/dL
H. **Methotrexate:** greater than 10 mcmol over 24 hr
I. **Phenobarbital:** greater than 40 mcg/mL
J. **Phenytoin:** greater than 30 mcg/mL
K. **Salicylate:** greater than 300 mcg/mL
L. **Theophylline:** greater than 20 mcg/mL

x Common Drug Class Suffixes

COMMON DRUG CLASS SUFFIXES

SUFFIX	MEDICATION CATEGORY
-dipine	Ca^+ channel blocker
-afil	Erectile dysfunction
-caine	Anesthetics
-pril	ACE inhibitor
-pam, -lam	Benzodiazepine
-statin	Antilipidemic
-asone, -solone	Corticosteroid
-olol	Beta blocker
-cillin	Penicillin
-ide	Oral hypoglycemic
-prazole	Proton pump inhibitor
-vir	Antiviral
-ase	Thrombolytic
-azine	Antiemetic
-phylline	Bronchodilator
-arin	Anticoagulant
-dine	Antiulcer
-zine	Antihistamine
-cycline	Antibiotic
-mycin	Aminoglycoside
-floxacin	Antibiotic
-tyline	Tricyclic antidepressants
-pram, -ine	SSRIs

SIDE EFFECTS AND ADVERSE REACTIONS

This worksheet will build upon your knowledge of medication side effects and adverse reactions. NCLEX will expect you to be able to manage clients experiencing side effects and adverse reactions to medications. Match the side effect or adverse reaction with the medication or classification. Each should only be used once.

___ 1. ACE inhibitors	A. Angioedema
___ 2. Benzodiazepines	B. Bronchospasm
___ 3. Beta blockers	C. Yellow tinge to vision
___ 4. Ciprofloxacin	D. Hypokalemia
___ 5. Digoxin	E. Tendon rupture
___ 6. Doxycycline	F. Tooth discoloration
___ 7. Furosemide	G. Ototoxicity
___ 8. Lithium	H. Thrombotic thrombocytopenic purpura
___ 9. Tobramycin	I. Anterograde amnesia
___ 10. Valacyclovir	J. Tremors

Answer Key: 1. A; 2. I; 3. B; 4. E; 5. C; 6. F; 7. D; 8. J; 9. G; 10. H

THE MEDICATION CATEGORIES

This worksheet will build on your overall knowledge of medications. Learning medications by categories will help you group medications and reduce the number you have to memorize. This list is not all-inclusive, but is a great place to start. NCLEX® will expect you to know entry-level pharmacology. Column one lists generic medication categories or classifications. In column two, write the commonly used "ending" for the medication classification. In column three, write an example of a medication that would be included in the classification.

MEDICATION CATEGORY	"ENDING"	MEDICATION
1. ACE inhibitors		
2. Antivirals		
3. Antifungals		
4. Antilipidemics		
5. Angiotensin II receptor blockers (ARBs)		
6. Beta blockers		
7. Calcium-channel blockers		
8. Erectile dysfunction medications		
9. Histamine$_2$ receptor antagonists		
10. Proton pump inhibitors		

Answer Key for Endings: 1. –pril; 2. –vir; 3. –azole; 4. –statin; 5. –sartan; 6. –olol; 7. –dipine; 8. –afil; 9. –dine; 10. –prazole
Medications: Answers for medications may vary.

SECTION 3

Medications for the Cardiovascular System

I Antihypertensives

Treatment for clients with hypertension includes lifestyle modification and medications.

A. **Nursing interventions for clients taking antihypertensive medications include:**
1. Assess weight, vital signs, and hydration status.
2. Assess blood pressure in supine, sitting, and standing positions.
3. Assess laboratory profiles: renal function, coagulation.
4. Teach clients to take medication at same time each day.
5. Clients should avoid hot tubs and saunas.
6. Do not discontinue medication abruptly.
7. Prevent orthostatic hypotension.

B. **Angiotensin-Converting Enzyme (ACE) Inhibitors and Angiotensin II Receptor Blockers (ARBs)**
1. **Action**
   a. ACE inhibitors: block the conversion of angiotensin I to angiotensin II.
   b. ARBs: selectively block the binding of angiotensin II to AT1 receptors found in tissues.

ACE INHIBITORS	ARBS
Captopril	Losartan
Enalapril	Valsartan
Enalaprilat (intravenous route)	Irbesartan
Fosinopril	
Lisinopril	

2. **Therapeutic use**: hypertension, heart failure, MI, diabetic nephropathy
3. **Precautions/Interactions**
   a. Use with caution if diuretic therapy is in place.
   b. Monitor potassium levels.
4. **Side/Adverse Effects**
   a. Persistent nonproductive cough with ACE inhibitors
   b. Angioedema; hypotension
   c. Should not be used in second and third trimester of pregnancy
5. **Nursing Interventions and Client Education**
   a. Captopril should be taken 1 hr before meals.
   b. Monitor blood pressure.
   c. Monitor for angioedema and promptly administer epinephrine 0.5 mL of 1:1,000 solution subcutaneously.

C. **Calcium-Channel Blockers**
1. **Action:** Slows movement of calcium into smooth-muscle cells, resulting in arterial dilation and decreased blood pressure
2. **Medications**
   a. Nifedipine
   b. Verapamil
   c. Diltiazem
   d. Amlodipine
3. **Therapeutic Use**
   a. Angina, hypertension
   b. Verapamil and diltiazem may be used for atrial fibrillation, atrial flutter, or SVT.
4. **Precautions/Interactions**
   a. Use cautiously in clients taking digoxin and beta blockers.
   b. Contraindicated for clients who have heart failure, heart block, or bradycardia.
   c. Do not consume grapefruit juice (toxic effects).
5. **Side/Adverse Effects**
   a. Constipation
   b. Reflex tachycardia
   c. Peripheral edema
   d. Toxicity
6. **Nursing Interventions and Client Education**
   a. Do not crush or chew sustained-release tablets.
   b. Administer IV injection over 2 to 3 min.
   c. Slowly taper dose if discontinuing.
   d. Monitor heart rate and blood pressure.

D. **Alpha Adrenergic Blockers (Sympatholytics)**
1. **Action:** Selectively inhibit alpha1 adrenergic receptors, resulting in peripheral arterial and venous dilation that lowers blood pressure
2. **Medications**
   a. Prazosin
   b. Doxazosin mesylate
3. **Therapeutic Use**
   a. Primary hypertension
   b. Doxazosin mesylate may be used in treatment of BPH.
4. **Precautions/Interactions**
   a. Increased risk of hypotension and syncope if given with other antihypertensives, beta blockers, or diuretics.
   b. NSAIDs may decrease the effect of prazosin.
5. **Side/Adverse Effects**
   a. Dizziness
   b. Fainting
6. **Nursing Interventions and Client Education**
   a. Monitor heart rate and blood pressure.
   b. Take medication at bedtime to minimize effects of hypotension.
   c. Advise to notify prescriber immediately about adverse reactions.
   d. Consult prescriber before taking any OTC medications.

E. **Centrally Acting Alpha$_2$ Agonists**
1. **Action:** Stimulate alpha adrenergic receptors (alpha$_2$) in the brain to reduce peripheral vascular resistance, heart rate, and systolic and diastolic blood pressure
2. **Medications**
   a. Clonidine
   b. Guanfacine HCl
   c. Methyldopa
3. **Therapeutic Use**
   a. Primary hypertension—may be used in combination with diuretics or other antihypertensives
   b. Hypertensive crisis
   c. Severe cancer pain (parenteral administration via epidural)
4. **Precautions/Interactions**
   a. Contraindicated with anticoagulant therapy, hepatic failure.
   b. Do not administer to clients taking MAOIs.
   c. Do not administer methyldopa through IV line with barbiturates or sulfonamides.
   d. Use cautiously in CVA, MI, diabetes mellitus, major depression, or chronic renal failure.
   e. Do not use during lactation.
5. **Side/Adverse Effects**
   a. Dry mouth
   b. Drowsiness and sedation (resolves over time)
   c. Rebound hypertension
   d. Black or sore tongue
   e. Leukopenia
6. **Nursing Interventions and Client Education**
   a. Monitor for adverse CNS effects.
   b. Monitor CBC, heart rate, and blood pressure.
   c. Assess for weight gain or edema.
   d. Monitor closely for rebound hypertension when medication is discontinued (48 hr).
   e. Instruct to never skip a dose.
   f. Take at bedtime to minimize effects of hypotension.
   g. Notify prescriber of any involuntary jerky movements, prolonged dizziness, rash, yellowing of skin.

F. **Beta Adrenergic Blockers (Sympatholytics)**
1. **Action:** Inhibit stimulation of receptor sites, resulting in decreased cardiac excitability, cardiac output, myocardial oxygen demand; lower blood pressure by decreasing release of renin in the kidney

NOTE: Beta$_1$ receptors are primarily in the cardiac and renal tissues. Beta$_2$ receptors are found primarily in the lungs, gastrointestinal tract, liver, uterus, vascular smooth muscle, and skeletal muscle.

2. **Medications:** May be selective or nonselective
   a. Cardioselective Beta$_1$ Medications
      1) Metoprolol
      2) Atenolol
      3) Metoprolol succinate
   b. Nonselective (Beta$_1$ and Beta$_2$) Medications
      1) Propranolol
      2) Nadolol
      3) Labetalol
3. **Therapeutic Use**
   a. Primary hypertension
   b. Angina
   c. Tachydysrhythmias, heart failure, and MI
4. **Precautions/Interactions**
   a. Contraindicated in clients who have AV block and sinus bradycardia.
   b. Do not administer nonselective beta blockers to clients who have asthma, bronchospasm, or heart failure.
   c. Propranolol may mask effects of hypoglycemia in clients who have diabetes mellitus.
   d. Do not administer labetalol in same IV line with furosemide.