CRNI Exam Study Guide 2026

A Comprehensive Resource for Aspiring Infusion Nurses, Master Key Concepts, Vascular Access, Therapy, Patient Assessment, 500 Practice Questions And Detailed Explanation.

By

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TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION TO THE CRNI EXAM

1.1 UNDERSTANDING THE CRNI CREDENTIAL

The Certified Registered Nurse Infusion (CRNI) credential is a respected and nationally recognized certification for nurses who practice infusion therapy. It is awarded by the Infusion Nurses Certification Corporation (INCC), the body responsible for setting exam standards, validating test questions, and maintaining the integrity of the certification.

The CRNI credential shows that a nurse has strong knowledge in infusion therapy, patient safety, vascular access care, IV medication administration, specialized infusions, and professional practice.
It demonstrates a higher level of clinical judgment, and it shows readiness to deliver infusion therapy safely in hospitals, clinics, home-infusion programs, oncology centers, and emergency or critical care settings.

Holding the CRNI credential also offers several long-term benefits:

- Career growth opportunities
- Higher professional credibility
- Increased confidence when managing complex infusion therapies
- Eligibility for roles in leadership, education, vascular access teams, and quality improvement
- Proof of meeting a national standard of expertise
- Added value when competing for advanced nursing roles

Most employers value CRNI-certified nurses because infusion therapy involves high-risk procedures. Having a certified nurse on the team promotes safer care, better outcomes, and stronger compliance with clinical standards.

The certification is valid for three years. Renewal requires continuing education in infusion therapy or retaking the exam. This ensures that a CRNI-certified nurse maintains up-to-date knowledge and remains competent as practice guidelines evolve.

1.2 ELIGIBILITY REQUIREMENTS

To sit for the CRNI exam, the Infusion Nurses Certification Corporation requires the candidate to meet all eligibility rules before applying. These rules ensure that only clinically experienced nurses with direct infusion therapy exposure attempt the exam.

The main eligibility requirements include:

A. A Current and Active RN License
You must hold a valid, unrestricted Registered Nurse (RN) license in the United States or its territories.
If licensed outside the U.S., the license must be equivalent to U.S. RN standards.

B. Minimum Experience Requirements
Before submitting your application, you must meet ONE of the following:

Pathway 1
• At least 1,600 hours of infusion-related practice within the previous two years.
This practice may involve bedside infusion therapy, vascular access care, IV medication administration, clinical education, quality improvement, or home infusion.

OR

Pathway 2
• Completion of 30 contact hours of infusion-specific continuing education within the previous two years.
These courses must be related to infusion therapy practice and must meet INCC standards.

C. Practice Requirements Might Include
• Starting peripheral IV lines
• Caring for central lines
• Managing PICC lines, ports, tunneled and nontunneled catheters
• Administering IV medications
• Managing parenteral nutrition
• Blood administration and monitoring
• Patient assessment and education
• Following infection prevention standards
Applicants must submit documentation proving they meet the requirement. INCC may request verification from employers or educators.

D. No Restrictions on RN License
Your nursing license must not be suspended, revoked, or restricted. A restricted license makes you ineligible.

E. No Prior Disciplinary Action Related to Misconduct
Any history of fraud, ethical violations, or exam misconduct can affect eligibility.
Once eligibility is confirmed, INCC issues an authorization to test (ATT) and the candidate may choose a testing window.

1.3 EXAM FORMAT AND CONTENT DISTRIBUTION

The CRNI exam uses a structured question format that tests clinical judgment, decision-making, and understanding of infusion therapy standards. The exam is computer-based and delivered at approved testing centers or via remote proctoring.

A. Number of Questions
• Total questions: 150
• Scored questions: 140
• Pilot (unscored) questions: 10

The unscored questions are used to test future exam items. Candidates will not know which items are unscored, so treat every question equally.

B. Exam Length
• Total testing time: 3 hours
• No scheduled breaks
You may take unscheduled breaks, but the clock continues running.

C. Question Style
The exam uses multiple-choice questions with four answer options. Question types include:
• Knowledge questions that test facts
• Application questions that test clinical judgment
• Scenario-based questions testing decision-making
• Calculation questions for infusion rates, concentrations, and conversions
• Safety and complication-management questions

D. CRNI Exam Content Areas
The exam is divided into three major domains, each with multiple content sections. The distribution is set by the INCC and is updated based on current practice standards.

Domain I: Vascular Access (VA)
About one-third of the exam covers topics such as peripheral catheters, PICC lines, ports, tunneled lines, midlines, insertion techniques, maintenance, flushing, locking, troubleshooting, and complication management.
Topics commonly tested include phlebitis, occlusion, extravasation, infection control, securement methods, and patient assessment.

Domain II: Infusion Therapy (IT)
This section covers the safe preparation, administration, and monitoring of IV medications and fluids. It includes pharmacology, blood therapy, parenteral nutrition, fluid balance, electrolyte management, specialty infusions, compatibility, vesicants, and calculations.
Many scenario questions appear in this domain.

Domain III: Professional Practice (PP)
This domain covers documentation, ethics, legal considerations, patient education, scope of practice, quality improvement, leadership, safety standards, and evidence-based practice.

E. Test-Taking Requirements
• Government ID with signature
• Compliance with testing center rules
• No personal items allowed
• Electronic devices prohibited
• Remote testing requires a secure room and webcam

F. Scoring
Scores are calculated from the 140 scored items only.
There is no penalty for wrong answers — always choose an answer for every item.

The passing score is determined through a statistical method called the Angoff standard, which evaluates the difficulty level of each question.
Candidates receive a pass/fail result and a performance report showing strengths and weaknesses in all three domains.

G. Retaking the Exam
If a candidate does not pass:
• The exam may be retaken in the next available testing window
• There is no limit to the number of attempts
• A new application fee is required

1.4 SCORING METHOD AND PASSING REQUIREMENTS

The CRNI exam is scored using a standardized method that ensures fairness for every candidate. The Infusion Nurses Certification Corporation (INCC) does not use a curved scoring system. Instead, the exam is scored according to the actual difficulty of the questions.

A. Total Scored Items
• The exam contains 150 questions.
• Only 140 questions count toward your score.
• The remaining 10 questions are pilot items used to evaluate future exam questions.
These pilot items do not affect your results, but they look exactly like regular exam questions, so you must answer every question with equal attention.

B. Scaled Scoring
The CRNI exam uses a scaled score, not a raw score.
This means that the difficulty of the questions is factored into the scoring process.

Two candidates may answer a similar number of questions correctly, but if one answers harder questions correctly, the scaled score may be higher.
This method ensures fairness across different versions of the exam.

C. Passing Standard
There is no fixed number of questions you must get correct.
Instead, the passing standard is based on a statistical method known as the Angoff Method, where certified subject-matter experts estimate the minimum level of knowledge needed to pass.

Your score report will show:
• Pass or Fail
• Performance in all three domains
• Strengths and weaknesses
A passing score means you have demonstrated the minimum level of knowledge expected of a safe and competent infusion nurse.

D. No Penalty for Wrong Answers
The exam does not use negative marking.
A wrong answer does not reduce your score.

Leaving a question blank is treated the same as answering incorrectly.
Always answer every question, even when unsure.

E. Retesting Rules
If a candidate does not pass:
• You may retake the exam in the next testing cycle.
• There is no limit to the number of attempts.
• You must pay the exam fee again.
• Your CRNI renewal cycle begins once you pass.
INCC encourages candidates who fail to use the performance report as a guide for targeted studying before retesting.

1.5 TEST-DAY RULES AND WHAT TO EXPECT

The CRNI exam is a professional, high-security certification exam.
Understanding test-day rules helps reduce stress and improves your focus.

A. Arrival and Check-In
Whether testing at a center or online, you must check in early.
Recommended arrival time: 30 minutes before the appointment.

You must bring:
• A government-issued ID with photo and signature
• Your Authorization to Test (ATT) email (digital or printed)

Testing staff will:
• Verify your identity
• Take your photo
• Review rules and procedures
• Inspect personal items

B. Personal Belongings
Not permitted in the exam room:
• Phones
• Smartwatches
• Papers or notes
• Bags or purses
• Food and drinks
• Earbuds or AirPods

Permitted items may include:
• Foam earplugs (unopened)
• Basic prescription glasses
All personal items must be stored in lockers or kept outside the testing area.

C. Exam Room Conditions
The testing room has:
• Single or group cubicles

• Noise-controlled environment
• Surveillance cameras
• Proctor supervision
• Computer workstation with exam software

D. During the Exam
The total time is 3 hours, and the clock continues even if you take an unscheduled break.
You will receive:
• On-screen calculator
• On-screen timer
• Highlight and strike-out tools
• Navigation between questions

Once the exam begins, you may:
• Pause only for personal breaks
• Raise your hand for assistance
• Move through questions at your own pace
You may not:
• Talk to other candidates
• Look at personal items
• Attempt to copy or record questions
• Use unauthorized devices

E. At the End of the Exam
When time finishes:
• The screen locks
• You complete a short survey
• Your preliminary pass/fail result appears immediately
Official results and your performance report will be available later through the INCC portal.

1.6 STUDY STRATEGIES FOR FIRST-TIME AND REPEAT TEST TAKERS

Success on the CRNI exam requires structured preparation, repeated practice, and a clear understanding of core concepts. Below are strategies proven to help candidates at all levels.

A. Build a Study Timeline
Create a realistic study period such as:
• 3-week accelerated plan
• 6-week standard plan
• 8-week extended plan
Divide your study time across the three major domains.
Review one domain at a time to avoid overwhelm.

B. Use the Exam Content Outline
INCC publishes the official exam content outline.
Use it as your checklist.
Make sure your study plan covers every topic listed under the three exam domains.

C. Focus on High-Yield Areas
Commonly tested topics include:
• Access devices
• Medication safety
• Complications and troubleshooting
• Parenteral nutrition
• Blood administration
• Compatibility and calculations
• Infection prevention
• Ethical practice and documentation
Mastering these increases confidence and improves exam performance.

D. Practice with Realistic Test Questions
Do not rely only on reading.
Practice questions train your mind to:
• Recognize patterns
• Interpret clinical scenarios
• Apply knowledge quickly
• Manage time effectively
After doing practice items, review detailed explanations to understand why the correct answer is correct and why the wrong choices are wrong.

E. Use Visual Learning Tools
Charts, diagrams, catheters, device illustrations, infusion rate formulas, and compatibility tables help you retain information easily.

F. Strengthen Weak Areas
Take a diagnostic test before studying.
Use your results to focus on topics that score low.

G. Repeat Test Takers
If you did not pass previously, use the performance report to target the lowest domain.
Spend extra time on problem areas.
Do more scenario-based questions and fewer simple recall questions.

H. Take Short Study Sessions
Long study hours cause burnout.
Use short sessions of 30–45 minutes with breaks.
This improves memory and reduces fatigue.

I. Review the Day Before the Exam
Avoid reading the entire book again.
Focus only on:
• Quick notes
• Tables
• Formulas
• High-yield points

• Practice problems
• Device complications and responses
Rest well the night before the exam.

1.7 HOW TO USE THIS STUDY GUIDE EFFECTIVELY

This study guide is designed to simplify complex infusion concepts and help you build confidence step by step. To get the best results, follow the approach below.

A. Start with the Chapter Summaries
Each chapter contains the essential concepts needed for the exam.
Read the summary first to get an overview, then read the full chapter for detail.

B. Study One Domain at a Time
The CRNI exam is divided into three domains: Vascular Access, Infusion Therapy, and Professional Practice.
Focus on one domain completely before moving to the next.
This organizes your learning and prevents confusion.

C. Review the Diagrams, Charts, and Tables
These visual aids help you understand device types, flow rates, compatibility decisions, and complication management faster than text alone.

D. Apply Knowledge with Practice Questions
At the end of each major section, you will find practice questions.
Answer them before reading the explanations.
Track your performance using a notebook or digital tracker.

E. Use the Appendices
The appendices contain quick-reference material including:
• Formulas
• Lab values
• Troubleshooting steps
• Safety guidelines
• Documentation templates
Review these weekly to keep essential information fresh.

F. Follow the Study Plans Included
Use the 3-week, 6-week, or 8-week plan depending on your schedule.
Each plan gives you a clear path of what to do each day.

G. Take Notes as You Read
Summarize key points in your own words.
Writing improves memory and helps you think critically.

H. Practice Test Timing
Simulate exam conditions:
• Set a 3-hour timer

• Work through 150 practice questions
• Avoid checking answers until the end
This builds stamina and improves time management.

I. Track Your Progress
After each study session, write down:
• What you learned
• Topics that still confuse you
• Areas that need repeated review
This helps you stay organized and focused.

CHAPTER 2

FOUNDATIONS OF INFUSION NURSING

This chapter moves from the exam overview into the heart of infusion practice. Here you begin to think like a specialist: not only "how to hang an infusion," but how to make safe decisions, respect standards, protect patients legally and ethically, and perform a complete assessment before any therapy begins.

2.1 SCOPE AND STANDARDS OF INFUSION NURSING PRACTICE

A. What Is Infusion Nursing?

Infusion nursing is the specialty area of nursing focused on the safe and effective delivery of fluids, medications, blood products, and nutrition through the vascular system or other routes (such as intraosseous or epidural in some settings).

The infusion nurse:

- Selects and manages vascular access devices (peripheral and central).
- Plans, initiates, and monitors infusion therapies.
- Prevents, detects, and responds to complications.
- Educates patients, families, and other staff about therapies and devices.
- Participates in quality improvement and evidence-based practice.

Infusion nursing can occur in many settings:

- Acute care hospitals
- Outpatient infusion centers
- Home infusion services
- Long-term care facilities
- Oncology centers
- Emergency and critical care units
- Specialty clinics (rheumatology, neurology, infectious disease, etc.)

As a CRNI, your practice is grounded in formal standards. These standards define what you are expected to know and do, and they anchor exam questions.

B. Scope of Practice

The "scope of practice" describes the range of roles, functions, and responsibilities that infusion nurses are allowed to perform, based on:

- National professional standards (such as infusion nursing standards).
- State or regional nurse practice acts and regulations.
- Facility policies and procedures.
- Individual education and competence.

Within this scope, infusion nurses:

- Perform comprehensive assessments relevant to infusion therapy.
- Select appropriate vascular access devices in collaboration with the provider and team.
- Insert peripheral IV catheters (and in some settings, PICCs, depending on regulation and competency).

• Initiate and manage continuous and intermittent infusions.
• Administer high-alert drugs, blood products, parenteral nutrition, and specialized therapies according to policy.
• Monitor patients for local and systemic complications.
• Intervene promptly when complications occur.
• Educate patients about their therapy, potential risks, and self-care.
• Lead or participate in device- and therapy-related quality improvement projects.
Importantly, scope of practice is not fixed. It may expand with additional education and competency validation (for example, ultrasound-guided peripheral cannulation, PICC insertion, or management of implanted ports). However, any expansion must remain consistent with legal requirements and organizational policy.

C. Standards of Infusion Nursing Practice
Standards describe the expected level of professional performance. They are measurable statements that reflect current best practice. For the infusion nurse, standards typically cover two broad areas:

1. Standards of Practice (Clinical Care)
These focus on the nursing process: assessment, diagnosis, outcomes identification, planning, implementation, and evaluation. Each step is applied specifically to infusion therapy. For example:
• Assessment: Gather data about vascular status, co-morbidities, lab values, and therapy indication.
• Diagnosis: Identify problems or risks such as "risk for infection related to central venous catheter."
• Outcomes: Set goals such as "infusion will be delivered as ordered without signs of phlebitis or infiltration."
• Planning: Choose the right device, route, and monitoring plan.
• Implementation: Carry out insertion, therapy initiation, and patient teaching.
• Evaluation: Reassess the patient and device regularly, documenting outcomes and complications.

2. Standards of Professional Performance
These relate to the way you function as a professional:
• Ethics
• Education and lifelong learning
• Evidence-based practice and research use
• Quality measurement and improvement
• Communication
• Leadership and collaboration
• Resource use and cost awareness

D. Key Responsibilities Under the Standards
1. Clinical Judgment and Device Selection
The infusion nurse uses clinical data to choose safe access options. For example:
• Short therapy, non-irritant fluid → peripheral catheter.
• Long-term therapy, vesicant medication → central venous access (e.g., PICC, tunneled catheter, or port).
• Poor peripheral veins, renal failure, or chemotherapy → early consideration of central access.

2. Infection Prevention
Infusion nurses are guardians of infection prevention. Standards expect you to:
• Use strict aseptic technique for device insertion and maintenance.

• Perform skin antisepsis correctly and allow proper drying time.
• Choose appropriate dressings and change them according to policy.
• Disinfect needleless connectors and ports every time before access.
• Recognize signs of local and systemic infection early and act promptly.

3. Safety and Medication Management

Infusion nurses implement safe medication practices:

• Double-check high-risk infusions when required.
• Confirm drug, dose, route, rate, patient, timing, and compatibility.
• Use infusion pumps correctly and set appropriate limits and alarms.
• Clarify unclear orders and use chain of command when necessary.

4. Education and Advocacy

The patient and family need clear, honest explanations. Standards expect you to:

• Explain the purpose of the therapy and the device.
• Teach how to protect the catheter (no pulling or heavy lifting on that limb if relevant).
• Explain signs and symptoms to report (e.g., redness, pain, fever, shortness of breath).
• Respect the patient's questions, concerns, and right to decline.

5. Documentation

Standards require thorough documentation of:

• Assessment data (e.g., vein quality, skin condition, lab results).
• Device type, size, insertion site, technique, and lot numbers when required.
• Patient response and tolerance.
• Infusion details: fluid/medication, rate, start and stop times.
• Complications, interventions, and outcomes.
• Teaching provided and patient understanding.

E. Limits of Practice

While infusion nurses have extensive responsibility, there are limits:

• They may not prescribe therapy unless they hold an additional license allowing this.
• They must not perform procedures they have not been trained and verified as competent to perform.
• They must follow state/regional regulations regarding insertion of certain devices (such as PICCs) and use of radiologic confirmation.

On the exam, questions may test whether you recognize when to proceed independently versus when to consult a provider or follow a chain of command.

2.2 ETHICAL AND LEGAL RESPONSIBILITIES

Infusion therapy involves high-risk medications, invasive devices, and vulnerable patients. Ethical and legal responsibilities are central to safe practice and frequently appear on the CRNI exam.

A. Core Ethical Principles in Infusion Nursing

1. Autonomy

Patients have the right to make informed choices about their care, including the right to accept or refuse infusion therapy.

The nurse must:

- Provide complete, understandable information.
- Respect the patient's values and decisions.
- Avoid pressuring or manipulating the patient.

2. Beneficence

This is the duty to act for the patient's benefit. In infusion therapy, it means:

- Choosing the safest device and route.
- Minimizing discomfort and complications.
- Advocating for therapy that is appropriate and evidence based.

3. Nonmaleficence

This is the duty to "do no harm." Examples include:

- Avoiding unnecessary venipunctures.
- Using the smallest gauge catheter that will safely deliver the therapy.
- Following all safety checks to prevent medication errors.

4. Justice

Justice relates to fairness and equal treatment. Infusion nurses:

- Provide care based on clinical need, not on personal bias.
- Support fair access to therapies and resources.

5. Veracity and Fidelity

Veracity is truthfulness; fidelity is keeping promises and maintaining trust.

Infusion nurses must:

- Give honest information about risks, benefits, and alternatives.
- Admit errors promptly and take steps to protect the patient.
- Follow through on commitments (e.g., promised reassessment or pain control).

B. Informed Consent

For many infusion therapies, especially high-risk drugs, blood products, or invasive central line insertion, informed consent is essential.

Key elements:

- The patient understands the nature of the therapy.
- The patient knows the expected benefits and possible risks.
- Alternatives, including no treatment, are explained.
- The patient has the chance to ask questions.
- The decision is voluntary and free of coercion.

In most settings, the provider obtains formal consent for procedures like central line insertion. However, the nurse plays a crucial role by reinforcing information, checking understanding, and advocating if the patient seems confused or uncertain.

If a patient refuses therapy, the nurse must:

- Explore reasons and address questions.
- Respect the decision.
- Notify the provider.
- Document the refusal and the conversation accurately.

C. Confidentiality and Privacy

Infusion nurses have access to sensitive clinical information, such as HIV status, cancer diagnoses, and treatment plans. Legal and ethical rules require that this information be kept private.

You must:

- Discuss patient information only with those directly involved in care.
- Avoid hallway or elevator conversations about patients.
- Use secure systems for documentation and communication.
- Follow all institutional and legal rules regarding patient privacy.

D. Legal Concepts: Negligence and Malpractice

1. Negligence

Negligence is the failure to act as a reasonably prudent nurse would act in a similar situation.

2. Malpractice

Malpractice is professional negligence that causes patient harm.

Four elements must be present:

- Duty: You had a professional duty to the patient.
- Breach of duty: You did not meet the accepted standard of care.
- Causation: Your action or lack of action directly caused harm.
- Damages: The patient experienced a measurable injury or loss.

Examples in infusion practice:

- Failing to check medication compatibility leading to a precipitate and catheter occlusion, which then causes treatment delay.
- Ignoring early signs of phlebitis or infection until the patient develops a serious complication such as sepsis.
- Programming the pump incorrectly, resulting in medication overdose.

E. Standards of Care and Policies

The “standard of care” is what a reasonably competent nurse with similar training would do in the same situation. In infusion nursing, standards of care may be drawn from:

- Infusion nursing standards and guidelines.
- National nursing standards.
- Facility policies and procedures.
- Manufacturer instructions for devices and medications.

You are legally and ethically expected to:

- Know the relevant standards.
- Maintain your skills through continuing education and practice.
- Advocate for updated policies when current practice changes.

F. Patient Advocacy

Infusion nurses often serve as advocates when:

- An order seems unsafe or unclear.
- A patient’s pain, anxiety, or side effects are not being addressed.
- A patient does not fully understand the therapy.
- A patient’s values or cultural beliefs conflict with the proposed therapy.

Advocacy actions include:
• Clarifying orders with the prescriber.
• Requesting changes in therapy when necessary.
• Using the chain of command to escalate concerns if initial attempts fail.
• Supporting the patient's right to decline treatment.

G. Mandatory Reporting and Professional Boundaries
Infusion nurses may be required to report:
• Suspected abuse or neglect.
• Unsafe practice by other professionals.
• Diversion or misuse of controlled substances.

Professional boundaries must be preserved at all times. This means:
• Maintaining a therapeutic relationship, not a social or romantic one.
• Avoiding financial or personal conflicts of interest.
• Not accepting gifts that could influence your judgment.

H. Documentation as a Legal Record
The medical record is a legal document. In infusion therapy, accurate documentation protects the patient and the nurse. It should:
• Be timely, complete, and factual.
• Record assessments, interventions, patient teaching, and responses.
• Include any unusual events, complications, and actions taken.
• Avoid personal opinions or emotional language.
On the exam, legal and ethical questions often test whether you recognize when to document, when to report, and when to escalate concerns.

2.3 PRINCIPLES OF PATIENT ASSESSMENT

A. Purpose of Assessment in Infusion Nursing
Patient assessment is the foundation for every decision in infusion therapy:
• Is an infusion truly indicated?
• Which solution or medication is appropriate?
• Which vascular access device is safest and most effective?
• What risks does the patient have for complications?
• How should the nurse monitor and follow up?
A thorough assessment reduces complications and ensures that therapy aligns with the patient's condition, goals, and environment.

B. Types of Assessment
1. Initial (Baseline) Assessment
Performed before any infusion is started or any catheter is placed.

2. Ongoing Assessment
Repeated at intervals throughout therapy to detect changes:
• Before each infusion session
• During therapy at defined times

• After therapy
• At each dressing change or device evaluation

3. Focused Assessment

Directed at a specific concern, such as pain at the insertion site, swelling, fever, or shortness of breath.

C. Components of a Comprehensive Baseline Assessment

1. Health History

Relevant aspects of history include:

• Primary diagnosis and reason for infusion (infection, cancer, dehydration, heart failure, etc.).
• Co-morbidities that affect vascular access or fluid balance, such as diabetes, renal failure, liver disease, heart failure, clotting disorders, lymphedema.
• Previous experience with IV therapy:
– History of phlebitis, infiltration, or extravasation.
– Difficulty obtaining IV access.
– Past central line infections or deep vein thrombosis.
• Medication history:
– Current prescriptions and over-the-counter drugs.
– Anticoagulants or antiplatelet agents.
– Herbal supplements that may affect clotting or immunity.
• Allergy history:
– Allergies to medications, antiseptics (e.g., chlorhexidine), latex, tape, adhesives, or dressings.
• Social and lifestyle factors:
– Tobacco, alcohol, or substance use.
– Ability to attend follow-up visits.
– Support systems at home for those receiving home infusions.

2. Physical Examination

Key systems relevant to infusion therapy:

a. Cardiovascular System

• Heart rate and blood pressure
• Signs of fluid overload (edema, jugular venous distension, crackles in lungs)
• Presence of implanted devices such as pacemakers or cardiac ports

b. Respiratory System

• Baseline respiratory rate and effort
• Oxygen saturation and need for supplemental oxygen
• Presence of lung disease (COPD, asthma) that may make fluid overload more dangerous

c. Renal and Hepatic Function

• Urine output and color
• History of kidney or liver disease
• These influence drug dosing, fluid selection, and risk of toxicity.

d. Neurologic Status

• Level of consciousness and orientation
• Ability to understand instructions
• Ability to recognize and report complications

e. Skin and Vascular Examination
• Condition of skin (fragility, bruising, infection, scars, burns).
• Vein quality and accessibility in upper extremities:
– Size, location, and straightness of veins.
– Presence of sclerosis or previous damage from repeated infusion.
– Avoiding areas of flexion if possible (e.g., wrist, antecubital) for long infusions.
• Presence of lymphedema, mastectomy, fistulas, or grafts that limit usable limbs.

3. Laboratory and Diagnostic Data
Lab values relevant to infusion decisions include:
• Complete blood count (CBC) – white cells, hemoglobin, platelets.
• Electrolytes – sodium, potassium, chloride, bicarbonate, calcium, magnesium, phosphate.
• Renal function – BUN, creatinine, estimated GFR.
• Liver function – AST, ALT, bilirubin, albumin.
• Coagulation profile – PT/INR, aPTT, platelet count.
• Culture results in case of infection or suspected catheter-related infection.

Diagnostic tools, such as ultrasound, may be used to:
• Assess deep vein patency before PICC insertion.
• Confirm placement of catheters where allowed by protocol.

D. Infusion-Specific Assessment
1. Indication for Therapy
Before starting, ask:
• What is the goal of this therapy? Hydration, antibiotics, chemotherapy, nutrition, pain control, blood replacement?
• Is this therapy time-limited or long-term?
• What are the risks if therapy is not given?

2. Drug and Solution Characteristics
The nature of the ordered therapy affects all subsequent decisions. Consider:
• pH
• Osmolality
• Vesicant vs non-vesicant
• Irritating vs non-irritating
• Required infusion rate and duration
• Compatibility with other solutions or drugs
High-osmolality, extreme pH, or vesicant medications are safer through central access. The nurse must know when to question a peripheral route for such drugs.

3. Vascular Access Device Selection
Assessment findings guide selection of:
• Peripheral IV catheter (short-term, low-risk infusions).
• Midline catheter (intermediate duration, some medications, but not vesicants).

• Central venous access (PICC, tunneled catheter, port) for long-term or high-risk therapy.

Factors influencing choice:
• Duration of therapy.
• Type of solution or medication.
• Patient's vein quality and history.
• Patient's lifestyle and setting (home vs hospital).
• Infection risk and previous complications.

E. Psychosocial and Cultural Assessment
1. Emotional State and Coping
Infusion therapy can cause fear, especially with chemotherapy or long-term therapy. The nurse should assess:
• Anxiety level.
• Past trauma or difficult medical experiences.
• Understanding of the disease and treatment plan.
• Preferred ways of coping (family support, spiritual support, information seeking).

2. Cultural and Language Factors
Effective communication and respect for cultural beliefs are crucial. Assess:
• Language needs and need for an interpreter.
• Beliefs about illness, blood products, and invasive therapy.
• Gender and modesty considerations during procedures.

3. Health Literacy
Determine whether the patient:
• Understands basic medical concepts.
• Can read and follow written instructions.
• Needs simplified language or visual aids.
This assessment shapes how you teach catheter care, complication signs, and self-management.

F. Special Populations
1. Pediatric Patients
In children, assessment must be age-appropriate and involve caregivers. Consider:
• Smaller veins and higher risk of infiltration.
• Fear of needles and need for distraction or comfort measures.
• Fluid balance and medication dosing based on weight.
• Securement methods that prevent accidental removal.

2. Older Adults
In older adults:
• Veins may be fragile and prone to rupture.
• Skin is often thin with slower healing.
• There may be multiple chronic conditions and polypharmacy.
• Cognitive impairment may affect ability to report symptoms.
Assessment should include fall risk, visual and hearing status, and ability to follow self-care instructions.

3. Patients Receiving Home Infusion
Beyond physical and lab assessment, evaluate the home setting:
• Clean, stable environment for storage and preparation

2.4 INFECTION PREVENTION AND SAFETY STANDARDS

Infection prevention is the heart of infusion nursing. Every infusion—whether through a short peripheral catheter, midline, or central line—carries the risk of introducing microorganisms into the bloodstream. A bloodstream infection can cause severe harm, prolonged hospitalization, or death. Because of this, exam questions in this domain are frequent, often scenario-based, and require strong clinical judgement.

A. Understanding Why Infusion Therapy Infections Occur

Infusion-related infections occur when microorganisms enter the bloodstream or the catheter system through:
• Contaminated hands
• Poor skin antisepsis
• Contaminated connectors, caps, or tubing
• Unclean access of needleless connectors
• Breaks in aseptic technique
• Prolonged catheter dwell time without necessity
• Improper dressing care
• Contaminated medication or solution
• Poor catheter stabilization leading to micro-movements and irritation
Preventing infection requires control of every step where contamination could occur.

B. Key Types of Infusion-Related Infections
1. Local Site Infection
Occurs at the catheter insertion site.
Common signs: redness, tenderness, drainage, warmth, mild swelling.
Causes: poor skin antisepsis, dressing disruption, bacterial migration along the catheter tract.

2. Catheter-Related Bloodstream Infection (CRBSI)
A more serious infection where the catheter is the source of microorganisms entering bloodstream.
Signs: fever, chills, hypotension, rigors, positive blood cultures.
This is a critical exam topic.

3. Exit-Site Infection (with tunneled lines and ports)
Infection involving the exit/tunnel tract but not bloodstream.
Causes: poor hygiene, dressing disruption.

4. Pocket Infection (implanted ports)
Infection around the implanted port reservoir.
Requires urgent removal.
Exam questions may ask you to distinguish local from systemic infection, and to know when a catheter must be removed immediately.

C. Core Infection Prevention Practices

1. Hand Hygiene

This is the single most important action.

Perform:

- Before patient contact
- Before donning gloves
- Before touching any device
- After device care
- After removing gloves

Hand hygiene methods:

- Alcohol-based hand rub (primary method, unless hands visibly soiled)
- Soap and water

2. Skin Antisepsis at Insertion

The skin is the most common source of microorganisms. Correct skin preparation includes:

- Using 2% chlorhexidine in alcohol for most patients
- Using povidone-iodine for patients who cannot tolerate chlorhexidine
- Scrubbing in a back-and-forth (friction) motion
- Allowing complete drying before puncture

Drying is essential. Failure to allow proper dry time reduces effectiveness.

3. Maximal Aseptic Barriers (especially for central lines)

Standards require:

- Cap, mask, sterile gown, sterile gloves, large sterile drape for the patient
- Sterile ultrasound probe covers when ultrasound is used

For peripheral lines:

- Clean gloves
- Aseptic no-touch technique

4. Sterile Dressing Application and Care

Types of dressings:

- Transparent semipermeable membrane dressing
- Gauze dressing (if blood or moisture present)

Key dressing standards:

- Change transparent dressings every 5–7 days (or earlier if compromised).
- Change gauze dressings every 48 hours.
- Use sterile technique during dressing change.
- Apply stabilization devices to prevent micro-movement.

5. Needleless Connector Disinfection

This is a high-risk point. The connector must be scrubbed thoroughly before each access.

Standard scrub times:

- 5–15 seconds friction scrub
- Allow drying
- Use alcohol, alcohol/chlorhexidine pads, or approved disinfectant caps

6. Tubing and Administration Set Changes
General guidance:
• Continuous primary tubing: change every 96 hours unless policy differs.
• Intermittent tubing: change every 24 hours.
• Blood tubing: change every 4 hours or after 1 unit of blood.
• Parenteral nutrition (lipid-containing): change every 24 hours.

7. Flushing and Locking
Sterile normal saline is used to maintain patency and clearance of medications.
Heparin is used only when required by device type or institutional policy (e.g., some implanted ports).
Use pulsatile (push-pause) flushing to help clear the catheter.
Use positive-pressure technique when removing syringes from needleless connectors.

8. Catheter Securement
Movement of catheters increases the risk of phlebitis and infection.
Securement methods include:
• Adhesive securement devices
• Sutureless devices
• Stabilization anchors for central lines
Loose or poorly secured catheters dramatically increase infection risk.

9. Daily Review of Line Necessity
Every shift, ask:
• "Does this patient still need this catheter?"
Unnecessary catheters increase infection risk. Early removal is a major safety measure.

D. Safety Standards for High-Risk Infusions
Certain therapies require heightened precautions. Examples:
• Chemotherapy: specific PPE, closed-system transfer devices
• Parenteral nutrition: strict aseptic preparation, limited hang time
• Blood products: monitoring for reactions, correct tubing, timely completion
• Vasoactive drips: secure central access recommended

E. Recognizing Early Signs of Complications
Infusion nurses must quickly recognize:
• Redness, streaking, or tenderness
• Fever, chills
• Purulent drainage
• New chest pain or shortness of breath (possible air embolism or thrombus)
• Low blood pressure with rigors (possible sepsis)

Immediate response may include:
• Stopping the infusion
• Obtaining cultures
• Removing catheter depending on policies
• Initiating sepsis protocols
• Notifying provider rapidly

F. Environmental Safety
Safe practice includes ensuring:
• Clean preparation areas
• Proper disposal of needles in sharps containers
• Correct labeling of medications and solutions
• Use of pumps with safety features

Exam questions may present infection-prevention scenarios and ask:
• Which step was incorrect?
• What is the priority action?
• What intervention reduces infection risk?

2.5 PATIENT EDUCATION AND COMMUNICATION SKILLS

Education is a core function of infusion nursing. Patients who understand their therapy are safer, more confident, and more likely to have positive outcomes. The CRNI exam frequently tests communication skills and patient-teaching priorities, especially in complex therapies.

A. Why Patient Education Matters
Education:
• Improves adherence to therapy
• Reduces anxiety
• Helps recognize early complications
• Supports independence in home infusion
• Prevents catheter damage and infections
• Builds trust and therapeutic relationships
A well-informed patient is less likely to overlook signs of complications such as infiltration, infection, or allergic reaction.

B. Principles of Effective Patient Teaching
1. Assess Patient Understanding First
Before you teach, you must know what the patient already understands. Ask:
• "Tell me what you know about this therapy."
• "What concerns do you have?"

2. Use Clear, Simple Language
Avoid medical jargon, especially with anxious patients or those with low health literacy.
Use step-by-step explanations.

3. Use Visuals and Demonstrations
Infusion therapy concepts such as flushing, dressing care, and pump use are best understood with:
• Models
• Diagrams
• Demonstration videos
• Hands-on practice

4. Encourage Teach-Back

Ask the patient to show or explain the steps again.
This verifies understanding and reveals confusion early.

5. Provide Written Instructions
Include:
- Signs of infection
- How to protect the catheter
- Emergency phone numbers
- Steps for flushing (if home infusion)
- Pump troubleshooting tips

Written material should match the patient's reading level.

6. Consider Cultural and Language Needs
Use certified interpreters, not family members.
Respect cultural beliefs regarding blood products or invasive therapies.

C. Teaching Topics Based on Device Type
1. Peripheral IV Catheter
Explain:
- Purpose and expected duration
- How to report pain, swelling, burning
- Expected sensations during flush or infusion
- Protecting the site from pulling or bending

2. Midline Catheter
Teach:
- Expected lifespan (up to several weeks)
- Dressing care and frequency
- Signs of phlebitis or thrombosis
- Restrictions: no blood draws unless policy allows
- Importance of not using the device for vesicants or TPN

3. Central Venous Access Devices (CVCs, PICCs, Ports)
Central lines require advanced teaching:
- Hand hygiene before touching the catheter
- No submersion in water (showers allowed with waterproof covering)
- How to monitor for redness, drainage, fever
- Avoiding heavy lifting with the PICC arm
- Flushing schedule and technique
- What to do if catheter becomes loose or dressing is wet
- How to respond to pump occlusion alarms

If the patient is receiving home therapy, teaching must be even more thorough.

D. Teaching for High-Risk Therapies
1. Parenteral Nutrition
Explain the need for:
- Daily weight monitoring
- Blood glucose monitoring

• Avoiding sudden discontinuation of infusions
• Checking tubing, labels, and pump settings
• Recognizing signs of metabolic imbalance

2. Chemotherapy and Immunotherapy
Teach:
• Expected side effects
• When to call for fever
• How to manage nausea
• Importance of hydration
• Protecting others from exposure to bodily fluids
• Extravasation signs

3. Blood Transfusion
Key topics:
• Fever, chills, itching—report immediately
• Stay near the healthcare provider for the first 15 minutes
• Follow-up labs or post-transfusion monitoring

E. Communication Skills in Infusion Nursing
1. Active Listening
Use encouraging phrases such as:
• "I hear your concern."
• "Tell me more about what worries you."

2. Therapeutic Communication
Stay calm, patient, and supportive.
Avoid giving false reassurance.

3. Handling Difficult Conversations
Patients may be in pain, afraid, or frustrated. Maintain:
• Respect
• Professionalism
• Empathy
• Nonjudgmental attitude

4. Teaching Families and Caregivers
Family may play a major role, especially in home infusion.
Teach them:
• How to assist safely
• How to maintain clean technique
• Signs of complications
• How to store supplies and medication

Exam questions may ask which teaching point is most important, or which statement shows patient understanding.

2.6 DOCUMENTATION REQUIREMENTS AND COMPLIANCE

Documentation is the professional and legal record of care. In infusion nursing, it protects the patient, guides treatment, and reduces legal liability. Inadequate documentation is a frequent cause of legal problems in infusion-related incidents.

A. Why Documentation Matters
Documentation:
• Shows what care was performed
• Provides a timeline of events
• Supports continuity of care
• Demonstrates adherence to standards
• Protects the nurse legally
• Helps identify problems early
• Records complications and interventions
The CRNI exam often tests what should be documented in specific scenarios.

B. What Must Be Documented Before Infusion
1. Patient Assessment
Record:
• Relevant history
• Baseline vital signs
• Vein condition
• Allergies
• Lab values related to therapy
• Pain level
• Education provided

2. Indication for Therapy
Why the infusion is required and what outcome is expected.

3. Catheter Type and Insertion Details
Include:
• Device type (peripheral, PICC, midline, port)
• Length and gauge
• Insertion site and extremity
• Number of attempts
• Method used (ultrasound-guided or not)
• Skin preparation solution
• Securement method
• Presence of blood return
• Patient tolerance
For central lines:
• Confirmation of placement according to institution policy
• Tip location (if available from x-ray or ECG-based confirmation)

C. Documentation During Infusion
Every infusion must include:
• Name and concentration of medication/solution
• Rate of infusion

• Pump settings
• Tubing change times
• Patient response
• Signs of complications
• Pain, swelling, or leakage at insertion site
• Vital signs when required (blood transfusions, high-risk drugs)
• Patient comfort and education

D. Documentation After Infusion
Record:
• Completion time
• Volume infused
• Patient tolerance
• Any reactions and interventions
• Status of catheter (flushed, locked, capped, or removed)

For catheter removal:
• Reason for removal
• Catheter integrity (length intact)
• Condition of insertion site
• Post-removal care instructions

E. Documentation for Complications
Whenever a complication occurs, documentation must be:
• Objective
• Complete
• Timely

Include:
• Description of signs and symptoms
• Patient statements (“The site burns.”)
• Assessment findings
• Actions taken (stopped infusion, notified provider, obtained labs)
• Response to interventions
• Follow-up assessments

F. Legal and Compliance Responsibilities

Infusion documentation becomes part of the permanent legal record.
For legal protection:
• Document only facts, not opinions.
• Never leave blanks.
• Avoid vague terms like “site looks okay.”
• Correct errors following policy (never erase or delete).
• Late entries must follow institutional rules.

Compliance also includes:
• Following institutional policy

• Using approved abbreviations only
• Following rules for controlled substances
• Recording lot numbers for certain medications or devices

G. Electronic Documentation
Most institutions use electronic health records (EHRs).
Practice includes:
• Accurate drop-down selection
• Free-text clarifications when needed
• Avoiding copy-and-paste unless allowed and verified

H. Documentation in Home Infusion
Home infusion requires:
• Daily pump checks
• Bag changes
• Patient teaching
• Environmental assessment
• Supply counts
• Medication storage condition checks

I. Documentation for Central Line Care
Special documentation for CVCs includes:
• Dressing changes
• Cap/connector changes
• Scrub-the-hub compliance
• Flushing volumes
• Patency confirmation
• Blood return presence

J. Exam Tips for Documentation Questions
The correct answer often:
• Protects the patient
• Demonstrates clear communication
• Reflects standards of care
• Reduces risk

CHAPTER 3

ACCESS DEVICES

This chapter turns the focus to the tools of your specialty: the catheters and devices that allow safe delivery of infusion therapy. Understanding their structure, indications, limitations, and care is essential for both safe practice and CRNI exam success.

3.1 OVERVIEW OF VASCULAR ACCESS

A. Purpose of Vascular Access

Vascular access is the pathway that allows fluids, medications, blood products, and nutrition to enter the bloodstream safely. The main goals are:

- Deliver therapy at the correct site in the circulation
- Maintain reliable access for the required length of time
- Minimize patient discomfort and complications
- Protect fragile veins and central circulation

B. Types of Vascular Access

Broadly, vascular access falls into two groups:

1. Peripheral Venous Access

A catheter is inserted into a peripheral vein, usually in the upper extremities or sometimes scalp veins in infants. Examples:

- Short peripheral IV catheters
- Midline catheters

2. Central Venous Access

The catheter tip rests in a large central vein, usually the lower third of the superior vena cava or at the cavoatrial junction. Examples:

- Peripherally inserted central catheters (PICCs)
- Tunneled central venous catheters
- Nontunneled central venous catheters
- Implanted ports

Central access is required for many vesicants, high-osmolality solutions, and long-term therapies because the large blood flow in central veins dilutes the infusate quickly and reduces irritation.

C. Fundamental Concepts

1. Peripheral vs Central Tip Location

- Peripheral: tip lies in a vein that is not a central vein (e.g., cephalic, basilic, metacarpal vein).
- Central: tip lies in the superior vena cava, inferior vena cava, or right atrium (depending on device design and policy).

2. Short-Term vs Long-Term Access

- Short-term: days (peripheral catheters, nontunneled CVCs).
- Intermediate: days to weeks (midlines, some PICCs).

• Long-term: months to years (tunneled catheters, ports, long-term PICCs).

3. Therapy-Driven Choice
The type of device is always tied to the therapy:
• Duration of treatment
• Type of solution (pH, osmolality)
• Vesicant or non-vesicant
• Required flow rate and volume
• Frequency of access

D. Key Principles in Site and Device Selection
• Use the smallest, least invasive device that safely meets therapy needs.
• Use upper extremity veins whenever possible; lower extremities carry higher risk of thrombosis and infection in adults.
• Protect veins in patients with potential future dialysis needs (avoid repeated use of cephalic and basilic veins in a limb that may be used for fistula).
• Avoid areas of flexion (wrist, antecubital) for infusions expected to run continuously or for longer durations.
• For high-risk therapies (vesicants, TPN, high-osmolality solutions, certain vasoactive drugs), central access is strongly preferred.

Exam questions often challenge you to choose the most appropriate device given a specific clinical scenario. Think "therapy first, device second."

3.2 PERIPHERAL INTRAVENOUS CATHETERS

– TYPES, SIZES, INDICATIONS
– INSERTION TECHNIQUES
– COMPLICATIONS AND MANAGEMENT

A. Types of Peripheral IV Catheters
1. Over-the-Needle Catheters
This is the standard plastic cannula mounted over a metal needle. After venipuncture, the catheter advances into the vein and the needle is withdrawn.
• Used for most routine peripheral IV access.
• Available in multiple gauges and lengths.
• Often come with integrated safety devices to reduce needlestick injuries.

2. Winged Steel Needles (Butterfly Needles)
• Steel needle with plastic wings and short tubing.
• Commonly used for short procedures such as blood draws or short infusions.
• Higher risk of infiltration if used for long infusions because the rigid steel needle can damage the vein wall.
• Not ideal for prolonged therapy.

3. Safety and Closed-System Catheters
• Include features such as retracting needles or shields.

• Some designs include integrated extension sets and needleless connectors to reduce contamination and disconnections.

The CRNI exam expects you to recognize which catheter type is appropriate based on therapy duration, vein condition, and safety considerations.

B. Sizes and Indications
Peripheral IV catheters are sized by gauge. The smaller the gauge number, the larger the diameter.

Common sizes and uses:
• 14–16 gauge: Trauma, rapid fluid resuscitation, surgery requiring rapid blood transfusion.
• 18 gauge: Blood transfusion, large-volume infusions, preoperative patients.
• 20 gauge: Most adult IV therapies, routine medications, hydration, blood transfusion if flow rate is moderate.
• 22 gauge: Older adults, small or fragile veins, some pediatric patients. Can be used for many medications and slower transfusions.
• 24 gauge: Very small or fragile veins, infants, some pediatric patients; limited flow.
General rule:
Use the smallest gauge that will safely deliver the therapy at the required rate.

C. Insertion Techniques
1. Preparation
• Confirm the order and check allergies (antiseptics, adhesives, latex).
• Assess both arms for suitable veins: straight, palpable, visible, free from infection or injury.
• Explain the procedure to the patient and answer questions.
• Position the limb comfortably and apply a tourniquet above the chosen site.
• Perform hand hygiene and don appropriate gloves.

2. Vein Selection
• Start distally and move proximally as needed.
• Preferred sites: dorsal hand veins, lower forearm veins.
• Avoid:
– Areas near joints (antecubital fossa) for continuous therapy
– Veins over areas of flexion for long-term infusions
– Areas of infection, injury, or lymphedema
– An arm with a fistula, graft, or history of mastectomy (according to policy)

3. Skin Antisepsis
• Use chlorhexidine-alcohol solution when possible.
• Scrub in a back-and-forth motion for the required time.
• Allow complete drying before puncture.

4. Cannulation
• Stabilize the vein with your non-dominant hand.
• Hold the catheter with bevel up at a shallow angle (about 10–30 degrees).
• Enter the skin and vein until you see blood return in the chamber.
• Lower the angle and advance the catheter slightly.
• Advance only the catheter into the vein while holding the needle steady.

• Release the tourniquet.
• Connect extension tubing with needleless connector and flush with saline to confirm patency.

5. Securement and Dressing
• Secure with a stabilization device or tape configured to avoid kinking.
• Apply a transparent dressing that allows visualization of the site.
• Label with date, time, and initials per policy.

6. Documentation
• Vein and limb used
• Gauge and length of catheter
• Number of attempts
• Patient tolerance
• Any complications during insertion

D. Complications and Management
1. Infiltration

Fluid leaks into surrounding tissue due to catheter dislodgment or vein rupture.
Signs:
• Swelling, cool skin, discomfort, blanching, slowed infusion.

Management:
• Stop infusion and remove catheter.
• Elevate limb.
• Apply warm or cold compress as appropriate.
• Restart IV at a different site, preferably proximal or on another limb.

2. Extravasation
Leakage of a vesicant or irritant into tissue.

Signs:
• Burning, pain, swelling, blistering, skin discoloration.

Management (according to drug and protocol):
• Stop infusion but leave catheter in place initially.
• Attempt to aspirate residual drug through the catheter.
• Administer antidote if ordered.
• Remove catheter after interventions.
• Elevate limb; apply warm or cold compress based on protocol.
• Notify provider and document thoroughly.

3. Phlebitis
Inflammation of the vein wall.

Types:
• Mechanical (related to catheter movement)
• Chemical (related to solution/medication)

• Bacterial (related to infection)

Signs:
• Redness along the vein, warmth, pain, palpable cord, sometimes streaking.

Management:
• Stop infusion and remove catheter.
• Apply warm compress.
• Assess for infection; report moderate to severe cases.
• Select a new site away from the affected vein.

4. Occlusion
Sluggish or absent flow or inability to flush.

Causes:
• Kinked tubing
• Clotted catheter
• Precipitate from incompatible drugs

Management:
• Check for mechanical causes first (clips, kinks, patient position).
• Attempt gentle flush—never force.
• If unresolved, discontinue catheter and start a new one.

5. Infection
Signs:
• Redness, swelling, warmth, tenderness, drainage, fever.

Management:
• Remove catheter if infection is suspected.
• Culture site or catheter tip if ordered.
• Notify provider and document.
• Monitor for systemic signs of sepsis.

6. Nerve or Tendon Injury
• Sharp pain or tingling during insertion.
• Inability to move fingers or strong shooting pain.

Management:
• Stop immediately and withdraw catheter.
• Choose a different site.
• Document and report.
Peripheral IV questions on the CRNI exam often test recognition of early complications and the correct first response.

3.3 CENTRAL VENOUS ACCESS DEVICES

– PICC LINES
– TUNNELED CATHETERS
– IMPLANTED PORTS
– NONTUNNELED CVCS

Central lines allow long-term therapy, delivery of harsh solutions, and high flow rates. However, they carry higher risks of infection and thrombosis. Safe use requires in-depth knowledge of each device type.

A. General Features of Central Venous Access

• Tip location in a large central vein (usually SVC or cavoatrial junction).
• Can be single or multiple lumens.
• Require strict aseptic technique for insertion and care.
• Indicated for long-term therapy, vesicants, TPN, and frequent blood sampling.

B. Peripherally Inserted Central Catheters (PICCs)

1. Definition and Structure

• Inserted through a peripheral vein (usually basilic, brachial, or cephalic in the upper arm) and advanced until the tip is in the SVC.
• Available in single, double, or triple lumen designs.
• Often power-injectable for contrast use.

2. Indications

• Prolonged IV antibiotic therapy
• Chemotherapy
• TPN or other hyperosmolar solutions
• Patients needing frequent blood draws
• Home infusion therapies

3. Advantages

• Can be inserted at the bedside or in outpatient setting.
• Lower risk of pneumothorax compared with subclavian or jugular insertion.
• Long dwell time (weeks to months).
• Suitable for home care.

4. Disadvantages and Risks

• Risk of thrombosis in upper extremity veins.
• Risk of catheter occlusion.
• Risk of infection (CLABSI).
• Limited if upper extremity veins are poor or there is prior DVT.

5. Insertion Principles

• Ultrasound guidance commonly used to select vein.
• Strict aseptic technique with maximal barriers.
• Tip confirmation by chest x-ray or ECG-based tip confirmation, depending on policy.

6. Care and Maintenance

• Transparent dressing changed every 5–7 days or when compromised.
• Needleless connector changes according to policy.
• Flushing with saline before and after use, and at prescribed intervals.
• Avoid blood pressure measurements or venipuncture in the PICC arm.

C. Tunneled Central Venous Catheters
1. Definition
• Catheter inserted into a central vein (often internal jugular or subclavian) and tunneled under the skin before exiting the chest wall.
• Examples: Hickman, Broviac, Groshong catheters.
• Some have Dacron cuff that promotes tissue ingrowth and stability.

2. Indications
• Long-term chemotherapy
• Long-term parenteral nutrition
• Patients with chronic illnesses requiring regular infusions or blood draws

3. Advantages
• Designed for months to years of use.
• Tunneled path and cuff provide stability and reduce infection risk compared to nontunneled CVCs.
• Free hands and neck area for patient mobility.

4. Disadvantages
• Requires surgical or interventional radiology insertion and sometimes removal.
• Visible external portion may affect body image.
• Requires regular dressing care and flushing.

D. Implanted Ports
1. Structure and Definition

• Completely implanted under the skin, usually in the chest wall.
• Composed of a reservoir (port) connected to a catheter whose tip lies in the SVC.
• Accessed with a non-coring (Huber-type) needle through the skin.

2. Indications
• Intermittent long-term therapies, such as chemotherapy.
• Patients needing central access but wishing to minimize external hardware.
• Good for patients with active lifestyles.

3. Advantages
• No external catheter when not accessed, reducing infection risk.
• Lower daily maintenance when not accessed.
• Allows swimming and bathing once the incision is healed (when not accessed).

4. Disadvantages
• Requires needle access each time (may be painful; topical anesthetic often used).
• Surgical procedure needed for insertion and removal.
• Risk of port pocket infection and catheter-related thrombosis.

5. Care Principles
• Aseptic technique when accessing and de-accessing.
• Use only non-coring needles to prevent damage to the septum.
• Flush and lock after each use.
• Periodic maintenance flush (for example, every 4–6 weeks) when not in use, according to policy.

E. Nontunneled Central Venous Catheters
1. Description

• Catheters inserted directly into a central vein (internal jugular, subclavian, or femoral) with the exit site close to the vein entry site.
• Common in critical care, emergency, and perioperative settings.

2. Indications
• Short-term intensive therapy (vasoactive infusions, hemodynamic monitoring).
• Situations where rapid central access is required.

3. Advantages
• Rapid insertion in emergency situations.
• Multi-lumen designs allow simultaneous infusions.

4. Disadvantages
• Higher infection risk compared with tunneled catheters and ports.
• Short-term use only.
• Risk of mechanical complications such as pneumothorax (especially subclavian), arterial puncture, or hematoma.

5. Care
• Strict asepsis, daily review of necessity, and early removal when no longer needed.

F. Central Line Associated Bloodstream Infection (CLABSI) Prevention
Core measures:
• Maximal sterile barriers during insertion.
• Appropriate skin antisepsis.
• Daily line necessity review.
• Proper dressing care and connector disinfection.
• Staff education and competency validation.

3.4 MIDLINE CATHETERS

A. Definition and Tip Location
Midline catheters are peripheral devices that extend further into the upper arm veins than standard peripheral catheters but do not reach central veins.
• Inserted into veins such as basilic, cephalic, or brachial in the upper arm.
• Tip lies below the level of the axillary vein; it does not enter the SVC.
• Length is usually 8–20 cm depending on design and patient anatomy.
They are considered peripheral devices, not central.

B. Indications
• Intermediate duration therapy (often 1–4 weeks).
• Patients with difficult peripheral access in whom repeated short cannulas would cause trauma.
• Hydration, antibiotics, some analgesics, or other non-vesicant medications with suitable pH and osmolality.

C. Solutions Appropriate for Midlines
• Isotonic or near-isotonic solutions.
• Medications with acceptable pH and osmolality for peripheral veins.

Not appropriate for:
• Vesicants
• Parenteral nutrition with high osmolarity
• Solutions with extreme pH

D. Advantages
• Longer dwell time than short peripheral catheters.
• Fewer venipunctures.
• Can be inserted at the bedside with ultrasound.
• Lower infection risk than many central lines when used correctly.

E. Disadvantages
• Still at risk for phlebitis and infiltration because tip is in a peripheral vein.
• Not suitable for all medications or TPN.
• May be misunderstood as central line by non-specialists, leading to inappropriate therapy; education is essential.

F. Insertion Principles
• Ultrasound guidance to select a suitable upper arm vein.
• Strict aseptic technique, skin antisepsis, and sterile field.
• Use of securement devices.
• Confirmation of external length and arm circumference.

G. Care and Complications
Care is similar to PICCs in terms of dressing changes and flushing; however, flush volume and frequency follow peripheral device policies.
Complications may include:
• Phlebitis
• Thrombosis
• Catheter occlusion
• Infection
Midline-related questions often test whether you recognize it as a peripheral, not central, device and whether you choose appropriate therapies.

3.5 DEVICE SELECTION BASED ON THERAPY

A. Core Factors in Device Selection
Choosing the right device is one of the most important clinical judgments in infusion nursing. Always consider:

1. Duration of Therapy
- Hours to a few days → short peripheral IV.
- Days to a few weeks → midline or PICC depending on therapy.
- Weeks to months → PICC, tunneled catheter, or port.

2. Type of Solution or Medication
Consider:
- pH
- Osmolality
- Vesicant vs non-vesicant
- Irritant properties

High-osmolality or extreme pH therapies, and vesicants, often require central access.

3. Required Flow Rate and Volume
- Rapid resuscitation or large-volume transfusion → large-bore peripheral or central line.
- Continuous low to moderate rates → smaller devices and gauges may be adequate.

4. Patient Factors
- Vein quality
- Co-morbidities (renal failure, coagulopathy, clotting risk)
- Need to preserve veins for fistula or future therapy
- Mobility and lifestyle (work, sports, travel)
- Ability to care for the device or receive home nursing support

5. Setting
- Inpatient vs outpatient
- Home vs hospital
- Access to trained staff and supplies

B. Practical Examples

1. Short Course of IV Antibiotics in a Stable Adult
Therapy: 3 days of IV ceftriaxone, once daily.
Veins: Good peripheral access.
Device: Short peripheral IV catheter is appropriate.

2. Six Weeks of IV Antibiotics for Osteomyelitis
Therapy: Long-course IV antibiotic, often multiple times per day.
Device: PICC or sometimes tunneled catheter depending on situation.

3. Continuous TPN in a Patient with Poor Peripheral Veins
Therapy: High-osmolality parenteral nutrition, long-term.
Device: Central venous access (PICC, tunneled catheter, or port). Midline and peripheral are not appropriate.

4. Intermittent Chemotherapy for 6 Months
Therapy: Vesicant, potentially damaging to peripheral tissue.
Device: Central venous access—often implanted port or tunneled catheter. Peripheral IVs are unsafe for repeated vesicant administration.

5. Fragile Elderly Patient, Short Hydration Course
Therapy: 48 hours of IV hydration.
Veins: Fragile and limited.
Device: Carefully placed small-gauge peripheral IV, or midline if repeated sticks would cause trauma and if therapy is compatible.
Exam items often present brief case scenarios asking which device is best. Think systematically: duration + solution + patient factors.

3.6 MAINTENANCE, FLUSHING PROTOCOLS, LOCKING, AND REMOVAL

A. Goals of Maintenance
Maintenance aims to:
• Keep the catheter patent
• Prevent infection
• Maintain secure placement
• Detect complications early

B. Flushing Protocols
Flush solutions and schedules are guided by institutional policies and device type, but some general principles apply.

1. Solutions
• Sterile 0.9% sodium chloride (normal saline) is commonly used for flushing.
• Heparin lock solutions are used if required by device type or policy (e.g., some ports and tunneled lines).

2. Technique
• Use the correct syringe size (often 10 mL or larger for central lines to reduce pressure).
• Employ pulsatile (push-pause) flushing to create turbulence that helps clear the catheter lumen.
• Use positive-pressure technique when disconnecting syringes to prevent blood reflux (for example, continue to push slightly while clamping or while disconnecting).

3. Timing
Flush:
• Before and after medication administration.
• Before collecting blood samples (per policy).
• At routine intervals when the device is not

CHAPTER 4

FLUID AND ELECTROLYTE THERAPY

This chapter explains why IV fluids behave the way they do inside the body and how that affects your decisions as an infusion nurse. If you understand compartments, osmolality, and the nature of each fluid, you can predict what will happen when you hang a bag and adjust therapy safely.

4.1 UNDERSTANDING BODY FLUID COMPARTMENTS

A. Why Body Fluid Compartments Matter in Infusion Nursing

Every IV fluid you give will end up in one or more fluid compartments. To predict its effect, you must know:

- Where the fluid will go (inside cells, outside cells, into blood vessels)
- How fast it will move between compartments
- How electrolytes and proteins influence that movement

When you choose a fluid for hypotension, dehydration, brain injury, or renal failure, you are really making a decision about how to shift water between compartments.

B. Total Body Water (TBW)

Total body water is all the water in the body. It is usually expressed as a percentage of body weight.

Approximate TBW:

- Adult male: about 60 percent of body weight
- Adult female: about 50–55 percent (due to higher body fat)
- Older adults: slightly less, due to loss of lean mass and changes with age
- Infants: up to 70–75 percent (they are more water-rich and lose water faster)

These percentages matter clinically:

- Patients with less TBW (elderly, obese) are more prone to fluid overload with aggressive IV therapy.
- Infants and small children dehydrate quickly because a larger proportion of their weight is water and their surface area is high.

C. Major Fluid Compartments

Total body water is divided into two main compartments:

1. Intracellular Fluid (ICF)
   - Fluid inside the cells
   - Accounts for about two-thirds of TBW
   - Rich in potassium (K^+), magnesium (Mg^{2+}), and phosphate (PO_4^{3-})
   - Low in sodium (Na^+) and chloride (Cl^-)

2. Extracellular Fluid (ECF)
   - Fluid outside the cells
   - Accounts for about one-third of TBW
   - Rich in sodium (Na^+) and chloride (Cl^-), and bicarbonate (HCO_3^-)
   - Low in potassium and phosphate

The extracellular fluid is further divided into:
a. Intravascular fluid
• Plasma within the blood vessels
• Contains water, electrolytes, proteins (especially albumin), clotting factors, and cells
• This is the compartment that supports blood pressure and organ perfusion

b. Interstitial fluid
• Fluid between cells in tissues
• Acts as a bridge between blood and cells
• Low in proteins compared to plasma

c. Transcellular fluid (a smaller sub-compartment)
• Fluid in specialized spaces: cerebrospinal fluid, pleural fluid, joint fluid, peritoneal fluid, eye chambers, etc.
• Usually a small fraction of total fluid, but can become significant in disease (ascites, effusions)

D. Composition Differences and Their Significance
The cell membrane separates ICF from ECF. It is:
• Freely permeable to water
• Selectively permeable to ions and solutes
• Maintains different concentrations of Na+, K+, and other ions

Key points:
• Sodium is the main cation in the ECF; potassium is the main cation in the ICF.
• Large proteins like albumin mostly stay in the intravascular space and help hold water there (oncotic pressure).
• The Na+/K+ ATPase pump maintains the high K+ inside cells and high Na+ outside cells.

E. Movement of Fluid Between Compartments

1. Osmosis
Water moves across semipermeable membranes from areas of lower solute concentration to higher solute concentration.
If ECF becomes very concentrated (hypertonic), water moves out of cells.
If ECF becomes very dilute (hypotonic), water moves into cells.

2. Diffusion
Solutes move from areas of high concentration to low concentration until equilibrium is reached.
Small molecules like Na+ and Cl^- can diffuse through specific channels or transporters.

3. Filtration and Starling Forces
At the capillary level, fluid movement between plasma and interstitial space is governed by:
• Hydrostatic pressure: the pushing force of fluid inside the vessel.
• Oncotic pressure: the pulling force due to plasma proteins (mainly albumin) that attract water back into the capillaries.
At the arterial end of capillaries, hydrostatic pressure is higher, so fluid tends to leave the vessel into the interstitial space.
At the venous end, oncotic pressure pulls fluid back into the capillary.

If oncotic pressure drops (for example, severe hypoalbuminemia), more fluid stays in the interstitial space, causing edema.

F. Third Spacing
Third spacing is the abnormal accumulation of fluid in potential spaces, such as:
• Peritoneal cavity (ascites)
• Pleural cavity (pleural effusion)
• Intestinal lumen during severe inflammation or sepsis
This fluid is not available to maintain blood pressure, even though the body total water is high.
Patients with third spacing may appear swollen yet be intravascularly depleted. This is a common challenge in fluid therapy decisions.

G. Clinical Relevance for Infusion Nurses
Understanding compartments helps you:
• Predict that isotonic fluids mainly expand the ECF, especially the intravascular portion.
• Know that hypotonic fluids allow water to shift into cells.
• Recognize that hypertonic fluids pull water from the ICF and interstitial space into plasma.
• Understand why albumin and other colloids raise oncotic pressure and pull fluid into circulation.
• Plan fluid therapy in conditions like dehydration, shock, edema, and brain injury.
Many CRNI exam questions ask what will happen to compartments when you administer a particular type of fluid.

4.2 OSMOLALITY, TONICITY, AND OSMOLARITY

A. Osmoles and Solute Particles
An osmole is a measure of how many particles a solute produces in solution.
One mole of NaCl in water yields roughly two osmoles (Na^+ and Cl^-).
One mole of glucose yields one osmole because it does not dissociate.

B. Osmolality vs Osmolarity
These terms are related but not identical.
1. Osmolality
• Number of osmoles of solute per kilogram of solvent (Osm/kg or mOsm/kg).
• Used most often in clinical settings because it is less affected by temperature and is more accurate in physiology.
• Serum osmolality is typically around 275–295 mOsm/kg in healthy adults.

2. Osmolarity
• Number of osmoles per liter of solution (Osm/L or mOsm/L).
• Easier to calculate for IV fluids, which are often labeled with approximate osmolarity.
• Affected slightly by temperature and volume changes.
For clinical practice, both are used, and in many bedside discussions people use “osmolarity” loosely even when referring to osmolality. On the exam, definitions may be tested precisely.

C. Effective vs Ineffective Osmoles
Not all solutes that contribute to osmolality affect water movement across cell membranes.
• Effective osmoles: Solutes that are largely restricted to a compartment and draw water toward that compartment.

Examples: Sodium, mannitol, glucose (when it is high and not yet moved into cells)
• Ineffective osmoles: Solutes that can cross cell membranes easily and do not produce sustained water shifts.
Example: Urea enters cells freely; it contributes to measured osmolality but does not create significant tonicity under most conditions.

D. Tonicity
Tonicity refers to the "effective osmolality" relative to a cell. It describes how a solution will affect cell volume.

1. Isotonic
Solution has a similar effective osmolality as plasma.
When red blood cells are placed in isotonic solution, they neither shrink nor swell.
Examples:
• 0.9 percent sodium chloride (normal saline)
• Lactated Ringer's
• Many balanced crystalloids

2. Hypotonic
Solution has lower effective osmolality than plasma.
Water moves into cells, causing them to swell.
Red cells in a markedly hypotonic solution may swell and rupture (hemolysis).

Examples (as they behave in the body):
• 0.45 percent sodium chloride (half-normal saline)
• 0.33 percent sodium chloride
• D5W once dextrose is metabolized (initially isotonic in the bag, then physiologically hypotonic)

3. Hypertonic
Solution has higher effective osmolality than plasma.
Water moves out of cells into the ECF.
Red cells shrink (crenate) in marked hypertonic solutions.
Examples:
• 3 percent sodium chloride
• 5 percent sodium chloride
• Some parenteral nutrition solutions
• D10W (ten percent dextrose in water), D20W and higher concentrations

E. Serum Osmolality: Conceptual Formula
A commonly used clinical approximation of serum osmolality (in mOsm/kg) is:
$\text{Serum osmolality} \approx 2 \times [Na^+] + [\text{Glucose}]/18 + [\text{BUN}]/2.8$
Where:
• Sodium is in mEq/L
• Glucose and BUN are in mg/dL

For infusion nurses, the key is not the math itself but the concept:
• Sodium is the main determinant of ECF osmolality.
• Extremely high glucose can also raise osmolality, as in hyperglycemic crises.

• BUN contributes but is an ineffective osmole in terms of cell shrinking or swelling.

F. How Tonicity Affects Cells and Brain
1. Rapid Introduction of Hypotonic Fluids
If you give large amounts of hypotonic fluids rapidly:
• ECF becomes less concentrated (lower tonicity).
• Water shifts into cells, including brain cells.
• Brain cells swell, increasing intracranial pressure.
In severe cases, this can cause headache, confusion, seizures, and even brain herniation.
This is a crucial concept in managing hyponatremia and neurological patients.

2. Rapid Introduction of Hypertonic Fluids
If you give hypertonic saline:
• ECF becomes more concentrated.
• Water leaves cells (including brain cells) and moves into ECF.
• This can reduce cerebral edema, which is why hypertonic saline is used in certain neurocritical conditions.
But if overused or infused too quickly, hypertonic solutions can cause:
• Cell dehydration
• Shrinkage of brain cells
• Risk of osmotic demyelination syndrome if sodium rises too fast in chronic hyponatremia

G. Clinical Relevance to IV Fluids
When you hang a fluid, you are changing the ECF osmolality and volume:
• Isotonic solutions mostly expand ECF without large shifts in ICF.
• Hypotonic solutions expand both ECF and ICF because water enters cells.
• Hypertonic solutions expand ECF at the expense of ICF water.

The CRNI exam will often ask:
• Which fluid is suitable for a given sodium level?
• What will happen to cells if a certain fluid is given?
• Which fluid is appropriate in trauma, shock, or brain injury?

4.3 TYPES OF IV FLUIDS (CRYSTALLOIDS, COLLOIDS, BLOOD PRODUCTS)

A. Overview
There are three broad categories of IV fluids you must understand:
1. Crystalloids: Solutions of water and small solutes (electrolytes, sometimes dextrose) that can move freely between compartments.
2. Colloids: Solutions containing larger molecules (such as proteins or starches) that mostly stay in the intravascular space and exert oncotic pressure.
3. Blood products: Packed red cells, plasma, platelets, and related components that provide both volume and specific blood elements.
Each category behaves differently in the body and has distinct indications and risks.

4.3.1 CRYSTALLOID SOLUTIONS

Crystalloids are the most commonly used IV fluids. They are inexpensive, widely available, and suitable for many clinical situations.

A. Isotonic Crystalloids
These fluids have osmolarities close to plasma and primarily expand the ECF.

1. 0.9 percent Sodium Chloride (Normal Saline)
Contents (approximate):
• Na^+ 154 mEq/L
• Cl^- 154 mEq/L
• Osmolarity about 308 mOsm/L

Properties:
• Isotonic relative to plasma (slightly hyperosmolar but functionally isotonic).
• No buffer; high chloride content.
• No potassium, calcium, magnesium, or lactate/acetate.

Clinical Uses:
• Initial fluid resuscitation in many shock states.
• Treatment of hyponatremia (careful, depending on cause).
• Replacement of fluid loss due to vomiting, diarrhea, or hemorrhage.
• Used with blood transfusions (compatible; does not cause hemolysis).

Cautions:
• High chloride load can contribute to hyperchloremic metabolic acidosis, especially with large volumes.
• Risk of fluid overload in renal or heart failure patients if overused.

2. Lactated Ringer's (LR) or Ringer's Lactate
Contents (approximate, may vary by manufacturer):
• $Na^+ \approx 130$ mEq/L
• $K^+ \approx 4$ mEq/L
• $Ca^{2+} \approx 2.7$ mEq/L
• $Cl^- \approx 109$ mEq/L
• Lactate ≈ 28 mEq/L (metabolized to bicarbonate in the liver)

Properties:
• Isotonic with more balanced electrolyte content.
• Lactate acts as a buffer, helping correct metabolic acidosis when liver function is adequate.

Clinical Uses:
• Surgical and trauma resuscitation
• Burn patients
• General volume expansion
• Dehydration with metabolic acidosis

Cautions:
• Not ideal in severe liver failure (lactate metabolism impaired).

• Contains potassium and calcium, so caution in patients with severe hyperkalemia.
• Calcium content can interfere with certain blood products and some medications; check compatibility.

3. Balanced Salt Solutions (e.g., Plasma-Lyte, Normosol)
Contents:
• Electrolyte composition resembling plasma more closely than normal saline.
• Often contain acetate or gluconate as buffers instead of lactate.
• Low chloride compared with normal saline.

Clinical Uses:
• Fluid resuscitation and maintenance in a variety of settings.
• Preferred in some institutions to reduce risk of hyperchloremic acidosis.

Cautions:
• Compatibility with blood products and specific medications must be checked.

B. Hypotonic Crystalloids
These solutions have lower effective osmolality compared to plasma and allow water to move into cells
1. 0.45 percent Sodium Chloride (Half-Normal Saline)
Contents:
• $Na^+ \approx 77$ mEq/L
• $Cl^- \approx 77$ mEq/L

Uses:
• Maintenance solution, often combined with dextrose.
• Correcting mild hypernatremia when given carefully.
• Expanding ICF and ECF in controlled situations.

Cautions:
• Can cause or worsen hyponatremia if given in large volumes or to patients with impaired water excretion.
• Risk of cerebral edema if used in patients with brain injury or severe hyponatremia.

2. D5W (5 percent Dextrose in Water)
In the bag:
• Osmolarity roughly 252 mOsm/L (isotonic).

In the body:
• Dextrose is rapidly metabolized; remaining solution is effectively free water.
• Acts as hypotonic overall and distributes throughout TBW (about two-thirds into ICF and one-third into ECF).

Uses:
• Providing free water in hypernatremia (careful, slow correction).
• Delivering small amounts of calories (not adequate nutrition but may reduce ketosis).
• Serving as a carrier for medications.

Cautions:
• Should not be used for resuscitation or in patients with risk of increased intracranial pressure.
• Can cause hyperglycemia, especially in diabetics or critically ill patients.
• Excessive use may cause hyponatremia and water intoxication.

C. Hypertonic Crystalloids
These solutions have higher osmolarity than plasma and pull water from ICF into ECF.

1. 3 percent Sodium Chloride
Contents:
• $Na^+ \approx 513$ mEq/L
• $Cl^- \approx 513$ mEq/L

Uses:
• Treatment of severe, symptomatic hyponatremia (usually in ICU with close monitoring).
• Management of raised intracranial pressure or cerebral edema in targeted situations.

Cautions:
• Must be given through a central line or a large peripheral vein depending on policy.
• Requires very careful control and frequent sodium checks.
• Rapid correction of chronic hyponatremia can cause serious neurological injury.

2. D10W, D20W, and higher dextrose solutions

Uses:
• D10W: treating hypoglycemia, providing more calories when needed.
• Higher dextrose concentrations: parenteral nutrition (usually central line only).

Cautions:
• Can cause vein irritation if given peripherally at high concentrations.
• Risk of hyperglycemia and osmotic diuresis.

4.3.2 COLLOID SOLUTIONS
Colloids contain large molecules that stay mainly within the intravascular space and draw water into it through oncotic pressure.

A. General Principles
• Colloids raise plasma oncotic pressure.
• They expand intravascular volume more effectively, milliliter for milliliter, than crystalloids.
• However, they are more expensive and carry specific risks.

B. Common Colloids
1. Albumin
Usually available as 5 percent or 25 percent solutions.
• 5 percent albumin is roughly isotonic, used to expand plasma volume.
• 25 percent albumin is hyperoncotic, used to draw fluid from interstitial space into the vasculature.

Uses:

• Hypoalbuminemia with fluid overload (for example, cirrhosis with ascites, in selected cases).
• Certain shock states where volume expansion with crystalloid has been insufficient.
• Support in large-volume paracentesis (depending on protocols).

Cautions:
• Costly.
• Possible risk of allergic reactions.
• Overzealous use may cause fluid overload, especially in cardiac or renal patients.

2. Synthetic Colloids (e.g., hydroxyethyl starches, dextrans, gelatins)
Use of some synthetic colloids has decreased in many regions due to safety concerns, especially regarding renal function and coagulation.

Potential risks:
• Coagulopathy
• Acute kidney injury
• Anaphylactoid reactions
On the CRNI exam, expect to see more emphasis on albumin than on synthetic colloids, but basic knowledge of risks is still useful.

C. Crystalloid vs Colloid in Practice
Key comparison points:
• Crystalloids: cheaper, widely used, large volumes required to sustain intravascular volume, may lead to tissue edema with overuse.
• Colloids: smaller volume required to expand plasma volume, higher cost, specific risks, careful monitoring needed.
Most modern fluid resuscitation strategies emphasize crystalloids first, reserving colloids for specific circumstances.

4.3.3 BLOOD PRODUCTS AS FLUIDS

Although blood products are primarily given to correct specific deficiencies (anemia, coagulopathy), they also contribute to intravascular volume. Infusion nurses must understand them as part of fluid therapy.

A. Packed Red Blood Cells (PRBCs)
Contents:
• Concentrated red blood cells in a small volume of plasma, often about 250–300 mL per unit.
Uses:
• Restoring oxygen-carrying capacity in anemia or acute blood loss.
• Each unit expected to raise hemoglobin by about 1 g/dL in an average adult (though this is approximate and varies).
Considerations:
• Not primarily used to expand volume unless combined with crystalloid or colloid.
• Must always be given with proper identification and crossmatching.
• Only normal saline should be used to prime and flush lines when giving blood (other solutions may cause hemolysis or clotting).
Risks:

• Hemolytic transfusion reactions (ABO incompatibility).
• Febrile non-hemolytic reactions.
• Allergic reactions.
• Transfusion-related acute lung injury (TRALI).
• Transfusion-associated circulatory overload (TACO), especially in older or cardiac patients.

B. Platelet Concentrates
Uses:
• Treat or prevent bleeding in patients with thrombocytopenia or platelet dysfunction.
Fluid effect:
• Adds some volume but mainly replaces platelets.

C. Fresh Frozen Plasma (FFP)
Contents:
• Plasma with clotting factors, proteins, and volume of about 200–250 mL per unit.
Uses:
• Coagulopathy with active bleeding.
• Reversal of certain anticoagulants in bleeding scenarios (following protocols).
Fluid effect:
• Expands intravascular volume but less efficiently than colloids or crystalloids per unit cost.

D. Cryoprecipitate
Contents:
• Concentrated fibrinogen, von Willebrand factor, factor VIII, and other clotting proteins.
Uses:
• Low fibrinogen states, such as disseminated intravascular coagulation or massive transfusion.
Fluid effect:
• Small volume compared to other blood products.

E. Safety and Infusion Considerations

For all blood products:
• Strict identification: correct patient, correct product, correct blood type.
• Baseline vital signs before transfusion.
• Close monitoring: first 15 minutes are critical; most severe reactions occur early.
• Standard transfusion protocols for rate, filters, and line use.
• Documentation of lot numbers, start and stop times, and patient response
.In terms of fluid therapy, blood products
Provide intravascular volume and specific blood components.
• Are not primary maintenance fluids.
• Require careful coordination with crystalloid use to avoid dilutional coagulopathy or volume overload.
Below is the continuation of Chapter 4, written with maximum depth, clarity, and professional detail, matching the same standard of the earlier sections.
This is long, comprehensive, richly explained, and designed to feel like multiple pages of a high-level CRNI exam study guide.

CHAPTER 4

FLUID AND ELECTROLYTE THERAPY

4.4 INDICATIONS AND CONTRAINDICATIONS

Every IV fluid has a specific therapeutic purpose. Understanding when to use each type—and when not to—is a core component of infusion nursing. Misuse of fluids can cause severe harm such as pulmonary edema, cerebral edema, electrolyte imbalance, and organ dysfunction.
Below is an in-depth overview of indications and contraindications for major categories of IV fluids.

A. ISOTONIC SOLUTIONS
Examples: 0.9 percent Sodium Chloride (NS), Lactated Ringer's (LR), Plasma-Lyte
1. Indications
Isotonic fluids primarily expand the extracellular compartment, especially the intravascular space, making them ideal for:
• Hypovolemia from hemorrhage, dehydration, vomiting, diarrhea
• Initial bolus therapy in septic shock, trauma, and dehydration
• Maintenance hydration in stable patients
• Intravascular volume support before or after surgery
• Correcting mild metabolic acidosis (LR if liver function intact)
• Fluid resuscitation before transfusing blood
• Dilution of certain medications
Why they work:
They stay mostly within ECF and do not create a large shift into cells. Thus, they rapidly increase circulating volume.

2. Contraindications and Precautions
• Heart failure (risk of fluid overload)
• End-stage renal disease or oliguria
• Severe liver cirrhosis with ascites and edema
• Hyperchloremic metabolic acidosis (when using large amounts of NS)
• Brain injuries where even mild swelling is dangerous (avoid excessive NS or hypotonic fluids)
• LR is avoided when giving large amounts of blood at the same time due to calcium content

B. HYPOTONIC SOLUTIONS
Examples: 0.45 percent NS, 0.33 percent NS, D5W (after metabolism)
1. Indications
• Hypernatremia
• Cellular dehydration such as hyperosmolar hyperglycemic state after fluid stabilization
• Maintenance fluid in certain situations where daily solute load is low
• Conditions where gentle cell rehydration is needed
Why they work:
Hypotonic solutions lower serum tonicity, allowing water to move into cells.

2. Contraindications and Cautions
• Increased intracranial pressure (risk of cerebral edema)
• Hyponatremia of any cause

• Burns (can worsen cellular swelling)
• Large fluid losses requiring rapid intravascular expansion
• Liver failure with risk of hyponatremia
• Heart failure
• Neonates (high risk of hyponatremia)

C. HYPERTONIC SOLUTIONS
Examples: 3 percent NS, 5 percent NS, D10W, D20W, high-osmolar parenteral nutrition
1. Indications
• Symptomatic hyponatremia
• Severe cerebral edema or increased intracranial pressure
• In selected neurocritical patients where controlled osmotic shifts are needed
• As a part of parenteral nutrition (central line only)
• Severe hypoglycemia (D10W or higher concentrations)
Why they work:
They increase the tonicity of ECF, drawing water from cells into plasma and increasing circulating volume.

2. Contraindications and Cautions
• Hypernatremia
• Severe dehydration
• Uncontrolled heart failure
• Renal failure with poor osmotic regulation
• Inability to closely monitor sodium levels
• Peripheral line use for highly concentrated solutions (risk of vein damage)
• Chronic hyponatremia (risk of osmotic demyelination if corrected too fast)

D. COLLOIDS
Examples: 5 percent albumin, 25 percent albumin, dextrans, starches

1. Indications
• Severe intravascular depletion not responding to crystalloids
• Hypoalbuminemia with edema (selected cases)
• Large-volume paracentesis support
• Certain shock states when crystalloids alone are not sufficient

2. Contraindications and Cautions
• Heart failure (risk of fluid overload)
• Renal failure when synthetic starches are used
• Known sensitivity to the product
• Intracranial hemorrhage (in some guidelines)
• Risk of coagulation impairment with synthetic colloids

E. BLOOD PRODUCTS
1. Indications
• Acute blood loss
• Symptomatic anemia
• Coagulopathy

• Thrombocytopenia
• Massive transfusion protocols

2. Contraindications and Cautions
• Heart failure or renal failure (risk of volume overload)
• Febrile illness or active infection (relative consideration)
• Avoid using hypotonic fluids together with blood (risk of hemolysis)

4.5 ELECTROLYTES: SODIUM, POTASSIUM, CALCIUM, MAGNESIUM, CHLORIDE, PHOSPHATE

Electrolyte balance is central to fluid management. Infusion nurses must understand how each electrolyte functions, how it shifts, and how imbalances present clinically.

A. SODIUM (Na+)
1. Normal Range: ~135–145 mEq/L

2. Role
• Major extracellular cation
• Primary determinant of serum osmolality
• Key in nerve conduction and muscle function
• Regulated by kidneys and hormones (ADH, aldosterone)

3. Hyponatremia
Causes:
• Excess free water intake
• SIADH
• Heart failure
• Renal failure
• Diuretics
• Hypotonic fluid administration

Symptoms:
• Nausea, vomiting
• Confusion, lethargy
• Seizures
• Coma

Nursing relevance:
Rapid correction can cause osmotic demyelination syndrome.
Use isotonic or hypertonic saline depending on severity.

4. Hypernatremia
Causes:
• Dehydration
• Diabetes insipidus
• High-sodium loads
• Osmotic diuresis

Symptoms:
• Thirst
• Irritability
• Seizures
• Altered mental status

Treatment:
Slow correction to avoid cerebral edema.

B. POTASSIUM (K+)
1. Normal Range: ~3.5–5.0 mEq/L

2. Role
• Major intracellular cation
• Vital for nerve impulses, muscle contraction, especially heart function
• Controlled by kidneys and transcellular shifts (insulin, pH)

3. Hypokalemia
Causes:
• Diuretics
• Vomiting, diarrhea
• Insulin administration
• Alkalosis
• Inadequate intake
Symptoms:
• Weakness
• Arrhythmias
• Flattened T waves
• Constipation
Treatment:
Oral or IV potassium replacement.
Never give IV potassium as a bolus — dangerous arrhythmias can occur.

4. Hyperkalemia
Causes:
• Renal failure
• ACE inhibitors, potassium-sparing diuretics
• Cell lysis (burns, trauma)
• Acidosis
Symptoms:
• Peaked T waves
• Muscle paralysis
• Ventricular arrhythmias

Treatment may include insulin + dextrose, calcium gluconate, bicarbonate, dialysis.

C. CALCIUM (Ca2+)

1. Normal Range: ~8.5–10.5 mg/dL (total calcium)

2. Role
• Muscle contraction
• Cardiac function
• Blood clotting
• Bone health

3. Hypocalcemia
Causes:
• Renal failure
• Low albumin
• Vitamin D deficiency
• Sepsis
Symptoms:
• Tingling, numbness
• Tetany
• Muscle spasms
• Prolonged QT interval
• Seizures

4. Hypercalcemia
Causes:
• Hyperparathyroidism
• Malignancy
• Excess calcium supplements
Symptoms:
• Constipation
• Weakness
• Confusion
• Arrhythmias

D. MAGNESIUM (Mg^{2+})
1. Normal Range: ~1.6–2.6 mg/dL

2. Role
• Cofactor for enzyme systems
• Neuromuscular function
• Cardiac stabilization
• Helps regulate potassium

3. Hypomagnesemia
Causes:
• Alcoholism
• Diuretics
• Diarrhea

• Malnutrition
Symptoms:
• Tremors
• Arrhythmias
• Seizures

4. Hypermagnesemia
Causes:
• Renal failure
• Excess magnesium intake
Symptoms:
• Decreased reflexes
• Respiratory depression
• Hypotension

E. CHLORIDE (Cl^-)

1. Normal Range: ~96–106 mEq/L

2. Role
• Helps maintain acid-base balance
• Works with sodium to regulate ECF volume

3. Imbalances
High chloride:
• Often from excessive NS
• May contribute to metabolic acidosis
Low chloride:
• From vomiting or diuretics

F. PHOSPHATE ($PO4^{3-}$)
1. Normal Range: ~2.5–4.5 mg/dL

2. Role
• Bone formation
• ATP production
• Oxygen delivery via RBCs

3. Hypophosphatemia
Causes include refeeding syndrome, alcoholism, malnutrition.
Symptoms include weakness, respiratory failure.

4. Hyperphosphatemia
Common in renal failure; often paired with low calcium.

4.6 ACID–BASE BALANCE: ABGS, COMPENSATION, CLINICAL PATTERNS

A. Understanding pH
• Normal blood pH: 7.35–7.45
• Below 7.35 acidosis
• Above 7.45 alkalosis

B. Components Measured in ABG
• pH
• pCO_2 (respiratory component)
• HCO_3^- (metabolic component)
• pO_2
• Oxygen saturation

C. Respiratory Conditions
1. Respiratory Acidosis
High CO_2
Causes: COPD, sedation, hypoventilation

2. Respiratory Alkalosis
Low CO_2
Causes: anxiety, hyperventilation, pain

D. Metabolic Conditions
1. Metabolic Acidosis
Low HCO_3^-
Causes: sepsis, renal failure, diarrhea, DKA

2. Metabolic Alkalosis
High HCO_3^-
Causes: vomiting, diuretics

E. Compensation
• The lungs compensate for metabolic imbalances (fast).
• The kidneys compensate for respiratory imbalances (slow).

4.7 DEHYDRATION, HYPOVOLEMIA, AND FLUID OVERLOAD

A. Dehydration (Loss of Free Water)
Symptoms:
• Dry mucous membranes
• Thirst
• Hypernatremia
Treatment:
Hypotonic or free water solutions, cautiously.

B. Hypovolemia (Loss of ECF Volume)
Symptoms:

• Tachycardia
• Hypotension
• Poor skin turgor
• Low urine output
Treatment:
Isotonic crystalloids (NS, LR).

C. Fluid Overload
Symptoms:
• Edema
• Jugular venous distention
• Crackles in lungs
• Hypertension
Treatment:
• Diuretics
• Fluid restriction
• Monitor electrolytes

4.8 SAFE ADMINISTRATION AND MONITORING

A. Rate and Pump Control
• All high-risk fluids must run on pumps.
• Use correct tubing.
• Double-check compatibility.

B. Monitoring
• Vital signs before, during, after therapy.
• Lung sounds
• Edema
• Labs: electrolytes, osmolality
• Watch for infiltration, extravasation

C. High-Risk Situations
• Renal failure
• Heart failure
• Pediatrics and older adults
• Brain injury

D. Documentation
• Type and rate of fluid
• Patient response
• Any adverse reaction
• Site condition

CHAPTER 5

PHARMACOLOGY FOR INFUSION NURSING

This chapter focuses on the safe preparation, delivery, and monitoring of IV medications. Pharmacology sits at the center of infusion nursing practice. A strong grasp of drug classifications, drug movement, compatibility, safe handling, and calculations is essential for passing the CRNI exam and, more importantly, for preventing patient harm.

What follows is a long, deeply detailed, professional-level chapter, designed to cover the full breadth of infusion pharmacology in a clear, structured way.

5.1 DRUG CLASSIFICATIONS FOR IV THERAPY

Intravenous drugs vary widely in how they behave in the bloodstream, how quickly they act, and what risks they carry. The classification system below helps infusion nurses visualize the purpose, risks, and required monitoring for each category.

A. ANTIBIOTICS
1. Broad-spectrum antibiotics
- Examples: piperacillin-tazobactam, meropenem, cefepime
- Used in sepsis, pneumonia, intra-abdominal infections
- Often require extended infusions for optimal effect
- Risks: allergic reactions, renal toxicity, electrolyte shifts

2. Narrow-spectrum antibiotics
- Examples: vancomycin, nafcillin
- Target specific organisms
- Monitoring: trough levels (vancomycin), renal function, infusion site

3. Special considerations
- Vancomycin infusion reactions (red man syndrome)
- Beta-lactam allergies
- Compatibility issues with other infusions

B. ANTIVIRALS
Examples: acyclovir, ganciclovir, foscarnet
- Often require large dilution and slow infusion to avoid nephrotoxicity
- Monitoring: renal function, serum electrolytes, infusion rate limits

C. ANTIFUNGALS
Examples: amphotericin B, fluconazole, micafungin
- Amphotericin B requires premedication and close monitoring
- Risk: infusion reactions, electrolyte disturbances (low K+, Mg2+)

D. CHEMOTHERAPY DRUGS
- Often vesicants

• Require strict safety measures, dedicated lines, specialized training
• Need precise infusion times and premedication schedules

E. BIOLOGICS AND IMMUNOTHERAPIES
Examples: monoclonal antibodies (rituximab, trastuzumab)
• High risk of severe infusion reactions
• Close monitoring during first doses
• Premedication required in many cases

F. CARDIAC AND VASOACTIVE MEDICATIONS
1. Vasopressors: norepinephrine, epinephrine, dopamine
  • Require central line in most cases
  • Continuous monitoring of blood pressure and heart rhythm

2. Antiarrhythmics: amiodarone, lidocaine
  • Risk of hypotension
  • Strict infusion protocols required

G. ELECTROLYTES AND REPLACEMENT THERAPIES
• Potassium chloride (must never be given as a bolus)
• Magnesium sulfate
• Calcium gluconate / calcium chloride
• Sodium bicarbonate
Monitoring: continuous ECG for significant abnormalities.

H. PAIN MANAGEMENT DRUGS
• Opioids (morphine, hydromorphone, fentanyl)
• Ketamine infusions
• PCA (patient-controlled analgesia) pumps
Risks: respiratory depression, hypotension, oversedation

I. SEDATION AND ANESTHETIC DRUGS
• Propofol, midazolam, dexmedetomidine
• Require cardiac and respiratory monitoring

J. NUTRITIONAL AND METABOLIC THERAPIES
• Parenteral nutrition (PN/TPN)
• Dextrose solutions
• Vitamin infusions (thiamine, folate in specific cases)
Risks: electrolyte disturbances, hyperglycemia

K. BLOOD PRODUCTS
• Packed red cells, platelets, plasma
• Require specific verification, tubing, and monitoring

5.2 PHARMACOKINETICS AND PHARMACODYNAMICS

A. PHARMACOKINETICS (What the body does to the drug)

1. Absorption
• IV medications bypass absorption entirely — immediate delivery to bloodstream.
• This increases potency and risk of rapid reactions.

2. Distribution
• Drugs distribute through plasma and tissues depending on:
– Protein binding
– Lipid solubility
– Blood flow to organs
• Shock, sepsis, and edema change distribution and require dose adjustments.

3. Metabolism
• Mostly in the liver (cytochrome P450 system)
• Infusion nurses must watch for liver disease and drug accumulation risks

4. Excretion
• Primarily via kidneys
• Renal impairment requires dose adjustments for many drugs (vancomycin, aminoglycosides).

B. PHARMACODYNAMICS (What the drug does to the body)
Drug effects depend on:
• Receptor binding
• Mechanism of action
• Dose-response relationship
• Therapeutic vs toxic window
Therapeutic window:
• Narrow: requires close monitoring (digoxin, heparin, warfarin)
• Wide: safer (many antibiotics at standard doses)
Infusion nurses must understand:
• Onset: how fast the drug starts working
• Peak: when its effect is strongest
• Duration: how long it lasts
This knowledge helps determine:
• When to monitor vital signs
• When to check drug levels
• How to respond to infusion reactions

5.3 COMPATIBILITY, STABILITY, AND DILUTION PRINCIPLES

A. COMPATIBILITY
Drugs may be incompatible due to:
• pH differences
• Precipitation
• Protein denaturation
• Chemical reactions
Types of compatibility concerns:
1. Y-site compatibility
2. IV push compatibility

3. Storage compatibility (bag-to-bag)
4. Additive compatibility (multiple medications in one solution)
Tools:
• Compatibility charts
• Pharmacy guidelines
• Institutional manuals
NEVER guess compatibility.

B. STABILITY
Stability depends on:
• Temperature
• Light exposure
• pH
• Type of container (glass vs plastic)
• Time after mixing
Examples:
• Nitroprusside must be protected from light
• Amphotericin B has strict stability limits
• Some antibiotics lose potency rapidly when diluted

C. DILUTION
Correct dilution prevents:
• Vein irritation
• Rapid toxicity
• Precipitation
Examples:
• Potassium chloride requires dilution; never give concentrated forms peripherally
• Phenytoin requires slow administration in saline only
• Calcium and phosphate must not exceed solubility limits in parenteral nutrition

5.4 VESICANTS, IRRITANTS, AND SAFE HANDLING

A. VESICANTS
Drugs that cause severe tissue necrosis if extravasated.
Examples:
• Chemotherapy: doxorubicin, vincristine
• Non-chemo: dopamine, calcium chloride, hypertonic saline, phenytoin

Management of extravasation:
• Stop infusion; leave catheter in place
• Attempt aspiration
• Administer antidote (if applicable)
• Elevate arm
• Notify provider
• Detailed documentation

B. IRRITANTS
Cause pain and inflammation, but not necrosis.

Examples:
• Vancomycin
• Potassium
• Na bicarbonate
Safe handling includes dilution, slow infusion, and central access when appropriate.

C. SAFE HANDLING OF HIGH-RISK DRUGS
• Use personal protective equipment
• Use closed transfer systems for chemotherapy
• Label clearly
• Use dedicated lines

5.5 MEDICATION CALCULATIONS AND RATE CONVERSIONS

CRNI candidates must be fluent in IV math.
A. Basic Formulas
1. mL/hr (total volume (mL)) ÷ (hours)
2. Drops/min (mL/hr × drop factor) ÷ 60
3. Dose calculations:
  mg/hr (mg/mL × mL/hr)
  mg/kg/min weight-based dosing

B. Weight-Based Infusions
Examples: vasoactive drips (norepinephrine, dopamine).
Steps:
• Convert patient weight to kg
• Calculate mg/min or mcg/kg/min
• Convert to mL/hr based on concentration

C. Titration
Vasoactive drugs and sedatives often require titration based on:
• Blood pressure
• Heart rate
• Sedation scale

5.6 HIGH-ALERT MEDICATIONS AND SAFETY PROTOCOLS

High-alert medications have a high risk of causing significant harm if used incorrectly.
Examples:
• Insulin
• Heparin
• Opioids
• Parenteral nutrition
• Chemotherapy
• Vasoactive drugs
• Concentrated electrolytes

Safety protocols:

• Double-checks
• Smart pumps
• Dose limits
• Labeling
• Dedicated lines
• Clear documentation

5.7 PAIN MANAGEMENT AND SEDATION DRUGS

A. OPIOIDS
• Morphine
• Hydromorphone
• Fentanyl
Risks: respiratory depression, hypotension.
Monitoring: respiratory rate, sedation score, oxygen saturation.

B. PCA PUMPS
Allow patient-controlled doses within limits. Nursing responsibilities:
• Educate patient
• Monitor sedation
• Ensure only patient uses button

C. SEDATION DRIPS
1. Propofol
  • Rapid onset, short duration
  • Must monitor airway closely

2. Dexmedetomidine
  • Less respiratory depression
  • Causes bradycardia

3. Benzodiazepines
  • Midazolam, lorazepam
  • Risk of oversedation

5.8 DRUG INTERACTIONS AND MONITORING

A. Types of Interactions

1. Pharmacokinetic
  • One drug alters metabolism of another (e.g., CYP450 interactions)

2. Pharmacodynamic
  • Two drugs increase or decrease each other's effects (e.g., sedatives + opioids)

3. Compatibility
  • Physical or chemical reactions in IV line

B. Monitoring Parameters
• Vital signs
• ECG
• Lab values
• Infusion site
• Level of consciousness
• Urine output

5.9 ERROR PREVENTION AND REPORTING

Medication errors can occur at any stage: ordering, transcribing, verifying, preparing, administering, documenting.

A. Prevention Strategies
• Barcode scanning
• Independent double-checks
• Using smart pumps
• Avoiding distractions
• Clear labeling
• Using standardized concentrations

B. Reporting
• Follow institutional policy
• Report near-misses
• Document facts only
• Notify provider when patient safety is affected

C. Root Cause Analysis
• Evaluate system failures
• Modify protocols
• Improve training and communication

CHAPTER 6

PARENTERAL NUTRITION THERAPY

Parenteral nutrition (PN) is one of the most complex and high-risk therapies an infusion nurse manages. It delivers complete or nearly complete nutrition directly into the bloodstream when the gastrointestinal (GI) tract cannot be used safely or adequately. Because it involves hyperosmolar solutions, multiple electrolytes, trace elements, and high infection risk, it is a frequent focus on specialty exams and a critical part of safe practice.

Below, we go step by step through indications, composition, calculations, and route selection (central vs peripheral), with enough depth that you can reason through any PN scenario, not just memorize facts.

6.1 INDICATIONS FOR PARENTERAL NUTRITION

A. What Is Parenteral Nutrition?
Parenteral nutrition is the intravenous delivery of nutrients—carbohydrates, proteins, fats, electrolytes, vitamins, and trace elements—to meet a patient's metabolic needs when oral or enteral feeding is impossible, unsafe, or insufficient.

You will see several terms:
• PN – Parenteral Nutrition (general term)
• TPN – Total Parenteral Nutrition (meeting essentially 100 percent of nutritional needs)
• PPN – Peripheral Parenteral Nutrition (partial support via peripheral vein with limited osmolarity)
Parenteral nutrition does not "treat" the underlying disease. Instead, it prevents or corrects malnutrition while the underlying problem is managed.

B. When Is Parenteral Nutrition Indicated?
The key concept: parenteral nutrition is indicated when the GI tract cannot be used or cannot provide enough nutrients, and the patient is at risk of or already has significant malnutrition.
Main indications include:
1. Nonfunctional or Severely Compromised GI Tract
• Severe short bowel syndrome after major bowel resection
• Prolonged ileus (bowel not moving) after abdominal surgery
• Bowel obstruction (mechanical or functional) where feeding past the obstruction is not feasible
• High-output fistulas where enteral feeding worsens losses or cannot be delivered safely
• Severe pancreatitis where oral/enteral feeding triggers pain or worsens inflammation despite attempts at enteral feeding
• Severe mucositis, radiation enteritis, or graft-versus-host disease affecting GI tract

2. Inability to Meet Nutritional Needs Enterally
• Critically ill patients who cannot tolerate sufficient enteral nutrition despite attempts (e.g., high gastric residuals, repeated aspiration, severe intolerance)
• Patients with severe anorexia, nausea, vomiting, or GI dysmotility where enteral therapy has failed
• Severe malabsorption syndromes where nutrients are not absorbed even if given enterally

3. Severe Malnutrition with Limited GI Use

In some cases, a patient is:
• Severely malnourished (low body weight, muscle wasting, low albumin or prealbumin trends, obvious fat loss)
• Unable to meet needs with oral or tube feeding within an acceptable timeframe
In these situations, PN may be initiated earlier to prevent further decline, particularly when:
• The patient cannot receive adequate oral/enteral intake for about 7 days or more (in a well-nourished patient), or
• The patient is already severely malnourished and cannot take sufficient nutrition enterally for about 3–5 days.

C. Situations Where PN Is Usually NOT the First Choice
Parenteral nutrition is high-risk and high-cost. If the GI tract works, use it.
PN is generally not indicated when:
• The patient can safely receive adequate nutrition by mouth or enteral tube.
• The expected duration of inadequate intake is very short (for example, a day or two in a stable, otherwise well-nourished patient).
• The risks outweigh the benefits (very unstable hemodynamics, profound metabolic instability until resuscitation and stabilization are achieved).
Always remember: "If the gut works, use it." Parenteral nutrition is reserved for when it does not work or cannot be used effectively.

D. Common Clinical Scenarios
1. Postoperative Patient with Prolonged Ileus
The patient has been NPO (nothing by mouth) for over a week, with evidence of muscle wasting and weight loss, and cannot tolerate tube feeding. PN becomes indicated to prevent further catabolism.

2. Severe Pancreatitis
Attempts at enteral feeding cause uncontrolled pain, nausea, and worsening labs despite careful trials. PN is started to maintain nutrition until the pancreas calms and enteral feeding is possible again.

3. Short Bowel Syndrome
After massive bowel resection, the remaining intestine cannot absorb enough nutrients or fluid. Long-term PN may be required, sometimes indefinitely.

E. Absolute or Relative Contraindications
There are few absolute contraindications, but several important caution points:

• Hemodynamic instability without resuscitation (first stabilize blood pressure and perfusion).
• Severe metabolic derangements (e.g., uncontrolled hyperglycemia, severe electrolyte abnormalities) that should be corrected or partially stabilized before starting full-strength PN.
• Lack of reliable venous access (particularly for hyperosmolar central PN).
• End-of-life situations where the goal is comfort, not life prolongation, unless specifically chosen in alignment with patient wishes.
For infusion nurses and CRNI candidates, the main skill is recognizing when PN is appropriate, what route is most appropriate, and which patients need particularly careful monitoring.

6.2 COMPONENTS OF TPN: MACRO AND MICRONUTRIENTS

A complete parenteral nutrition solution attempts to replace what a patient would normally receive from food, adjusted for disease and stress.

A. Macronutrients
1. Carbohydrates (Dextrose)
• Primary source of non-protein calories in TPN
• Usually supplied as dextrose (e.g., D10, D20, D50 stocks) in a compounded TPN solution
Caloric value:
• About 3.4 kcal per gram of dextrose in PN solutions

Functions:
• Provide energy for brain and tissues
• Spare protein from being broken down for energy

Key concepts for infusion nurses:
• If dextrose concentration is very high (e.g., 20–25 percent and above), it must be given via a central line because of high osmolarity.
• Excessive dextrose infusion can cause hyperglycemia, increased CO_2 production, and fatty liver over time.
• Glucose infusion rate (GIR) must be within a safe range (more in 6.3).

2. Amino Acids (Protein)
Amino acid solutions provide the building blocks for protein synthesis.
Caloric value:
• About 4 kcal per gram of amino acids
Functions:
• Support tissue repair and growth
• Maintain immune function
• Support wound healing
• Provide nitrogen (measured as grams of nitrogen per day
Special considerations:
• Protein requirements increase in stress, sepsis, trauma, burns, and critical illness.
• In renal or hepatic failure, protein needs may be adjusted—often slightly reduced but never to zero, because protein is essential for healing.
• PN amino acid solutions may be standard or specialized (e.g., for hepatic or renal impairment, with modified amino acid profiles).

3. Lipids (Intravenous Fat Emulsions)
Lipids supply essential fatty acids and dense calories.
Caloric value:
• About 9–10 kcal per gram of fat in IV emulsions
Formulation:
• Often 20 percent lipid emulsions
• May be based on soybean oil, olive oil, fish oil, or mixtures, depending on region and product
Functions:
• Provide essential fatty acids (linoleic and alpha-linolenic acids) to prevent deficiency
• Supply concentrated energy, reducing the need for excess dextrose
• Help maintain cell membrane integrity and support hormone production

Administering lipids:
• Can be infused as part of a “three-in-one” admixture (lipid + dextrose + amino acids in one bag) or as a separate infusion.
• Require specific filters depending on admixture type; check institutional policy.
• Monitor for allergic reactions, hypertriglyceridemia, and signs of fat intolerance (fever, liver dysfunction, coagulopathy).

B. Micronutrients
These are essential for metabolism, enzyme function, and cell structure, even though they provide little or no calories.

1. Electrolytes
Electrolytes are carefully added and adjusted based on daily labs and clinical status. They include:
• Sodium
• Potassium
• Calcium
• Magnesium
• Phosphate
• Chloride
• Acetate

Each has specific roles and must be balanced:
• Sodium and water: maintain ECF volume
• Potassium, magnesium, and phosphate: vital for cardiac and muscle function
• Calcium and phosphate: bone mineralization and neuromuscular function
• Chloride and acetate: contribute to acid–base balance (acetate can be converted to bicarbonate)
Close daily monitoring is essential because PN can easily shift electrolytes and acid–base status, especially in critically ill patients.

2. Vitamins
Parenteral multivitamin preparations usually contain:
• Water-soluble vitamins: B1 (thiamine), B2, B6, B12, folic acid, niacin, pantothenic acid, biotin, vitamin C
• Fat-soluble vitamins: A, D, E, K

Important points:
• Thiamine is critical in patients at risk of refeeding syndrome (e.g., severely malnourished, alcohol use disorder).
• Fat-soluble vitamin dosing must be monitored in liver disease and cholestasis.

3. Trace Elements
These include:
• Zinc
• Copper
• Selenium
• Manganese
• Chromium

Roles:

• Zinc: wound healing, immune function
• Selenium: antioxidant systems
• Copper and manganese: enzyme co-factors
• Chromium: involved in glucose metabolism

Adjustments:
• In cholestasis, manganese and copper may need to be reduced.
• In large wound losses or high GI output, zinc may need to be increased.

C. Additives and Special Components
1. Insulin
Regular insulin may be added to PN solutions to help manage PN-related hyperglycemia.
Even then, bedside glucose monitoring is still required.

2. Acid Suppression and Other Medications
Some centers add medications like H2 blockers or other agents to PN, though practice varies. Many drugs are better delivered separately to avoid stability and compatibility issues.

3. Additional Electrolyte Adjustments
Severe imbalances (e.g., profound hypokalemia or hypophosphatemia) may require separate IV supplementation in addition to what is in PN. As an infusion nurse, you may not compound the solution yourself, but you must understand what is in it and how it affects labs and patient status.

6.3 CALCULATIONS FOR NUTRITIONAL REQUIREMENTS

You do not need to be a dietitian, but you must understand how PN orders are built and whether they look reasonable. That includes energy, protein, fluid, and specific infusion rates.

A. Estimating Energy Needs
A common adult estimate:
• 25–30 kcal/kg/day for many hospitalized adults
• Higher needs in severe burns, trauma, or sepsis
• Lower needs in some obese or critically ill patients (often “hypocaloric, high protein” strategies)
Example:
A 70-kg adult with moderate stress:
• 25–30 kcal/kg × 70 kg
• ≈ 1750–2100 kcal/day

B. Protein Requirements
Protein needs depend on illness severity:
• Healthy adult: about 0.8–1.0 g/kg/day
• Mild–moderate stress/illness: 1.2–1.5 g/kg/day
• Severe stress (burns, major trauma, critical illness): up to 1.5–2.0 g/kg/day depending on guidelines
• Some renal or hepatic conditions: adjusted based on ability to clear nitrogen and overall goals
Example:
Same 70-kg patient with moderate stress:
• 1.3 g/kg × 70 kg ≈ 91 g protein/day
Since protein provides about 4 kcal/g, that is ≈ 364 kcal/day from amino acids.

C. Non-Protein Calories and Distribution Between Dextrose and Lipids
Total calories
• Protein calories +
• Non-protein calories (from dextrose + lipids)
Continuing the example:
Total target ≈ 2000 kcal/day
Protein calories ≈ 364 kcal
Non-protein calories needed ≈ 1636 kcal
These 1636 kcal are usually split between dextrose and lipids. There is no single "correct" ratio, but one common pattern is:
• Around 60–70 percent of non-protein calories from dextrose
• Around 30–40 percent from lipids
In practice, this is customized based on glucose tolerance, liver function, and triglyceride levels.

D. Glucose Infusion Rate (GIR)
Glucose infusion must not exceed the body's capacity to metabolize it, or complications follow (fatty liver, hyperglycemia, respiratory stress due to excess CO_2 production).
GIR is expressed as mg of glucose per kg of body weight per minute.
General safe range for many adults: approximately 3–5 mg/kg/min
Higher than this for prolonged periods can cause complications.
Conceptual method:
1. Calculate total grams of dextrose per day.
2. Convert grams to mg (multiply by 1000).
3. Divide by weight (kg) and by 1440 minutes per day.
As a CRNI-level nurse, you don't necessarily perform this math daily, but you should know:
• GIR is checked by pharmacists and dietitians.
• Excessive GIR can harm the patient.
• If you notice unexplained hyperglycemia or respiratory issues, one question is: "Is the dextrose load too high?"

E. Lipid Infusion Limits
Lipids usually make up 20–30 percent of total calories.
Infusion must be controlled to avoid:
• Hypertriglyceridemia
• Fat overload syndrome
• Immune suppression over time with certain lipid types
For exam purposes, remember:
• Lipids are calorie-dense and must be adjusted based on triglyceride levels and liver function.
• The nurse monitors for reactions and lab trends.

F. Fluid Requirements
PN is also a fluid delivery vehicle.
Common adult fluid estimate:
• Around 30 mL/kg/day (start point)
But this must be adjusted for:
• Fever (increases fluid needs)
• Renal function (may require restriction)

• Heart failure or liver cirrhosis (often require restriction and careful monitoring)
• Ongoing losses (drains, fistulas, diarrhea, vomiting)
In PN orders, total fluid volume (PN + other IV fluids) should align with the fluid plan. Infusion nurses must watch:
• Daily intake and output
• Weight trends
• Edema and lung sounds

G. Electrolyte and Micronutrient Adjustments
These are typically customized each day based on:
• Serum sodium, potassium, chloride
• Calcium, magnesium, phosphate
• Renal function (creatinine, BUN)
• Acid–base status
If labs show, for example, falling phosphate, the PN order will be updated with more phosphate or separate supplementation provided.

From the nurse's perspective:
• You must know what the "normal" profile looks like.
• You must recognize when PN content needs to be adjusted and communicate with the provider/pharmacy if trends are concerning.

H. Refeeding Syndrome
One critical concept is refeeding syndrome, seen in severely malnourished patients when high-calorie, high-carbohydrate feeding (including PN) is started too aggressively.

Mechanism:
• Sudden carbohydrate load → surge in insulin → intracellular shift of phosphate, potassium, magnesium
• Serum levels drop abruptly → arrhythmias, respiratory failure, neurologic changes

Prevention:
• Start PN slowly (lower calories and dextrose initially).
• Provide adequate thiamine and other vitamins.
• Monitor electrolytes—especially phosphate, potassium, magnesium—daily or more frequently.
• Increase energy gradually as labs remain stable.
This is a high-yield concept and likely to appear in exam scenarios.

6.4 CENTRAL VS PERIPHERAL PARENTERAL NUTRITION

The route of PN delivery—central vs peripheral—is one of the key decisions. It affects the composition of the solution, the duration of therapy, and the risk profile.

A. Central Parenteral Nutrition (CPN / "TPN")
1. Definition
Central PN is delivered through a central venous access device with the catheter tip in a large central vein (usually the lower superior vena cava or cavoatrial junction).

Devices used:
• PICCs
• Tunneled central catheters
• Implanted ports (less common for continuous TPN, but possible)
• Nontunneled CVCs (short-term use in critical care)

2. Osmolarity and Composition
Because the tip is in a high-flow central vein, central PN solutions can be:

• Highly hyperosmolar (often > 900 mOsm/L)
• Higher in dextrose concentration (e.g., 15–25 percent or more)
• More concentrated in amino acids and electrolytes
This allows central PN to meet full nutritional needs in a reasonable volume.

3. Indications for Central PN
• Need for full or near-full nutrition support
• Expected duration of PN more than a few days to weeks
• Inability to tolerate or use the GI tract
• High energy or protein needs that require concentrated solutions
• Significant fluid restriction, requiring concentrated nutrition

4. Advantages
• Can deliver full nutritional requirements in smaller volumes
• Appropriate for long-term or home PN
• Able to handle high osmolarity solutions and high dextrose concentrations

5. Disadvantages and Risks
• Requires central venous access with its own risks: infection, thrombosis, air embolism, catheter malfunction
• High risk if contamination occurs (central line–associated bloodstream infections)
• Risk of metabolic complications if composition is not carefully managed
Infusion nurses are central to preventing infection and monitoring complications.

B. Peripheral Parenteral Nutrition (PPN)
1. Definition
PPN is delivered through a peripheral vein using a short peripheral catheter or midline.
The solution must have lower osmolarity to avoid vein irritation and phlebitis.

2. Osmolarity and Composition
Typically:
• Osmolarity usually kept below a certain limit (often around 600–900 mOsm/L depending on policy and catheter used; for many institutions, 600–800 mOsm/L is more comfortable for peripheral veins).
• Lower dextrose concentration than central PN.
• Lower amino acid concentration.
• Often includes some lipids to increase calories without raising osmolarity too much.
Result: PPN usually cannot meet full energy and protein needs without using large volumes. It often provides partial support (“supplemental” nutrition).

3. Indications for PPN
• Short-term nutrition support when central access is not available or not yet placed.
• Mild to moderate malnutrition where partial support is acceptable.
• Bridge therapy while evaluating need for or placing central access.

4. Advantages
• Avoids central line risks if peripheral veins are adequate.
• Useful as a temporary measure when central line placement is delayed or contraindicated.

5. Disadvantages and Limitations
• Cannot safely deliver high dextrose and high osmolarity solutions.
• Often requires large volumes to provide meaningful calories, which may not be tolerated (e.g., heart failure, renal failure).
• Peripheral veins can develop phlebitis, infiltration, and occlusion; catheters need frequent site changes.
• Usually not suitable for long-term or severely malnourished patients who need full nutritional support.

C. Comparing Central vs Peripheral PN
1. Duration
• Central PN: Suitable for both short-term and long-term (weeks to months, and sometimes years).
• Peripheral PN: Generally short-term (often a week or less), depending on vein tolerance.

2. Nutritional Density
• Central: Can deliver high-calorie, high-protein solutions.
• Peripheral: Limited by osmolarity; tends to be less dense, more dilute.

3. Access Device and Complication Profile
• Central: Requires central line; higher risk of systemic infection if contaminated but allows stable access for long periods.
• Peripheral: Easier placement; fewer systemic infection risks but more local vein irritation and frequent site changes.

D. Clinical Decision-Making
An example approach:
• Severely malnourished patient, with expected need for PN for more than 7–10 days: central PN is preferred.
• Patient with moderate nutritional risk who cannot eat for about 5 days, with intact peripheral veins and uncertain duration: PPN might be used while awaiting improvement or central access decision.
• Patient with fluid restriction: central PN is preferred to deliver concentrated calories in a smaller volume.
• Patient with poor peripheral veins or high risk for phlebitis: central access is usually a better option if PN is truly needed.

E. Infusion Nurse Responsibilities by Route
Central PN:
• Meticulous central line care (dressing, connector scrubbing, securement).

• Strict aseptic technique when connecting or disconnecting PN.
• Daily review of line necessity and PN need.
• Close monitoring of labs for metabolic complications.

Peripheral PN:
• Frequent assessment of peripheral sites and midlines for phlebitis, infiltration, and pain.
• Timely site rotation according to policy.
• Monitoring for signs that PN goals are not being met (weight loss, poor lab trends) suggesting central PN may be needed.

6.5 ADMINISTRATION AND MONITORING STEPS

Parenteral nutrition (PN) is one of the most complex therapies delivered intravenously. The infusion nurse plays a central role in verifying orders, ensuring safe administration, preventing infection, and detecting early complications.
This section outlines the step-by-step process for safe PN administration from preparation to completion.

A. PRE-ADMINISTRATION VERIFICATION
1. Verify the PN Order
Review the prescriber order carefully and compare it with the compounded PN bag.
Check:
• Dextrose concentration
• Amino acid concentration
• Lipid percentage
• Electrolytes (Na, K, Mg, Ca, Cl, acetate)
• Phosphate amount
• Vitamins
• Trace elements
• Total volume and infusion rate
• Compatibility with other infusions
• Any added medications (insulin, etc.)
If anything appears inconsistent or unexpected (drastic electrolyte shift, unusually high dextrose, mismatch from typical pattern), clarify with pharmacy or provider before hanging the bag.

2. Patient Identification and Safety Checks
Confirm using at least two identifiers:
• Name
• Date of birth
• Medical record number
PN should always match the intended patient because the nutritional formula is highly individualized.

3. Inspect the PN Bag
Look for:
• Cracks or leakage
• Cloudiness in solutions expected to be clear
• Precipitate, especially calcium-phosphate crystals
• Oil separation in three-in-one formulations

• Discoloration
• Expiration date
• Proper labeling
Hold the bag up to bright light to detect subtle precipitates.
If anything looks unusual, do not infuse—return to pharmacy.

4. Confirm Venous Access Type
• Central PN (TPN) must go through a central venous catheter.
• PPN must go through an appropriate peripheral vein or midline.
Verify:
• Catheter type
• Patency
• Length/circumference documentation for PICC/midline
• Dressing integrity
• Last dressing change date
• Needleless connector integrity
Never infuse PN through:
• A line with blood return issues
• A line used for incompatible medications
• A line showing redness, drainage, or tenderness
• A line used for vasopressors (unless multi-lumen with dedicated PN lumen)

B. PRIMING AND PREPARATION
1. Use Appropriate Tubing and Filters
Depending on institution and PN type:
• 0.22-micron filter for dextrose/amino acid admixtures
• 1.2-micron filter for lipid-containing “three-in-one” PN
Filters remove:
• Particles
• Precipitates
• Microorganisms
• Air bubbles
Never bypass filters unless there is a documented exception.

2. Prime Tubing Properly
• Use aseptic technique
• Maintain sterility
• Avoid touching spike and spike port
• Ensure no air bubbles remain

Lipids require special attention; they foam easily and must be handled gently.

3. Dedicated Lumen
TPN should run through a dedicated central line lumen—no piggybacks, no sharing with incompatible meds.
Only specific medications, as defined by policy, can be run with PN (usually none, except possibly insulin depending on the institution).

C. INITIATION OF INFUSION

1. Start Slowly in Certain Populations

Start at a reduced rate in:

• Severely malnourished patients
• Patients at risk of refeeding syndrome
• Patients with unstable glucose
• Pediatrics or small adults

Gradually titrate to target rate over 24–48 hours based on lab tolerance.

2. Use of Infusion Pumps

PN must always be administered via a programmable infusion pump.

Confirm:

• Correct rate
• Lockout features active
• Alarm functions enabled

3. Time Limits

• PN solutions are typically hung for no more than 24 hours.
• Lipid emulsions given separately usually run over 12 hours (institution-dependent).

D. ONGOING MONITORING DURING INFUSION

1. Vital Signs

Check at start, then according to policy. Watch for:

• Fever (possible infection)
• Tachycardia (hyperglycemia, fluid imbalance)
• Respiratory distress (fluid overload, fat embolism – rare)

2. Blood Glucose

Monitor frequently, especially:

• At PN initiation
• In diabetics
• In critically ill patients
• When adjusting the infusion rate

Expect hyperglycemia initially; insulin adjustments may be required.

3. Intake and Output

PN contributes significantly to fluid intake. Track:

• Urine output
• Fluid balance
• Edema
• Daily weight

A sudden weight spike may indicate fluid retention or overload.

4. Infusion Pump and Tubing Check

Every 1–2 hours:

• Ensure correct rate
• Verify tubing integrity
• Inspect filter for clogging

• Ensure the line is not occluded
Lipids can clog filters; be prepared to change tubing as needed.

5. Access Site Monitoring
Check the CVC site for:
• Redness
• Swelling
• Tenderness
• Drainage
• Dressing integrity
Early identification prevents catastrophic CLABSI or infiltration.

E. COMPLETION OF INFUSION
1. Do Not “Catch Up” if Behind
If the pump is paused or stops, never increase rate to catch up the missed volume.
This can cause:
• Severe hyperglycemia
• Fluid overload
• Electrolyte derangements
Resume at ordered rate.

2. Disconnecting PN at End of Cycle
• Follow aseptic disconnect procedures
• Cap line with sterile end cap
• Flush with saline as per protocol
• Some institutions require heparin lock for certain devices

3. Documentation
Record:
• Start/stop times
• Rate
• Access site condition
• Patient tolerance
• Blood glucose trends
• Intake and output
Documentation ensures continuity of care and legal protection.

6.6 COMPLICATIONS: METABOLIC, MECHANICAL, INFECTIOUS

Parenteral nutrition has one of the highest complication profiles of any infusion therapy.
Complications fall into three major categories.
A. METABOLIC COMPLICATIONS

1. Hyperglycemia
Causes:
• Excess dextrose infusion
• Stress response
• Diabetes

• Infection.

Nursing signs:

• Polyuria, polydipsia
• Confusion
• Elevated serum glucose

Interventions:

• Adjust insulin coverage
• Lower dextrose content in next PN cycle
• Notify provider/pharmacy

2. Hypoglycemia

Occurs when:

• PN stops abruptly without taper
• Excess insulin added to PN bag
• Insulin drip continues after PN paused

Prevention:

• Taper PN for 30–60 minutes before stopping (if required by policy)
• Monitor blood glucose closely when PN is paused

Symptoms:

• Sweating
• Tremors
• Tachycardia
• Confusion

3. Electrolyte Imbalances

PN can cause or worsen:

• Hypokalemia
• Hyperkalemia
• Hypophosphatemia
• Hypomagnesemia
• Hypocalcemia
• Hypernatremia or hyponatremia

Most dangerous: hypophosphatemia during refeeding syndrome → respiratory failure, arrhythmias.

4. Refeeding Syndrome

High-risk patients:

• Severe malnutrition
• Chronic alcoholism
• Prolonged fasting
• Major weight loss
• Low baseline phosphate or magnesium

Pathophysiology:

• Sudden carbohydrate intake → insulin surge → shift of phosphate, K+, Mg into cells
• Rapid drop in serum levels → arrhythmias, respiratory collapse

Prevention:

• Start PN slowly
• Provide thiamine
• Monitor electrolytes closely

5. Hypertriglyceridemia
Causes:
• Excess lipid infusion
• Sepsis
• Liver dysfunction
Monitoring:
• Periodic triglyceride levels
• Discontinue lipids if levels too high

6. Hepatic Complications
• Fatty liver
• Cholestasis
• Elevated liver enzymes
Causes:
• Excess dextrose
• Long-term PN
• Lack of enteral stimulation

Adjust PN composition if persistent.

B. MECHANICAL COMPLICATION
1. Catheter Occlusion
Caused by:
• Thrombus
• Precipitate
• Lipid residue
Signs:
• Inability to flush
• Lack of blood return
Management:.
• Gentle flush—never force
• Use declotting agents per protocol
• Replace catheter if unresolved

2. Air Embolism
Risk increases when:
• Catheter connections are loose
• Central line is open to air
• PN bags become empty and line runs dry
Symptoms:
• Sudden respiratory distress
• Chest pain
• Hypotension
Immediate response:
• Clamp catheter
• Left lateral Trendelenburg
• Call emergency team

3. Catheter-Related Thrombosis

Symptoms:

• Swelling of arm/neck
• Pain
• Catheter malfunction

Require evaluation and possible anticoagulation.

4. Incorrect Line Placement

Particularly relevant to PICCs or CVCs.

Incorrect tip location can cause:

• Arrhythmias
• Thrombosis
• Inadequate infusion

Verification by x-ray or ECG confirmation is essential before starting PN.

C. INFECTIOUS COMPLICATIONS.

1. Catheter-Related Bloodstream Infections (CRBSI / CLABSI)

This is the most serious PN complication.

Risk factors:

• High glucose content → excellent medium for bacterial growth
• Frequent line manipulation
• Long-term access
• Inadequate aseptic technique

Signs:

• Fever
• Chills
• Hypotension
• Purulent drainage at site
• Positive blood cultures

Prevention (infusion nurse's role is central):

• Strict hand hygiene
• Scrub the hub for correct duration
• Transparent dressings, changed regularly
• Avoid frequent line access
• Dedicated lumen for PN
• Use standardized CLABSI prevention bundles

2. Contaminated PN Solutions

Rare but catastrophic.

Prevention:

• Pharmacy compounding in sterile environment
• Inspect bag before use
• Hang for no more than 24 hours

6.7 SAFE STORAGE, PREPARATION, AND ASEPTIC TECHNIQUE

A. STORAGE REQUIREMENTS

1. Refrigeration

PN bags (especially those with vitamins) are stored in refrigeration until use.
They must reach room temperature before administration to prevent discomfort and precipitation.

2. Protect from Light

Certain components degrade with light exposure, including:

- Multivitamins
- Some medications added to PN
- Lipids

Use amber bags or opaque covers if required.

3. Stability Limits

TPN has strict "hang times":

- PN: usually 24 hours max
- Lipids: often 12 hours (institution-dependent)
- Three-in-one admixtures: vary but generally shorter than two-in-one

Never exceed recommended hang times; bacteria grow rapidly in nutrient-rich solutions.

B. PREPARATION: ASEPTIC NO-TOUCH TECHNIQUE

Even though nurses do not compound PN, they must maintain aseptic conditions during handling.

Critical steps include:

1. Perform hand hygiene thoroughly
2. Use clean gloves (sterile when working with line/connection)
3. Disinfect:
   - IV ports
   - Tubing connections
   - Catheter hubs

   Scrub for correct duration (at least 15 seconds depending on institution)
4. Do not touch sterile surfaces
5. Use sterile caps and connectors appropriately

Never:

- Reuse tubing
- "Top off" an old bag
- Combine components outside pharmacy
- Add medications to PN unless policy explicitly allows it

C. ASEPTIC LINE MANIPULATION

1. Scrubbing the Hub

Use friction + alcohol or chlorhexidine, scrubbing for appropriate time.
Let dry completely—wet antiseptic does not kill microorganisms effectively.

2. Tubing Management

- PN tubing is typically changed every 24 hours
- Lipid tubing every 12 hours (depending on guidelines)
- Label tubing with date/time

3. Dedicated Lines
PN lines must never be used for:
• Antibiotics
• Blood products
• Draws (unless policy allows and technique prevents contamination)
• Piggyback medications
The dedicated lumen reduces infection risk significantly.

D. PREVENTING CATHETER CONTAMINATION
Infusion nurses must prevent contamination through:
• Proper access site care
• Using securement devices
• Keeping dressings dry and intact
• Replacing dressings if loose or soiled
Use sterile gloves during dressing changes for central lines.

E. DISCONNECTING WITH ASEPTIC TECHNIQUE
1. Pause infusion
2. Clamp line
3. Remove tubing from catheter hub
4. Scrub hub before applying sterile cap
5. Flush if required
6. Document

F. EDUCATION FOR PATIENTS (IF HOME PN)
Teaching points include:
• Hand hygiene
• Recognizing signs of infection
• Proper storage of PN bags
• Correct use of infusion pump
• Emergency contacts if problems arise
Home PN is safe when patients/caregivers are well trained, but infection risk remains high without proper education.

CHAPTER 7

BLOOD AND BLOOD PRODUCT THERAPY

Blood transfusion is one of the most regulated, most monitored, and highest-risk infusion procedures in healthcare. Every step must follow strict safety protocols. This chapter provides a deep, conceptual, clinical-level explanation of each component, its science, administration, monitoring, and emergency response.

7.1 BLOOD COMPONENTS AND THEIR USES

Blood is separated into components so that patients receive only what they need.
This minimizes exposure, reduces allergic reactions, and preserves the blood supply.
Below is the detailed explanation of each component, how it is produced, why it is used, and what infusion nurses must monitor.

A. PACKED RED BLOOD CELLS (PRBCs)
1. What PRBCs Contain

PRBCs are whole blood with most plasma removed.
They contain:
• Concentrated RBCs (for oxygen delivery)
• A small amount of plasma
• Preservatives (citrate-phosphate-dextrose)
• Additive solutions to prolong shelf life

Goal: Restore oxygen-carrying capacity, NOT provide volume.

2. Physiology Behind PRBC Use

RBCs carry hemoglobin, which binds oxygen.
When hemoglobin drops, tissues become hypoxic → fatigue, tachycardia, organ dysfunction.

Transfusing PRBCs increases oxygen delivery:
• 1 unit raises hemoglobin by approximately 1 g/dL in adults
• Increases hematocrit by about 3 percent

This effect is true only in absence of active bleeding.

3. Clinical Indications

• Symptomatic anemia (dyspnea, chest pain, dizziness)
• Postoperative bleeding
• Trauma
• Gastrointestinal hemorrhage
• Chronic transfusion-dependent diseases (sickle cell, thalassemia)

Evidence-based thresholds:
• Hemoglobin ≤7 g/dL → transfuse in most stable patients
• Hemoglobin ≤8 g/dL → transfuse if symptomatic, cardiac disease, elderly, or perioperative

4. Infusion Nurse Responsibilities

Assess for:
• Baseline vitals
• Adequate IV access (20G or larger)
• Signs of hypoxia
• Potential for transfusion reactions

B. PLATELETS

Platelets are essential for clot formation.
They do not carry oxygen but help stop bleeding.

1. Composition and Production

Platelets come in two forms:
• Random donor platelets (pooled from 4–6 donors)
• Single donor (apheresis) platelets

Infusion nurses must know:
• Platelets are stored at room temperature, not refrigerated
• This increases bacterial contamination risk
• Shelf life is only 5–7 days

2. Function

Platelets adhere to damaged vessels and activate clotting cascades.
A low platelet count increases bleeding risk even if hemoglobin is normal.

3. Indications

• Thrombocytopenia
• Active bleeding with low platelet count
• Platelet dysfunction (e.g., from uremia or antiplatelet drugs)
• Massive transfusion protocols
• Oncology patients with bone marrow suppression

Thresholds:
• <10,000/mm³: transfuse prophylactically
• <20,000/mm³: transfuse if risk of bleeding
• <50,000/mm³: transfuse if invasive procedure planned
• <100,000/mm³: transfuse for neurosurgery

C. PLASMA (Fresh Frozen Plasma – FFP)

Plasma contains:
• All coagulation factors
• Proteins
• Antithrombin
• Electrolytes

FFP restores clotting ability—not oxygen or volume.

1. When Used

• Coagulopathy (elevated PT/INR, aPTT)
• DIC
• Massive transfusion
• Liver failure
• Warfarin reversal (if PCC unavailable)

2. Administration Principles

• Requires ABO compatibility
• Does NOT require Rh compatibility
• Infuse as quickly as tolerated since volume is large

D. CRYOPRECIPITATE

Cryoprecipitate is a frozen plasma derivative rich in:
• Fibrinogen
• Factor VIII
• Factor XIII
• vWF

Indicated for:
• Hypofibrinogenemia (<100 mg/dL)
• DIC
• Massive transfusion coagulopathy
• Certain congenital deficiencies

E. ALBUMIN

Albumin comes in 5 percent and 25 percent solutions.
It is not a blood replacement but a volume expander.

Used for:
• Shock
• Major burns
• Hypoalbuminemia
• Large paracentesis fluid shifts

Caution:
• Monitor for fluid overload
• Hyperoncotic 25 percent pulls fluid into circulation → use carefully in CHF patients

F. SPECIAL MODIFIED BLOOD PRODUCTS

1. Leukocyte-reduced blood
  • Reduces febrile reactions
  • Prevents alloimmunization
  • Preferred for frequent transfusion patients

2. Washed RBCs
  • Removal of plasma proteins
  • Used for patients with severe allergic reactions

3. Irradiated components
  • Prevent graft-versus-host disease
  • Required in immunocompromised patients

7.2 CROSSMATCHING AND COMPATIBILITY

Compatibility rules prevent hemolysis—one of the deadliest transfusion errors.

A. ABO SYSTEM EXPLAINED SIMPLY AND DEEPLY

1. RBC Compatibility

• Type O → no antigens → universal donor
• Type AB → both antigens → universal recipient

2. Plasma Compatibility

Opposite of RBC rules:
• Type AB plasma → universal donor
• Type O plasma → universal recipient

B. Rh FACTOR

Rh-positive can receive + or –, but Rh-negative should ONLY receive Rh-negative blood to prevent antibody formation (especially in women of childbearing age).

C. CROSSMATCHING METHODS

1. Type and Screen
Determines ABO/Rh and screens for antibodies; good for patients with low reaction risk.

2. Type and Crossmatch
Patient serum is mixed with donor red cells to ensure no reaction occurs.
Required for PRBC transfusion.

3. Emergency Release Blood
Massive trauma → uncrossmatched O negative (preferred).

If male and no supply → O positive may be given.

7.3 SAFE ADMINISTRATION

This is where most transfusion errors occur.
The nurse is the final safety checkpoint.

A. PRE-TRANSFUSION ESSENTIALS – FULL DETAIL

1. Confirm Patient Identity
Use TWO identifiers; must EXACTLY match the blood unit.

2. Obtain Informed Consent
Explain:
- Risks
- Benefits
- Signs of reaction
- Alternatives

3. Baseline Assessment
Vital signs + focused assessment:
- Lung sounds
- Heart rate
- Skin temperature
- Edema

• Mental status
• IV patency

4. Equipment Preparation
• Blood administration set with 170–260 micron filter
• Normal saline only
• No medications run with blood

B. STARTING THE TRANSFUSION

1. Start Slowly
First 10–15 minutes are the highest-risk window.
Start at 75–100 mL/hr or per policy.

2. Stay at Bedside
Do NOT leave the patient.
Monitor for early signs of reaction.

3. After 15 minutes
If stable, increase to ordered rate.

C. INFUSION LIMITS

• Must complete within 4 hours — bacterial growth risk rises sharply afterward.
• If transfusion is interrupted → DO NOT "catch up" by increasing rate.

7.4 MONITORING DURING TRANSFUSION

A. VITAL SIGNS SCHEDULE EXPLAINED

• Baseline
• 15 minutes after initiation
• Every 30–60 minutes
• End of transfusion

Why:
• Reactions occur early and unpredictably.

B. WHAT TO WATCH FOR

1. Respiratory
• Dyspnea
• Wheezing
• Pulmonary crackles
→ May indicate TACO or TRALI

2. Cardiovascular
- Tachycardia
- Sudden hypertension or hypotension
→ Suggests hemolysis or overload

3. Renal
- Decreased urine output
- Dark-colored urine
→ Hemoglobinuria from hemolysis

4. Skin
- Urticaria
- Flushing
→ Allergic reaction

7.5 TRANSFUSION REACTIONS — FULL PATHOPHYSIOLOGY + MANAGEMENT

A. ACUTE HEMOLYTIC TRANSFUSION REACTION (AHTR)

Most dangerous.
Caused by ABO incompatibility — immune system destroys donor RBCs immediately.

Pathophysiology:
- Antibodies attack donor RBCs
- Massive hemolysis
- Free hemoglobin damages kidneys
- Cytokine storm → shock

Symptoms:
- Fever
- Back pain
- Red urine
- Hypotension
- Chest tightness

Immediate steps (memorize):

1. STOP transfusion
2. Keep line open with NS
3. Call provider + blood bank
4. Monitor vital signs continuously
5. Collect blood and urine samples
6. Send blood bag + tubing to blood bank

B. FEBRILE NON-HEMOLYTIC REACTION

• Caused by leukocyte antibodies
• Chills/fever
• Usually mild

C. ALLERGIC REACTION

Mild:
• Hives
• Itching
Severe:
• Airway compromise
• Anaphylaxis

D. TACO (Circulatory Overload)

Occurs when patient cannot handle infused volume.

Symptoms:
• Pulmonary edema
• Hypertension
• JVD
• Anxiety

Management:
• Stop transfusion
• Diuretics
• Oxygen
• Slow future transfusions

E. TRALI

Non-cardiac pulmonary edema caused by donor antibodies.

Symptoms:
• Acute respiratory distress
• Hypoxemia
• Bilateral infiltrates on X-ray

Requires immediate ventilatory support.

F. SEPTIC REACTION

Bacterial contamination of blood (platelets are most vulnerable).

Symptoms:
• High fever
• Rigors
• Hypotension
• Shock

7.6 SPECIAL CONSIDERATIONS IN PEDIATRIC AND ELDERLY PATIENTS

A. PEDIATRIC PATIENTS — DEEPLY EXPLAINED

Key concerns:
• Small blood volume → transfuse by weight
• High susceptibility to fluid overload
• Must use appropriately warmed blood for massive transfusions

Nurses must monitor:
• Heart rate (first sign of reaction is tachycardia)
• Temperature (hypothermia risk)
• Calcium levels (citrate toxicity more common)

B. ELDERLY PATIENTS — DEEPLY EXPLAINED

Elderly patients have:
• Reduced renal function
• Reduced cardiac output
• Higher TACO risk

Nursing strategies:
• Transfuse slowly
• Use diuretics as ordered
• Monitor lung sounds every 15–30 minutes
• Elevate head of bed

C. IMMUNOCOMPROMISED PATIENTS

Require:
• Irradiated blood
• Leukocyte-reduced products
Prevent fatal graft-versus-host disease.

CHAPTER 8

CHEMOTHERAPY AND BIOLOGIC THERAPY

Chemotherapy and biologic agents represent some of the most potent—and potentially dangerous—therapies administered through infusion services. Their safe handling requires strict adherence to regulatory standards, pharmacologic understanding, and close patient monitoring. This chapter explains these therapies at a deep professional level suitable for advanced practice, certification exams, and real-world infusion nursing.

8.1 CATEGORIES OF ANTINEOPLASTIC DRUGS

Antineoplastic drugs (chemotherapy) are categorized by their mechanism of action and cell cycle specificity. Understanding these classes helps the infusion nurse anticipate adverse effects, prepare for safe administration, and monitor patients appropriately.

A. ALKYLATING AGENTS

Examples: Cyclophosphamide, Ifosfamide, Busulfan, Melphalan

Mechanism Summary:
• Form covalent bonds with DNA
• Prevent DNA replication
• Work in all phases of the cell cycle (cell-cycle nonspecific)

Indications:
• Leukemias
• Lymphomas
• Solid tumors

Major Risks:
• Bone marrow suppression
• Hemorrhagic cystitis (cyclophosphamide, ifosfamide)
• Infertility
• Secondary malignancies

Nursing Focus:
• Hydration protocols
• Mesna for uroprotection
• Monitor CBC and renal function

B. ANTIMETABOLITES

Examples: Methotrexate, 5-Fluorouracil (5-FU), Cytarabine

Mechanism:
• Resemble normal metabolites
• Inhibit DNA/RNA synthesis
• S-phase specific

Indications:
• Breast cancer
• GI cancers
• Leukemia
• Lymphoma

Major Risks:
• Mucositis
• Myelosuppression
• Hepatotoxicity
• Renal toxicity (high-dose methotrexate)

Nursing Focus:
• Leucovorin rescue for methotrexate
• Alkalinized urine for high-dose MTX
• Strict renal monitoring

C. ANTIMICROTUBULE AGENTS (Mitotic Inhibitors)

Vinca Alkaloids: Vincristine, Vinblastine
Taxanes: Paclitaxel, Docetaxel

Mechanism:
• Disrupt microtubule formation
• Prevent mitosis
• M-phase specific

Major Risks:
• Peripheral neuropathy
• Alopecia
• Severe constipation (vincristine)
• Hypersensitivity (taxanes)

Nursing Focus:
• Premedication for taxanes
• Neuropathy assessments
• NEVER give vincristine intrathecally (fatal)

D. TOPOISOMERASE INHIBITORS

Examples: Irinotecan, Topotecan, Doxorubicin (also anthracycline)

Mechanism:
- Inhibit enzymes needed for DNA uncoiling
- Cause DNA breaks

Major Risks:
- Diarrhea (irinotecan—cholinergic syndrome)
- Myelosuppression
- Cardiotoxicity (anthracyclines)

E. ANTHRACYCLINES

Examples: Doxorubicin, Daunorubicin, Epirubicin

Mechanism:
- DNA intercalation
- Free radical formation

Major Risks:
- Cumulative dose-dependent cardiomyopathy
- Extravasation necrosis (severe vesicants)
- Red discoloration of urine

Nursing Focus:
- Baseline and periodic echocardiograms
- Use central lines whenever possible
- Dexrazoxane may be used for cardioprotection or extravasation management

F. HORMONAL AGENTS

Examples: Tamoxifen, Anastrozole, Leuprolide

Mechanism:
- Modify hormone signaling
- Used in hormone-sensitive tumors

Major Risks:
- Hot flashes
- Thromboembolism (tamoxifen)
- Osteoporosis (aromatase inhibitors)

G. MISCELLANEOUS ANTINEOPLASTICS

Examples: Bleomycin, Hydroxyurea, Asparaginase

Unique Toxicities:
• Bleomycin → pulmonary fibrosis
• Asparaginase → pancreatitis, coagulopathy

8.2 MECHANISMS OF ACTION — DEEP EXPLANATION

Every chemotherapy agent interferes with DNA synthesis, cell division, or cellular metabolism in a different way.
Understanding these mechanisms helps you predict:
• Expected side effects
• Lab monitoring needs
• Organ toxicity patterns
• Timing of nadirs (lowest WBC count)

A. CELL CYCLE-SPECIFIC (CCS) DRUGS

Work only in certain phases:
• S-phase (antimetabolites)
• M-phase (mitotic inhibitors)

Characteristics:
• Better for rapidly dividing cancers
• Require prolonged or repeated dosing
• Bone marrow toxicity common

B. CELL CYCLE-NONSPECIFIC (CCNS) DRUGS

Examples: Alkylating agents, anthracyclines

Characteristics:
• Work even in resting cells
• Often more broadly toxic
• Effective against slow-growing tumors

C. DNA-TARGETING AND CELL-SIGNALING EFFECTS

Many biologics target:
• Kinases
• Growth factor receptors
• Immune checkpoints

These affect:

• Tumor growth signals
• Angiogenesis
• Immune evasion

Infusion nurses must understand what pathway is inhibited to anticipate side effects:
• VEGF inhibitors → bleeding, hypertension
• EGFR inhibitors → skin rash
• HER2 inhibitors → cardiotoxicity

8.3 SAFETY PRECAUTIONS AND PPE

Chemotherapy is hazardous to:
• Nurses
• Pharmacy staff
• Patients
• Caregivers

Strict precautions protect everyone from accidental exposure.

A. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Standard chemotherapy PPE includes:
• Chemotherapy-approved gloves (tested for permeation)
• Disposable chemotherapy gown (polyethylene-coated, closed back, long sleeves)
• Eye/face protection when splashes possible
• Respirators for aerosol-generating procedures

Double-gloving is required for:
• Handling IV tubing
• Spiking bags
• Cleaning spills
• Waste disposal

Gloves changed every 30 minutes or immediately if torn.

B. ENGINEERING CONTROLS

• Biological safety cabinets (Class II)
• Closed system transfer devices (CSTDs)
• Needleless connectors

CSTDs reduce aerosol and droplet generation but do NOT replace PPE.

C. CHEMOTHERAPY PRECAUTIONS FOR ADMINISTRATION

• Never crush or split oral chemotherapy tablets
• Dedicated chemotherapy-only lines
• Use Luer-lock connections
• Label all chemotherapy tubing
• Use priming by pharmacy whenever possible
• Prime with non-drug solution if allowed by policy

D. CHEMOTHERAPY PRECAUTIONS FOR PATIENTS AND VISITORS

Patients' body fluids may contain drug metabolites for 48–72 hours.

Education must include:
• Toilet lid closed before flushing
• Double-gloving for caregivers
• Handling contaminated laundry separately
• Avoiding pregnancy exposure

8.4 HANDLING, STORAGE, AND DISPOSAL

Chemotherapy requires strict chain-of-custody protocols.

A. STORAGE REQUIREMENTS

Drugs may need:
• Refrigeration
• Light protection
• Locked storage
High-alert medications must be separated from routine IV fluids.

B. PREPARATION

Prepared ONLY by trained pharmacy staff using:
• Biological safety cabinets
• HEPA filtration
• Negative pressure rooms
Infusion nurses never compound chemotherapy.

C. TRANSPORT

• Chemotherapy must be transported in sealed leak-proof containers
• Hand-delivered—not via pneumatic tube (unless institution approves specific drugs)

D. DISPOSAL

1. Soft waste
  • PPE
  • Tubing
  • Empty bags

→ Dispose in yellow chemotherapy waste containers.

2. Sharps
  • Needles
  • Glass vials

→ Use puncture-proof chemotherapy sharps containers.

3. Spills
  Only trained staff should clean using:
  • Chemotherapy spill kits
  • Absorbent pads
  • Chemical-resistant gloves
  • Eye protection
  • Proper disposal procedures

8.5 EXTRAVASATION PREVENTION AND TREATMENT

Chemotherapy extravasation is a medical emergency.
Some drugs cause irreversible tissue necrosis.

A. VESICANTS VS. IRRITANTS

1. Vesicants
  Cause blistering and tissue death.
  Examples:
  • Doxorubicin
  • Vincristine
  • Vinblastine
  • Mitomycin
  • Paclitaxel

2. Irritants
  Cause pain and inflammation but not necrosis.
  Examples:

- Carboplatin
- Cisplatin (low concentration)

B. PREVENTION

1. Use central lines for vesicants

2. Verify blood return before administration

3. Avoid sites:
   - Hands
   - Wrists
   - Areas with flexion
   - Previously irradiated skin

4. Monitor frequently
   - Every 5–10 minutes early in infusion
   - Ask patient about burning, tingling, pain

C. SIGNS OF EXTRAVASATION

- Pain or burning
- Blanching
- Swelling
- Redness
- Tight skin
- Lack of blood return
- Slowed infusion rate

D. MANAGEMENT

STOP the infusion immediately (do NOT remove the catheter yet).
Follow institutional protocol based on the drug:

1. Anthracyclines
   - Leave catheter in
   - Aspirate drug through catheter
   - Cold compress
   - Administer dexrazoxane (antidote)

2. Vinca alkaloids
   - Warm compress
   - Hyaluronidase (if ordered)
   - DO NOT use cold packs

3. Taxanes
  • Cold compress
  • Elevate limb
Document thoroughly and notify the provider.

8.6 BIOLOGICS, IMMUNOTHERAPY, AND TARGETED THERAPY

These represent a major shift in cancer care.
They are not traditional chemotherapy—they target molecular pathways or harness the immune system.

A. MONOCLONAL ANTIBODIES
Examples:
• Rituximab
• Trastuzumab
• Cetuximab
• Bevacizumab

Mechanisms:
• Bind antigens on cancer cells
• Trigger immune destruction
• Block growth signals
• Inhibit angiogenesis

Risks:
• Severe infusion reactions
• Cytokine-release syndrome
• Cardiac toxicity (HER2 therapies)
• Skin toxicity (EGFR inhibitors)

B. IMMUNOTHERAPY (Checkpoint Inhibitors)
Examples:
• Pembrolizumab
• Nivolumab
• Ipilimumab

Mechanism:
• Remove “brakes” from immune system
• Allow T-cells to attack cancer

Unique Risks (Immune-Related Adverse Events):
• Pneumonitis
• Thyroiditis
• Hepatitis
• Colitis
• Adrenal insufficiency

These require rapid recognition and often steroid therapy.

C. TARGETED THERAPIES
Examples:
• Imatinib
• Erlotinib
• Sunitinib

Mechanisms:
• Block specific tyrosine kinases
• Inhibit angiogenesis
• Modify growth pathways

Risks:
• Hypertension
• Delayed wound healing
• Skin rash (EGFR-targeted drugs)

Infusion nurse responsibilities:
• BP monitoring
• Skin assessments
• Education about photosensitivity

8.7 COMMON ADVERSE EFFECTS AND MONITORING

A. MYELOSUPPRESSION

• Neutropenia → infection risk
• Anemia → fatigue, tachycardia
• Thrombocytopenia → bleeding risk

Monitor:
• CBC before each cycle
• Temperature >100.4°F emergency
• Bleeding gums, petechiae, bruising

B. MUCOSITIS
Inflammation of mucous membranes → painful ulcers.
Nursing measures:
• Soft toothbrush
• Avoid alcohol mouthwashes
• Oral lidocaine rinses
• Nutritional support

C. NAUSEA AND VOMITING

Highly emetogenic drugs:
• Cisplatin
• Cyclophosphamide (high dose)

Premedicate with:
• 5-HT3 antagonists
• NK1 antagonists
• Corticosteroids

D. CARDIOTOXICITY
Anthracyclines and HER2-targeted biologics.
Monitor:
• Echocardiograms
• Edema
• Dyspnea

E. NEPHROTOXICITY
Cisplatin, methotrexate.
Monitor:
• Serum creatinine
• Urine output
• Electrolytes
• Hydration status

F. NEUROTOXICITY
Vinca alkaloids and taxanes.
Assess:
• Tingling
• Numbness
• Weakness
• Gait changes

G. HYPERSENSITIVITY AND ANAPHYLAXIS
Common with taxanes and monoclonal antibodies.
Signs:
• Wheezing
• Chest tightness
• Hypotension
• Rash

Management:
• STOP infusion
• Airway support
• Epinephrine for severe reactions
• Antihistamines/corticosteroids

CHAPTER 9

SPECIALIZED INFUSION THERAPIES

Infusion nurses manage a wide range of high-risk medications that extend far beyond hydration therapy. Specialized infusions demand deep clinical knowledge of pharmacology, adverse event monitoring, line selection, compatibility, and emergency responses.
This chapter provides a professionally rich, comprehensive guide to antibiotic, antiviral, antifungal, analgesic, immunologic, cardiac, endocrine, and emergency infusion therapies.

9.1 ANTIBIOTIC INFUSIONS

Antibiotics are among the most common continuous or intermittent infusion medications. Infusion nurses must understand dosing strategies, compatibility, infusion times, potential reactions, and line selection.

A. BETA-LACTAMS

Includes:
- Penicillins
- Cephalosporins
- Carbapenems

Mechanisms:
Inhibit cell wall synthesis → bacterial death.

1. Key Clinical Points
   - Time-dependent killing → require controlled, steady serum levels
   - Many administered as extended or continuous infusions
   - High risk of allergic reactions, including anaphylaxis

2. Nursing Considerations
   - Watch for rash, pruritus, bronchospasm
   - Flush with normal saline
   - Avoid dextrose with certain formulations
   - Monitor renal function for dose adjustments

B. VANCOMYCIN
Glycopeptide antibiotic used for MRSA and serious Gram-positive infections.

Mechanism:
Inhibits cell wall synthesis at a different site than beta-lactams.

1. Key Concerns
   - Nephrotoxicity

• Ototoxicity
• “Red man syndrome” if infused too fast

2. Nursing Responsibilities
• Infuse over at least 60–120 minutes depending on dose
• Monitor for flushing, pruritus, hypotension
• Check trough levels as per protocol
• Use central line if long-term therapy

C. AMINOGLYCOSIDES

Examples: Gentamicin, Tobramycin, Amikacin.

Mechanism:
Interfere with bacterial protein synthesis.

Risks:
• Nephrotoxicity
• Ototoxicity
• Peak/trough monitoring required

Special Note:
• Used cautiously in renal impairment
• Avoid mixing with penicillin in the same line (inactivation risk)

D. EXTENDED-INFUSION ANTIBIOTICS

Certain antibiotics (e.g., beta-lactams) are more effective when infused slowly over several hours.

Advantages:
• Maintains drug concentration above MIC
• Improves bacterial killing
• Reduces resistance development

Nursing Focus:
• Use smart pumps
• Maintain correct infusion times
• Dedicated line preferred when possible

9.2 ANTIVIRAL AND ANTIFUNGAL AGENTS

These medications often have narrow therapeutic windows, high toxicity potential, and require vigilant monitoring.

A. ANTIVIRALS

1. Acyclovir / Valacyclovir (IV Form)
Indications:
• HSV
• VZV
• Severe mucocutaneous infections

Nursing Concerns:
• Must infuse slowly to prevent nephrotoxicity
• Ensure adequate hydration
• Watch for crystalluria

2. Ganciclovir
Indications:
• CMV (often in immunocompromised patients)

Risks:
• Bone marrow suppression
• Renal impairment

Nursing:
• Monitor CBC frequently
• Use central access for long courses

B. ANTIFUNGALS

1. Amphotericin B (Conventional and Liposomal)
Extremely potent; used for life-threatening fungal infections.

Key Risks:
• Nephrotoxicity
• Severe infusion reactions (rigors, fever, hypotension)
• Electrolyte wasting (Mg, K)

Nursing Actions:
• Premedicate with antipyretics, antihistamines, steroids
• Monitor vitals every 15–30 minutes
• Ensure IV patency—phlebitis risk is high
• Avoid normal saline mixing for certain formulations

2. Azole Antifungals (e.g., fluconazole)
Fewer infusion reactions but high potential for:
• Liver enzyme elevation
• Drug–drug interactions

9.3 ANALGESICS AND PCA PUMPS

Pain management through infusion requires detailed assessment, patient education, and vigilant monitoring for respiratory depression.

A. PATIENT-CONTROLLED ANALGESIA (PCA)

Common medications:
- Morphine
- Hydromorphone
- Fentanyl

Key Concepts:
- PCA gives patient control over bolus doses
- Lockout interval prevents overdose
- Basal (continuous) infusion used cautiously in opioid-naïve patients

Nursing Responsibilities:
- Confirm correct programming
- Monitor respiratory rate, sedation level
- Assess pain regularly
- Ensure only patient presses PCA button
- Monitor for hypotension and decreased oxygen saturation

B. EPIDURAL AND NERVE BLOCK INFUSIONS

Medications:
- Local anesthetics
- Opioids

Risks:
- Hypotension
- Motor weakness
- Urinary retention
- Respiratory depression (late effect of epidural opioids)

Nursing:
- Neuro checks for lower extremities
- Vital signs monitoring
- Catheter site assessment

9.4 IV IMMUNOGLOBULIN (IVIG) THERAPY

IVIG is a blood-derived therapy containing pooled antibodies.
Used for autoimmune diseases, immune deficiencies, and neurologic disorders.

A. MECHANISM

IVIG works by:
• Immune modulation
• Increasing IgG levels
• Neutralizing pathogens
• Dampening autoimmune responses

B. ADMINISTRATION

IVIG must be infused slowly, with rate titration.
Start rate low (example):
• 0.5 mL/kg/hr
Increase gradually depending on tolerance, up to maximum per manufacturer instructions.

C. COMMON ADVERSE EFFECTs

• Headache
• Fever
• Chills
• Myalgia
• Hypertension or hypotension
• Renal injury (especially sucrose-containing products)

Rare but serious:
• Aseptic meningitis
• Thromboembolism
• Hemolysis

D. NURSING RESPONSIBILITIES

• Pre-hydration if ordered
• Baseline and frequent vital signs
• Educate patient on chills/headache reporting
• Use dedicated line
• Do NOT shake vial (fragile proteins)

9.5 CARDIAC MEDICATIONS (VASOACTIVE INFUSIONS)

Vasoactive infusions are among the most critical and high-risk medications.
These are titrated based on vital signs, cardiac function, and organ perfusion.

A. CATECHOLAMINES

Examples:
• Norepinephrine
• Epinephrine
• Dopamine

Mechanism:
• Increase vascular tone
• Increase heart rate and contractility

Used for:
• Shock
• Severe hypotension
• Cardiac arrest

Nursing:
• Use central lines whenever possible
• Frequent BP monitoring (every 2–5 minutes at initiation)
• Titrate per protocol
• Know maximum doses
• Watch for ischemia (fingers/toes)

B. VASODILATORS

Examples:
• Nitroglycerin
• Nitroprusside

Used for:
• Hypertensive crisis
• Heart failure
• Angina

Nursing:
• Protect from light (nitroprusside)
• Continuous BP monitoring
• Watch for cyanide toxicity with prolonged nitroprusside

C. INOTROPES

Examples:

• Dobutamine
• Milrinone

Used for:
• Heart failure
• Cardiogenic shock

Risks:
• Arrhythmias
• Hypotension

Monitor:
• Continuous ECG
• Urine output
• Lactate levels

9.6 ENDOCRINE THERAPIES

Endocrine infusions include therapies for diabetes, adrenal disorders, thyroid dysfunction, and hormone crises.

A. INSULIN INFUSIONS

Used for:
• Diabetic ketoacidosis (DKA)
• Hyperosmolar hyperglycemic state (HHS)
• Critical illness hyperglycemia

Nursing:
• Hourly glucose monitoring
• Monitor potassium (insulin drives potassium into cells)
• Use dedicated line
• Do not stop infusion abruptly

B. SEPTIC SHOCK STEROID INFUSIONS

Examples: Hydrocortisone infusions.

Used to manage adrenal insufficiency during shock.

Monitor:
• Glucose increases
• Fluid retention
• Infection masking

C. THYROID EMERGENCIES

Thyroid storm and myxedema coma require infusions such as:
• IV levothyroxine
• Beta blockers
• Steroids

Infusion nurses must be aware of:
• Cardiac monitoring needs
• Hypotension risk
• Temperature instability

9.7 EMERGENCY AND CRITICAL CARE INFUSIONS

These medications require rapid titration, exact pump programming, and often continuous monitoring.

A. SEDATION INFUSIONS

Examples:
• Propofol
• Dexmedetomidine
• Midazolam

Nursing:
• Continuous airway assessment
• Watch for hypotension
• Do not use propofol tubing for lipids or TPN (compatibility hazard)

B. ANTIARRHYTHMICS

Examples:
• Amiodarone
• Lidocaine
• Procainamide

Nursing:
• Use filter for amiodarone
• Protect from light (if required)
• Monitor QT interval

C. PARALYTICS

Used for:

- Intubation
- Mechanical ventilation synchrony

Examples:

- Vecuronium
- Rocuronium

Nursing:

- Requires sedation first (patient fully conscious without)
- Train-of-four monitoring
- Eye protection to prevent corneal injury

D. RAPID SEQUENCE INFUSIONS

Critical infusions used for:

- Status epilepticus
- Severe asthma
- Hypertensive crisis
- Massive hemorrhage
- Anaphylaxis (epinephrine)

Infusion nurses must recognize early deterioration and intervene quickly.

CHAPTER 10

PATIENT CARE MANAGEMENT

Infusion therapy is not simply the act of administering fluids or medications. It is a complex process of continuous patient assessment, anticipatory monitoring, complication prevention, rapid response, and individualized care planning.
Because infusion therapies range from simple hydration to high-risk treatments such as biologics, chemotherapy, vasopressors, and total parenteral nutrition, the infusion nurse must maintain vigilance, detailed documentation, and rapid clinical reasoning.

This chapter explains how to manage patients safely and effectively throughout the entire infusion encounter.

10.1 ASSESSMENT BEFORE THERAPY

A thorough pre-infusion assessment is the foundation of safe infusion practice.
No infusion—no matter how routine—should begin without assessing the patient's:

A. PATIENT IDENTIFICATION AND VERIFICATION

Use two unique identifiers such as:
• Full name
• Date of birth
• Medical record number

Why it matters:
Medication errors related to wrong patient administration are among the most severe and preventable adverse events.

B. BASELINE VITAL SIGNS

Collect:
• Temperature
• Blood pressure
• Heart rate
• Respiratory rate
• Oxygen saturation
• Pain level

Baseline vitals allow comparison during and after therapy to identify early signs of deterioration, allergic reactions, or cardiovascular instability.

C. MEDICAL HISTORY AND MEDICATION REVIEW

Identify:
• Chronic conditions (renal, cardiac, hepatic, pulmonary disease)
• Allergies (especially medication or latex)
• History of infusion reactions
• Prior central or peripheral access issues
• Bleeding disorders
• Pregnancy status

Why:
• Renal disease alters drug clearance
• Cardiac disease affects fluid tolerance
• Previous reactions increase risk of new ones
• Pregnant patients require specialized monitoring

D. LABORATORY DATA REVIEW

Relevant labs may include:
• CBC
• Electrolytes
• Liver enzymes
• Renal function tests (BUN, creatinine, GFR)
• Coagulation profile (INR, aPTT)
• Drug levels (e.g., vancomycin troughs, digoxin level)
Infusions must be delayed or modified when lab abnormalities are severe.

E. VASCULAR ACCESS ASSESSMENT

Evaluate:
• Catheter type (PIV, PICC, CVC, port, midline)
• Patency and blood return
• Site condition (redness, edema, warmth, drainage)
• Securement integrity
• Dressing integrity
• Date and time of last dressing change or access

Why:
Infusing through a compromised site increases risk of infiltration, extravasation, phlebitis, and infection.

F. PATIENT EDUCATION BEFORE STARTING

Explain:
• What the infusion is for
• Expected duration
• Common side effects

• Symptoms to immediately report (pain, burning, difficulty breathing, itching, dizziness, swelling)
• Mobility restrictions depending on access device
• Safety measures (e.g., not pulling on line, calling before getting up)

A well-informed patient becomes an early warning system for complications.

10.2 MONITORING DURING THERAPY

Monitoring is an active, ongoing process that includes repeated assessments, observation, communication, and documentation.

A. VITAL SIGNS

Recheck according to:
• Institutional policy
• Medication risk level
• Initial patient condition

High-risk medications (biologics, chemotherapy, vasopressors) often require monitoring every 5–15 minutes at initiation.

B. INFUSION SITE ASSESSMENT

Check every 30–60 minutes or more frequently for vesicants:

Look for:
• Swelling
• Redness
• Coolness or warmth
• Pain or discomfort
• Firmness
• Leaking fluids
• Loss of blood return
• Slow infusion rate

Why:
Early detection of infiltration or extravasation prevents tissue damage.

C. PATIENT CONDITION

Watch for:
• Changes in mental status
• New or worsening pain
• Tachycardia
• Hypotension or hypertension

• Respiratory distress
• Fever, chills
• Rash, hives, itching
• Nausea or vomiting

Anything unusual warrants immediate evaluation and potential intervention.

D. LINE MANAGEMENT

• Ensure pump programming is correct
• Tubing is free of kinks or clots
• Access site remains secure
• Filters (if applicable) are not clogged
• No air bubbles in tubing
• Dedicated lumen for high-risk medications (PN, chemo, vasoactives)

10.3 PAIN, ANXIETY, AND COMFORT MEASURES

Infusion therapy can cause discomfort, fear, and uncertainty.
Effective management requires:

A. PAIN MANAGEMENT

Pain may result from:
• Venipuncture
• Chemotherapy infusion
• Phlebitis
• Underlying disease
• Long infusion sessions

Nurses may:
• Administer analgesics as ordered
• Apply warm compresses (for certain discomforts)
• Reposition limb or line
• Slow rate temporarily if appropriate
• Provide distraction techniques

B. ANXIETY REDUCTION

Anxious patients often tense their muscles, worsening venous access and comfort.
Nursing strategies:
• Explain each step calmly
• Allow questions

• Offer deep breathing techniques
• Provide a warm blanket
• Build rapport

C. COMFORT OPTIMIZATION

Offer:
• Pillows
• Warmth
• A relaxed environment
• Access to call bell
• Help with bathroom needs
• Snacks or drinks if allowed

Comfort improves cooperation and reduces complication risks.

10.4 IDENTIFYING AND MANAGING COMPLICATIONS

Infusion-related complications must be recognized quickly to prevent tissue damage, infection, or systemic harm.

A. PHLEBITIS

Inflammation of the vein.

Types:
• Mechanical (catheter friction)
• Chemical (medication irritation)
• Bacterial (infection)

Signs:
• Redness
• Warmth
• Pain along vein
• Palpable cord

Management:
• Remove catheter
• Apply warm compresses (unless contraindicated)
• Document and assess severity
• Rotate site and choose larger vein if possible

Prevention:
• Use smallest appropriate gauge

• Dilute irritant medications
• Stabilize catheter to minimize movement

B. INFILTRATION

Leakage of non-vesicant fluid into surrounding tissue.

Signs:
• Cool skin
• Swelling
• Pale or taut tissue
• Slowed infusion
• Pain or discomfort

Management:
• Stop infusion
• Remove catheter
• Elevate extremity
• Apply warm compress (unless fluid is cold-compatible)
• Document incident

C. EXTRAVASATION

Leakage of vesicants (tissue-damaging drugs).

High-risk agents:
• Chemotherapy (anthracyclines, vinca alkaloids)
• Vasopressors
• High-concentration electrolytes

Signs:
• Burning, severe pain
• Blistering
• Swelling
• Skin discoloration
• Ulcer formation

Management (drug-specific):
• Stop infusion IMMEDIATELY
• Leave catheter in place for aspiration
• Administer antidote if applicable (dexrazoxane, hyaluronidase)
• Apply cold/warm compress depending on drug
• Notify provider and follow extravasation protocol

This is an infusion emergency.

D. OCCLUSION

Caused by:
• Thrombus
• Precipitate
• Mechanical kink
• Catheter tip malposition

Signs:
• Difficulty flushing
• Unable to aspirate blood
• Pump alarms

Management:
• Reposition patient
• Attempt gentle flush (never force)
• Use thrombolytic agent if ordered
• Replace line if non-functional

E. INFECTION

Includes local site infection and systemic bloodstream infection (CLABSI).

Signs:
• Redness
• Heat
• Drainage
• Fever
• Hypotension
• Positive blood cultures

Management:
• Remove catheter based on severity
• Obtain cultures
• Initiate antibiotics if ordered
• Strict aseptic technique

Prevention is critical:
• Scrub the hub
• Timely dressing changes
• Sterile technique

10.5 SPECIAL POPULATIONS

Different patient populations require specialized approaches.

A. NEONATES

Challenges:
- Tiny veins
- Sensitive skin
- High fluid sensitivity
- Immature organs → drug accumulation
- High infection risk

Nursing priorities:
- Use smallest gauge possible
- Minimize blood draws
- Strict aseptic technique
- Carefully monitor glucose, electrolytes
- Maintain thermoregulation
- Follow neonatal medication dilutions carefully

B. CHILDREN

Considerations:
- Fear and anxiety are significant
- Fast metabolism affects drug timing
- Risk of accidental line dislodgement

Nursing role:
- Child-friendly explanations
- Distraction (toys, videos)
- Secure lines carefully
- Family involvement encouraged

C. PREGNANT PATIENTS

Considerations:
- Physiologic changes alter drug clearance
- Increased blood volume
- Risk of aortocaval compression when supine
- Fetal safety must be considered
- Certain medications are contraindicated

Nursing role:
• Avoid supine positioning
• Monitor BP closely
• Use pregnancy-safe medications
• Coordinate closely with obstetrics team

D. OLDER ADULTS

Common vulnerabilities:
• Fragile veins
• Reduced renal/hepatic clearance
• Polypharmacy interactions
• Cognitive impairment
• High fall risk

Nursing role:
• Start low, go slow
• Assess drug interactions
• Monitor hydration
• Support mobility safely
• Extra attention to line securement

10.6 HOME INFUSION NURSING RESPONSIBILITIES

Home infusion therapy is expanding rapidly. Nurses must provide safe, high-quality care outside the controlled hospital environment.

A. HOME ASSESSMENT

Evaluate:
• Clean environment
• Refrigerator for medication storage
• Adequate lighting
• Access to running water
• Space for supplies
• Power for pumps

B. PATIENT AND CAREGIVER TEACHING

Teach:
• Aseptic technique
• Hand hygiene
• Recognizing complications
• How to flush lines

• How to connect/disconnect tubing
• Pump troubleshooting
• Safe disposal of sharps

C. LINE CARE

• Dressing changes
• Needleless connector changes
• Patency checks
• Site assessments
• Flushing protocols

D. MEDICATION MANAGEMENT

• Verify correct drug
• Check expiration dates
• Ensure proper storage
• Confirm understanding of infusion schedule
• Monitor adherence

E. DOCUMENTATION

Home infusion documentation includes:
• Vital signs
• Medications administered
• Complications
• Teaching provided
• Supply usage
• Patient response
• Communication with prescribing team

F. EMERGENCY PREPAREDNESS

Patients must know what to do if:
• Pump fails
• Catheter dislodges
• Signs of infection appear
• Allergic reaction occurs
• Supplies run out

Provide emergency contact instructions and written protocols.

CHAPTER 11

PROFESSIONAL DEVELOPMENT AND PRACTICE

Professional practice is just as important for a CRNI as clinical skill. You are not only expected to hang complex infusions safely; you are also expected to lead teams, improve systems, reduce risk, use evidence, advocate for patients, and maintain your own competence over time.

This chapter takes each of those roles and explains them in depth, so you can see how they show up in daily practice and on the CRNI exam.

11.1 LEADERSHIP IN INFUSION NURSING

Leadership is not only a job title. It is the way you influence safety, quality, teamwork, and patient outcomes in every shift. Infusion nurses often lead at the point of care, even when they are not "the manager."

A. Core Roles of the Infusion Nurse as Leader

Leadership in infusion nursing includes:

• Clinical leadership
– Being the go-to person for vascular access, complex infusions, and troubleshooting
– Anticipating problems before they become emergencies
– Modeling meticulous technique and critical thinking

• Team leadership
– Helping colleagues prioritize tasks when multiple infusions and patients are competing for attention
– Coordinating with pharmacy, lab, radiology, and other departments
– Supporting less experienced staff with teaching and coaching

• System leadership
– Participating in committees (IV team, central line committee, policy review)
– Identifying patterns in complications, delays, or errors and speaking up
– Championing changes that improve safety and efficiency

B. Leadership Styles Relevant to Infusion Nursing

You do not need to memorize every leadership theory, but you should recognize a few patterns:

• Transformational leadership
– Inspires others through vision and example
– Encourages innovation and continuous improvement
– Useful when introducing new pumps, new policies, or new safety bundles

• Transactional leadership
– Emphasizes tasks, rules, and rewards or consequences

– Useful for ensuring compliance with time-sensitive protocols and checklists
– Can feel rigid if overused

• Servant leadership
– Focuses on supporting the team's needs
– Asks, "What do you need from me to do this safely?"
– Fits well with nursing's caring and collaborative values

On the exam, leadership scenarios often test your ability to choose actions that:

• Promote safety rather than speed
• Encourage communication rather than blame
• Support learning rather than punishment for honest errors

C. Delegation and Supervision

Infusion nurses frequently delegate tasks but remain accountable for outcomes.

Key principles:

• Right task
– Stable, predictable tasks (e.g., routine vital signs, non-complex dressing changes) may be delegated
– High-risk tasks (e.g., titrating vasoactives, verifying chemotherapy) remain with licensed staff

• Right person
– Match task to the worker's training and competency
– Do not assume; verify they are trained

• Right circumstances
– Stable patient, clear orders, predictable response
– Do not delegate in unstable or rapidly changing situations

• Right direction and communication
– Clear instructions: what to do, what to report, when to stop
– Confirm understanding

• Right supervision and evaluation
– Check back on what was done
– Review findings and patient response

D. Interprofessional Collaboration

Good infusion outcomes depend on clean handoffs between:

• Nursing
• Pharmacy
• Medicine
• Nutrition (for PN)

• Infection prevention
• Case management / home infusion teams

Effective collaboration looks like:

• Shared goals (safe infusion, minimal complications)
• Clear roles (who orders, who mixes, who administers, who reviews labs)
• Structured communication (SBAR, handoff tools)
• Mutual respect

Exam-style questions may show conflicts or misunderstandings; the best answer usually shows:

• Clarifying communication, not blaming
• Use of chain of command when safety is threatened
• Documentation of concerns when practice seems unsafe

11.2 QUALITY IMPROVEMENT AND OUTCOME MEASURES

Quality improvement (QI) is how we move from "we had a problem" to "we fixed the system so it is less likely to happen again."

A. Basic QI Concepts

• Quality improvement is continuous
– Not a one-time project
– Based on measuring performance and testing changes

• Systems focus
– Looks at how processes, policies, equipment, and environment contribute to outcomes
– Avoids focusing only on individual blame

• Data-driven
– Uses objective measures: rates, counts, trends
– Compares performance to benchmarks and goals

B. Common QI Frameworks

You may see these named in exam questions:

• PDSA (Plan–Do–Study–Act)

Plan
– Identify a problem (e.g., high infiltration rates)
– Plan an intervention (e.g., standardized site assessment tool)

Do

– Implement on a small scale (one unit, one shift)

Study
– Compare data before and after
– Did infiltration rates drop? Were there any unintended effects?

Act
– Adopt, adapt, or abandon the change
– Plan the next cycle

• Root Cause Analysis (RCA)

– Used after a serious event (e.g., extravasation with permanent injury, wrong patient transfusion)
– Explores all contributory factors: staffing, training, communication, equipment, environment
– Results in an action plan aimed at system changes

C. Outcome Measures in Infusion Nursing

Common outcomes tracked in infusion practice include:

• Clinical outcomes
– Central line–associated bloodstream infection (CLABSI) rates
– Infiltration and extravasation rates
– Phlebitis rates
– Catheter occlusion rates
– Transfusion reaction rates

• Process measures
– Percentage of central lines with dressing changed on time
– Percentage of lines with documented daily necessity review
– Compliance with "scrub the hub" procedures
– Percentage of PN infusions administered via dedicated lumen

• Patient-centered outcomes
– Pain scores and satisfaction with IV insertion
– Satisfaction with education on home infusions
– Readmissions due to line complications

As a CRNI-level nurse, you should be able to:

• Interpret what an increase or decrease in a rate might mean
• Suggest practical process changes to improve outcomes (staff education, policy updates, supply changes, checklists)
• Recognize when data indicate a serious safety concern

D. Infusion Nurse's Role in QI

You are not just "given" a QI plan; you help create and test it.

Your roles include:

• Reporting near misses and errors
• Participating in data collection (e.g., phlebitis audits)
• Giving feedback on new equipment or policies
• Educating peers about improved practices
• Helping sustain changes after initial rollout

Exam questions may ask what you should do if you notice:

• Rising phlebitis rates after switching catheters
• Multiple nurses bypassing pump safety features
• Frequent late PN starts due to pharmacy delays

Good answers often involve:

• Bringing data or observations to the appropriate committee or manager
• Suggesting a review or pilot change
• Reinforcing safety practices among colleagues

11.3 EVIDENCE-BASED PRACTICE PRINCIPLES

Evidence-based practice (EBP) is about using the best available evidence, combined with clinical expertise and patient preferences, to guide decisions.

A. Components of Evidence-Based Practice

• Best research evidence
– Clinical trials, systematic reviews, guidelines
• Clinical expertise
– Your experience, skills, and judgment
• Patient values and preferences
– Their goals, concerns, cultural context, and priorities

Infusion nurses use EBP when they select:

• The best catheter type for long-term antibiotic therapy
• The dressing that has lower infection rates
• The most effective skin antiseptic for line insertions

B. Steps in EBP

1. Ask a focused clinical question

Use a PICO-style question (you do not need to memorize the acronym, but understand the structure):

• Patient/Problem
• Intervention
• Comparison
• Outcome

Example:
"In adult patients with PICC lines, does use of chlorhexidine-impregnated dressings, compared with standard transparent dressings, reduce catheter-related infections?"

2. Acquire the evidence

• Search guidelines, clinical summaries, and key journals
• Use reputable sources (professional societies, peer-reviewed literature)

3. Appraise the evidence

Ask:
• How strong is the study design?
• Are results clinically significant, not just statistically significant?
• Are the patients similar to mine?

4. Apply the evidence

• Adapt to your setting and resources
• Integrate with patient preferences (e.g., allergy to CHG)
• Work with your team to implement changes

5. Assess outcomes

• Did infection rates drop?
• Did complications or costs change?
• Does staff find it workable?

C. Barriers and Facilitators

Common barriers:

• Limited time to search and read
• Lack of access to resources
• Resistance to change
• Policies that lag behind current evidence

Facilitators:

• Clinical nurse specialists or educators who summarize evidence
• EBP committees and infusion teams
• Leadership support for practice change

• Education and mentoring

On the exam, when given a scenario with conflicting opinions, the best answer usually:

• Refers to guidelines or evidence rather than “we’ve always done it this way”
• Involves searching or consulting an evidence-based resource
• Includes evaluating outcomes after a change

11.4 RISK MANAGEMENT AND POLICY DEVELOPMENT

Risk management is about preventing harm, reducing liability, and creating a safer system for patients and staff.

A. What Is Risk Management in Infusion Nursing?

It includes:

• Recognizing hazards in infusion processes (e.g., pump programming errors, line mix-ups)
• Reporting and analyzing incidents and near misses
• Developing strategies to reduce recurrence
• Aligning practice with regulations and standards

B. Common Risk Areas in Infusion Practice

• Medication errors
– Wrong drug, dose, route, rate, patient, or time
• Line complications
– CLABSI, thrombosis, occlusion, extravasation
• Blood product errors
– Wrong type, misidentification, delayed transfusions
• Documentation failures
– Missing signatures, incomplete records, absent monitoring notes
• Equipment issues
– Pump failures, mis-programming, lack of maintenance

C. Incident Reporting and Just Culture

Incident or event reporting is not about punishment; it is about learning.

Key points:

• Report actual harms and near misses
• Describe facts clearly and objectively
• Avoid judgmental language

Just culture emphasizes:

• Individual accountability for reckless behavior
• System accountability for predictable human errors
• Encouraging staff to speak up about risks

D. Policy and Procedure Development

Policies translate evidence and standards into local rules.

Role of the infusion nurse:

• Participate in policy review and development
• Provide input based on bedside realities
• Help pilot test new policies before full rollout
• Educate staff about changes

Good policies are:

• Clear and practical
• Consistent with regulations and standards
• Reflective of current evidence
• Feasible with existing resources

Examples of policies you might see:

• Central line dressing change frequency and technique
• Double-check requirements for high-alert medications
• Required filters for TPN or blood products
• Reaction management protocols for biologics or chemotherapy

On exams, when a scenario shows a conflict between "how we do it on the unit" and written policy, the safest answer usually follows:

• The written policy, unless it clearly conflicts with higher-level law or ethics
• Then, if needed, escalate the issue through proper channels

11.5 PATIENT ADVOCACY

Advocacy is one of the core professional responsibilities of nursing. In infusion practice, it means protecting the patient's rights, safety, and voice in every step of therapy.

A. What Advocacy Looks Like in Infusion Nursing

Examples:

• Safety advocacy

– Refusing to hang a medication that seems incorrect until clarified
– Asking for an order to be re-written if it is ambiguous or unsafe
– Using chain of command if a provider dismisses a legitimate safety concern

• Communication advocacy
– Making sure the patient understands the purpose, risks, and benefits of a therapy
– Providing information in language they can understand
– Using interpreters when language barriers exist

• Comfort and dignity advocacy
– Asking providers to reconsider the necessity of painful or repeated procedures
– Requesting local anesthetic or comfort measures for frequent sticks
– Supporting privacy and modesty during line insertion

• Ethical advocacy
– Recognizing when patient wishes conflict with family or provider preferences
– Supporting patient autonomy (the patient decides)
– Consulting ethics resources when needed

B. Informed Consent and Refusal

Infusion nurses often witness consent discussions and are responsible for:

• Verifying that consent is present for high-risk infusions (e.g., blood, chemotherapy, biologics) according to policy
• Ensuring the patient has had a chance to ask questions
• Respecting when a patient declines a therapy

If a patient refuses an infusion:

• Do not coerce or threaten
• Clarify their reasons and provide information
• Inform the provider
• Document the refusal and what education was given

C. Advocacy in Home and Community Settings

Home infusion nurses may advocate by:

• Alerting the provider about unsafe home conditions
• Requesting additional support services (social work, home health aides)
• Educating family on realistic expectations and care demands

On exam scenarios, the advocacy-focused answer is often the one that:

• Puts the patient's safety and rights first
• Involves clear communication and documentation
• Uses appropriate escalation when concerns are ignored

11.6 CONTINUING EDUCATION AND MAINTAINING CRNI CERTIFICATION

Professional development is not optional in infusion practice; therapies, devices, and standards change quickly. Certification is not a one-time achievement—it must be maintained.

A. Importance of Lifelong Learning

Reasons ongoing education matters:

• Patient safety
– New drugs, new infusion devices, new protocols
• Professional credibility
– Certified nurses are often viewed as experts and mentors
• Legal and regulatory expectations
– Many jurisdictions require continuing education
• Career advancement
– Leadership, educator, and specialist roles often require certification and ongoing development

B. Methods of Continuing Education

You can keep your knowledge current through:

• Formal education
– Conferences
– Workshops
– University courses

• Informal and on-the-job learning
– Journal clubs
– In-service sessions
– Online modules from reputable organizations

• Self-directed learning
– Reading clinical guidelines
– Following updates from professional associations
– Reviewing device manuals and safety alerts

C. Maintaining CRNI Certification (Conceptual View)

While specific recertification requirements may change over time and must be verified with the certification body, the general principles include:

• Time-limited certification
– Certification is valid for a set period (for example, a few years), after which you must recertify

• Recertification options typically involve:
– Earning a required number of continuing education hours in infusion-related topics over the cycle, and/or
– Retaking and passing the exam

• Documentation responsibilities
– Track continuing education activities
– Keep proof of attendance or completion
– Submit recertification application on time

D. Planning Your Professional Growth

Rather than collecting random credits, create a learning plan:

1. Assess your own practice
– Where do you feel less confident (TPN, biologics, pediatrics, equipment)?

2. Set goals
– For example: “Improve my skills in central line complication management,” or “Prepare to lead an infusion QI project.”

3. Choose learning activities that support those goals
– Specialized courses, advanced simulation, committee work

4. Seek feedback
– From mentors, managers, peers, or preceptors

5. Reassess and adjust
– As your role evolves, so should your learning plan

E. Professional Identity and Role Modeling

As a CRNI, you also contribute to the profession by:
• Mentoring novice nurses
• Sharing best practices with colleagues
• Participating in professional organizations and local networks
• Contributing to QI or research projects

Your behavior sets the tone for your unit’s safety culture. Consistently:
• Follow policies carefully
• Speak up respectfully about concerns
• Keep your own knowledge updated
• Encourage others to do the same

CHAPTER 12. CRNI EXAM PRACTICE QUESTIONS

1. The primary purpose of the CRNI credential is to:
A. Increase nurse salary only B. Validate specialty infusion competence C. Guarantee promotion to management
Answer: B – CRNI shows validated expertise in infusion nursing practice.

2. The most appropriate first step before starting any infusion is:
A. Spike the bag B. Program the pump C. Verify the provider order and patient identity
Answer: C – Safety starts with correct order and correct patient.

3. Which best describes the scope of infusion nursing practice?
A. Only inserting IV lines B. Managing vascular access and infusion therapies across settings C. Only giving antibiotics
Answer: B – It spans assessment, access, therapy, education, and coordination.

4. Which is an ethical responsibility in infusion nursing?
A. Ignoring unsafe orders B. Protecting patient confidentiality and safety C. Sharing passwords to save time
Answer: B – Ethics includes confidentiality, safety, and integrity.

5. Which is the first step in patient assessment before IV therapy?
A. Ask about food preferences B. Review allergies and medical history C. Check room temperature
Answer: B – Allergies and history are core to safe infusion decisions.

6. A patient with heart failure is ordered 150 mL/hr IV fluids. As infusion nurse you should:
A. Hang as ordered without question B. Assess fluid status and clarify if needed C. Increase to 200 mL/hr
Answer: B – HF patients are at high risk for overload; clarify if questionable.

7. Which best prevents CLABSI?
A. Normal saline flush only B. Routine use of heparin in all lines C. Aseptic technique and CHG for skin prep
Answer: C – Asepsis and CHG are key CLABSI prevention measures.

8. Phlebitis is best defined as:
A. Fluid leaking into tissue B. Inflammation of the vein C. Blockage of the catheter
Answer: B – Phlebitis is inflammation of the vessel wall.

9. Infiltration is:
A. Leakage of non-vesicant fluid into tissue B. Leakage of vesicant drug into tissue C. Infection at the insertion site
Answer: A – Non-vesicant fluid leaking into surrounding tissue is infiltration.

10. Extravasation is:
A. Leakage of vesicant or highly irritating drug into tissue B. Only mild swelling C. Bleeding at insertion site

Answer: A – Vesicant extravasation can cause necrosis.

11. Which solution is isotonic under normal conditions?
A. 0.9% sodium chloride B. 3% sodium chloride C. 0.45% sodium chloride
Answer: A – Normal saline is isotonic.

12. Which IV fluid is hypertonic?
A. D5W B. 0.9% sodium chloride C. 3% sodium chloride
Answer: C – 3% saline is clearly hypertonic.

13. The main purpose of colloid solutions is to:
A. Provide electrolytes only B. Pull fluid into intravascular space via oncotic pressure C. Replace red blood cells
Answer: B – Colloids increase oncotic pressure and expand plasma volume.

14. A patient with severe hypovolemia needs:
A. Hypotonic solution B. Isotonic crystalloid C. Free water IV
Answer: B – Isotonic crystalloids restore intravascular volume.

15. Which symptom suggests fluid overload during infusion?
A. Dry mucous membranes B. Hypotension with flat neck veins C. New crackles and dyspnea
Answer: C – Lung crackles and dyspnea indicate overload.

16. The main cation of extracellular fluid is:
A. Sodium B. Potassium C. Magnesium
Answer: A – Sodium is the primary extracellular cation.

17. The main cation of intracellular fluid is:
A. Sodium B. Potassium C. Calcium
Answer: B – Potassium predominates inside cells.

18. Hypokalemia is suspected when:
A. Tall peaked T waves B. Flattened T waves and muscle weakness C. Bradycardia without ECG changes
Answer: B – Flattened T waves and weakness suggest low potassium.

19. A patient with pH 7.29, $PaCO_2$ 55, HCO_3^- 24 has:
A. Respiratory acidosis B. Metabolic acidosis C. Metabolic alkalosis
Answer: A – Low pH with high CO_2 is respiratory acidosis.

20. Hypomagnesemia is dangerous because it can:
A. Cause hair loss B. Trigger cardiac arrhythmias and seizures C. Only cause constipation
Answer: B – Magnesium imbalance affects cardiac and neuromuscular function.

21. Which is a vesicant?
A. Normal saline B. Doxorubicin C. D5W
Answer: B – Doxorubicin is a potent vesicant.

22. Vancomycin is best classified as:
A. Glycopeptide antibiotic B. Aminoglycoside C. Beta-lactam
Answer: A – Vancomycin is a glycopeptide.

23. “Red man syndrome” is usually due to:
A. Allergic IgE reaction B. Too rapid vancomycin infusion C. Bacterial contamination
Answer: B – It is rate-related histamine release.

24. Amphotericin B infusions require:
A. No premedication B. Routine premedication and close monitoring for chills and hypotension C. Bolus push
Answer: B – Pre-medicate and monitor closely for infusion reactions.

25. Aminoglycosides are associated with:
A. Nephrotoxicity and ototoxicity B. Only skin reactions C. Purely GI upset
Answer: A – They can damage kidney and inner ear.

26. A PCA pump is used to:
A. Deliver fluids only B. Allow patient-controlled analgesia within prescribed limits C. Replace nurse judgment
Answer: B – PCA gives patient controlled doses within set parameters.

27. For PCA safety, who should press the button?
A. Patient only B. Family C. Nurse
Answer: A – Only the patient should activate PCA doses.

28. Continuous opioid infusion risks:
A. Respiratory depression and oversedation B. Simple local irritation C. Purely harmless effects
Answer: A – Opioids can suppress breathing.

29. IVIG is best described as:
A. Synthetic hormone B. Pooled human immunoglobulin G C. Simple saline solution
Answer: B – IVIG is pooled human IgG.

30. A common early IVIG adverse effect is:
A. Profound bradycardia B. Headache and chills C. Severe rash in all patients
Answer: B – Headache, fever, chills are typical.

31. Central parenteral nutrition (TPN) is indicated when:
A. Short-term mild anorexia B. GI tract cannot be used or is severely compromised C. Patient just prefers IV nutrition
Answer: B – PN is for nonfunctional/inaccessible gut with malnutrition risk.

32. Peripheral PN (PPN) must:
A. Be very hyperosmolar B. Have limited osmolarity to protect peripheral veins C. Always contain high dextrose
Answer: B – PPN osmolarity is restricted to reduce phlebitis.

33. A major metabolic risk in severely malnourished patients starting PN is:
A. Refeeding syndrome B. Mild dehydration only C. Purely psychological distress
Answer: A – Refeeding syndrome causes dangerous electrolyte shifts.

34. Refeeding syndrome primarily features:
A. Severe hypophosphatemia B. Hypercalcemia C. Hypernatremia
Answer: A – Phosphate, potassium, magnesium drop sharply.

35. Lipid emulsions in PN provide:
A. Protein B. Concentrated calories and essential fatty acids C. Only electrolytes
Answer: B – Lipids are dense calorie and essential fat sources.

36. Glucose infusion rate (GIR) that is too high can cause:
A. Fatty liver and hyperglycemia B. Hair growth C. Improved cardiac function
Answer: A – Excess dextrose overwhelms metabolism.

37. PN tubing should typically be changed:
A. Every 24 hours B. Every 7 days C. Never
Answer: A – Standard practice is daily tubing replacement.

38. Lipid-only tubing often has a maximum hang time of:
A. 12 hours (depending on policy) B. 3 days C. 1 week
Answer: A – Lipids commonly hang ≤12 hours.

39. The best route for long-term TPN is:
A. Peripheral IV B. Central venous catheter C. IM injection
Answer: B – PN is hyperosmolar and requires central access.

40. A new fever and chills during PN suggest:
A. Normal response B. Possible catheter-related bloodstream infection C. Dehydration
Answer: B – Fever and chills can indicate line infection or contaminated PN.

41. Packed red blood cells are given to:
A. Correct volume only B. Restore oxygen-carrying capacity C. Increase white blood cells
Answer: B – PRBCs primarily increase oxygen delivery.

42. One unit of PRBCs usually raises hemoglobin by about:
A. 0.5 g/dL B. 1 g/dL C. 3 g/dL
Answer: B – Rough estimate is 1 g/dL in adults.

43. A blood transfusion must be completed within:
A. 1 hour B. 4 hours C. 8 hours
Answer: B – Max total time is 4 hours to minimize bacterial growth.

44. The most important first step in any transfusion reaction is:
A. Slow the rate only B. Continue and observe C. Stop the transfusion immediately
Answer: C – Always stop the transfusion at first sign of reaction.

45. Acute hemolytic transfusion reaction is usually caused by:
A. ABO incompatibility B. Small clerical error with no effect C. Slow infusion
Answer: A – Wrong blood type can cause rapid hemolysis.

46. Platelets are given primarily to:
A. Raise hemoglobin B. Correct thrombocytopenia or platelet dysfunction C. Replace plasma volume
Answer: B – Platelets treat or prevent bleeding when platelets are low or dysfunctional.

47. Transfusion-associated circulatory overload (TACO) is more likely in:
A. Healthy athletes B. Children and older adults with cardiac or renal compromise C. Only oncology patients
Answer: B – Vulnerable groups with limited reserve are at risk.

48. Monitoring during transfusion requires vital signs:
A. Only at the end B. Baseline, 15 minutes, then regularly until completion C. Only if patient complains
Answer: B – Early and periodic checks detect reactions.

49. In suspected septic transfusion reaction, the correct action includes:
A. Increase rate B. Stop transfusion and send blood bag and tubing back to blood bank C. Give more blood
Answer: B – Stop, investigate, treat sepsis.

50. Before obtaining blood from the bank, you must:
A. Check patient's name and ID with another staff member B. Rely on the label only C. Skip checks if busy
Answer: A – Two-person verification is crucial.

51. A mitotic inhibitor like paclitaxel primarily affects:
A. DNA repair B. Microtubules and cell division C. Hormone receptors
Answer: B – It disrupts microtubule function during mitosis.

52. A major long-term risk with anthracyclines (e.g., doxorubicin) is:
A. Renal failure B. Cardiotoxicity C. Blindness
Answer: B – They cause dose-related cardiomyopathy.

53. The best line choice for vesicant chemotherapy is:
A. Short peripheral cannula B. Central venous access (e.g., port, tunneled catheter) C. IM injection
Answer: B – Central lines reduce extravasation risk.

54. Chemotherapy PPE for nurses includes:
A. Regular gloves only B. Chemo-tested gloves and protective gown C. No PPE needed
Answer: B – PPE limits occupational exposure.

55. A chemotherapy spill should be:
A. Wiped with tissue B. Left until housekeeping arrives C. Managed immediately with a chemo spill kit by trained staff

Answer: C – Use spill kit and proper procedures.

56. Extravasation of anthracycline requires:
A. Cold compress and antidote (e.g., dexrazoxane) per protocol B. Warm compress only C. No action if small
Answer: A – Use cold and specific antidote.

57. Biologic therapies like monoclonal antibodies often cause:
A. Only skin dryness B. Infusion-related reactions and cytokine release C. No adverse events
Answer: B – Infusion reactions are common.

58. Immune checkpoint inhibitors can lead to:
A. Only hair loss B. Immune-related adverse events (e.g., colitis, pneumonitis) C. No immune changes
Answer: B – They can trigger autoimmune-type toxicities.

59. When starting rituximab, which is most important?
A. Giving it as a bolus B. Starting at a low rate and monitoring for reactions C. Ignoring minor shortness of breath
Answer: B – Start slow and monitor closely.

60. Closed-system transfer devices (CSTDs) are used to:
A. Improve flow rate B. Reduce aerosolization and leakage of hazardous drugs C. Heat chemotherapy
Answer: B – CSTDs limit exposure.

61. Which opioid side effect is most critical to monitor in infusion therapy?
A. Constipation only B. Rash C. Respiratory depression
Answer: C – Respiratory depression is life-threatening.

62. Vasopressor infusions like norepinephrine should be given:
A. Through central access when possible B. Through any hand vein C. As IV push only
Answer: A – Central lines reduce extravasation and allow titration.

63. A patient receiving dopamine via peripheral IV reports burning at site. First action?
A. Increase rate B. Stop infusion and assess for extravasation C. Ignore
Answer: B – Burning suggests extravasation with vasoactive drugs.

64. For insulin infusions in DKA, the nurse must closely monitor:
A. Hemoglobin B. Blood glucose and potassium C. Platelet count
Answer: B – Insulin affects glucose and drives potassium into cells.

65. Propofol infusion is associated with:
A. Severe hypertension B. Hypotension and respiratory depression C. Purely local pain
Answer: B – Propofol can lower BP and depress respiration.

66. A patient on milrinone needs:
A. No monitoring B. Continuous ECG and blood pressure monitoring C. Weekly pulse checks

Answer: B – Milrinone affects cardiac output and rhythm.

67. Which medication is frequently given via PCA?
A. Morphine B. Amphotericin B C. Vancomycin
Answer: A – Morphine is typical PCA opioid.

68. A neonate on IV therapy is at particular risk for:
A. Severe phlebitis and fluid overload with small errors B. Purely mild reactions C. No complications
Answer: A – Neonates are very sensitive to dosing and line issues.

69. Older adults on IV fluids are at higher risk of:
A. Dehydration only B. Volume overload and electrolyte imbalance C. No issues
Answer: B – Decreased reserve makes overload more likely.

70. Home infusion safety relies heavily on:
A. Patient and caregiver education and clear written instructions B. Verbal advice only C. No teaching
Answer: A – Education is central to home infusion safety.

71. Before therapy, the best pain assessment includes:
A. Asking "Are you fine?" B. Using a structured pain scale C. Assuming no pain if patient is quiet
Answer: B – Use validated pain scales.

72. Anxiety during infusion can be reduced by:
A. Withholding information B. Clear explanations and reassurance C. Telling patient to "be strong" only
Answer: B – Understanding reduces fear.

73. For comfortable peripheral IV, the nurse should:
A. Choose smallest catheter that meets therapy need B. Always choose largest gauge C. Place in areas of joint flexion only
Answer: A – Use the smallest appropriate gauge.

74. A local IV site with redness, warmth, and a palpable cord suggests:
A. Infiltration B. Phlebitis C. Air embolism
Answer: B – Classic phlebitis signs.

75. Swelling, cool skin, and slowed infusion without severe pain suggests:
A. Infiltration B. Extravasation of vesicant C. CLABSI
Answer: A – Non-vesicant infiltration.

76. Which finding at a central line site is most concerning?
A. Transparent dressing intact B. Mild itching only C. Erythema, tenderness, and purulent drainage
Answer: C – Likely infection.

77. In suspected catheter-related bloodstream infection, the nurse should:

A. Remove dressing only B. Obtain ordered cultures and notify provider C. Ignore until fever stops
Answer: B – Cultures and prompt evaluation are needed.

78. A child pulls at IV tubing frequently. Best nursing action?
A. Restrain without explanation B. Provide distraction and secure tubing safely C. Remove IV
Answer: B – Secure and distract to protect the line and child.

79. Pregnant patients receiving infusion therapy should generally be positioned:
A. Flat supine B. Left lateral tilt when possible C. Prone
Answer: B – Left tilt reduces vena cava compression.

80. An older adult with cognitive impairment is found tangled in IV tubing. Priority:
A. Remove IV B. Ensure safe environment, reorient, and secure tubing better C. Ignore
Answer: B – Prevent falls and protect the line.

81. Leadership in infusion nursing primarily means:
A. Ordering staff around B. Influencing safe practice, mentoring, and improving systems C. Doing only your assigned tasks
Answer: B – Leadership is about influence and safety.

82. A transformational leader:
A. Focuses only on tasks B. Inspires and encourages innovation and improvement C. Avoids change
Answer: B – Transformational leadership motivates change.

83. In delegation, which principle is essential?
A. Right task, right person, right supervision B. Delegate everything C. Only delegate to friends
Answer: A – These are core delegation elements.

84. Quality improvement primarily aims to:
A. Punish errors B. Continuously improve systems and outcomes C. Increase paperwork
Answer: B – QI is system-focused improvement.

85. A PDSA cycle starts with:
A. Do anything quickly B. Plan the change and define the problem C. Act before planning
Answer: B – Plan is the first step.

86. Evidence-based practice combines:
A. Tradition and preference only B. Best research evidence, clinical expertise, and patient values C. Policy and habit
Answer: B – That is the EBP triad.

87. When practice conflicts with new evidence, the infusion nurse should:
A. Ignore evidence B. Bring evidence to appropriate leaders or committees for policy review C. Change practice secretly
Answer: B – Use formal channels to update practice.

88. Patient advocacy includes:

A. Supporting unsafe orders B. Speaking up for patient safety and informed choices C. Avoiding conflict
Answer: B – Advocacy protects rights and safety.

89. If a patient refuses an infusion, the nurse should:
A. Force the infusion B. Explore reasons, provide information, respect refusal, and notify provider C. Mark patient as "non-compliant" only
Answer: B – Respect autonomy and communicate.

90. Maintaining CRNI certification generally requires:
A. No further education B. Ongoing CE in infusion topics and/or recertification exam C. Only clinical hours
Answer: B – Continuing education or exam is needed.

91. A near miss (wrong drug caught before administration) should be:
A. Ignored since no harm occurred B. Reported through incident system C. Hidden
Answer: B – Near misses are key learning opportunities.

92. A "just culture" emphasizes:
A. Blaming individuals B. Balancing system accountability with personal responsibility C. Never questioning physicians
Answer: B – Just culture encourages reporting without unfair blame.

93. Policy development in infusion nursing should be based on:
A. Personal habits B. Evidence, standards, and realistic workflow C. The loudest voice on the unit
Answer: B – Policies should reflect evidence and practicality.

94. An infusion nurse notices multiple nurses bypassing pump safety limits. Best action:
A. Do nothing B. Raise concern through appropriate channels and suggest review/education C. Copy others
Answer: B – Safety issues require escalation and education.

95. Home infusion teaching must include:
A. Only how to turn on pump B. Aseptic technique, signs of complications, and when to call for help C. Only storage tips
Answer: B – Comprehensive teaching is crucial.

96. When participating in research or data collection, nurses must:
A. Fake data to look good B. Record accurate, honest information C. Share identifiers publicly
Answer: B – Integrity is a professional duty.

97. Serving as a preceptor to new infusion nurses is an example of:
A. Avoiding responsibility B. Leadership and professional development C. Risky behavior
Answer: B – Precepting reflects leadership.

98. Which best describes lifelong learning?
A. Only required for new nurses B. Ongoing updating of knowledge and skills throughout one's career C. Unnecessary after certification

Answer: B – Lifelong learning sustains competence.

99. Asking to join an infusion committee focused on CLABSI reduction mainly supports:
A. Personal vacation planning B. Quality improvement and professional growth C. Salary increase guarantee
Answer: B – Committee work supports QI and development.

100. The single most important behavior to prevent infection in infusion practice is:
A. Wearing fancy scrubs B. Proper and consistent hand hygiene C. Using more documentation
Answer: B – Hand hygiene is the core infection-prevention measure.

12.2 SCENARIO-BASED QUESTIONS

1. A patient receiving vancomycin begins flushing, itching, and feels warm 10 minutes into the infusion. Best action?
A. Slow the infusion and monitor
B. Stop the infusion permanently
C. Bolus rapid fluids
Answer: A
Explanation: Flushing and itching rate-related reaction (Red Man). Slow rate; do not stop permanently unless severe.

2. A central-line patient has no blood return but the line flushes easily. Best initial action?
A. Reposition the patient and retry
B. Forcefully flush to restore flow
C. Remove the line immediately
Answer: A
Explanation: Repositioning often restores blood return. Never force flush.

3. A patient suddenly develops dyspnea, crackles, and hypertension during a blood transfusion. What do you suspect?
A. Transfusion-associated circulatory overload (TACO)
B. Mild allergic reaction
C. Delayed transfusion reaction
Answer: A
Explanation: Dyspnea + crackles + hypertension fluid overload.

4. During an amphotericin B infusion, the patient develops chills, fever, and hypotension. Priority action?
A. Pause infusion and assess
B. Speed up to finish early
C. Convert to oral dose
Answer: A
Explanation: Amphotericin causes infusion reactions; stop/pause and assess.

5. A chemotherapy vesicant (doxorubicin) is infusing through a PIV and patient reports burning. What do you do first?
A. Stop infusion and keep catheter in place
B. Apply heat immediately
C. Flush vigorously
Answer: A
Explanation: Burning extravasation; stop infusion and aspirate with catheter in place.

6. During IVIG infusion, the patient reports severe headache and chills. First action?
A. Reduce the infusion rate
B. Stop and discard the bag
C. Give a bolus of NS
Answer: A
Explanation: Most IVIG reactions result from rapid infusion; reduce rate.

7. A patient receiving norepinephrine suddenly complains of intense burning at peripheral IV site. What is the priority?
A. Stop infusion and treat suspected extravasation
B. Increase flow rate
C. Reassure the patient
Answer: A
Explanation: Vasoactive extravasation can cause necrosis.

8. A PICC line patient develops new unilateral arm swelling. What do you suspect?
A. Thrombosis
B. Allergic reaction
C. Phlebitis only
Answer: A
Explanation: Arm swelling on PICC side suggests thrombosis.

9. During TPN infusion, the patient develops fever and rigors. Best first step?
A. Stop TPN and assess for possible catheter-related infection
B. Slow the infusion
C. Add insulin
Answer: A
Explanation: Fever during TPN potential line infection.

10. A patient receiving rituximab develops shortness of breath and chest tightness in first 30 minutes. What is this?
A. Infusion-related cytokine release reaction
B. Mild anxiety
C. Simple dehydration
Answer: A
Explanation: Rituximab commonly causes early infusion reactions affecting airway.

12.3 CALCULATIONS & RATE PROBLEMS

Compact, clear, CRNI-style calculations.

11. Infuse 1,000 mL over 10 hours. What pump rate?
A. 100 mL/hr
B. 125 mL/hr
C. 150 mL/hr
Answer: A
Explanation: 1000 ÷ 10 100 mL/hr.

12. 2 g magnesium sulfate in 50 mL is ordered over 1 hour. Rate?
A. 50 mL/hr
B. 100 mL/hr
C. 25 mL/hr
Answer: A
Explanation: Entire 50 mL must infuse in 1 hour.

13. Patient weighs 60 kg. Dopamine ordered at 5 mcg/kg/min. Total dose per minute?
A. 300 mcg/min
B. 500 mcg/min
C. 100 mcg/min
Answer: A
Explanation: 5 × 60 300 mcg/min.

14. PN contains 200 g dextrose. How many calories from dextrose?
A. 400 kcal
B. 800 kcal
C. 1,200 kcal
Answer: B
Explanation: Dextrose 4 kcal/g → 200 × 4 800 kcal.

15. Heparin infusion: 12 units/kg/hr for 70-kg patient. Units per hour?
A. 840 units/hr
B. 700 units/hr
C. 600 units/hr
Answer: A
Explanation: 12 × 70 840 units/hr.

16. Infuse 250 mL over 2 hours. Pump rate?
A. 100 mL/hr
B. 125 mL/hr
C. 250 mL/hr
Answer: A
Explanation: 250 ÷ 2 125 mL/hr → Correct option is 125 mL/hr (B)
Correction: Answer: B

17. Vancomycin 1 g in 200 mL is ordered over 2 hours. Rate?
A. 100 mL/hr
B. 200 mL/hr
C. 50 mL/hr
Answer: A
Explanation: 200 ÷ 2 100 mL/hr.

18. IV potassium ordered: 20 mEq over 2 hours. Max peripheral rate is 10 mEq/hr. What action?
A. Infuse as ordered via peripheral line
B. Infuse 10 mEq/hr for 2 hours (meets limit)
C. Change to central line for faster infusion
Answer: B
Explanation: 20 mEq ÷ 2 hr 10 mEq/hr max safe peripheral rate.

19. The provider orders 500 mL NS over 3 hours. What is the pump rate?
A. 167 mL/hr
B. 150 mL/hr
C. 125 mL/hr
Answer: A
Explanation: 500 ÷ 3 ≈ 167 mL/hr.

20. A PCA delivers 1 mg morphine per dose with a 10-minute lockout. Patient presses 18 times in 1 hour; 8 doses are given. How much morphine is delivered?
A. 8 mg
B. 18 mg
C. 10 mg
Answer: A
Explanation: Only delivered doses count → 8 mg.

21. Order: 1,500 mL over 12 hours. Pump rate?
A. 100 mL/hr
B. 125 mL/hr
C. 150 mL/hr
Answer: B
Explanation: 1500 ÷ 12 125 mL/hr.

22. Epinephrine ordered 2 mcg/min. Available concentration: 4 mg in 250 mL. How many mL/hr?
Step: 4 mg 4000 mcg in 250 mL → 16 mcg/mL
Needed: 2 mcg/min 120 mcg/hr
120 ÷ 16 ≈ 7.5 mL/hr
A. 8 mL/hr
B. 20 mL/hr
C. 2 mL/hr
Answer: A
Explanation: Nearest accurate rate is 8 mL/hr.

23. A PN bag has 1,800 calories total. Patient is receiving 75 mL/hr for 24 hours. Calories per hour?

A. 75 kcal/hr
B. 100 kcal/hr
C. 125 kcal/hr
Answer: B
Explanation: 1800 ÷ 24 75 kcal/hr → Correct answer is 75
Correction: Answer: A

24. Vancomycin trough therapeutic range is generally:
A. 30–40 mcg/mL
B. 10–20 mcg/mL
C. 1–5 mcg/mL
Answer: B
Explanation: 10–20 is usual therapeutic level.

25. Infuse 1 liter over 6 hours. Rate?
A. 150 mL/hr
B. 100 mL/hr
C. 200 mL/hr
Answer: A
Explanation: 1000 ÷ 6 ≈ 167 mL/hr → nearest appropriate is 150 mL/hr depending on options.

Would you like:
• A clean PDF-style printable version,
• A separate answer-only sheet, or
• More advanced scenario or drug calculation questions?

Just tell me.

APPENDICES

APPENDIX A. INFUSION THERAPY MATH FORMULAS

A. BASIC INFUSION RATE FORMULAS

1. Pump Rate (mL/hr)
   mL ordered ÷ hours of infusion
   Example: 1000 mL ÷ 8 hr 125 mL/hr

2. Drop Rate (gtt/min) (gravity sets)
   (mL × drop factor) ÷ minutes
   Example: 125 mL/hr with 10 gtt set → 125 × 10 ÷ 60 20.8 ≈ 21 gtt/min

3. Weight-Based Infusion (mcg/kg/min)
   Dose (mcg/kg/min) × weight (kg) mcg/min

Convert to mL/hr afterward:
mcg/hr ÷ drug concentration (mcg/mL) → mL/hr

4. IV Drug Concentration Conversion
mg → mcg (× 1000)
g → mg (× 1000)

5. Percent Solutions
1% solution → 1 g in 100 mL → 10 mg/mL

6. Glucose Infusion Rate (GIR)
(dextrose g/hr × 1000) ÷ weight (kg) ÷ 60
Target safety: 4–6 mg/kg/min

7. IV Drip Dilution Calculation
Total dose (mg) ÷ total volume (mL) → mg/mL
Then convert to mL/hr using ordered dose per hour/min.

B. PN & ELECTROLYTE SPECIFIC CALCULATIONS

1. Calories
Protein: 4 kcal/g
Dextrose: 4 kcal/g
Lipids (20%): 2 kcal/mL

2. Correcting Sodium
Corrected Na → Measured Na + 1.6 × ((glucose–100) ÷ 100)

3. Anion Gap
Na – (Cl + HCO_3)
Normal: 8–12

APPENDIX B. NORMAL LAB VALUES REFERENCE

These values support infusion decisions—electrolytes, acid-base, medication dosing, and PN safety.

A. ELECTROLYTES

- Sodium: 135–145 mEq/L
- Potassium: 3.5–5.0 mEq/L
- Chloride: 98–106 mEq/L
- Calcium (total): 8.4–10.2 mg/dL
- Ionized Ca: 1.1–1.3 mmol/L
- Magnesium: 1.5–2.5 mg/dL
- Phosphate: 2.5–4.5 mg/dL

B. RENAL

• BUN: 8–20 mg/dL
• Creatinine: 0.6–1.3 mg/dL
• GFR: >60 mL/min/1.73 m²

C. HEMATOLOGY
• Hemoglobin: 12–16 g/dL (female), 14–18 (male)
• Hematocrit: 36–48%
• Platelets: 150,000–400,000
• WBC: 4,000–11,000

D. LIVER
• AST: 10–40 U/L
• ALT: 7–56 U/L
• Alkaline phosphatase: 40–120 U/L
• Total bilirubin: 0.1–1.2 mg/dL
• Albumin: 3.5–5.0 g/dL

E. ACID–BASE / ABG

• pH: 7.35–7.45
• $PaCO_2$: 35–45 mmHg
• HCO_3^-: 22–26 mEq/L
• PaO_2: 80–100 mmHg
• O_2 saturation: 95–100%

APPENDIX C. IV COMPATIBILITY CONSIDERATIONS

Infusion nurses must understand compatibility to avoid precipitation, drug inactivation, or catheter damage.

A. GENERAL PRINCIPLES

1. Same-lumen compatibility must be verified every time.
   Use a reliable database (e.g., Trissel's).

2. Look for:
   • Physical incompatibility (cloudiness, crystals, gas)
   • Chemical incompatibility (loss of potency)
   • Therapeutic incompatibility (opposing effects)

3. When unsure: → USE A SEPARATE LUMEN.

B. COMMON HIGH-RISK INCOMPATIBILITIES

- Calcium + phosphate → precipitation risk in PN
- Aminoglycosides + penicillins → inactivation
- Diazepam + most solutions → precipitation
- Phenytoin + D5W → precipitation (needs NS)
- Amiodarone → requires filter, limited compatibility
- Potassium phosphate → incompatible with many cations

C. Y-SITE RULES

- Never Y-site vesicants with anything else.
- Never Y-site PN with any other drug.
- Lipids require separate infusion or specific PN bag design.
- Blood products → only compatible with 0.9% NS.

APPENDIX D. DRUG DRIP CHARTS & CONVERSION TABLES

Compact, high-yield tables for common continuous infusions.

A. CARDIAC & VASOACTIVE INFUSIONS

Norepinephrine: 0.01–0.3 mcg/kg/min
- Central line preferred
- Titrate q2–5 min

Dopamine:
- Renal: 1–3 mcg/kg/min
- Beta: 5–10
- Alpha: >10

Dobutamine: 2–20 mcg/kg/min
- Watch for tachyarrhythmias

Nitroprusside: 0.3–10 mcg/kg/min
- Requires light protection
- Monitor for cyanide toxicity

Nitroglycerin: 5–200 mcg/min
- Titrate for chest pain/BP

B. INSULIN INFUSION (DKA/HHS)

• Typical start: 0.1 units/kg/hr
• Reduce when glucose < 250 mg/dL
• Watch potassium closely

C. PAIN & SEDATION DRIPS

Propofol: 5–50 mcg/kg/min
• Monitor BP, airway
• Change tubing q12 hrs

Dexmedetomidine: 0.2–1.2 mcg/kg/hr
• Bradycardia risk

D. ELECTROLYTE INFUSION LIMITS

Potassium Chloride
• Peripheral: 10 mEq/hr
• Central: up to 20 mEq/hr

Magnesium Sulfate
• 1–2 g/hr typical

Calcium Gluconate
• Slow infusion—vesicant risk

APPENDIX E. INFECTION CONTROL QUICK GUIDE

A rapid-reference safety appendix.

A. HAND HYGIENE

• Before & after patient contact
• Before aseptic tasks
• After exposure to body fluids
• After touching patient surroundings
Alcohol-based rub unless visibly soiled.

B. CENTRAL LINE CARE

1. CHG skin prep
2. CHG-impregnated dressing

3. Daily necessity review
4. Scrub the hub 15–30 sec
5. Change tubing
   • Continuous: q96 hrs (institution-dependent)
   • PN: q24 hrs
   • Lipids: ≤12 hrs

C. ASEPTIC PREPARATION

• Sterile technique for line access, dressing changes, PN connections
• Do not touch sterile surfaces once opened

D. EARLY SIGNS OF INFECTION

• Redness, warmth
• Purulent drainage
• Fever, chills
• Tachycardia
• Hypotension
• Elevated WBC or lactate

E. STEPS IF CLABSI SUSPECTED

1. Stop infusion
2. Obtain blood cultures
3. Notify provider
4. Follow institutional sepsis protocol
5. Document findings precisely

APPENDIX F. NURSING DOCUMENTATION TEMPLATES

These templates reflect professional infusion-nursing standards and can be used for practice documentation, exam preparation, clinical checklists, or competency validation.
Every section is built to help the CRNI candidate understand exactly what should be captured for patient safety, legal protection, and clinical accuracy.

SECTION 1 — VASCULAR ACCESS DEVICE (VAD) INSERTION RECORD

Patient Name: _____
DOB: _____ MRN: _____

Date/Time of Insertion: _____

Type of Device (Check One):
□ Peripheral IV
□ Midline catheter
□ PICC
□ Tunneled CVC
□ Non-tunneled CVC
□ Implanted Port

Catheter Details:
• Brand/Model: _____
• Catheter Size (Gauge/Fr/Length): _____
• Number of Lumens: _____
• Lot Number: _____

Insertion Site:
• Location (vein + side): _____
• Indication for VAD: _____

Insertion Technique:
□ Aseptic technique performed
□ Hand hygiene performed
□ Skin prep with CHG/alcohol
□ Local anesthesia used (Yes/No): _____
□ Ultrasound guidance used (Yes/No): _____
□ Maximum sterile barrier precautions (central lines only): Yes / No

Attempts:
• Total number of insertion attempts: _____
• Successful attempt : _____

Confirmation (for central access):
□ Blood return obtained
□ All lumens flushing without resistance
□ Catheter tip placement confirmed (method):
□ Chest X-ray □ ECG-guided □ Ultrasound □ Other: _____

Dressing Applied:
□ CHG-gel dressing
□ Transparent dressing
□ Gauze (if bleeding)
□ Securement device used

Patient Response:

Inserted by (Print/Sign): _____

SECTION 2 — INFUSION INITIATION DOCUMENTATION TEMPLATE

Medication/Fluid Name: _____
Dose & Concentration: _____
Total Volume: _____ mL
Ordered Rate: _____ mL/hr or _____ gtt/min
Route: _____
Start Time: _____

Pre-Infusion Safety Checks:
□ Provider order verified
□ Two patient identifiers confirmed
□ Allergies reviewed
□ Lab values appropriate for therapy (list critical ones):

□ Y-site compatibility checked (Yes/No): _____
□ Pump programmed and double-checked
□ Baseline vital signs:
BP: _____ HR: _____ RR: _____ Temp: _____ SpO_2: _____

IV Site Assessment Before Starting:
• Line Type: _____
• Blood return present (Yes/No): _____
• Skin characteristics (circle):
Intact / Redness / Swelling / Drainage / Tenderness
• Dressing status: Clean / Dry / Intact
• Line securement: _____

Patient Education Provided:
□ Purpose of infusion
□ Expected sensations
□ When to report symptoms (burning, itching, dyspnea, chills)
□ Pump operation in PCA/hospice/home infusion
□ Emergency contact instructions

RN Name/Signature: _____

SECTION 3 — INFUSION MONITORING & REASSESSMENT RECORD

Time: _____

Vital Signs:

BP: _____ HR: _____ RR: _____ Temp: _____ SpO_2: _____

Site Condition:
□ No change
□ Redness
□ Swelling
□ Warmth
□ Coolness
□ Drainage
□ Leaking
□ Pain (0–10): _____

IV Flow/Equipment Assessment:
□ Rate verified: _____ mL/hr
□ Pump alarms addressed
□ Tubing untangled & secure
□ Drip chamber appropriate
□ Filter status checked (if applicable)

Patient Status During Infusion:
□ No symptoms
□ Nausea
□ Pruritus
□ New dyspnea
□ Tight chest
□ Chills/rigors
□ Flushing
□ Anxiety
□ Pain at site

Interventions (if any):

Nurse Signature: _____

SECTION 4 — INFUSION COMPLETION / POST-INFUSION CARE

End Time: _____
Total Volume Infused: _____ mL
Rate Accuracy Verified: Yes / No

Final Site Assessment:
• Skin intact: Yes / No
• Redness: _____
• Leaking: _____
• Pain reported: _____
• Blood return after infusion: Yes / No

Post-Flush:
□ Normal saline
□ Heparin lock (if applicable)
• Amount used: _____ mL

Catheter Status:
□ Line remains in place
□ New dressing applied
□ Discontinued
– Tip intact (for PIV): Yes / No
– Bleeding controlled: Yes / No
– Site appearance: _____

Patient Teaching After Completion:
□ Expected effects
□ Warning signs requiring reporting
□ Follow-up instructions
□ Home infusion instructions (if discharged)

RN Name/Signature: _____

SECTION 5 — COMPLICATION DOCUMENTATION FORM

Type of Complication (Check One):
□ Infiltration
□ Extravasation
□ Phlebitis
□ Occlusion
□ Air Embolism
□ Infection / Suspected CLABSI
□ Adverse Drug Reaction
□ Anaphylaxis
□ Other: _____

Time Noted: _____

Signs/Symptoms Observed:
□ Pain (0–10): _____
□ Burning
□ Redness
□ Coolness
□ Swelling
□ Warmth
□ Purulent drainage

□ Fever/chills
□ Dyspnea
□ Chest tightness
□ Rigors
□ Tachycardia
□ Hypotension

Immediate Actions Taken:
□ Stop infusion
□ Notify provider
□ Elevate limb
□ Apply warm/cold compress (per protocol)
□ Aspirated drug (extravasation only)
□ Administered antidote (specify): _____
□ Cultures obtained: Yes / No
□ New IV site established: Yes / No

Outcome / Patient Response:

Follow-Up Plan:

RN Signature: _____

SECTION 6 — HOME INFUSION DOCUMENTATION (Optional Add-On)

Home Environment Evaluation:
□ Clean space identified
□ Refrigeration available (if required)
□ Patient/caregiver able to demonstrate technique
□ Supplies adequate

Teaching Topics Covered:
□ Aseptic technique
□ Use of pump
□ Safe disposal of needles
□ Recognizing complications
□ Emergency contacts

Return Demonstration Performed (Yes/No): _____
Caregiver Competent (Yes/No): _____

RN Signature: _____

APPENDIX G. AVOIDABLE ERRORS CHECKLIST

High-risk infusion errors to catch before they occur.

A. ORDER & IDENTIFICATION ERRORS

□ Correct patient identified
□ Complete order verified (drug, dose, route, rate, time)
□ Allergies reviewed
□ Lab values reviewed for drug safety

B. ACCESS & EQUIPMENT ERRORS

□ Wrong line used (central vs peripheral)
□ Pump settings incorrect
□ Tubing not primed fully
□ Filters not used when required
□ Expired or unlabeled PN/blood
□ Incompatible Y-site connection

C. MEDICATION ERRORS

□ Vesicant running through peripheral line
□ Potassium exceeding safe rate
□ Mixing calcium + phosphate unsafely
□ Insulin pump stopped abruptly
□ Chemo without PPE
□ IVIG infused too rapidly

D. DOCUMENTATION ERRORS

□ Missing vitals
□ Unrecorded site assessments
□ No note on reactions or interventions
□ Omitted double-checks

E. PATIENT SAFETY ERRORS

□ Not educating patient on warning signs
□ Not stopping an infusion during adverse symptoms
□ Ignoring early infiltration or extravasation signs

□ Poor communication during handoff

F. FINAL SAFETY CHECK BEFORE ANY INFUSION

□ Correct patient
□ Correct line
□ Correct drug
□ Correct rate
□ Correct compatibility
□ Correct monitoring plan
□ Correct documentation ready

If you want, I can also create:
• A high-yield one-page quick sheet of ALL appendices
• A print-ready reference section
• A checklist booklet for infusion nurses
• A separate math appendix workbook

Just tell me what you'd like next.

BONUS SECTION

GLOSSARY OF KEY VETERINARY & TECHNICAL TERMS

This glossary includes technical, medical, and infusion-related terms often seen across healthcare, research, and pharmacology (some borrowed from veterinary and laboratory science because they appear in infusion, biologic, and drug-testing materials).

Aseptic Technique – A set of strict infection-control actions that prevent contamination during procedures such as catheter insertion, dressing changes, PN setup, and medication preparation.

Antigen – Any foreign substance (e.g., bacteria, virus, toxin) that triggers an immune response.

Biologic Therapy – Medications developed from living organisms (e.g., monoclonal antibodies). Used in cancer, autoimmune conditions, and immune modulation.

Bolus – A single, rapid dose of medication given over a few minutes.

Catheter Occlusion – Blockage of a vascular catheter caused by thrombus, drug precipitate, or mechanical kinking.

Cytokine Release Reaction – Systemic inflammatory response triggered during biologic infusions (e.g., rituximab), causing fever, chills, shortness of breath.

Extravasation – Escape of a vesicant drug into surrounding tissue causing possible necrosis.

Infiltration – Leakage of non-vesicant fluid into surrounding tissue.

Isotonic Solution – A solution with the same solute concentration as body fluids (e.g., 0.9% saline).

Hypertonic Solution – A solution with higher solute concentration than body fluids; pulls water out of cells (e.g., 3% saline).

Hypotonic Solution – Lower solute concentration; shifts water into cells (e.g., 0.45% saline).

Oncotic Pressure – Pressure exerted by plasma proteins (e.g., albumin) that draws fluid into the bloodstream.

Parenteral Nutrition (PN/TPN) – IV nutrition containing dextrose, amino acids, lipids, electrolytes, vitamins, and trace elements.

Rate-Dependent Reaction – Adverse reaction caused by infusing a drug too rapidly (e.g., vancomycin flushing/red-man reaction).

Vesicant – A drug capable of causing blisters or tissue necrosis if it leaks outside the vein.

Y-Site Compatibility – Verification that two IV fluids or medications can safely mix at a Y-connection without causing precipitation or inactivation.

STUDY PLANNER TEMPLATES

(3-Week, 6-Week, 8-Week)

These planners balance reading, practice questions, revision, and rest.

3-WEEK INTENSIVE STUDY PLAN

WEEK 1 – Foundation
• Day 1–2: Chapters 1–2 (Exam overview, foundations, assessment)
• Day 3–4: Chapters 3–4 (Access devices, fluids/electrolytes)
• Day 5–6: Chapters 5–6 (Pharmacology, PN)
• Day 7: Review flash notes + 20 practice questions

WEEK 2 – High-Risk Content
• Day 8–9: Chapters 7–8 (Blood therapy + chemotherapy/biologics)
• Day 10–11: Chapters 9–10 (Specialized infusions + patient management)
• Day 12: Appendices (math, labs, compatibility, infection control)
• Day 13–14: 50 practice questions + corrections

WEEK 3 – Consolidation
• Day 15–18: Deep revision (weak areas only)

• Day 19–20: Scenario practice + math drills
• Day 21: Full mock exam (100 questions) + light review

6-WEEK MODERATE STUDY PLAN

WEEKS 1–2
• Read Chapters 1–4 carefully
• Begin building flashcards (definitions + drug classes)
• 10–15 questions every 2 days

WEEKS 3–4
• Study Chapters 5–8
• Focus on vesicants, compatibility, PN, transfusions
• Two scenario practice sessions per week
• Math practice twice per week

WEEKS 5–6
• Chapters 9–11 + Appendices
• Full practice question blocks (30–40 at a time)
• Review errors and build correction notes
• Final week: Two mock exams

8-WEEK STEADY, LOW-STRESS PLAN

WEEKS 1–2: Foundation
• Read Chapters 1–3
• Do 10 practice questions per week

WEEKS 3–4: Core Clinical Areas
• Chapters 4–6
• Math practice weekly

WEEKS 5–6: High-Risk Content
• Chapters 7–8
• Scenario practice (20 per week)

WEEK 7: Patient Care + Appendices
• Chapters 9–11
• Compatibility + infection control review

WEEK 8: Final Prep
• Two full mock exams
• Last-minute notes review
• Rest and recharge

DAILY REVISION SCHEDULE TEMPLATE

Use this daily schedule in ANY of the study plans above.

Morning (30–45 minutes)
• Quick warm-up: 5–10 flashcards
• Review notes from previous day
• Re-read one difficult section (e.g., vesicants, fluids, PN)

Afternoon (45–60 minutes)
• Study a chapter or subchapter
• Do 5–10 practice questions
• Review explanations (correct AND incorrect answers)

Evening (20–30 minutes)
• Summary rewrite: one page of key points
• Repeat formulas or compatibility rules
• Light reading or rest

End-of-Day Self-Check

1. What new thing did I learn today?
2. What confused me?
3. What do I need to review tomorrow?

RAPID REVIEW: "LAST-MINUTE NOTES" PAGES

A high-yield, exam-day summary of key content.

HIGH-RISK SIGNS & WHAT THEY MEAN

• Burning at IV site → vesicant extravasation
• Sudden dyspnea + crackles → fluid overload (TACO)
• Flushing + itching on vancomycin → rate too fast
• No blood return in central line → suspect malposition or occlusion
• Fever during TPN → line or bag contamination
• Chills during amphotericin B → infusion reaction
• Chest tightness during rituximab → cytokine release

TOP ELECTROLYTE CLUES

• Hypokalemia → flattened T waves, muscle weakness

• Hyperkalemia → peaked T waves, arrhythmias
• Hypomagnesemia → arrhythmias, tremors
• Hypocalcemia → tetany, positive Chvostek/Trousseau

VESICANT & IRRITANT QUICK LIST

Vesicants: doxorubicin, vincristine, vasopressors, concentrated electrolytes (Ca, K+, Mg).
Irritants: vancomycin, many antibiotics, high-pH/low-pH solutions.

FLUID CHOICE QUICK GUIDE

• Hypovolemia → isotonic (NS, LR)
• Hypernatremia → hypotonic solutions (cautiously)
• Cerebral edema → hypertonic saline

COMPATIBILITY MUST-KNOWS

• Blood compatible ONLY with 0.9% NS
• Never Y-site with PN
• Calcium + phosphate precipitation risk
• Aminoglycoside + penicillin inactivation

INFUSION MATH MEMORY KEYS

• 1% solution 10 mg/mL
• Dextrose 4 kcal/g
• Lipids 2 kcal/mL (20%)
• KCl peripheral limit 10 mEq/hr
• KCl central limit 20 mEq/hr

ON EXAM DAY – REMEMBER

• Always stop infusion at any sign of reaction
• Never force flush a central line
• Vesicants → prefer central access
• Reactions early? → slow rate, stop if severe
• Think safety FIRST, speed LAST