
Components of Preparedness Statements to Accompany 2003 Task Analysis

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The Nuclear Medicine Technology Certification Board presents Components of Preparedness Statements (COPS) to accompany its recently revised task list. The COPS expand the tasks identified as important to the practice of nuclear medicine technology. These tasks are developed through an extensive process called a task analysis, which is reviewed in the article. The COPS represent the final step in this process. The COPS presented in this special report complement the task analysis published in 2003.

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The Nuclear Medicine Technology Certification Board (NMTCB) prepares and administers examinations for nuclear medicine technologists. It currently offers 3 examinations: an entry-level examination and specialty examinations in PET and nuclear cardiology. The entry-level examination has been the major undertaking of the NMTCB since its inception in 1977, and the board continues to devote a considerable amount of effort to maintaining it as the premiere certification examination in the field.

The NMTCB's entry-level examination is a criterion-referenced examination, meaning that the examinee must meet specific criteria to pass the examination. This may be contrasted to a norm-referenced examination, in which examinees are compared with each other (similar to a "curve" grading system). The criteria that must be met are determined by a process called task analysis. The major component of task analysis is a survey of practicing nuclear medicine technologists to determine what tasks constitute the current scope of practice for the field. Since the field of nuclear medicine is dynamic, the task analysis must be conducted in a set interval to capture the current procedures.

The NMTCB has been conducting the task analysis every 5 y.

The most recent task analysis for the NMTCB's entry-level examination was published in 2003 (1). The task list itself is brief, consisting of only 48 tasks, each stated succinctly. This list is the basis for the entry-level examination and is augmented by lists detailing the procedures, equipment, and pharmaceuticals to which the task list applies. Because the tasks are stated in such brief form, the NMTCB also provides Components of Preparedness Statements (COPS) to augment the task list. Each component of preparedness statement has 2 parts: the content base (knowledge applicable to the task) and the example objectives (examples of learning objectives for the task, given at 3 different levels). The most recent publication of the COPS was in 1999 (2); the publication of a new task list prompts this update.

TASK ANALYSIS

A brief overview of the entire process is in order. Task analysis begins with an extensive list of tasks performed by nuclear medicine technologists. One way to create such a list is through a "Day in the Life" exercise, in which several nuclear medicine technologists write down everything they do in a day. This list of tasks, along with lists of procedures, equipment, and pharmaceuticals, forms the basis for the task analysis survey. It is important at this point that the list be as comprehensive as possible to get the best response from the survey. One can always group tasks together after the survey, but it is impossible to break a task into multiple tasks once the survey has been sent out.

The task analysis survey asks working technologists to rate each task according to how frequently the task is performed in their working situations. Directors of the NMTCB, acting as "experts," rate the criticality of each task. Thus, each task has 2 ratings, one for frequency and one for criticality. These 2 ratings are combined using a statistical method called Kane weighting, and the extensive list of tasks can then be ordered from the most important to the least important. Working from this ordered list, the NMTCB Task Analysis Committee determines which tasks

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should be removed from the list and which tasks may be combined, based on the importance of each task and its Kane weighting. In the 2003 task analysis, the 66 tasks on the survey were winnowed to the 48 that made the final task list.

The questions that are found on the entry-level examinations are each tied to 1 of the 48 tasks. The task list is divided into 4 groups, and each group is assigned a percentage of the test questions, according to the expert opinion of the NMTCB Directors. The groups (with the percentage) are I, Radiation Safety (15%); II, Instrumentation (20%); III, Clinical Procedures (45%); and IV, Radiopharmacy (20%). Changing either the percentages or the number of subgroups has significant psychometric implications, so the NMTCB has chosen to maintain consistency in this aspect of the examinations.

The task list, therefore, forms the foundation for the entry-level examinations and is generally changed only after a task analysis survey is completed. Lists of procedures, equipment, and pharmaceuticals are also generated through the survey process (1). These lists may be changed on a more frequent basis, in order to keep up with changes in the field. For example, a newly Food and Drug administration (FDA)-approved radiopharmaceutical will be added to the pharmaceuticals list once it is commercially available. Because these lists are updated often, the most current reference for them is the NMTCB web site (www.nmtcb.org).

COMPONENTS OF PREPAREDNESS

The task list is succinct and does not contain enough information to be useful as a study tool in and of itself. So the NMTCB has developed the COPS as a way to “flesh out” the task list. The content base spells out the concepts and factual information applicable to the task. The NMTCB entry-level examinations ask only items (individual multiple-choice questions) that are relevant to the practice of nuclear medicine technology, but often the examinee must draw on basic science knowledge. The content base attempts to delineate the basic science necessary for each task.

The example objectives are given at 3 taxonomic levels, based on the work of Bloom et al. (3). Taxonomic levels represent progressive stages of understanding; Bloom et al. identify 6 levels, but only the first 3 are applicable to multiple-choice examinations. Thus, example objectives are given at the taxonomic levels of comprehension, application, and analysis. These may be distinguished as follows:

- Comprehension involves recall and a low level of understanding. It does not require the examinee to apply the knowledge in any way.
- Application, as the word implies, involves applying the basic knowledge to a specific situation. Most mathematics calculations are found at this level, as are many “situational” questions. Application questions look forward and ask, “What should be done next?”
- Analysis questions, on the other hand, look backward, to answer questions such as, “What was done incorrectly?” or “How can this error be repaired?” Analysis questions require the examinee to synthesize both comprehension and application into a plan of action.

The 48 tasks of the NMTCB’s task list are broadly stated, and each covers several topics that could be the basis for an examination item. The objectives under each taxonomic level are therefore specifically identified as examples, to emphasize that they are not all-encompassing.

The NMTCB’s intent in developing the COPS is to assist students and educators to prepare for the entry-level examination. The COPS are essential to the process of item writing as well. In the bigger picture, the COPS provide a statement of the scope of practice for nuclear medicine technology. Such statements take on more importance as the delineations between professions begin to blur. Take, for example, the recent PET/CT curriculum published by the American Society of Radiologic Technologists and Society of Nuclear Medicine Technologist Section. The NMTCB’s COPS were extensively used in defining the nuclear medicine knowledge base that must be demonstrated for a person not trained in nuclear medicine to become certified to perform PET procedures.

CONCLUSION

Publication of the COPS represents the last stage in the NMTCB’s cycle of task analysis. The COPS provide a statement of the knowledge base required for the practice of nuclear medicine technology. They are valuable not only to students and educators but also to the larger nuclear medicine community. The NMTCB is dedicated to maintaining the high quality of the entry-level examinations and views the COPS as an important aspect of that level of quality.

REFERENCES

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COMPONENTS OF PREPAREDNESS STATEMENTS

Group I: Radiation Safety

Task 1: Post appropriate signs in designated areas to comply with NRC regulations.

Content base

1. NRC regulations
 - a. Restricted and unrestricted areas
 - b. Effective dose equivalent limits
2. Radiation surveys
 - a. Survey meters
 - b. Area monitoring
3. Radiation units
4. Inverse square law and shielding equation

Comprehension

Example: Identify appropriate signs for posting in designated radiation areas.

Application

Example: Given a radiation measurement, calculate the area to be designated according to NRC regulations.

Analysis

Example: Determine appropriateness of posted radiation signs.

Task 2: Prepare and package radioactive materials for transportation.

Content base

1. Regulatory requirements
 - a. NRC
 - b. DOT
2. Radiation surveys of packages
 - a. Survey meters
 - b. Well counters
 - c. Surface contamination limits
 - d. Shipping labels
3. Packaging types (materials)
 - a. Exempt quantities
 - b. Nonexempt quantities
4. Record keeping

Comprehension

Example: State the regulatory requirements for packaging and transporting radioactive materials.

Application

Example: Based on exposure rate and activity, determine the appropriate shipping label for a quantity of radioactive material.

Analysis

Example: Analyze consequences of improper packaging of radioactive materials and take appropriate actions.

Task 3: Use personal radiation monitoring devices.

Content base

1. NRC regulations
 - a. Effective dose equivalent limits
 - b. Monitoring requirements
2. Types, characteristics, and proper use of personnel monitoring devices
3. Properties of nuclear radiation
4. Radiation surveys
 - a. Area monitoring
 - b. Patient monitoring

5. Exposure limits
 - a. Hospitalized patients
 - b. Hospital personnel
 - c. General public
6. Record keeping

Comprehension

Example: Identify various personnel monitoring devices and explain their proper use.

Application

Example: Determine appropriate patient monitoring devices given specific circumstances.

Analysis

Example: Analyze personal monitoring results and recommend corrective action as needed.

Task 4: Review monthly personnel exposure records.

Content base

1. NRC regulations
 - a. Effective dose equivalent terms and limits
 - b. ALARA concepts
2. Properties of nuclear radiation
3. Absorbed dose units
4. Types, characteristics, and proper use of personnel monitoring devices
5. Record keeping

Comprehension

Example: State the total effective dose equivalent limit for radiation personnel.

Application

Example: Examine monthly personnel exposure records for compliance with regulations.

Analysis

Example: Analyze instances of increased radiation exposure and recommend measures to reduce or eliminate unnecessary exposure.

Task 5: Take appropriate measures to reduce radiation exposure.

Content base

1. NRC regulations
 - a. Effective dose equivalent limits
 - b. ALARA concepts
 - c. Shielding requirements
2. Properties of nuclear radiation
3. Radiation units
4. Biologic effects of radiation
5. Radiation protection techniques
 - a. Time
 - b. Distance
 - c. Shielding
6. Exposure rate calculations
7. Types and characteristics of personnel monitoring devices
8. Radiation surveys
 - a. Area monitoring
 - b. Patient monitoring
9. Record keeping

Comprehension

Example: Identify proper measures to reduce radiation levels and to keep exposure as low as reasonably achievable.

Application

Example: Calculate changes in exposure rates resulting from use of radiation protection techniques.

Analysis

Example: Examine instances of increased radiation levels and recommend measures to reduce them.

Task 6: Notify the appropriate authority of excessive radiation exposure.

Content base

1. NRC regulations
 - a. Acceptable ranges for diagnostic and therapeutic procedures
 - b. Effective dose equivalent limits (TEDE, etc.)
 - c. Reporting procedures
2. Types and characteristics of personnel and patient monitoring devices
3. Radiation surveys
 - a. Survey meters
 - b. Area monitoring
4. Exposure rate calculations

Comprehension

Example: Identify unacceptable levels of radiation exposure and the appropriate authority to notify.

Application

Example: Determine if excessive radiation exposure has occurred and select the appropriate authority to notify.

Analysis

Example: Analyze instances of excessive exposure and recommend ways to reduce or eliminate unnecessary exposure.

Task 7: Notify the appropriate authority of misadministration.

Content base

1. Regulatory requirements
 - a. NRC
 - i. Recordable events
 - ii. Medical events (reportable)
 - iii. Reporting procedures
 - b. FDA
2. Nuclear medicine diagnostic and therapeutic procedures
 - a. Approved radiopharmaceuticals
 - b. Routes of administration
 - c. Activity ranges
3. Record keeping

Comprehension

Example: Identify a medical event and the appropriate authority to notify.

Application

Example: Determine an acceptable dose range based on prescribed dose and NRC regulations.

Analysis

Example: Analyze instances of medical or recordable events and recommend measures to prevent further occurrences.

Task 8: Utilize proper methods for the use and storage of radioactive materials.

Content base

1. Regulatory requirements
 - a. NRC
 - b. FDA
2. Characteristics of radioactive materials
 - a. Physical properties
 - b. Radiation emissions
3. Radiation protection techniques
 - a. β -emitters
 - b. γ -emitters
 - c. Radioactive gases
4. Storage requirements of radioactive materials
 - a. Temperature
 - b. Light
 - c. Humidity
 - d. Ventilation
 - e. Shielding
5. Record keeping

Comprehension

Example: Identify proper handling and storage methods for radioactive materials.

Application

Example: Determine if ventilation conditions are adequate for use of radioactive gases.

Analysis

Example: Analyze circumstances contributing to special hazards associated with a given radioactive material and alter procedures appropriately.

Task 9: Instruct the patient, family, and staff in radiation safety precautions after the administration of therapeutic radiopharmaceuticals.

Content base

1. NRC regulations
2. Biologic properties of radiopharmaceuticals
 - a. Biodistribution
 - b. Excretion
3. Radiation safety practices
 - a. Sodium ^{131}I
 - b. Pure β -emitters
4. Communications skills
 - a. Written
 - b. Oral
5. Patient and personnel monitoring
6. Record keeping

Comprehension

Example: Identify radiation safety precautions that should be conveyed to the patient, family, and staff after administration of therapeutic radiopharmaceuticals.

Application

Example: Determine the distance that others must maintain to limit radiation exposure to regulatory levels.

Analysis

Example: Analyze circumstances contributing to radiation exposure following the administration of therapeutic radio-

pharmaceuticals and recommend measures to minimize exposure to family and staff.

Task 10: Provide instruction on proper radiation emergency procedures.

Content base

1. NRC regulations
2. Radiation safety procedures
3. Management of radiation emergencies
4. Decontamination procedures
5. Operation of radiation detection devices

Comprehension

Example: Identify equipment required for dealing with a radiation emergency.

Application

Example: Choose appropriate instructions to be followed in a radiation emergency situation until radiation personnel arrive.

Analysis

Example: Analyze circumstances contributing to radiation exposure in a radiation emergency and recommend procedures to minimize exposure.

Task 11: Perform wipe tests and area radiation surveys.

Content base

1. NRC regulations
2. Properties of nuclear radiation
3. Radiation units
4. Survey instruments and well counters
5. Area monitoring
 - a. Area surveys
 - b. Wipe tests
6. Record keeping and frequency of required tests

Comprehension

Example: Identify the procedure for performing wipe tests.

Application

Example: Perform area radiation surveys with appropriate survey instrument and frequency.

Analysis

Example: Determine if survey or wipe test results exceed regulatory limits and initiate corrective action.

Task 12: Prepare, survey, and clean radiotherapy isolation room.

Content base

1. NRC regulations
2. Radiation safety procedures
3. Decontamination procedures
4. Area monitoring
 - a. Operation of radiation detection devices
 - b. Surveys and wipe tests
5. Radioactive waste storage and disposal
6. Record keeping

Comprehension

Example: Identify procedures for preventing contamination to contents and surfaces of a room that is to be used by a patient receiving a therapeutic radiopharmaceutical.

Application

Example: Perform the required surveys and decontamination procedures before releasing the room for regular use.

Analysis

Example: Assess situations and determine procedures to be followed for decontamination or storage of room contents used by a radiotherapy patient.

Task 13: Survey, inspect, and inventory incoming radioactive materials.

Content base

1. Regulatory requirements
 - a. NRC
 - b. DOT
2. Package monitoring requirements
 - a. Survey instruments
 - b. Survey methods
 - c. Wipe tests
3. Record keeping

Comprehension

Example: State limits for radiation levels on packages containing radioactive materials.

Application

Example: Determine appropriate procedure for receiving packages containing radioactive materials.

Analysis

Example: Determine if wipe tests and survey results of package meet regulatory requirements.

Task 14: Monitor and dispose of radioactive material.

Content base

1. Regulatory requirements
 - a. NRC
 - b. DOT
2. Disposal methods for radioactive liquids, solids, gases, and contaminated materials
3. Radiation safety procedures
4. Half-life calculations
5. Survey meters
6. Record keeping

Comprehension

Example: Identify disposal procedures for radioactive liquids, solids, gases, and contaminated materials.

Application

Example: Based on the exposure rate and half-life, estimate the time after which a radioactive material may be disposed.

Analysis

Example: Determine if materials can be removed from long-term radioactive storage and be disposed as regular or biohazardous trash.

Task 15: Use proper procedures for managing a radioactive spill.

Content base

1. NRC regulations
2. Radioactive spill management
 - a. Containment: major and minor spills
 - b. Equipment

- c. Trigger levels and monitoring methods
 - d. Radiation protection measures
 - e. Area decontamination procedures
3. Patient and personnel decontamination
 4. Waste disposal

Comprehension

Example: Distinguish between minor and major spills of radioactive materials.

Application

Example: Determine the appropriate procedures for containing and decontaminating a radioactive spill and for notifying the proper authority.

Analysis

Example: Determine when a contaminated area can be returned to regular use.

Group II: Instrumentation

Task 16: Perform and evaluate quality control on a well counter or probe.

Content base

1. Basic electronics
2. Sodium iodide scintillation detector
 - a. System components
 - b. Performance characteristics
 - c. Quality control
 - d. Calibration procedures
3. γ -ray spectra and pulse height analysis
4. Formulas
 - a. Energy resolution
 - b. Sensitivity and absolute efficiency
 - c. χ^2 statistic
5. Record keeping

Comprehension

Example: Define background, sensitivity, energy resolution, and FWHM as they apply to a sodium iodide detector.

Application

Example: Determine proper calibration and FWHM of a well counter or probe.

Analysis

Example: Evaluate results of FWHM determination and χ^2 test.

Task 17: Calibrate a scintillation camera.

Content base

1. Sodium iodide scintillation camera
 - a. Components
 - b. Performance characteristics
 - c. Calibration procedures
2. γ -ray spectra and pulse height analysis
3. System sensitivity

Comprehension

Example: State the purpose of calibration of a scintillation camera.

Application

Example: Determine the appropriate adjustment of the pulse height analyzer of a scintillation camera.

Analysis

Example: Evaluate changes in system sensitivity of a scintillation camera and determine causes.

Task 18: Perform and evaluate field uniformity of a scintillation camera.

Content base

1. Scintillation camera
 - a. System components
 - b. Performance characteristics
 - c. Collimators
 - d. Image recording equipment
 - e. Image quality
2. Uniformity
 - a. Procedures
 - b. Requirements
 - c. Analysis
3. Record keeping

Comprehension

Example: Distinguish between intrinsic and extrinsic field uniformity procedures.

Application

Example: Determine the field uniformity of a scintillation camera using images and computer analysis.

Analysis

Example: Analyze field uniformity images and differentiate sources of nonuniformity.

Task 19: Perform and evaluate detector linearity and spatial resolution of a scintillation camera.

Content base

1. Scintillation camera
 - a. System components
 - b. Performance characteristics
 - c. Collimators
 - d. Image quality
2. Quality control definitions and procedures
 - a. Linearity
 - b. Spatial resolution
 - c. Evaluation
3. Phantoms
4. Artifacts
5. Record keeping

Comprehension

Example: State a procedure for determining the spatial resolution of a scintillation camera.

Application

Example: Determine the linearity and spatial resolution of a scintillation camera.

Analysis

Example: Analyze images for nonlinearity or loss of spatial resolution and determine the causes.

Task 20: Assess performance of image recording equipment.

Content base

1. Scintillation camera
 - a. System components
 - b. Multiformatter, CRT

2. Computer
 - a. Contrast and background controls
 - b. Gray and color scales
 - c. Matrix sizes
 - d. Printers
 - e. Video displays
3. Image recording devices
 - a. Types
 - b. Quality control procedures
4. Photographic film
 - a. Characteristics
 - b. Film processing
5. Film processor quality control

Comprehension

Example: Identify components of the image recording equipment and state their functions.

Application

Example: Determine performance of image recording equipment.

Analysis

Example: Analyze images for proper performance of image recording equipment and assess cause of improper performance.

Task 21: Determine operational status of survey meter.

Content base

1. NRC regulations
2. Survey meter operation
 - a. Types
 - b. Basic electronics
 - c. System components
3. Survey meter quality control
4. Radiation interactions and ranges
5. Record keeping

Comprehension

Example: State required quality control tests for survey meter and their frequency.

Application

Example: Determine the operational status of a survey meter.

Analysis

Example: Assess survey meter operation based on quality control results.

Task 22: Perform and evaluate dose calibrator accuracy, linearity, and geometry tests.

Content base

1. NRC regulations
2. Dose calibrator operation
3. Dose calibrator quality control
 - a. Definitions
 - b. Procedures
4. Record keeping

Comprehension

Example: Identify timing and record keeping required for dose calibrator accuracy, geometry, and linearity.

Application

Example: Determine the response of a dose calibrator to different source geometries and calculate correction factors.

Analysis

Example: Analyze accuracy and geometry test results and initiate corrective action as needed.

Task 23: Perform and evaluate dose calibrator constancy test.

Content base

1. NRC regulations
2. Dose calibrator operation
3. Dose calibrator quality control procedures
4. Record keeping

Comprehension

Example: Define constancy.

Application

Example: Perform dose calibrator constancy check.

Analysis

Example: Assess results of constancy check and dose calibrator performance and identify corrective action when necessary.

Task 24: Perform and evaluate quality control procedures for a SPECT camera.

Content base

1. SPECT camera
 - a. System components
 - b. Performance characteristics
2. SPECT quality control
 - a. Center of rotation
 - b. Field uniformity requirements
 - c. Pixel calibration
 - d. Phantom studies
 - e. Artifacts
3. Record keeping

Comprehension

Example: State the requirements for field uniformity for SPECT.

Application

Example: Determine pixel size on a scintillation camera.

Analysis

Example: Analyze COR test results and assess if corrections need to be made.

Task 25: Perform and evaluate quality control procedures for a PET system.

Content Base

1. PET system
 - a. System components
 - b. Application of corrections
 - c. Performance characteristics
2. PET quality control
 - a. Daily blank scan
 - b. Normalization scan
 - c. Cross-calibration
3. Record keeping
4. Appearance of artifacts

Comprehension

Example: Describe the application of normalization correction factors to PET images.

Application

Example: Obtain a cross-calibration factor between the PET system and the dose calibrator.

Analysis

Example: Analyze daily blank scans for artifacts.

Group III: Clinical Procedures

Task 26: Maintain and operate auxiliary equipment (as described in equipment list).

Content base

1. Theory of operation
2. Use in nuclear medicine procedures
3. Safety requirements
4. Quality control procedures

Comprehension

Example: Identify and state the proper procedure for use of auxiliary equipment required for imaging procedures.

Application

Example: Determine appropriate procedures to maintain and operate auxiliary equipment.

Analysis

Example: Troubleshoot problems with auxiliary equipment.

Task 27: Schedule patient studies, ensuring appropriate sequence of multiple procedures, and interact with staff regarding special orders.

Content base

1. Imaging and nonimaging procedures
2. Sequencing of procedures
3. Radiopharmaceuticals
 - a. Effective half-life
 - b. Energy ranges
4. Special orders
 - a. Premedication
 - b. Dietary restrictions
 - c. Specimen collection
 - d. Radiologic contrast agents
 - e. Other
5. Inventory controls
6. Communication skills

Comprehension

Example: Identify appropriate patient scheduling sequences and special orders for procedures.

Application

Example: Determine the most appropriate and timely sequence for patient studies and any special orders required.

Analysis

Example: Analyze patient scheduling difficulties and revise schedule accordingly.

Task 28: Receive patient and provide proper nursing care during nuclear medicine procedures.

Content base

1. Communication skills
2. Basic nursing procedures
 - a. Body mechanics
 - b. Vital signs
 - c. Infection control
 - d. First aid

3. Patient support devices
 - a. Intravenous lines/pumps
 - b. Oxygen
 - c. Foley catheter and drainage bag
 - d. ECG monitor
 - e. Other

Comprehension

Example: State normal ranges for pulse, respirations, and blood pressure.

Application

Example: Determine appropriate nursing care during procedure.

Analysis

Example: Appraise a situation that requires nursing care be provided and determine the most appropriate action.

Task 29: Communicate effectively with patient, family, and staff.

Content base

1. Nuclear medicine
 - a. Procedures
 - b. Patient history
 - c. Instructions
 - d. Precautions
2. Communication skills
3. Medical ethics
4. Legal aspects of communications

Comprehension

Example: Identify responsibilities of the technologist in maintaining effective communication with patients, family, and staff.

Application

Example: Recommend appropriate instructions to be given to patients for a particular nuclear medicine procedure.

Analysis

Example: Determine information that cannot be provided by a nuclear medicine technologist.

Task 30: Provide safe and sanitary conditions.

Content base

1. Body mechanics
2. Infection control/universal precautions
3. Use of nuclear medicine and auxiliary equipment
4. Waste disposal
 - a. Biohazardous
 - b. Radioactive
5. Medical/legal aspects

Comprehension

Example: Identify methods to prevent the spread of infection.

Application

Example: Determine appropriate methods for handling waste materials.

Analysis

Example: Analyze a situation to determine if an unsafe condition exists and the appropriate action to be taken.

Task 31: Recognize and respond to emergency conditions.

Content base

1. Vital signs
 - a. Pulse rate
 - b. Respiratory rate
 - c. Blood pressure
 - d. Temperature
2. Signs/symptoms
 - a. Fainting
 - b. Seizure
 - c. Cardiopulmonary arrest
 - d. Hypoglycemia
3. Anaphylactic and vasovagal reactions
4. First aid techniques and cardiopulmonary resuscitation

Comprehension

Example: Describe symptoms of medical emergencies.

Application

Example: Determine patient condition and initiate CPR or appropriate first aid measures.

Analysis

Example: Assess an emergency condition and initiate appropriate action.

Task 32: Receive patient, verify patient identification and written orders for study, and follow up on inappropriate orders.

Content base

1. NRC regulations
2. Patient preparation
3. Medical/legal aspects
4. Communication skills
5. Nuclear medicine procedures
 - a. Indications
 - b. Contraindications
 - c. Patient preparation
 - d. Sequence of procedures
6. Record keeping

Comprehension

Example: Identify procedures for verifying patient identification and authenticating written orders for study.

Application

Example: Determine appropriate methods for receiving patients and verifying readiness for study.

Analysis

Example: Assess appropriateness of orders.

Task 33: Obtain pertinent patient history and check procedural contraindications.

Content base

1. Communication skills
2. Medical/legal aspects
3. Organs and organ systems
 - a. Anatomy
 - b. Physiology
 - c. Pathology
 - d. Medical and surgical interventions

4. Nuclear medicine procedures
 - a. Patient preparation
 - b. Patient history
 - c. Contraindications
 - d. Premedications and dietary restrictions
 - e. Radiopharmaceutical administration
 - f. Other

Comprehension

Example: Identify contraindications for nuclear medicine procedures.

Application

Example: Determine if interfering drugs have been stopped for a suitable length of time before study.

Analysis

Example: Analyze consequences of administration of radiopharmaceuticals when contraindications exist.

Task 34: Prepare patient for procedure.

Content base

1. Communications skills
2. Procedural requirements
 - a. Hydration and excretion
 - b. Sedation
 - c. Route of administration
3. Radiopharmacology
 - a. Mechanisms of localization
 - b. Biologic and effective half-life
 - c. Blood clearance rates
 - d. Temporal relationship to other medications
4. Record keeping

Comprehension

Example: Identify sedatives that can be used for nuclear medicine procedures.

Application

Example: Determine appropriate patient preparation for specific nuclear medicine procedures.

Analysis

Example: Assess the consequences of premature or delayed imaging times and initiate corrective measures as appropriate.

Task 35: Select and administer the appropriate radiopharmaceutical by the proper route.

Content base

1. Nuclear medicine procedures and approved radiopharmaceuticals and dosages
2. Patient identification
3. Radiopharmaceutical administration
 - a. Approved routes
 - b. Aseptic technique
 - c. Bolus technique
 - d. Venipuncture supplies and techniques
 - e. Insertion and maintenance of indwelling intravenous line
4. Radiation biology and safety

Comprehension

Example: Identify the appropriate radiopharmaceuticals for nuclear medicine procedures and their routes of administration.

Application

Example: Determine best site for intravenous line insertion.

Analysis

Example: Assess radiation safety consequences of an incorrectly performed radiopharmaceutical administration and take corrective action if necessary.

Task 36: Prepare proper instrument, computer, and auxiliary equipment and acquire imaging procedures as indicated by protocol.

Content base

1. Nuclear medicine procedures and routine images
2. Patient positioning
 - a. Anatomy
 - b. Positioning terminology
 - c. Anatomic markers
 - d. Immobilization techniques
3. Imaging parameters for data acquisition
 - a. Collimator choices and zoom settings
 - b. Type of acquisition (static, dynamic, gated, SPECT, list mode)
 - c. Methods of image termination (time, total counts, information density)
 - d. Data storage mode (matrix size, byte vs. word mode)
 - e. Number of images in dataset
4. Auxiliary equipment operation

Comprehension

Example: Identify routine patient and camera positions for an imaging procedure.

Application

Example: Determine the appropriate instrument, imaging and data acquisition parameters, and auxiliary equipment necessary to perform an imaging procedure according to protocol.

Analysis

Example: Assess patient limitations and adapt protocols accordingly.

Task 37: Evaluate image appearance and perform any additional views as required.

Content base

1. Nuclear medicine procedures
2. Radiopharmaceuticals
 - a. Biodistribution
 - b. Causes of altered biodistribution
3. Patient positioning
 - a. Anatomy
 - b. Positioning terminology
 - c. Anatomic markers
4. Quality control procedures

Comprehension

Example: Identify common artifacts that may appear on images.

Application

Example: Recommend appropriate special views for an imaging procedure.

Analysis

Example: Assess diagnostic images or computer information for technical quality and initiate corrective measures if appropriate.

Task 38: Process and evaluate computer-generated data.

Content base

1. Data storage, transfer, and retrieval
2. Image formation (static, dynamic, MUGA, list mode)
3. Image reconstruction (SPECT, PET)
4. Image enhancement
 - a. Exponential, logarithmic, and color scales
 - b. Filtering
 - c. Matrix conversion
5. Quantitative analysis
 - a. Regions of interest and quantification
 - b. Curve generation and analysis
 - c. Image normalization and subtraction
 - d. Co-registration of image sets
6. Display formatting (size of image, number of images per film, intensity enhancement)
7. Quality control procedures

Comprehension

Example: Identify techniques to retrieve and process computer data.

Application

Example: Determine the appropriate technique for quantitative analysis of a nuclear medicine study.

Analysis

Example: Analyze computer-generated information for technical quality and artifacts and initiate corrective measures if appropriate.

Task 39: Prepare and perform cardiac monitoring or stress testing.

Content base

1. Nuclear cardiology procedures
2. Basic electrocardiography
 - a. Cardiac conduction system
 - b. The normal electrocardiogram
 - c. Basic ECG interpretation
 - d. Arrhythmias
3. ECG lead placement
 - a. 3 lead
 - b. 12 lead
4. Treadmill/bicycle stress techniques
 - a. Contraindications
 - b. Duration/termination parameters
5. Pharmacologic stress techniques
 - a. Pharmacologic stress agents
 - b. Contraindications
 - c. Duration/termination parameters
 - d. Drug side effects and appropriate treatment
 - e. Reversal agents and techniques
6. Vital signs
 - a. Pulse rate
 - b. Respiratory rate
 - c. Blood pressure
7. Signs/symptoms of adverse reactions
8. CPR techniques
9. Record keeping

Comprehension

Example: Identify components of a normal electrocardiogram and common arrhythmias.

Application

Example: Determine the appropriate duration and termination parameters for a stress test.

Analysis

Example: Assess a patient's history for contraindications to stress testing.

Task 40: Prepare/administer interventional pharmacologic agent.

Content base

1. Nuclear medicine procedures
2. Approved interventional pharmacologic agents
 - a. Contraindications and precautions
 - b. Normal physiologic response
 - c. Adverse side effects and treatment
 - d. Antidote medications
3. Pharmaceutical administration
 - a. Dosages
 - b. Approved routes
 - c. Aseptic technique
 - d. Administration and timing/speed/duration
 - e. Reversal agents and techniques
4. Vital signs
 - a. Pulse rate
 - b. Respiratory rate
 - c. Blood pressure
5. Adverse reactions
6. Emergency techniques
7. Record keeping

Comprehension

Example: Identify dosage, timing, and speed of dose administration for nuclear medicine procedures requiring pharmacologic intervention.

Application

Example: Determine whether the patient's history identifies possible contraindications for the use of particular interventional agents.

Analysis

Example: Assess whether a patient is having an adverse reaction to a particular interventional agent and determine appropriate action to be taken.

Task 41: Obtain samples or data for nonimaging studies.

Content base

1. Nuclear medicine procedures
2. Collection techniques for patient specimen
 - a. Timing
 - b. Methods and containers
 - c. Storage
3. Hematocrit determination
4. Standard dilution preparation
5. Specimen preparation
6. Counting statistics and background correction
7. External counting techniques

Comprehension

Example: Identify type of specimen required for a given procedure and describe specimen collection, preparation, and storage procedures.

Application

Example: Determine the appropriate dilution of a standard for a given procedure and calculate the amount of sample and solvent required.

Analysis

Example: Evaluate specimen quality and obtain new specimen if necessary.

Task 42: Calculate and evaluate results of nonimaging studies.

Content base

1. Nuclear medicine procedures
2. Error analysis
 - a. Sources of random error
 - b. Sources of systematic error
 - c. Precision
 - d. Accuracy
 - e. Procedure-specific sources of error
3. Calculations
 - a. Equations
 - b. Graphing techniques
 - c. Data presentation
 - d. Derivation of appropriate patient values
4. Patient records and reports
 - a. Contents
 - b. Medical/legal considerations
5. Instrument quality control procedures

Comprehension

Example: Identify formula or graphing technique required to calculate results of a nonimaging procedure.

Application

Example: Determine final results of a given nonimaging procedure using the appropriate formulae or graphing technique.

Analysis

Example: Analyze data to differentiate acceptable from unacceptable data and determine source of error.

Group IV: Radiopharmacy

Task 43: Elute radionuclide generator, perform, and evaluate quality control tests.

Content base

1. Types of generators
 - a. Elution
 - b. Generator yield–volume and activity
2. Aseptic techniques
3. Regulatory requirements
 - a. NRC
 - b. USP
4. Dose calibrator operation/units of radioactivity
5. ^{99}Mo and Al^{3+} breakthrough testing
6. Record keeping

Comprehension

Example: Identify methods used to assay generator eluate and information that must appear on the label.

Application

Example: Elute generator using proper shielding and aseptic techniques.

Analysis

Example: Assess radionuclidic and chemical purity of eluate and determine methods to minimize contamination.

Task 44: Review the daily work schedule to plan radiopharmaceutical needs.

Content base

1. Patient scheduling
2. Nuclear medicine procedures
 - a. Appropriate radiopharmaceuticals and activity ranges
 - b. Time interval between radiopharmaceutical administration and procedure
3. Radiopharmaceuticals
 - a. Activity and volume limits
 - b. Effect of radioactive decay
 - c. Shelf life
4. Record keeping

Comprehension

Example: Identify the radiopharmaceutical and activity required for each procedure.

Application

Example: Determine radiopharmaceutical needs to complete daily work schedule based on shelf life and decay.

Analysis

Example: Adjust daily work schedule or radiopharmaceutical kit preparation to use available radiopharmaceutical inventory effectively.

Task 45: Prepare radiopharmaceutical kits, perform quality control, and evaluate results.

Content base

1. Radiopharmaceutical kits
 - a. Preparation techniques
 - b. Activity and volume limitations
 - c. Activity calculations
2. Radiopharmaceutical quality control
 - a. Visual inspection: color and clarity
 - b. Microscopic inspection: particle size
 - c. Radiochemical purity
3. Dose calibrator operation and units of activity
4. Regulatory requirements
 - a. NRC
 - b. USP
5. Label contents
 - a. Radiopharmaceutical name
 - b. Concentration
 - c. Expiration date/time
 - d. Total activity
 - e. Assay time and date
6. Storage of kits before and after reconstitution
7. Record keeping

Comprehension

Example: Define radiochemical purity and state acceptable limits of impurities.

Application

Example: Determine total volume and radioactivity to be added to a radiopharmaceutical kit to be within stated limits.

Analysis

Example: Analyze circumstances leading to improper particle size, color, or clarity of a radiopharmaceutical and assess whether patients or nuclear medicine procedures would be adversely affected.

Task 46: Prepare and dispense diagnostic radiopharmaceuticals.

Content base

1. Regulations
 - a. NRC
 - b. USP
 - c. FDA
2. Units of activity and decay calculations
3. Vial/syringe label contents
 - a. Date and time of preparation
 - b. Radiopharmaceutical identity and lot number
 - c. Total volume and activity
 - d. Specific activity or concentration
4. Nuclear medicine procedures and acceptable radioactivity ranges
5. Dose calculations, including pediatric doses and unit dose adjustments
6. Aseptic technique
7. Dose calibrator operation
8. Administration of radiopharmaceutical dose
9. Operation of radioactive gas/aerosol administration equipment
10. Record keeping

Comprehension

Example: Identify required written records for radiopharmaceutical preparation and administration and the length of time these records must be kept.

Application

Example: Calculate activity, volume, or number of capsules to be administered for a specific procedure.

Analysis

Example: Determine adjustments to a unit dose volume to allow use of the dose before the calibration time.

Task 47: Prepare and dispense therapeutic radiopharmaceuticals.

Content base

1. Regulations
 - a. NRC
 - b. USP
 - c. Total quality management/written directive
2. Units of activity and decay calculations
3. Vial/dose container label contents

- a. Date and time of administration
- b. Radiopharmaceutical identity and lot number
- c. Total activity
- d. Total volume
- e. Specific activity/concentration
4. Aseptic technique
5. Radiation safety precautions
6. Dose calibrator operation
7. Administration of therapeutic radiopharmaceuticals
8. Record keeping

Comprehension

Example: State the regulations on misadministration of a therapeutic radiopharmaceutical.

Application

Example: Determine the procedure to withdraw an accurate volume of radiopharmaceutical into a syringe using aseptic technique and radiation safety precautions.

Analysis

Example: Analyze circumstances leading to a misadministration and recommend corrective action.

Task 48: Label blood components with a radiopharmaceutical according to protocol for procedure.

Content base

1. Labeling procedure
 - a. Required laboratory equipment and supplies
 - b. Anticoagulants and other additives
 - c. Chemical reactions
 - d. Cell washing
 - e. Radiopharmaceuticals required
2. Aseptic technique
3. Centrifuge operation
4. Calculation of labeling efficiency and administered dosage
5. Determination of cell viability
6. Record keeping

Comprehension

Example: Identify appropriate blood components, equipment, and supplies necessary to label cells with a radiopharmaceutical.

Application

Example: Determine appropriate procedure for labeling blood cells with a given radiopharmaceutical.

Analysis

Example: Analyze adequacy of cell labeling using viability studies or image quality.

