

ITEM WRITERS' GUIDELINES

for the

NUCLEAR MEDICINE TECHNOLOGY CERTIFICATION BOARD

The purpose of this guide is to assist item writers in developing test questions (items) of the highest quality that will provide a reliable measure of an examinee's preparedness to practice as a nuclear medicine technologist.

The role of the item writer in test development is very important and critical to the success of the examination. Each year, NMTCB identifies individuals who are recognized experts in the areas of radiopharmacy, radiation protection, instrumentation, imaging, and non-imaging, to participate in developing new items for the NMTCB Examination. These Guidelines will assist item writers in writing technically-sound multiple-choice test items.

Item-writing Principles

The development of multiple-choice test items follows well-defined steps. First, item writers are assigned a task at a specific taxonomy level (Comprehension, Application or Analysis) from the task list. Each assigned task represents an activity identified by the NMTCB as required in the certification examination. The task and taxonomy level should lead the item writer to select an appropriate topic for the question to be developed.

Multiple-choice Tests

The multiple-choice format is generally regarded as the most widely applicable and adaptable to the measurement of important learning objectives. This examination form has been adopted by the NMTCB and has the advantages of efficient high-speed scanner scoring and effective psychometric analysis.

Every test item begins with an idea. Ideas selected for test items should be important in the practice of nuclear medicine technology and should be relevant to the purpose of the test; they should not be trivial bits of knowledge written to stump knowledgeable examinees. Because the purpose of the NMTCB Examination is to identify examinees who are prepared to practice, rather than to compare the performances of examinees with each other, the item topics selected for the assigned task should be fundamental, significant and relevant to the practice of nuclear medicine technology.

Once the topic is determined, the next step is the construction of the stem. The stem should present examinees with all the information they will need in order to respond to the item. Examinees should not have to sift through the various alternative answers in order to determine the intent of the item, nor through unnecessary information in the stem that is unrelated to the intent of the item; this simply increases the time required to answer the item.

Characteristics of Taxonomy Levels

Comprehension

- ~ most basic level of understanding and remembering;
- ~ recall, recognition, or understanding of facts, specifics, or patterns;
- ~ may involve recognizing information presented in graphic form;
- ~ knowledge of relationships or implications of basic information to other information are not involved;
- ~ Items written at the Comprehension level usually require examinees to restate, recognize, remember, express, identify, recall or translate important ideas.

Application

- ~ comprehension as well as the ability to apply knowledge in a specific situation;
- ~ identifying the operations necessary for a problem or context, and performing them;
- ~ recognizing and applying technical principles, ideas, theories, and formulas in a specific context;
- ~ interpreting graphs or images.
- ~ Items written at the Application level usually require examinees to interpret, employ, illustrate, practice, sketch, predict, use or apply information.

Analysis

- ~ includes comprehension and application as well as analyzing a concept, principle or idea;
- ~ separating a concept, principle, or idea into its component parts or identifying relationships among the parts;
- ~ combining concepts, principles or ideas into a new pattern or structure;
- ~ evaluation of an image or procedure to determine accuracy and/or errors
- ~ reducing complex expressions into simpler or more basic expressions;
- ~ comparing, contrasting, identifying similarities and differences among concepts, principles or ideas.
- ~ Items written at the Analysis level usually require the examinee to compare, contrast, diagram, examine, analyze, construct and relate important concepts.

Once the stem has been written, the next step is to design a single keyed (correct) response. The final step, once the stem and keyed response have been developed, is to develop the four incorrect alternative responses (incorrect choices, also called "foils"). These alternatives are designed to differentiate between those examinees who are prepared to practice from those who are not. The incorrect responses should not be written to trick examinees, but to discriminate between those examinees who truly know the answer and those who do not. Statements which are true in their own right, but are only peripherally related to the question asked, or choices that would appear attractive to an examinee who does not know the correct answer, make excellent alternative responses.

Multiple-choice Item Forms

Regardless of the specific form of a multiple-choice, each item has three main parts:

1. a stem - a question or an incomplete statement presented to the examinee first;
2. the four incorrect alternative responses to the question - the incorrect responses to the stem;
3. the keyed response - the correct response to the question.

Diagrammatically, a multiple-choice item can be represented as follows:

1. presentation of question or problem (stem)
 - A. incorrect response] - - - > (incorrect
 - B. incorrect response] - - - > alternative
 - C. incorrect response] - - - > responses)
 - * D. keyed response] (key)
 - E. incorrect response] - - - >

The item stem should convey the question or problem in its entirety. The test of whether this criterion is met is to ask if a knowledgeable examinee could answer the question without looking at the choices. The keyed response must be the most acceptable of the five responses. Remember: the purpose of incorrect alternatives is not to trick examinees but to differentiate the examinees who are prepared to practice from those who are not. The alternatives, "none of the above" or "all of the above" are to be avoided.

Multiple-choice items take several different forms. The forms selected for use on the NMTCB Examination are:

Correct-answer form. One response is unequivocally correct. Factual information lends itself well to the correct-answer form (keyed responses are designated with an asterisk).

Example:

A patient's pulse should be measured at which anatomical location?

- A. neck
- B. ankle
- * C. wrist
- D. underarm
- E. temple

Best-answer form. The examinee is required to select the best answer from among those presented; the answer, however, may not be the best of all possible answers.

Example:

Which of the following radiopharmaceuticals should be used to evaluate renal function?

- *A. Tc-99m DTPA
- B. Tc-99m DMSA
- C. Tc-99m MAA
- D. I-131 RISA
- E. I-125 fibrinogen

In this example, the best of all possible answers (based solely on the information available in the stem) generally is conceded to be Tc-99m MAG3, which is not among the alternative responses provided. Note: the qualifier "of the following" is important because it excludes this option from consideration; Tc-99m DTPA thus becomes the best answer. Strictly speaking, if the stem states, "The radiopharmaceutical of choice to evaluate renal function is...", the best answer would not be among the alternatives provided. In a simple item such as this, adding the qualifier may not be critical; nevertheless, neglecting such features can increase the ambiguity of any item, which, in turn, impairs test reliability.

Negative-approach form. The examinee is asked to identify the exception among the alternative responses. The examinee must select the INCORRECT or LEAST defensible response from among several correct or more satisfactory ones.

Example:

Which of the following is NOT a computer language?

- A. COBOL
- B. BASIC
- C. FORTRAN
- * D. FOTAL
- E. PASCAL

The negative aspect should be highlighted or capitalized; e.g., NOT, CANNOT, LEAST, NEVER, and FALSE. The question must be worded very carefully to avoid confusion.

Example:

All the following are likely to be helpful to a person in shock EXCEPT:

- A. giving oxygen
- *B. applying external heat
- C. placing the person in a dorsal recumbent position
- D. giving reassurance
- E. keeping the person quiet

Because this item form asks the examinee to identify the exception, the item writer must be extremely cautious when developing this type of item to ensure that the item is clear and unambiguous. Avoid using double-negatives (having one negative in the stem and another in the response).

Sample Items

The following examples may assist writers by demonstrating the strengths of several items.

Example Item

Intrinsic bar phantom images taken over three days are compared. A significant degradation in spatial resolution is noted and is most likely due to:

- A. incorrect detector orientation.
- B. a change of 4° in room temperature.
- * C. drift in the high-voltage power supply.
- D. damage to the collimator surface.
- E. improperly mixed emission phantom.

Comment

The task for this item is to perform spatial resolution checks on a scintillation camera. This is a good example of an item written in accordance with the task. This is to be written at a taxonomy level of "application". This item also demonstrates application knowledge of the candidate in detecting an instrument malfunction and identifying the cause of the malfunction is required.

Example Item

A patient has received therapeutic 32-P colloidal chromic phosphate. The most likely source of radiation hazard to hospital personnel is:

- A. the spread of contamination caused by the patient's respiration.
- B. radiation exposure from handling the patient's urine.
- C. radiation exposure from handling the patient's stool.
- D. radiation exposure from the radionuclide inside the patient.
- * E. leakage from a puncture wound made during or after administration.

Comment

This is written at a taxonomy level of "analysis".

This item is well-written because:

~it has a single focus in the stem;

~the stem is a complete question unto itself and could be answered without viewing any of the responses; and

~all the incorrect responses have some relevance to the correct response and stem.

Example Item

A technologist prepared Tc-99m macroaggregated albumin (MAA) by adding only one-tenth of the minimum recommended volume of Tc-99m pertechnetate. What is the most likely result?

- A. hot spots will appear in lung images.
- B. labeled particles will aggregate more rapidly.
- C. the prepared radiopharmaceutical will be a nonhomogeneous suspension.
- * D. a patient dose will have more than the recommended number of particles to be administered.
- E. the radiopharmaceutical preparation will have particles that exceed the recommended size.

Comment

This item is a good example of an item written at the application taxonomy level. It requires the examinee to have a knowledge of a common radiopharmaceutical preparation and to predict what will occur when the proper preparation procedure is not utilized.

Although discussing radiopharmaceutical preparation, the item is not specific to any individual manufacturer's kit.

Example Item

A technologist who schedules a 42-year-old woman for a 3-phase bone scan of the foot must first determine if the patient:

- *A. has the possibility of being pregnant, or is nursing.
- B. is allergic to iodine.
- C. is afraid of radiation.
- D. has a history of seizures.
- E. has had a recent foot X-ray.

Comment

This is written at a taxonomy level of "comprehension".

An improvement in the responses could be made:

~by removal of extraneous words from the first response; and

~the correct response would then not be markedly longer than any other responses.

Improvement

- *A. is pregnant.
- B. is allergic to iodine.
- C. is afraid of radiation.
- D. has a history of seizures.
- E. has had a recent radiograph of the foot.

Item Submission and References

The attached item development form is to be used to submit items to the NMTCB. Of utmost importance is that the item content must be specific to the task number and taxonomy assigned. Each item must be supported with a reference so the correct response to an item can be verified. A photocopy of the reference must be attached with the supporting information underlined. Items will not be considered by the Board without supporting reference material.

All submitted test items and accompanying figures, illustrations, images, etc. are CONFIDENTIAL and are the property of the NMTCB. The item writer cannot use any of the material submitted to the NMTCB in future publications, courses, presentations, exams, review sessions, etc.

Instructions regarding the submission of digital images:

- All patient identifiers must be removed before submitting images.
- The maximum size of any visual is 500 pixels high x 700 pixels wide. The window size is 5 1/2 x 8.
- To reduce byte size, only the image should be scanned, that is, white and black borders should be eliminated (this can also be accomplished by cropping the scanned image). Images can also be reduced or cropped before they are scanned to fit into the required space. Scanning heavy black lines should be avoided (if possible) because that type of line takes up a lot of space. For images with labels imbedded in a black border, please relabel image so that the border does not have to be scanned.
- The visuals should be saved in bitmap (.bmp) format.
- Once the images are copied onto a CD or diskette, they should be rechecked to ensure the image in fact was copied, is not too large, is not misaligned, and has not been cut off.

Item Writers' Checklist

An item for the NMTCB Exam is well-written and appropriate if the

1. item is classified completely and in accordance with the task.
2. item asks a single question.
3. item is clear, complete and well-focused, and concerns a topic that experts in the field would agree is significant.
4. stem is direct, concise, and unambiguous.
5. stem includes all necessary, but no extraneous, information.
6. item has five responses.
7. stem and responses do not contain confusing double-negatives or logical inconsistencies.
8. responses provide logically appropriate completions of the stem.
9. responses are homogeneous in focus, phrasing and length.
10. responses do not overlap with one another.
11. responses do not clue examinees who are less well prepared as to which response is correct.
12. keyed response is clearly the best of the choices offered as responses to the stem.
13. incorrect responses are plausible but clearly not the best.
14. item does not contain jargon, slang, and nonstandard abbreviations.
15. item does not use information which is instrument-specific or kit-specific.

NUCLEAR MEDICINE TECHNOLOGY CERTIFICATION BOARD
ITEM DEVELOPMENT FORM

Group (Circle One) I II III IV

Task Number: _____

Taxonomy: (Circle One) Comprehension Application Analysis

ITEM STEM:

RESPONSES: [Five Required]

(* indicates correct response)

(4) Correct Response (letter): _____

Item Submitted by: _____

(62) Reference: _____ Page No: _____

Item Writer: ATTACH A PHOTOCOPY OF THE REFERENCE PAGE BEING CITED

For NMTCB Use Only

(63) Keyword #1: _____

(64) Keyword #2: _____

For ACT Use Only

(1) WPCI _____ (5) CTC1 _____ (12) Item Type _____ Date Item Received:

(3) IBNO _____ (6) CTC2 _____ (15) Item Stat _____

(7) CTC3 _____ (16) Graphics _____

(11) CTC5 _____

(66) Nedelsky Value _____

