2011 NURSING REORIENTATION

Clinical Competency Section

(Licensed Staff Only)

Testing will be available during the annual Skills Assessment Workshop (SAW) on September 18, 19, 25, & 26. The test will also be available in N-18, Monday thru Friday (except county holidays) between the hours of 0800 – 1500.

The mandatory completion date for the Clinical Competency test(s) is November 30, 2011.
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INSTRUCTIONS FOR CLINICAL COMPETENCIES

1. Review the content in each section.

2. Complete the study questions at the end of each section.

3. Check your answers against the answer key provided for each set of study questions.

4. The Clinical Competency consists of three sections: Nursing Documentation, Blood Sampling via Venipuncture and Medication Calculation Section.

   Nursing Documentation: There are 5 multiple choice questions and you are allowed to miss one.

   Blood Sampling via Venipuncture: There are 5 multiple choice questions and you are allowed to miss one.

   Medication Calculation Section: Divided into 3 parts. Part I (basic) is to be completed by all licensed nurses. There are 10 questions and you are allowed to miss 2 questions. Parts II (heparin infusion) and III (advanced) are to be completed by nurses working in select areas. There are 5 questions in part II and in part III. You are allowed to miss 1 question in part II and part III.

5. PLEASE DO NOT WRITE IN THE MANUAL
**NURSING DOCUMENTATION**

**Objectives:**
Upon completion of this section, the nurse will be able to:

1. Discuss the purpose of nursing documentation in health care
2. Identify the components of complete documentation
3. List the names of three (3) regulatory bodies setting documentation standards
4. State the names of different types of nursing documentation
5. Review the components of the nursing process
6. Differentiate between LVN and RN documentation responsibilities.
7. Identify the priority needs of a patient when formulating a nursing diagnosis
8. Discuss the difference between a short term and a long term goal when implementing nursing interventions
9. Review the application of the nursing process with an example
10. Identify a minimum of eight (8) required components of documentation required by Harbor-UCLA Medical Center

Instructions to the employee:

Please read the following section and then answer the study questions at the end of this section
I. INTRODUCTION

Communication is a dynamic, continuous, and multidimensional process for sharing information as determined by standards and policies. Reporting and documenting are communication techniques used by health care providers in directing patient-based decision making and continuity of care. The medical record serves as a legal document for recording all patient-related activities initiated by health care providers. Documenting the patient’s care has always been important, but with health care growing increasingly complex, expert documentation skills have become indispensable for health care providers. Cost constraints, sicker patients, and nurse’s expanding responsibilities further emphasize the need for a properly documented medical record.

Documentation is defined as written evidence of:

- Communication between health care professionals, patients, their families, and health care organizations
- The administration of tests, procedures, treatments, medications and patient education
- The response or the results of treatment provided to the patient, related diagnostic tests and interventions related to disease conditions

Documentation serves as written evidence of professional responsibility and accountability of a health care provider toward his/her patient. Documentation also serves as a continuity-of-care tool, a record of care provided to patient, and a quality management guide for the organization.

Documentation provides crucial legal protection as the medical record is legal documentation of patient care. Documentation provides a description of exactly what happened to a patient. The patient's medical care must be documented in an accurate, complete, systemic, logical, concise, and timely manner. One of the contributing factors for clinical mishaps and malpractice law suits is omitted or incomplete documentation. If care is not documented in the patient’s record, it did not occur. In lawsuits, 80 – 85% of the time the medical record is the determining factor in providing proof of significant events that took place during the patient’s hospital stay.

Thorough documentation requires:

- Legible and neat handwriting or computer entry
- Correct spelling and grammar
- Use of authorized abbreviations only
- Date, time, and initials/signature for each entry
- Accurate, factual, time-sequenced, descriptive notations

Although all health care professionals record patient care activities, the majority of the documentation falls on the nurse’s shoulders. Every state’s Nurse Practice Act addresses documentation and its importance. Nurses are responsible for the care that the patient receives and can be held liable if appropriate interventions are not implemented in a timely manner when information is available that would dictate otherwise.

II. REGULATORY BODIES AND LAW

A. Nurse Practice Act: The Nurse Practice Act (NPA) is an attempt to recognize and control the practice of nursing on a state-by-state basis. The NPA establishes guidelines for the safe practice of nursing. The Nurse Practice Act provides a guideline for the standard of care based on the nursing process and compliance as evidenced in documentation. Nurses should be aware of the standard of practice stated in the Nurse Practice Act of the state in which they work.

B. The Joint Commission: The Joint Commission (TJC) surveys health care facilities to measure compliance with its standards for safe health care provision. TJC accreditation is necessary in
TJC’s documentation survey focuses on the following provision of care standards:

1. The involvement of the patient or family in the development of the plan of care, which must be documented in the medical record
2. Interdisciplinary planning and implementation of all aspects of care
3. Documentation of an individualized plan must be evident for each patient, although TJC no longer requires that an organization have a traditional nursing care plan. Documenting the steps of the nursing process ensures compliance with TJC’s plan of care requirements

C. Federal and State Agencies: Peer review organizations (PROs), consisting of physicians and nurses, are required by the federal government to monitor and evaluate the quality and appropriateness of care provided. Medical record documentation is the mechanism for the PRO review, which evaluates the intensity of the services and the severity of the illness. From a hospital perspective, reimbursement is maximized when information in the medical record demonstrates compliance with Medicare and MediCal standards.

Table 1. Examples of Mandatory Documentation Required by Regulatory Bodies

- Intake and output
- Daily weight
- Pain assessment and reassessment
- Oryx core measures
- Type of hair removal for surgical patients

D. Federal Government: A federal requirement of an organization receiving Comprehensive Omnibus Budget Reconciliation (COBRA) funds is the stabilization of the patient in the emergency room prior to transferring to another facility. If the client’s condition is not stable, the institution cannot initiate a transfer. Facilities in violation of COBRA laws are fined and stand to lose their eligibility for Medicare and Medicaid funding. Compliance with this law is evaluated through medical record review. The documentation concerning client transfers must include:
  1. Chronology of events
  2. Measures taken
  3. Treatment implemented
  4. Patient’s response to treatment
  5. Results of measures taken to prevent the client’s condition from deteriorating

Documentation provides a written record that reflects patient care provided on the basis of assessment data and the patient’s response to interventions. Documentation is essential for the existence of an organization, accreditation purposes, reimbursement and above all, quality-of-care provided for patients.

III. TYPES OF DOCUMENTATION

Systems of recording and reporting data pertinent to the care of patients have evolved in response to the demand that health care providers be held to societal norms, professional standards of practice, legal and regulatory standards, and institutional policies and standards. Activities in the areas of quality improvement and cost containment increase the demand for thorough documentation and as a result several systems and types of documentation have evolved. Efficiency of documentation is measured in terms of time, thoroughness, and quality of the observations being recorded. Documentation must reflect the complexity of care and must be accurate, complete, and provide evidence of professional practice.
There are many methods used for documentation, however, this section will focus on narrative charting, charting by exception (only when using a clinical pathway) and Assessment, Intervention, Evaluation (AIE) charting.

A. Narrative Charting

This traditional method of nursing documentation is a chronological account written in paragraph format describing the patient’s status, interventions, treatments, and response to treatments. Narrative charting is the most flexible of all methods and is most useful in clinical settings. The documentation shows the relationship between nursing interventions and the patient’s response(s). The chronological order allows the health care team members to review the progress of the patient each day. Charting usually focuses on report from the patient(s) and is subjective. A narrative note is appropriate to document:
1. pertinent interactions
2. patient concerns
3. physician notification/intervention/results of interventions
4. professional consultations
5. changes in patient condition

B. Charting by Exception

Charting by exception (CBE) is a documentation method using standardized protocols stating the expected course of the illness. Documentation focuses only on significant findings or exceptions in a narrative form. This type of documentation assumes that patient care needs are routine and predictable and that the patient’s responses and outcomes are also routine and predictable. In CBE documentation “if it is not charted, it was not done” is replaced by the presumption that unless documented otherwise, all standardized protocols have been met and no further documentation is needed. At Harbor-UCLA Medical Center, CBE documentation is done only when a patient is admitted with a clinical pathway.

Table 2. Examples of Clinical Pathways

| • Acute coronary syndrome  |
| • Cellulitis                |
| • Appendectomy laparoscopic |
| • Appendectomy with/without rupture |
| • Cholesystectomy laparoscopic |
| • Colon resection          |

C. AIE Documentation

Use of the nursing process and goal directed nursing care is supported by documentation in the format of assessment, intervention and evaluation (AIE). AIE documentation provides a complete picture of a patient in relation to a specific nursing diagnosis and the care provided. AIE documentation is directly related to the patient care plan. Statements as used in the Nursing Evaluation and Progress Notes are defined below:
1. The assessment (A) statement includes signs and symptoms, as well as ongoing clinical judgments as they relate to the nursing diagnosis/problem and/or observation
2. The statement of interventions (I) describes the nurse’s actions that were implemented as they relate to the nursing diagnosis/problem and/or observation. Interventions are to be listed on the care plan
3. The evaluation (E) statement describes the patient’s response to the intervention(s). The evaluation is to relate to the stated nursing diagnosis/problem and describe outcomes specific to the particular diagnosis
The LVN’s AIE documentation will differ from the RN’s in several ways. The LVN Practice Act states that the LVN cannot make a nursing diagnosis, establish a patient care plan nor identify interventions, however, he/she may document on diagnoses already established on the patient care plan. The following table will point out how an LVN’s AIE documentation will differ from an RN’s.

### Table 3. LVN Specific Documentation

<table>
<thead>
<tr>
<th>Assessment</th>
<th>The LVN assessment is limited to data collection. The LVN refers any abnormal data/findings to the accountable RN or MD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interventions</td>
<td>The LVN does not make independent decisions to implement new interventions or interventions that are not already on the care plan. The LVN does not independently establish a patient care plan. The LVN contributes to the nursing care plan</td>
</tr>
<tr>
<td>Evaluation</td>
<td>The LVN evaluation describes the patient’s responses to the intervention</td>
</tr>
<tr>
<td>Nursing Diagnosis</td>
<td>The LVN cannot make a nursing diagnosis. The LVN will only document on a nursing diagnosis previously identified by the RN. If the LVN documents care related to a patient problem that is not on the care plan the nursing notes should be written in a narrative form</td>
</tr>
</tbody>
</table>

### IV. CARE PLANS

Care plans are a method to provide directions for the nursing staff to care for a particular patient. In health care settings, the care plan can be handwritten, computerized or preprinted. In order to create a care plan for the patient the nurse must follow the nursing process. The review and revision of the care plan of a patient must be done by the registered nurse during patient care. The care provided to the patient may be routine or added care indicated by the assessment data. A care plan must follow the different steps of nursing process.

### V. NURSING PROCESS

The nursing process is a systematic method of planning and providing care to patients. It is the basis for accurate and complete documentation required to meet legal standards as well as the standards of care identified in the Nurse Practice Act and by TJC. The nursing process encourages orderly thought, analysis and planning when working with patients to decide those things that need to be done. Lydia Hall used the term first in 1955, however the process was not widely used until the late 1960s. At that time, the nursing process involved only three steps, assessment, planning and evaluation. In 1974 the North American Nursing Diagnosis Association (NANDA) added nursing diagnosis as a separate and distinct step in the nursing process.

Currently, the steps in the nursing process are:

A. Assessment
B. Nursing diagnosis
C. Outcome identification
D. Planning
E. Implementation
F. Evaluation
The nursing process is dynamic and requires creativity in its application. Although the steps remain the same in each patient situation, the application and results will differ. The nursing process is designed to be used with patients throughout the life span and in any kind of care setting.

A number of skills are required of the nurse in the use of the nursing process as a framework in providing care for patients. Critical thinking is an essential skill for each nurse when providing care for any type of patient population. Critical thinking can be learned, just as any other skill. The following table provides examples of critical thinking when using the nursing process.

Table 4. Steps of Nursing Process and Critical Thinking

<table>
<thead>
<tr>
<th>Steps of the Nursing Process</th>
<th>Critical Thinking Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment</td>
<td>What data are necessary to prevent, anticipate, or detect the current health problem?</td>
</tr>
<tr>
<td>Nursing Diagnosis</td>
<td>How can the data be put together and analyzed? What are the underlying causes of or risk factors associated with this diagnosis?</td>
</tr>
<tr>
<td>Outcome Identification</td>
<td>What are the specific desired outcomes for this patient?</td>
</tr>
<tr>
<td>Planning</td>
<td>What interventions will help to detect or manage the current health problem(s) of the patient?</td>
</tr>
<tr>
<td>Implementation</td>
<td>What are the steps to follow to implement the interventions for the current health problem?</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Were the specific desired goals and outcome met? Were the specific desired goals and outcome measurable?</td>
</tr>
</tbody>
</table>
A. Assessment

Assessment is the first step in the nursing process and includes the systematic collection, verification, organization, interpretation, and documentation of patient data. Complete and correct information obtained in this step directly relates to the accuracy of the steps that follow. The purpose of the assessment is to identify a patient’s health promoting behaviors as well as actual and/or potential health problems. Through assessment the nurse can identify the functional capability, and the absence or presence of dysfunction. Assessment also serves as a therapeutic communication relationship with the patient and nurse during the disease process and hospital stay. The type and scope of information needed for assessment is determined by the health care setting, patient population, role of the nurse, scope of practice and the disease process. Assessments can be comprehensive, focused or ongoing. Data is collected by either subjective or objective methods. It is the responsibility of the nurse to validate the collected data for accuracy. Once the data is validated it must be documented and reported. Data that reflects a significant deviation from the normal baseline needs to be reported. Documentation of the assessment is the basis for determining the quality of care and should include appropriate data to support identified problems.

<table>
<thead>
<tr>
<th>Table 5. Assessment and Reporting Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Rapid heart rate with irregular rhythm</td>
</tr>
<tr>
<td>• Severe difficulty breathing</td>
</tr>
<tr>
<td>• Temperature of 101.9°F</td>
</tr>
</tbody>
</table>

B. Nursing Diagnosis

The second step in the nursing process involves further analysis and synthesis of the collected data and formulation of a nursing diagnosis. Lists of nursing diagnoses are available through NANDA. The nursing diagnosis is a clinical judgment by the RN about the patient’s responses to actual or potential health problems. Selection of nursing interventions to achieve outcomes is based on the nursing diagnosis. A patient will receive both nursing and medical diagnoses; therefore, it is important to have a clear understanding of the difference between a nursing diagnosis as compared to a medical diagnosis. The following table explains the different examples:

<table>
<thead>
<tr>
<th>Table 6. Difference between Nursing Diagnosis and Medical Diagnosis²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nursing Diagnosis</strong></td>
</tr>
<tr>
<td>Recognizes situations that the nurse is licensed and qualified to treat</td>
</tr>
<tr>
<td>Concentrates on the patient’s responses to actual or potential health problems</td>
</tr>
<tr>
<td>Varies as the patient’s responses and/or health problem changes</td>
</tr>
<tr>
<td>Examples: Nausea</td>
</tr>
<tr>
<td>Acute pain</td>
</tr>
<tr>
<td>Ineffective breathing pattern</td>
</tr>
<tr>
<td>Decreased cardiac output</td>
</tr>
</tbody>
</table>
The nurse needs to use his/her critical thinking and decision-making skill in developing nursing diagnoses. The nursing diagnosis focuses on a patient’s response to a health problem rather than a problem itself. The nursing diagnosis provides a structure for the nurse to develop a plan of care. Nursing diagnoses can be either actual (a problem exists) or potential (risk for developing). In contrast, medical diagnoses identify or determine a specific disease, condition or pathologic state.

C. Outcome Identification

Outcome identification is the third step of nursing process. A registered nurse identifies the expected outcome individualized to the patient’s nursing diagnosis. To accomplish the outcome, the nurse must involve the patient, family members and other health care providers whenever possible and appropriate. The nurse must include other aspects of care such as culture and socioeconomic status in order to develop a realistic outcome in relation to the patient’s present and potential capabilities.

D. Planning

The fourth step of nursing process includes the formulation of a proposed course of nursing action(s). Planning consists of three phases: initial, ongoing and discharge. Each phase of planning contributes to the comprehensive plan of care. The steps of each planning phase include:

1. Prioritizing the list of nursing diagnoses
2. Identifying the long and short term goals and outcomes
3. Developing specific nursing interventions
4. Documentation of the nursing care plan

In order to plan accurately the nursing diagnoses should be prioritized. The nurse needs to think critically and must identify which diagnoses are the most important and therefore require attention first. The nurse must be able to identify and separate the nursing diagnoses dependent on the severity of the disease process, such as a life-threatening vs. non-life-threatening diagnosis.

Table 7. Prioritizing Nursing Diagnoses

- Airway
- Breathing
- Cardiac/circulation
- Vital signs
- Mental status change
- Acute pain
- Elimination
- Untreated medical diagnoses (e.g., diabetes)
- Abnormal lab values
- Psychosocial problems

After establishing a nursing diagnosis the nurse must formulate a goal to meet the expected outcome. The purpose of creating a goal is to evaluate the desired outcome of a patient’s condition. Patient-centered goals ensure that nursing care is individualized and focused on the patient. A short term goal is the resolution of a nursing diagnosis over a short period of time, usually a few hours or days. A long-term goal is an objective statement that outlines the desired resolution of a nursing diagnosis over a longer period of time, usually weeks to months. A short-term goal focuses on etiology while a long-term goal focuses on the problem component of the nursing diagnosis. The goals and outcomes are achieved through specific nursing interventions. A nursing intervention is an action performed by the nurse to attain the goal(s).
Table 8. Examples of Nursing Interventions

- Weigh the patient at each visit
- Teach the mother to hold the baby for breast feeding
- Assist the patient to turn, cough, and deep breath every 2 hours
- Teach the patient to use call light for assistance
- Teach the mother nipple care when breast feeding

E. Implementation

The fifth step in the nursing process involves implementation of the nursing care plan. During this phase the nurse continues to assess the patient’s condition before, during, and after each nursing intervention. Ongoing assessment allows the nurse to identify positive or negative responses of the patient and allows the nurse to make necessary changes to the plan of care. In order to make the implementation phase effective, the nurse must identify interventions to transition the patient from illness to a healthy lifestyle. Nursing interventions can be written as orders in the care plan that the nurse may be able to initiate independently or with the collaboration of physicians or other health care professionals. Interventions can be a specific order(s), standing order(s), or protocol(s). Implementation also involves documentation and reporting. Information that must be documented includes the patient’s condition prior to the intervention, specific intervention(s) performed, the patient’s response to the intervention(s) and the outcome(s). Handoff communication among nurses and other health care providers is essential for communicating the patient’s current health status. Handoff communication occurs during change of shift, break period, or transfer of care from one service or provider to another. Some of the essential components reported during handoff communication are:

1. Activities completed and those yet to be completed
2. Status of current relevant problem(s)
3. Any abnormalities or changes in assessment
4. Results of treatments
5. Diagnostic tests scheduled or completed
6. Newly diagnosed problem(s)

In summary, the implementation step of the nursing process is directed towards the patient needs, resulting health promotion, prevention of disease, disease management, or health restoration.

F. Evaluation

The sixth step of nursing process involves evaluating whether the patient goals have been met, partially met, or not met. The nurse needs to make decisions during each evaluation phase. If a goal is met, the nurse must decide whether nursing activities should cease or continue in order for status to be maintained. If a goal is only partially met or not met, the nurse must reassess the situation and develop new intervention(s).

Table 9. Possible reasons for goals that are not met or partially met

- Initial assessment data were incomplete
- Inappropriate nursing diagnosis
- Unrealistic goals and expected outcome
- Unrealistic time frame
- The goals and/or interventions planned were not appropriate for the patient or diagnoses
- Implementation of the plan of care is not fully carried out
Evaluation is a fluid process that depends on all the other components of the nursing process. Evaluation is woven into every phase of the nursing process and an ongoing evaluation is essential for all aspects of nursing care.

**Figure 2. Nursing Assessment**

![Nursing Assessment Diagram](image)

**VI. NURSING DOCUMENTATION**

Documentation requirements differ depending on the health care setting, such as inpatient vs. outpatient settings. Regardless of the patient care administered, the documentation of that care must reflect the nursing process. Nursing documentation must be logical, focused, and relevant to care, and must represent each phase in the nursing process. Nursing documentation based on the nursing process will provide an effective tool to the facility because patient care can be traced from assessment, problem identification, care planning, implementation and evaluation.

**VII. Computerized Charting**

A software program supports nursing documentation in an electronic record. Usually these types of programs follow the components of the nursing process. The nursing documentation system works hand in hand with the hospital information system (HIS). Computerized charting increases legibility, stores and retrieves information quickly and easily, helps link diverse sources of patient information, reduces documentation time, increases accuracy, and improves communication among health care
providers. One of the major drawbacks with computerized charting is concern that patient confidentiality may be compromised if security measures are neglected.

Computerized documentation tips:
- Never share the computer user name and password
- User must log off to prevent unauthorized access by others
- Keep monitors and print versions of patient information where others cannot see the information
- Table 10 provides some important aspects of effective nursing documentation

Table 10. General Documentation Guidelines

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ensure that the nurse has the correct patient medical record or chart and the patient identification is verified using a minimum of two patient identifiers.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>The Registered Nurse (RN) and Licensed Vocational Nurse are responsible for documenting nursing care on the Nursing Evaluation and Progress Notes.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>An RN is required to document on every patient every shift</strong></td>
<td></td>
</tr>
<tr>
<td>➢ The ongoing assessment on the flow sheet may satisfy this requirement when an LVN is assigned to the patient. Additionally, an RN is required to document patient care on the Nursing Evaluation and Progress Notes whenever the patient’s condition changes, when a critical incident occurs, and/or when the patient is transferred or discharged.</td>
<td></td>
</tr>
<tr>
<td><strong>If possible, document as soon as the patient encounter is completed. This practice will ensure accurate recall of the data.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>The nursing documentation can follow an AIE format, narrative notes or a transfer summary following the nursing process standards.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Events shall be recorded chronologically, as they occur throughout the shift. Identify late entries as such and date and time accordingly.</strong></td>
<td></td>
</tr>
<tr>
<td><em><em>Each entry shall be dated, timed and initialed</em>.</em>*</td>
<td></td>
</tr>
<tr>
<td><strong>Use military time.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>All entries shall be signed using the initial of the first name and full last name followed by the employee’s job classification, e. g., S. Williams, RN.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Do not leave empty spaces between entries.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Corrections to medical record entries shall be made so that the original entry remains readable (i.e., drawing one line through the entry) with the correction dated, timed, and initialed. Also, notes recorded to clarify previously written information must make reference to the prior note being clarified. All paper documentation errors must be signed and marked as follows:</strong></td>
<td></td>
</tr>
<tr>
<td>a. Single word/single line error</td>
<td></td>
</tr>
<tr>
<td>1. Draw a single line through the error and write the word “error”.</td>
<td></td>
</tr>
<tr>
<td>2. Sign initial of first name and full last name followed by employees job classification, time and date*.</td>
<td></td>
</tr>
<tr>
<td>* Note: Initials may be used on flow sheets if the legend has the full name and initials.</td>
<td></td>
</tr>
<tr>
<td>b. Multiple errors</td>
<td></td>
</tr>
<tr>
<td>1. X out entire passage in error and write the word “error”.</td>
<td></td>
</tr>
<tr>
<td>2. Sign initial of first name and full last name followed by employee’s job classification, time and date.</td>
<td></td>
</tr>
<tr>
<td>c. Entire page error</td>
<td></td>
</tr>
<tr>
<td>1. X out entire page and write the word “error.”</td>
<td></td>
</tr>
<tr>
<td>2. Sign initial of first name and full last name followed by employees job classification, time and date.</td>
<td></td>
</tr>
<tr>
<td>Electronic documentation errors must be handled as follows:**</td>
<td></td>
</tr>
<tr>
<td>a. Go to Edit and Delete</td>
<td></td>
</tr>
<tr>
<td>b. Right click on the document to change and edit or delete and make the necessary change(s).</td>
<td></td>
</tr>
<tr>
<td>c. If unable to delete all of the documentation error, type “charted on wrong patient” (if applicable) in the comment section.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Never change another person’s entry, even if it is incorrect.</strong></td>
<td></td>
</tr>
</tbody>
</table>
• Use quotation marks to indicate direct patient responses (e.g., “I feel nauseated”)
• Write legibly.
• Use a black or blue pen for all documentation purposes (black is usually preferable because it photocopies well).
• Document in a complete but concise manner by using phrases and abbreviations as appropriate.
• Document all telephone calls that the nurse makes or receives that are related to the patient’s condition.
• Transfer and discharge summary must be documented on the appropriate form. The RN notes the patient’s mental and physical status, activity, skin condition, where they were transferred/discharged to, with whom, time and mode of transportation. The discharge summary must also include patient teaching/counseling and understanding of same, in addition to the ability to manage continuing care.
• All instructions and evidence of patient/family understanding and ability to manage continuing care must be documented in the nursing notes or on the interdisciplinary Patient/Family/Education Record. If the patient has a medical condition that makes it impossible or impractical to undertake patient education indicate the reason in the Teaching Needs section of the record.

In conclusion, nursing documentation is a professional responsibility and accountability of all nurses. As the professional responsibility of all health care providers, documentation provides written evidence of the health care provider’s accountability to the client, the institution, the profession, and society. Nurses are responsible for assessing and documenting that that patient has an understanding of the planned care prior to the intervention(s). Nursing documentation reflects a nurse’s decision-making ability, patient’s plan of care, critical-thinking skills, judgments, and evaluations.
References


Bibliography


Study Questions

1. The steps in the nursing process include diagnosis, assessment, planning, evaluation, outcome identification and:
   a. Intervention
   b. Implementation
   c. Critical thinking
   d. Patient discharge

2. The type of charting most likely to be used in a clinic is:
   a. AIE
   b. Narrative
   c. Clinical pathway
   d. Charting by exception

3. A nursing diagnosis is a clinical judgment:
   a. About a pathologic condition
   b. Identifying a specific disease or condition
   c. Understanding the routine care provided by a nurse
   d. About a patient’s subjective/objective responses health problem(s)

4. When establishing priorities for a patient’s nursing care plan, the nurse should prioritize life-threatening diagnoses as the highest priorities and which as the lowest priorities?
   a. Patient safety needs such as fall prevention measures
   b. Referral to shelter/AAA classes for alcohol prevention
   c. Patient discharge teaching of insulin self administration
   d. Provision of home oxygen and suction equipment after discharge

5. Documentation of nursing interventions:
   a. Provides job security for nurses
   b. Ensures progress towards expected outcome
   c. Constitutes a legal record of care provided to the patient
   d. Frees nursing staff from performing complete physical assessments

6. When a documentation error has been made, a nurse should:
   a. Erase the error
   b. Scratch out or white out
   c. Use a new nursing progress note
   d. Draw one line through the error, write “error” and date, time and first initial and last name followed by job classification
Check Your Answers to the Study Questions

1. b
2. b
3. d
4. b
5. c
6. d

If you missed one or more questions, read the content again and repeat the study questions.
**BLOOD SAMPLING VIA VENIPUNCTURE**

**Objectives:**
Upon completion of this section, the nurse will be able to:

1. Identify two potential contamination sources in blood sampling procedure
2. Recognize a viable vein for blood sampling procedure
3. State a nursing intervention that needs to be performed prior to drawing blood on a patient with an ongoing intravenous infusion
4. State the correct sequence when collecting blood sample with multiple tubes
5. Identify the correct amount of blood needed for coagulation study in a sodium citrate tube

Instructions to the employee:

Please read the following section and then answer the study questions at the end of this section.
Blood sampling via venipuncture

I. INTRODUCTION

Blood sampling procedure is the process of collecting a blood sample from a vein using a needle.¹ This process is commonly requested by the primary care provider to help determine any changes in a patient's condition. Blood sampling procedure is considered easy to perform, but if collected incorrectly, the reliability of the result is doubtful and the rippling effect of the error precedes complex setback.

Here at Harbor-UCLA Medical Center, a retrospective chart review from January 2010 to June 2010 was conducted jointly by the Department of Pathology and Clinical-Professional Development (CPD). Through chart review, 63 blood samples were found contaminated. The blood samples were contaminated by ethylenediamine tetraacetic acid (EDTA) and sodium citrate exposure, a tainted line, hemolysis, and mislabeled specimen (Figure 1). Hence, the contaminated specimens were discredited and the procedure had to be repeated.

Figure 1. Sources of Contamination and Rate

![Bar chart showing sources of contamination and rate]

The purpose of this clinical competency is to review how to properly collect a blood sample. Collecting a blood sample from an existing line, e.g., central venous catheter, is not included in this clinical competency.

II. ARTERY

The nurse needs to be able to distinguish an artery from a vein. The main difference is that an artery has a pulse and a vein does not. An artery usually lies deep in the tissue, but few are easily reachable, e.g., radial, brachial. It is important to palpate the area prior to needle puncture to confirm and differentiate between an artery and a vein. Figure 2 illustrates the anatomy of the artery and vein and Figure 3 illustrates the proximity of the artery to a vein in the upper limb.
III. VEIN

Veins are more superficial and lie beneath the surface of the skin. A vein is viable when it feels full and bounces back when lightly pressed. The nurse should use one to two fingers of the non-dominant hand to palpate. The viable vein should feel straight and tubular in shape. A viable vein should not feel hard, bumpy or flat. A sclerosed or damaged vein will feel hard and knotty and will not withstand catheter threading. A vein also has a valve, which promotes blood return to the heart. A valve can be seen as a small bulge through the skin and felt on palpation. In contrast, an artery does not have a valve.

The wall of the vein is comprised of three layers: The internal layer (tunica intima), middle layer (tunica media), and outer layer (tunica adventitia). Figure 2 illustrates these layers.

The internal layer of the vein is naturally designed to ensure constant blood flow and disallow blood cells from adhering to the inner wall. Any trauma to the vein affects its natural design and may result in thrombus formation in the inner wall.

The middle layer is made of elastic tissue and smooth muscle fibers. This layer is sensitive to changes in temperature and mechanical irritation which can cause venous spasm, e.g., administration of cold fluids or irritating drugs.
The outer layer is composed of connective tissue, collagen and nerve fibers. Veins generally have less fibrous tissue than arteries, making them easier to palpate, but more prone to collapse.²

**Figure 4. Capillaries**

**IV. CAPILLARY**

The capillary is thin-walled vessel through which nutrients and waste products are exchanged (Figure 4). The capillary consists of a layer of endothelial cells and basement membrane surrounded by a pericapillary sheath of connective tissue. Capillaries allow for the exchange of oxygen and carbon dioxide between the blood and body tissues.

**V. VEIN SELECTION**

The veins of the upper extremities are the most accessible, convenient, easily visualized and are ideal for venipuncture. The antecubital fossa is the most commonly used site and the basilic, cephalic and median veins seem to be the most punctured. If unable to visualize and palpate the veins, apply a warm compress to the site for a few minutes. The heat will increase the blood flow to the extremity and dilate the veins.³

The dorsal metacarpal veins are also acceptable for venipuncture, but should only be considered if the major superficial veins of the upper extremity are not accessible. The dorsal metacarpal veins are smaller and more likely to collapse if multiple tubes need to be filled.

Avoid the leg and foot veins as much as possible and use as last resort due to higher probability of complications, e.g., thrombophlebitis.⁴ It is advisable to consult with a physician prior to obtaining a blood sample via venipuncture from the leg or foot.

Choose the appropriate needle size in comparison to the vein size. This may help reduce unnecessary pain. Distraction has been shown to help reduce pain particularly in children.⁵ The use of television or a personal audio device, if available, may provide some sort of distraction.

Avoid over advancement of the needle. Once the flashback of blood is noted in the tubing, advance the needle approximately 1-2 mm and reduce the angle of the needle slightly. If bruising or swelling develops after venipuncture, pressure should be applied to the site. Placing an icepack to the puncture site may ease the discomfort.

If collecting a blood sample from the extremity with a peripheral intravenous (IV) infusion, the nurse should stop the IV for five minutes prior to collection. This can reduce the chance of specimen contamination. The venipuncture site should be below and away from the infusion site. If the patient is receiving an IV containing vasoactive medications such as dopamine, the IV should never be stopped. Blood should be collected in the opposite extremity.

**VI. CORRECT SEQUENCE**

The nurse needs to know the correct sequence when using multiple collection tubes. This is important because most of the common collection tubes used for blood draws have additives. These additives are purposely placed by the manufacturer as a preservative and are required to properly conduct the necessary tests.

Collection tubes have color coded tops, signifying the type of additive in the tube. Tubes have additives specific for the type of tests that are performed on the blood in the tube. If the additive from one tube is inadvertently mixed with blood in a different tube, the test result will be inaccurate and the specimen is considered contaminated. **When the laboratory suspects one tube (test) has been contaminated, all tests sent with the contaminated test are considered contaminated, and all the laboratory specimens must be redrawn.**
For example, a physician orders a complete blood count and chemistry tests to be drawn for a patient. The nurse collected the blood specimen as ordered, but was unaware of the proper sequence of collection draw. The nurse collected the complete blood count first (purple tube) then the chemistry (gold tube) second. The purple tube contains an additive, K2 EDTA. If the K2 EDTA from the purple tube/needle mixes with the specimen in the gold tube, the K2 EDTA adds extra potassium in the patient's blood sample producing false high serum potassium and low serum calcium. See figures 5 and 6 for images of incorrect sequence.

In another example, a physician orders a chemistry test and coagulation study. The nurse collected the blood specimen in the correct sequence, coagulation study first (blue tube), then chemistry next, but did not draw enough blood for the second tube. The nurse then removed the cap from the blue tube and poured one ml of blood from the blue tube into the gold tube (Figure 7). The blue tube contains sodium citrate. If the sodium citrate from the blue tube/needle mixes with the sample in the gold tube, high serum sodium and low serum calcium will result.

In addition, the nurse must invert the tube after the collection for at least five to eight times to adequately mix the specimen with the additive. Do not shake the tube, as this can lead to hemolysis.
Once the blood specimen is collected and labeled in the presence of the patient, the sample needs to be delivered to laboratory immediately. Figure 8 illustrates the correct sequence of draw.

**Figure 8. Correct Sequence of Draw and Additives**

<table>
<thead>
<tr>
<th>Color</th>
<th>Usage</th>
<th>Additive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. BLOOD CULTURE BOTTLES</td>
<td>Blood Culture</td>
<td>n/a</td>
</tr>
<tr>
<td>2. BLUE TOP TUBE</td>
<td>Coagulation tests (e.g., PTT, PT, INR)</td>
<td>Sodium Citrate</td>
</tr>
<tr>
<td>3. GOLD, RED, or TIGER TOP TUBE</td>
<td>Chemistries (e.g., comprehensive panel, electrolytes)</td>
<td>Gel Separator</td>
</tr>
<tr>
<td>4. GREEN TOP TUBE</td>
<td>CK-MB, troponin, ammonia</td>
<td>Heparin</td>
</tr>
<tr>
<td>5. PURPLE TOP TUBE</td>
<td>CBC</td>
<td>K2 EDTA</td>
</tr>
<tr>
<td>7. GRAY TOP TUBE</td>
<td>Glucose tolerance test, lactic acid</td>
<td>Fluoride</td>
</tr>
</tbody>
</table>

**PROCEDURE: Blood Sampling Procedure via Venipuncture**

<table>
<thead>
<tr>
<th>Action</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Obtain physician's order.</td>
<td>Complete physician's order required</td>
</tr>
<tr>
<td>2. Gather supplies.</td>
<td>Check the collection tube for expiration date(s)</td>
</tr>
<tr>
<td>3. Explain procedure and answer all questions before obtaining blood sample.</td>
<td>Support to ease anxiety level</td>
</tr>
<tr>
<td>4. Wash hands and don clean gloves.</td>
<td>Reduce transmission of microorganisms</td>
</tr>
<tr>
<td>5. Use two patient identifiers, e.g., name and medical record number.</td>
<td>Promote patient safety</td>
</tr>
<tr>
<td>6. Apply the tourniquet. Inspect, palpate and select an appropriate vein.</td>
<td>The tourniquet should be tight enough to impede venous return, but should not obstruct arterial flow; a distal arterial pulse should still be palpable</td>
</tr>
<tr>
<td><strong>NOTE:</strong> Avoid site with extensive scars from burns, surgery, arm on side of mastectomy, or skin malformation. Wait for two minutes before reapplying the tourniquet.</td>
<td></td>
</tr>
<tr>
<td>7. Ask the patient to make a fist and then clean the skin with the alcohol wipe for at least 30 seconds and allow to air dry. Do not re-palpate or touch the skin.</td>
<td>Reduce contamination of samples for microbiology and to reduce risk of skin pathogens entering the circulatory system</td>
</tr>
<tr>
<td>8. Apply traction to the skin below the intended puncture site.</td>
<td>To stabilize the vein and increase the likelihood of success</td>
</tr>
<tr>
<td>9. Hold the wings of the device firmly, ensure the bevel of the needle is upwards and insert the needle through the skin at an angle of 10-30º, observe for flashback of blood into the tubing.</td>
<td>Reduce the risk of puncturing the back wall of the vein during the insertion, to confirm successful entry into the vein</td>
</tr>
<tr>
<td>10. Connect collection tube in correct sequence for multiple tests and withdraw the correct amount. For the blue tube, fill the tube with ≥ 90% or ≤ 110% amount of blood. For the gold, pink, and purple tubes, fill the tube with ≥ 50% amount of blood.</td>
<td>Ensure that there is enough blood in the tube to mix with the additive and reach the correct blood to additive ratio for greater accuracy</td>
</tr>
<tr>
<td>11. Invert the collection tube five to eight times, do <strong>not</strong> shake.</td>
<td>Prevents hemolysis</td>
</tr>
<tr>
<td>12. When the blood withdrawal is nearly finished, release the tourniquet (during the filling of the</td>
<td>Reduce the venous pressure and restore venous return. This will reduce bleeding and hematoma</td>
</tr>
</tbody>
</table>

Nursing Department Reorientation Self Study Guide: Clinical Competencies - 22
<table>
<thead>
<tr>
<th>Action</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>last tube).</td>
<td>when the needle is withdrawn</td>
</tr>
<tr>
<td>13. When blood collection is complete, place a sterile swab over the insertion site, withdraw the needle, apply pressure until the bleeding stops.</td>
<td>Prevent contamination of the venipuncture site, to secure hemostasis and prevent bruising</td>
</tr>
<tr>
<td>14. Label the collection vial in the presence of the patient. Ensure label on the vial is visible and read from top to bottom.</td>
<td>Ensure patient safety</td>
</tr>
<tr>
<td>15. Send sample to laboratory immediately.</td>
<td></td>
</tr>
</tbody>
</table>

VII. CONCLUSION

Collecting blood specimen is a skill that the nursing staff must perform precisely. Although collecting blood specimen is a common clinical procedure that happens on a daily basis, mistakes continue to occur. It is crucial for the nursing staff to recognize the numerous possible complications associated with collecting a blood sample, if poor technique is used. It is advisable for the nurse to be familiar with the theoretical aspects of venipuncture along with the supplies used to safely collect the blood sample, thus avoiding erroneous results.
References


Bibliography


Study Questions

1. A difference between an artery and a vein is that an:
   a. Artery is superficial and a vein is not
   b. Artery has a valve and a vein does not
   c. Artery has a pulse and a vein does not
   d. Artery has three layers and a vein does not

2. The nurse started D5 ½ NS at 125 mL per hour. A few hours later, the nurse received an order to draw for a chemistry test. The only viable vein identified was located on the same extremity as the IV infusion site. The nurse should:
   a. Stop the running IV and immediately collect the blood above the site
   b. Stop the running IV and immediately collect the blood below the site
   c. Stop the running IV for five minutes then collect the blood above the site
   d. Stop the running IV for five minutes then collect the blood below the site

3. The nurse collected a specimen for a complete blood count first (purple tube) then a specimen for a chemistry (gold tube) second. Few hours later, the nurse received a call from the laboratory stating a critical elevated value of potassium. Since the nurse did not follow the correct sequence of draw, this result is most likely due from:
   a. Fluoride exposure
   b. Silica gel exposure
   c. K2 EDTA exposure
   d. Sodium citrate exposure

4. The nurse received an order for multiple blood draws which consist of using the purple, gold, blue, and pink top vial. To correctly collect the specimen, the nurse must follow this sequence:
   a. Blue, gold, purple, and pink
   b. Gold, blue, pink, and purple
   c. Blue, gold, pink, and purple
   d. Purple, gold, pink, and blue

5. The correct amount needed for a coagulation study using a blue top vial is:
   a. 90% full
   b. 75% full
   c. 60% full
   d. 45% full
Check Your Answers to the Study Questions

1. c
2. d
3. c
4. c
5. a

If you missed one or more questions, read the content again and repeat the study questions.
<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Part I reviews basic medication calculations and must be completed by licensed staff working in all areas of the hospital.</td>
</tr>
<tr>
<td>2.</td>
<td>Part II reviews calculations for intravenous heparin bolus and infusion doses.</td>
</tr>
<tr>
<td>3.</td>
<td>Part III reviews advanced medication calculations for continuous infusion medications (i.e., drips) and must be completed by registered nurses working in neonatal, pediatric, and adult ICUs; the pediatric and adult emergency room; and the post anesthesia recovery unit.</td>
</tr>
</tbody>
</table>

Calculation questions on the Medication Calculation clinical competency test will be fill in the blank, **NOT** multiple choice. You may use a calculator when completing the test.

**Instructions to the Employee:**

Refer to the “Medication Calculation Matrix – Completion Requirements by Area” to determine the sections that you must complete.

Gather scratch paper and pencils. Please read the appropriate section(s). Record the calculations and the answers to the study questions on your scratch paper. You may use a calculator to complete this competency. **Do not write in this manual.**
Medication Calculation Matrix – Completion Requirements by Area

This table identifies the requirements for completion of the Medication Calculation competency. Requirements are based on work area.

<table>
<thead>
<tr>
<th>AREA</th>
<th>Part I Basic Medication Calculation</th>
<th>Part II Heparin Infusion (RNs Only)</th>
<th>Part III Advanced Medication Calculation for Continuous Infusion Medications (RNs Only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3W</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3E</td>
<td>X</td>
<td>X</td>
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</tr>
<tr>
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<td>X</td>
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<tr>
<td>3WCTU</td>
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<td>X</td>
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<td>X</td>
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<td>7W</td>
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<td>7E NLII</td>
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<tr>
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<td>WILMINGTON H.C.</td>
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<tr>
<td>WOUND CARE TEAM</td>
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</tr>
</tbody>
</table>
Part I

Basic Medication Calculations

To be completed by licensed staff in all nursing areas.

Objectives – Part I: Basic Medication Calculations:

Upon completion of this section, the workforce employee will be able to:

1. Identify metric units of measurement commonly used in dosage calculation of oral and parenteral medications.
2. State common equivalents in the metric system that are used for medication administration.
3. Convert metric weights and volumes within the metric system.
4. Express metric weights and volumes using correct notation rules.
5. Describe the use of milliequivalents (mEq), units, and percentages (%) in dosage calculation.
6. Use one of the following methods to accurately calculate medication dosages:
   - \( \frac{D}{H} \times Q \)
   - Ratio and proportion
I. Introduction

This competency will focus on the dosage calculation of oral and parenteral medications. This competency will review medication measurement systems most commonly encountered in the clinical setting. Two common formulas for dosage calculations are presented for use in working through the practice problems.

II. Systems of medication measurements

A. Metric system

The metric system is the most commonly used system of measurement for prescribing and administering medications. The metric system is a decimal system based on multiples of ten. Numbers to the left of the decimal are whole numbers and numbers to the right of the decimal are fractions of whole numbers. Each number has a place value. The value of each place is ten times the value of the place immediately to its right.

The first number after the decimal point is the tenth place. 0.1 is read as one tenth (1/10).

The second number after the decimal point is the hundredth place. 0.01 is read as one hundredth (1/100).

The third number after the decimal point is the thousandth place. 0.001 is read as one thousandth (1/1000).

Because each place is a multiple of ten, moving a decimal point one place produces a 10-fold change in the number. A medication error involving a misplaced decimal point can result in serious under or overdosages of a medication. For example, if a nurse gives 12 mL of a medication instead of 1.2 mL, the patient will receive 10 times the dose!

The metric system has three basic units of measure: meter (length), liter (volume), and gram (weight). Metric units important in dosage calculation are the liter (L) and the gram (gm). Common prefixes are used to indicate the value of each unit of length, volume, or weight.

The following indicate smaller parts than the basic unit of measure:

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Value</th>
<th>Decimal Equivalent</th>
<th>Relationship to Basic Unit (meter, liter, gram)</th>
</tr>
</thead>
<tbody>
<tr>
<td>deci</td>
<td>one tenth</td>
<td>0.1</td>
<td>10 times smaller</td>
</tr>
<tr>
<td>centi</td>
<td>one hundredth</td>
<td>0.01</td>
<td>100 times smaller</td>
</tr>
<tr>
<td>milli</td>
<td>one thousand</td>
<td>0.001</td>
<td>1,000 times smaller</td>
</tr>
<tr>
<td>micro</td>
<td>one millionth</td>
<td>0.000001</td>
<td>1,000,000 times smaller</td>
</tr>
</tbody>
</table>

One prefix indicates a larger unit than the basic unit of measure:

| Kilo    | one thousand | 1000.0 | 1000 times greater |
It is helpful to memorize some of the common metric unit abbreviations and their equivalents used in clinical dosage calculations (Table 1).

**Table 1. Metric Equivalents.**  

<table>
<thead>
<tr>
<th>WEIGHT</th>
<th>VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 kilogram (kg) = 1000 grams (g)</td>
<td>1 liter (L) = 1000 milliliters (mL)</td>
</tr>
<tr>
<td>1 gram (g) = 1000 milligrams (mg)</td>
<td>or 1000 cubic centimeters (cc)*</td>
</tr>
<tr>
<td>1 milligram (mg) = 1000 micrograms (mcg)</td>
<td>1 milliliter (mL) = 1 cubic centimeter (cc)</td>
</tr>
</tbody>
</table>

*The cubic centimeter (cc) is the amount of space that 1 mL occupies. The two measures are interchangeable, but mL is the preferred abbreviation.

As shown above, each of the common units of measure used in dosage calculations differs from the next by 1000. Since each place is a multiple of ten, and each zero represents one place value, to convert between these units of measure the decimal point is moved three places. The direction the decimal point is moved is dependent on whether the value is moving down to a smaller unit of measure or moving up to a larger unit of measure. If moving down in value, the quantity becomes larger so the decimal point is moved three places to the right (Table 2). If moving up in value, quantities become smaller and the decimal point is moved three places to the left (Table 3). Being able to convert these common units is important when calculating dosages.
Table 2. Moving Down in Value: Example.

<table>
<thead>
<tr>
<th>0.5 gm is equivalent to how many milligrams?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 gm 0.500. = 500 mg</td>
</tr>
</tbody>
</table>

We converted down the scale. Milligrams are a smaller unit of measure than grams. To convert grams to milligrams, move the decimal point three places to the right and change the units to milligrams. In order to do this, two zeros must be added.

Another method to convert grams (large) to milligrams (small) is to multiply by 1000.

\[
0.5 \text{ gm} \times 1000 = 500 \text{ mg}
\]

Table 3. Moving Up in Value: Example.

<table>
<thead>
<tr>
<th>2500 mL is equivalent to how many liters?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2500 mL 2.500. = 2.5 L</td>
</tr>
</tbody>
</table>

We converted up the scale. A liter is a larger unit of measure than a milliliter. To convert mL to L, move the decimal point three places to the left and change the units to L. Once done, it is possible to drop two zeros as retaining them does not change the value.

Another method to convert milliliters (small) to liters (large) is to divide by 1000.

\[
2500 \text{ mL} \div 1000 = 2.5 \text{ L}
\]

NOTE: Errors in metric system dosage calculations occur more frequently when the dosage contains a decimal. Whenever possible, perform the conversions to eliminate the decimal point. It is also important to ALWAYS place a zero in front of decimal fractions (Table 4).

Table 4. Proper Notation.

<table>
<thead>
<tr>
<th>.3 mg is an improper notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 mg is the correct notation</td>
</tr>
</tbody>
</table>
B. Other systems of medication measurements

*Units* - Medications are sometimes measured in units. A unit measures a medication in terms of its action rather than its weight. There are three major medications measured in units: heparin, penicillin, and insulin.

*Milliequivalents* - Milliequivalents (mEq) are the number of grams of a medication contained in a mL of solution. Milliequivalents are used to designate measurement in a variety of solutions, especially electrolytes.

*Percentage* - Percentages (%) are parts per hundred. Specifically, percentages represent the number of grams of medication per 100 mL of solution. The higher the percentage strength, the stronger the mixture. Percentages, as a unit of measure, are used in solutions, topical ointments and other medications. Refer to Table 5 for instructions on how to change from a percent to a fraction. The following illustrates the concentration of medications expressed as percentages:

\[
\begin{align*}
\text{Lidocaine 2%} & = \frac{2 \text{ gm of medication}}{100 \text{ mL of solution}} \\
D_{10W} & = \frac{10 \text{ gm of dextrose}}{100 \text{ mL of water}}
\end{align*}
\]

Notice that the denominator is always 100, and the numerator shows how many parts out of 100.

Table 5. Changing Percent (%) to Fraction.

1. Drop the % sign.
2. Write the number as the numerator.
3. Write 100 as the denominator.
4. Reduce to lowest terms

**EXAMPLE:**

\[
\frac{5 \text{ gm}}{100 \text{ mL}} = \frac{1 \text{ gm}}{20 \text{ mL}}
\]

PLEASE COMPLETE THE STUDY QUESTIONS ON THE NEXT PAGE
MEDICATION CALCULATION
Study Questions - Metric Units of Measure and Equivalents

Complete the following questions.

1. How many micrograms (mcg) are in a milligram (mg)?

2. How many milliliters (mL) are in a liter (L)?

3. Which is smaller?
   a. gm
   b. kg

4. Which is larger?
   a. mg
   b. mcg

5. What is the concentration of Calcium Gluconate 10%?
   a. 10 mg/100 mL
   b. 10 mg/1 L
   c. 10 gm/100 mL
   d. 10 gm/1 L

Convert the following metric measures:

6. 500 mL = L

7. 375 mg = gm

8. 1.5 kg = gm

9. 0.05 gm = mg = mcg

10. 750 mcg = mg

11. 15 cc = mL

12. 1.5 L = mL

13. 0.5 mg = mcg

14. 45 mg = gm

15. 1.2 gm = mg

PLEASE CHECK YOUR ANSWERS TO THE STUDY QUESTIONS
MEDICATION CALCULATION
Answers to Study Questions - Metric Units of Measure and Equivalents

1. 1000
2. 1000
3. a
4. a
5. c
6. 0.5 L
7. 0.375 gm
8. 1500 gm
9. 50 mg = 50,000 mcg
10. 0.75 mg
11. 15 mL
12. 1500 mL
13. 500 mcg
14. 0.045 gm
15. 1200 mg

If you answered all of the questions correctly, go on to the next section. If you missed one or more, read the content again and repeat the study guide questions.
III. Dosage calculations

**Tablets** and **capsules** each contain a specific amount of medication (Table 6). Most tablets and capsules come in multiples of the ordered dosage. When necessary, scored tablets may be divided. Most orders require giving ½ to 3 tablets. If a nurse’s calculation results in an unusual number, this could be a warning that a calculation mistake has been made. **Liquid** medication preparations contain a specific amount of medication in a certain volume of solution.

When the dosage ordered is different from what is available, dosage calculations are necessary. There are several different ways to calculate medication dosages. The following section will present two common methods of dosage calculations for preparing oral and parenteral medications, dimensional analysis and ratio and proportion. Practice the medication calculations using each method presented. Then select one method and work the study questions.

A. Medication calculations using dimensional analysis

Dimensional analysis is a method to calculate medication doses using fractions. With dimensional analysis, the problem is set up according to the following:

\[
\frac{D}{H} \times Q = X
\]

- **D** represents the desired dosage or what the physician has ordered
- **H** represents the dosage on hand or the strength available
- **Q** represents the quantity that contains the available dose
- **X** represents the volume desired and is the unknown value.

*If the problem involves tablets the Q is always 1 and therefore can be eliminated from the equation (e.g., 250 mg/tablet). However, when solving for medication in solution, the Q amount varies (e.g., 250 mg/5 mL) and must be included in the equation.*

**Table 7. Steps to Calculate Medication Dosages Using Dimensional Analysis.**

1. Ensure all units are in the same size. Convert if necessary in a manner that will eliminate the decimal point. When converting be sure to convert to the units of the available medication.

2. Estimate what would be a reasonable amount to administer.

3. Place all the information into the correct position in the formula.

4. Calculate the answer.
# EXAMPLES: Medication Calculations Using Dimensional Analysis

**Order:** 600 mg p.o.  
**Available:** 300 mg tablets

**Step 1:** Units are already in the same size (mg), no conversion is necessary.

**Step 2:** A reasonable estimate is that more than 1 tab will be given because the dosage ordered is larger than the dosage on hand.

**Step 3:**

- \( \frac{600 \text{ mg}}{300 \text{ mg}} \times \frac{1 \text{ tab}}{1} = X \)

**Step 4:**

- \( \frac{600 \text{ mg}}{300 \text{ mg}} \times 1 \text{ tab} = 2 \text{ tabs} \)

---

**Order:** 0.025 mg p.o.  
**Available:** 50 mcg scored tablets

**Step 1:** Convert to like units. Convert mg to mcg, to eliminate the decimal point. To do this, multiply by 1000 OR move the decimal point 3 places to the right and change units to mcg: 0.025 mg = 25 mcg.

**Step 2:** A reasonable estimate is that less than 1 tab will be given because the dosage ordered is less than the dosage on hand.

**Step 3:**

- \( \frac{25 \text{ mcg}}{50 \text{ mcg}} \times \frac{1 \text{ tab}}{1} = X \)

**Step 4:**

- \( \frac{25 \text{ mcg}}{50 \text{ mcg}} = \frac{1}{2} \text{ tab} \)

---

**Order:** 50 mEq p.o.  
**Available:** 20 mEq/15 mL

**Step 1:** Units are already in the same size, no conversion is necessary.

**Step 2:** A reasonable estimate is that more than 15 mL will be given because the dosage ordered is more than the dosage on hand.

**Step 3:**

- \( \frac{50 \text{ mEq}}{20 \text{ mEq}} \times \frac{15 \text{ mL}}{15 \text{ mL}} = X \)

**Step 4:**

- \( \frac{50 \text{ mEq}}{20 \text{ mEq}} \times 15 \text{ mL} = \frac{75}{2} = 37.5 \text{ mL} \)
B. Medication calculations using ratio and proportion method

A *ratio* is a comparison of two numbers which are somehow related to each other. A medication dosage ratio can be used to show the amount of medication contained in one tablet. A dosage ratio can also be used to show the amount of medication in a given volume of solution. These relationships (ratios) are expressed by either placing a colon between the numbers or writing the numbers in fraction form.

Table 8. Expression of a Ratio.

| A medication is available in a dose of 250 mg per 5 mL. The ratio is expressed as: |
| 5 mL : 250 mg or | 5 mL |
| 250 mg |

A proportion is used to prove that two ratios are equal (Tables 9 and 10). A proportion may be separated by an equal sign (=) or double colon (::).

Table 9. Expression of a Proportion
- Written as Fraction.

| 250 = 500 |
| 1 | 2 |

Read as 250 is to 1 as 500 is to 2

Proof of the ratios in a proportion being equal is demonstrated by cross multiplication. When expressed as a fraction, the numerator (top number) of each ratio is multiplied by its opposite denominator (bottom number). When expressed as a ratio, the inside numbers are multiplied, then the outside numbers are multiplied. The products in a true proportion are equal. In the above example in Table 9, the product (answer) of the numerator in the ratio on the left "250" multiplied by the denominator in the ratio on the right "2" is "500". The product of the numerator in the ratio on the right "500" multiplied by the denominator in the ratio on the left "1" is "500". Thus, these ratios are equal. In Table 10, proof of the ratios being equal is evident by multiplying the means (1 X 500 = 500) and multiplying the extremes (250 X 2 = 500).

Table 10. Expression of a Proportion
- Written as Ratio.

| 250:1 : 500:2 |

Read as 250 is to 1 as 500 is to 2

The middle numbers in a proportion are called the "means", and the two outer numbers are called the "extremes".

Ratio and proportion can be used to calculate dosages when only one complete ratio is known and the second is incomplete. If three numbers of the two ratios are known, the fourth can be determined. In the ratio and proportion method of dosage calculation, the unknown number is represented by X. When setting up a proportion, remember the following key points:

- Ratio for known equivalent = ratio for unknown equivalent. Keep the “known” information on the left.
- Set up the equation according to the following:

If using fractions, set up like this:
\[
\frac{\text{dosage on hand}}{\text{amount on hand}} = \frac{\text{dosage desired}}{\text{amount desired}} (X)
\]

If using ratio, set up like this:
\[
\text{dosage on hand: amount on hand: dosage desired: amount desired} (X)
\]

- Label the units and make sure the units in the numerators match and the units in the denominators match

**Example (fraction):**

Order: 150 mg
Available: 100 mg/2 mL

\[
\frac{100 \text{ mg}}{2 \text{ mL}} = \frac{150 \text{ mg}}{x \text{ mL}}
\]

- **Known information**
- **Denominator units are the same**

**Example (ratio):**

Order: 150 mg
Available: 100 mg/2 mL

\[
100 \text{ mg} : 2 \text{ mL} : 150 \text{ mg} : x \text{ mL}
\]

- **Known information**
- **Units on left of each ratio are the same**
- **Units on right of each ratio are the same**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ensure all units are in the same size, converting if necessary. When converting be sure to convert to the units of the available medication.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Estimate what would be a reasonable amount to administer.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Set up the problem as a proportion.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Calculate the answer by multiplying and solving for X.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 11. Steps to Calculate Medication Dosages Using Ratio and Proportion Method.**

Using the same example sets used to demonstrate the formula method, ratio and proportion will now be used to calculate medication dosages.
EXAMPLES: Medication Calculations Using Ratio & Proportion Method

Order: 600 mg p.o.
Available: 300 mg tablets

Step 1: No conversion necessary

Step 2: A reasonable estimate is that more than 1 tab will be given because the dosage ordered is more than the dosage on hand.

Step 3: \[
\frac{300 \text{ mg}}{1 \text{ tab}} = \frac{600 \text{ mg}}{X \text{ tabs}}
\]

Step 4: Cross multiply, keeping X on the left side of the equation

\[
300 \text{ mg} \times X \text{ tabs} = 600 \text{ mg}
\]

Solve for X by dividing the number on the right side of the equation by the number in front of X.

\[
\frac{300X}{300} = \frac{600}{300}
\]

X = \text{2 tabs}

Same problem, but in this example, the equation is set up using ratios (NOTE: this is the only example in which solving ratio and proportion by setting up the equation using ratios is described)

Step 1: No conversion necessary

Step 2: A reasonable estimate is that more than 1 tab will be given because the dosage ordered is more than the dosage on hand.

Step 3: \[
300 : 1 :: 600 : X
\]

Step 4: Multiply means and extremes

\[
300X = 600
\]

Solve for X by dividing the number on the right side of the equation by the number in front of X.

\[
\frac{300X}{300} = \frac{600}{300}
\]

X = \text{2 tabs}
Order: 0.025 mg p.o.
Available: 50 mcg scored tablets

Step 1: Convert to like units. To convert mg to mcg, move the decimal point 3 places to the right and change the units to mcg: 0.025 mg = 25 mcg

Step 2: A reasonable estimate is that less than 1 tab will be given because the dosage ordered is less than the dosage on hand.

Step 3: \[
\frac{50 \text{ mcg}}{1 \text{ tab}} = \frac{25 \text{ mcg}}{x \text{ tab}}
\]

Step 4: Cross multiply and solve for \(x\)

\[
50x = 25
\]

\[
\frac{50x}{50} = \frac{25}{50}
\]

\[
x = 0.5 \text{ or } \frac{1}{2} \text{ tab}
\]

Order: 50 mEq p.o.
Available: 20 mEq/15 mL

Step 1: Units are already in the same size, no conversion is necessary.

Step 2: A reasonable estimate is that more than 15 mL will be given because the dosage ordered is more than the dosage on hand.

Step 3: \[
\frac{20 \text{ mEq}}{15 \text{ mL}} = \frac{50 \text{ mEq}}{x \text{ mL}}
\]

Step 4: Cross multiply and solve for \(x\)

\[
20x = 750
\]

\[
\frac{20x}{20} = \frac{750}{20}
\]

\[
x = 37.5 \text{ mL}
\]

PLEASE COMPLETE THE STUDY QUESTIONS ON THE NEXT PAGE
Using either dimensional analysis \( \frac{D}{H} \) or the ratio and proportion method of dosage calculations, work the following problems. Include units in the answer.

1. 75 mg of medication is ordered by the physician to be given PO. Available are 50 mg scored tablets. How many tablets will the nurse administer?

2. 4000 units of medication are ordered to be given as a subcutaneous injection. Available is a vial containing 6000 units per 1.2 mLs. How many mLs will the nurse administer?

3. Available is 125 mg/5 mL syrup. The physician orders 0.5 gm PO. How many mLs will the nurse administer?

4. 30 mEq of a liquid medication is ordered to be given PO. Available is 20 mEq/15 mL. How many mLs will the nurse administer?

5. 80 mcg of medication is ordered. On hand is a liquid suspension of 0.04 mg/mL. How many mLs will the nurse administer?

6. 250,000 units of a medication is ordered IM. On hand is 100,000 units per mL. How many mLs will the nurse draw up?

7. Order: 3 gm  
   Available: 500 mg/mL  
   How many mLs will the nurse administer?

8. Order: 20 mg  
   Available: 40 mg/5 mL  
   How many mLs will the nurse administer?

9. Order: 0.3 mg  
   Available: 25 mcg/mL  
   How many mLs will the nurse administer?

10. Order: 0.5 gm  
     Available: 500 mg/mL  
            How many mLs will the nurse administer?

PLEASE CHECK YOUR ANSWERS TO THE STUDY QUESTIONS ON THE NEXT PAGE
MEDICATION CALCULATION
Answers to Study Questions - Dosage Calculations

1. 1.5 tablets
2. 0.8 mL
3. 20 mL
4. 22.5 mL
5. 2 mL
6. 2.5 mL
7. 6 mL
8. 2.5 mL
9. 12 mL
10. 1 mL

If you answered all of the questions correctly, go on to the next section. If you missed one or more, read the content again and repeat the study guide questions. **If you are required to complete Part II, proceed to the next page and complete Part II.**

**NOTE:** Calculation questions on the Medication Calculation clinical competency test will be fill in the blank, **NOT** multiple choice. You may use a calculator when completing the test. Metric equivalencies and dimensional analysis formula will be provided.
Part II

Heparin Infusion

To be completed by registered nurses working in the following areas

3EAST       3WICU
3WEST       3WCTU
4EAST       4WCCU
4WEST       5WICU
5EAST       6EICU
5EGCRC      6ENICU
5WRTU       6WICU
6WEST       Adult ER
7E L&D      Pediatric ER
7WEST       PACU

Cardiac Catheterization Laboratory
Interventional Radiology

Objectives – Part III: Heparin Infusion

Upon completion of this section, the workforce employee will be able to:

1. Given a heparin bolus dose in units/kg and a patient's weight, calculate total dose.
2. Given a concentration of heparin and a desired dose in units/kg/hour calculate total hourly dose in units/hour and the infusion rate in mL/hr.
I. INTRODUCTION

Heparin is a widely used anticoagulant. Heparin prevents the formation of blood clots and extension of existing clots within the blood. It does not break down existing clots. Indications for heparin administration include deep vein thrombosis, pulmonary embolism, unstable angina and non-ST elevated myocardial infarction, and cardiac valve replacement. Heparin is also prescribed for patients on continuous renal replacement therapy and an intra-aortic balloon pump.

At Harbor-UCLA continuous infusion heparin must be ordered on one of the approved pre-printed order forms [i.e., Heparin Continuous Intravenous Infusion (Adult) Physician Order Form, Low Dose Heparin Continuous Infusion Orders (Adult), Heparin Continuous Infusion Protocol (Pediatric) Order Form]. The prescriber is responsible for completing the order form, however the nurse is responsible for ensuring the order is correct, including all calculations performed on the order form.

II. DEFINITIONS

- **Units/kg**: number of units per kilogram of body weight.
- **Total units**: total number of units the patient receives per hour; determined by multiplying the units/kg by patient’s weight in kilograms. Also represents the total dose.
- **Units/kg/hour**: number of units per kilogram of body weight per hour
- **Units/hour**: total number of units the patient receives per hour; determined by multiplying the units/kg/hour by the patient’s weight in kilograms. Also represents the total hourly dose.

III. BOLUS DOSE

A heparin “drip” is usually preceded by a weight based bolus dose. The prescriber orders both the weight based dose (i.e., units/kg) AND the total dose (i.e., total units).

**To calculate (or verify) TOTAL BOLUS DOSE**

\[
\text{Units/kg} \times \text{patient’s weight} = \text{total units}
\]

**EXAMPLE:** Patient weighs 60 kg

Bolus Dose Order: Heparin 80 units/kg = 4,800 units

To verify the total units, multiply the dose/kg by the patient’s weight.

\[
80 \text{ units/kg} \times 60 \text{ kg} = \text{4,800 units}
\]

**Order is correct**

**NOTE:** There is a maximum dose for a heparin bolus injection. This means that regardless of the arithmetic, the total dose must not exceed the maximum bolus dose. The maximum bolus dose is identified on the order form and is dependent on the indication for heparin.
**EXAMPLE:** Patient weighs 80 kg.

The patient is being treated for a deep vein thrombosis (DVT). The maximum bolus dose for DVT is 5,000 units.

*Bolus Dose Order: Heparin 80 units/kg = 6,400 units*

To verify the total units, multiply the dose/kg by the patient’s weight.

\[
80 \text{ units/kg} \times 80 \text{ kg} = 6,400 \text{ units}
\]

Although the total dose is mathematically correct, it exceeds the maximum dose and the order is incorrect.

**IV. INFUSION DOSE**

In adults, heparin infusion is ordered in units/hr*. However, the dose is based on the patient’s weight and dependent on indication. The prescriber will order the total hourly dose (units/hour) and the rate of administration (mL/hour) based on a standard concentration of heparin. The nurse is responsible for verifying the infusion dose (units/hour) AND the rate of administration (mL/hour).

**To calculate (or verify) INFUSION DOSE**

**EXAMPLE:** Heparin concentration is 20,000 units/500 mL (40 units/mL)

Patient weighs 60 kg

Continuous infusion dose: 18 units/kg/hour

**ORDER:**

Infusion rate: 1,080 units/hour = 27 mL/hour

To verify total hourly dose (units/hour), multiply the recommended dose (units/kg/hour) by the patient’s weight.

\[
18 \text{ units/kg/hour} \times 60 \text{ kg} = 1,080 \text{ units/hour}
\]

Total dose is correct

To verify the rate of administration (mL/hour), use dimensional analysis:

\[
\text{Desired dose is 1,080} \\
\text{Available on hand is 40 units} \\
\text{Quantity is 1 mL}
\]

\[
\frac{1,080}{40} = 27 \text{ mL/hour}
\]

Rate is correct

**PLEASE COMPLETE THE STUDY QUESTIONS ON THE NEXT PAGE**

---

* Heparin is ordered in units/kg/hour in infants and children. Calculations for computing dose/kg/time are reviewed in Part III.
MEDICATION CALCULATION
Study Questions – Part II: Heparin Infusion

Using scratch paper, complete the following questions. DO NOT write in this manual.

1. The patient weighs 55 kg. The heparin bolus dose order reads as follows:

   \[
   IV \text{ bolus: } 80 \text{ units/kg} \times 55 \text{ kg} = 4,400 \text{ units}
   \]

   Is this order for the bolus dose correct?
   
   a. Yes
   b. No

2. The patient weighs 80 kg. The heparin bolus dose order reads as follows:

   \[
   IV \text{ bolus: } 60 \text{ units/kg} \times 80 \text{ kg} = 4,200 \text{ units}
   \]

   Is this order for the bolus dose correct?
   
   a. Yes
   b. No

3. The patient weighs 60 kg and is being prescribed heparin to treat a deep vein thrombosis (DVT). The bolus dose for this indication is 80 units/kg. What total bolus dose in units should this patient receive? (Maximum bolus dose is 5,000 units).

4. The patient weighs 70 kg and is being prescribed heparin to treat a deep vein thrombosis (DVT). The bolus dose for this indication is 80 units/kg. What total bolus dose in units should this patient receive? (Maximum bolus dose is 5,000 units).

Questions #5 and #6 pertain to the following scenario:

The patient weighs 70 kg. The indicated heparin infusion dose is 12 units/kg/hour. The heparin concentration is 40 units/mL. The heparin infusion order reads as follows:

\[
\text{Infusion rate} = 840 \text{ units/hour} = 21 \text{ mL/hour}
\]

5. Is the heparin infusion dose (units/hour) correct?
   
   a. Yes
   b. No

6. Is the heparin infusion rate (mL/hour) correct?
   
   a. Yes
   b. No
7. The patient weighs 90 kg. The indicated heparin infusion dose is 18 units/kg/hour. The heparin concentration is 40 units/mL. The heparin infusion order reads as follows:

\[ \text{Infusion rate} = 1,260 \text{ units/hour} = 31.5 \text{ mL/hour} \]

Is the heparin infusion dose \( \text{units/hour} \) correct?

a. Yes
b. No

Questions #8-10 pertain to the following scenario
The patient weighs 65 kg and is being prescribed heparin to treat a deep vein thrombosis. The indicated bolus dose is 80 units/kg (maximum 5,000 units). The indicated heparin infusion dose is 12 units/kg/hour. The heparin concentration is 40 units/mL.

8. What bolus dose (total units) of heparin should this patient receive?

9. What infusion dose (units/hour) should this patient receive?

10. What rate of administration (mL/hour) should this patient receive?

PLEASE CHECK YOUR ANSWERS TO THE STUDY QUESTIONS ON THE NEXT PAGE
MEDICATION CALCULATION
Answers to Study Study Questions – Part II: Heparin Infusion

1. a
2. b
3. 4,800 units
4. 5,000 units
5. a
6. a
7. b (the correct dose is 1,620 units/hour)
8. 5,000 units
9. 780 units/hour
10. 19.5 mL/hour

If you answered all of the questions correctly, go on to the next section. If you missed one or more, read the content again and repeat the study guide questions. **If you are required to complete Part III, proceed to the next page and complete Part III.**
Part III

Advanced Medication Calculations
for
Continuous Infusion Medications

To be completed by registered nurses working in the following areas

3WICU
3WCTU
4WCCU
5WICU
6EICU
6ENICU
6WICU
Adult ER
Pediatric ER
PACU
Cardiac Catheterization Laboratory
Interventional Radiology

Objectives – Part III: Advanced Medication Calculations:

Upon completion of this section, the workforce employee will be able to:

1. Identify common dosing units for continuous infusion medications.
2. Given a concentration of a drug and a desired dose, calculate infusion rate in mL/hr.
3. Given a concentration of a drug and an infusion rate, calculate dose in terms of one of the following: mg/kg/hr, mcg/kg/hr, mcg/kg/min, mg/hr, mg/min, units/kg/hr, units/hr.
I. INTRODUCTION

A. Pharmacological agents used in critically ill patients are administered in a variety of doses. Examples of these doses include the following:

1. Mcg/kg/min
2. Mcg/min
3. Mg/hr
4. Units/kg/hr

B. Dosing

The dose of the medication is the amount of medication that must be administered over a certain period of time (e.g., dopamine 5 mcg/kg/min). The units of measure differ between the various medications. The length of time is expressed either in 1 minute or in 1 hour. If the medication is weight-based, then the dosing is calculated per kilogram of patient weight. Table 13 lists dosing units for commonly administered continuous infusion medications. Note: Many drugs use different dosing methods in adults and children.

Table 13. Dosing Units for Common Continuous Infusion Medications

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosing Units</th>
<th>Adults</th>
<th>Infants/Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amiodarone</td>
<td>mg/min</td>
<td>mcg/kg/min*</td>
<td></td>
</tr>
<tr>
<td>Dobutamine</td>
<td>mcg/kg/min</td>
<td>mcg/kg/min</td>
<td></td>
</tr>
<tr>
<td>Dopamine</td>
<td>mcg/kg/min</td>
<td>mcg/kg/min</td>
<td></td>
</tr>
<tr>
<td>Epinephrine</td>
<td>mcg/min</td>
<td>mcg/kg/min</td>
<td></td>
</tr>
<tr>
<td>Fentanyl</td>
<td>mcg/kg/hr</td>
<td>mcg/kg/hr*</td>
<td></td>
</tr>
<tr>
<td>Heparin</td>
<td>units/hr</td>
<td>units/kg/hr</td>
<td></td>
</tr>
<tr>
<td>Midazolam</td>
<td>mg/hr</td>
<td>mg/kg/hr*</td>
<td></td>
</tr>
<tr>
<td>Morphine</td>
<td>mg/hr</td>
<td>mcg/kg/hr*</td>
<td></td>
</tr>
<tr>
<td>Nitroprusside</td>
<td>mcg/kg/min</td>
<td>mcg/kg/min</td>
<td></td>
</tr>
<tr>
<td>Vecuronium</td>
<td>mcg/kg/min</td>
<td>mg/kg/hr</td>
<td></td>
</tr>
</tbody>
</table>

* Once a child reaches a weight in which the weight-based dose would exceed the adult dose, non-weight based is used.

C. Rate

The flow rate is the rate at which the medication is delivered. The rate is always expressed in mL/hr.

D. Concentration

The concentration is the amount of medication diluted in a given volume of IV solution (e.g., 400 mg of dopamine diluted in 250 mL D₅W).
II. CONTINUOUS IV MEDICATION INFUSION

A. All units of measure in the formulas must be the same. Sometimes, it is necessary that conversions be made to the concentration of the medication prior to performing the calculation (e.g., concentration of dopamine is stated in mg, but the actual dosing of dopamine is stated in mcg). Furthermore, the calculation is made simpler if the concentration is expressed per milliliter of fluid, rather than the total volume of the diluent in the IV bag/syringe.

B. The mathematical formula for continuous IV drip medications involves three factors: the dose, the flow rate and the concentration. When two out of three factors are known, the third can be calculated by using the basic formula.

**DRUGS DOSED AS DOSE/KG/HR**

**To calculate FLOW RATE**

\[
\text{Dose (mg/kg/hr OR mcg/kg/hr) } \times \text{ wt (kg) = flow rate (mL/hr)} \\
\text{Concentration (mg/mL or mcg/mL)}
\]

**EXAMPLE: Fentanyl 1000 mcg/100 mL NS to infuse at 2 mcg/kg/hr. Patient weighs 70 kg.**

a. Determine concentration of drug in 1 mL

\[
\frac{1000 \text{ mcg}}{100 \text{ mL}} = \frac{X \text{ mcg}}{1 \text{ mL}}
\]

\[
\frac{1000 \text{ mcg}}{100 \text{ mL}} = \frac{X \text{ mcg}}{1 \text{ mL}}
\]

\[
100X = 1000
\]

\[
X = 10 \text{ mcg/mL}
\]

b. Enter known factors into formula

\[
\frac{2 \text{ mcg/kg/hr} \times 70 \text{ kg}}{10 \text{ mcg/mL}} = 14 \text{ mL/hr}
\]
To calculate DOSE

Concentration (mcg/mL OR mg/mL) X rate (mL/hr) = dose/kg/hr
wt (kg)

EXAMPLE: Fentanyl 250 mcg/50 mL NS is running at 0.6 mL/hr. Patient weighs 3 kg.

a. Determine concentration of drug in 1 mL

\[
\frac{250 \text{ mcg}}{50 \text{ mL}} = \frac{X \text{ mcg}}{1 \text{ mL}}
\]

\[
\frac{250 \text{ mcg}}{50 \text{ mL}} \times \frac{X \text{ mcg}}{1 \text{ mL}}
\]

\[
50X = 250
\]

\[
X = 5 \text{ mcg/mL}
\]

b. Enter known factors into formula

\[
\frac{5 \text{ mcg/mL} \times 0.6 \text{ mL/hr}}{3 \text{ kg}} = 1 \text{ mcg/kg/hr}
\]

DRUGS DOSED AS DOSE/KG/MIN

To calculate FLOW RATE

\[
\text{Dose (mcg/kg/min)} \times \text{60 min/hr} \times \text{wt (kg)} = \text{flow rate (mL/hr)}
\]

\[
\text{Concentration (mg/mL or mcg/mL)}
\]

EXAMPLE: Dopamine 160 mg/50 mL D5W to infuse at 5 mcg/kg/min. Patient weighs 15 kg.

a. Determine concentration of drug in 1 mL

\[
\frac{160 \text{ mg}}{50 \text{ mL}} = \frac{X \text{ mg}}{1 \text{ mL}}
\]

\[
\frac{160 \text{ mg}}{50 \text{ mL}} \times \frac{X \text{ mg}}{1 \text{ mL}}
\]

\[
50X = 160 \text{ mg}
\]

\[
X = 3.2 \text{ mg/mL}
\]

b. Convert concentration units to dosing units

3.2 mg x 1000 mcg/mL = 3200 mcg/mL

c. Enter known factors into formula

\[
\frac{5 \text{ mcg/kg/min} \times 60 \text{ min} \times 15 \text{ kg}}{3200 \text{ mcg/mL}} = 1.4 \text{ mL/hr}
\]
To calculate DOSE

Concentration (mcg/mL or mg/mL) x rate (mL/hr) ÷ 60 (min/hr) ÷ wt (kg) = dose/kg/min

EXAMPLE: Nitroprusside 50 mg/250 mL D₅W is running at 5 mL/hr. Patient weighs 55 lbs.

a. Determine concentration of drug in 1 mL

\[
\frac{50 \text{ mg}}{250 \text{ mL}} = \frac{X \text{ mg}}{1 \text{ mL}}
\]

250X = 50

\[X = 0.2 \text{ mg/mL}\]

b. Convert concentration units to dosing units

0.2 mg x 1000 mcg/mL = 200 mcg/mL

c. Convert patient’s weight from pounds to kilograms

\[
\frac{55 \text{ lbs}}{2.2 \text{ kg}} = 25 \text{ kg}
\]

d. Enter known factors into formula

\[
200 \text{ mcg/mL} \times 5 \text{ mL/hr} ÷ 60 ÷ 25 = 0.67 \text{ mcg/kg/min}
\]

PLEASE COMPLETE THE STUDY QUESTIONS ON THE NEXT PAGE
MEDICATION CALCULATION
Study Questions – Part III: Advanced Medication Calculation for Continuous Infusion Medications

Using scratch paper, complete the following questions. DO NOT write in this manual.

1. Dobutamine is mixed 500 mg/250 mL D$_5$W. Ordered dose is 5 mcg/kg/min. The patient weighs 65 kg. At what rate (mL/hour) should the dobutamine be infused?

2. Dopamine is mixed 400 mg/250 mL D$_5$W. Ordered dose is 10 mcg/kg/min. The patient weighs 5 kg. At what rate (mL/hour) should the dopamine be infused?

3. Fentanyl is mixed 1000 mcg/100 mL NS. Ordered dose is 2 mcg/kg/hr. The patient weighs 70 kg. At what rate (mL/hour) should the fentanyl be infused?

4. Dobutamine is mixed 100 mg/50 mL D$_5$W. It is running at 2.7 mL/hr. The patient weighs 15 kg. What dose is the patient receiving?

5. Fentanyl is mixed 1000 mcg/100 mL NS. It is running at 17 mL/hr. The patient weighs 85 kg. What dose is the patient receiving?

CHECK YOUR ANSWERS TO THE STUDY QUESTIONS

Answers to Study Questions - Part III: Advanced Medication Calculation for Continuous Infusion Medications

1. 9.75 mL/hr
2. 1.875 mL/hr
3. 14 mL/hr
4. 6 mcg/kg/min
5. 2 mcg/kg/hr (170 mcg/hr)

If you missed 1 or more questions, read the content again and repeat the study questions.

NOTE: Calculation questions on the Medication Calculation clinical competency test will be fill in the blank, not multiple choice. You may use a calculator when completing the test. The formulas listed in Part III of this competency will be provided for you during the test.