Constructing Written Test Questions for the Basic and Clinical Sciences

NBME®

National Board of Medical Examiners
3750 Market Street
Philadelphia, PA 19104

Printed copies are not mailed, supplied, distributed or otherwise made available directly from the National Board of Medical Examiners (NBME), except in conjunction with an NBME-sponsored activity (e.g., item writing workshop, meeting or seminar, promotional or otherwise). Additional copies can be obtained by downloading the manual from the NBME U website. Permission to copy and distribute this document is granted by the NBME provided that: (1) the copyright and permission notices appear on all reproductions; (2) use of the document is for noncommercial, educational, and scientific purposes only; and (3) the document is not modified in any way. Any rights not expressly granted herein are reserved by the NBME.

Copyright © 1996, 1998 National Board of Medical Examiners® (NBME®).
Copyright © 2001, 2002 National Board of Medical Examiners® (NBME®).
Copyright © 2016 National Board of Medical Examiners® (NBME®).
All rights reserved. Printed in the United States of America.

Constructing Written Test Questions For the Basic and Clinical Sciences

Edited by

Miguel A. Paniagua, MD
Medical Advisor
Professional Services, Test Development Services
National Board of Medical Examiners

Kimberly A. Swygert, PhD
Director, Research and Development
Professional Services, Test Development Services
National Board of Medical Examiners

NATIONAL BOARD OF MEDICAL EXAMINERS
3750 MARKET STREET
PHILADELPHIA, PA 19104

Contributors from the National Board of Medical Examiners Professional Services, Test Development Services[1]

Melissa S. Billings
Director, Test Materials Development

Kristine DeRuchie
Director, Test Materials Development

Steven A. Haist, MD, MS
Vice President

Kieran Hussie
Manager, Multimedia Services and Applications

Jacquelyn Merrell
Managing Editor

Miguel A. Paniagua, MD
Medical Advisor

Kimberly A. Swygert, PhD
Director, Research and Development

Julie Tyson
Senior Editor

[1] Contributing authors for the previous edition of this book also included Susan M. Case, PhD (NBME staff at the time of publication) and David B. Swanson, PhD (NBME staff at the time of publication).

Table of Contents

Section 1: Issues Related to Format and Structure of Test Items 1

Chapter 1: Introduction 3
Assessment: An Important Component of Instruction 3
Issues of Content Sampling 3
Issues of Psychometric Performance 4
Purposes of Testing 4
What Material Should Be Tested? 4

Chapter 2: Multiple-Choice Item Formats 5
True-False vs. One-Best-Answer Items 5
The True-False Family 6
General Rules for True-False Items 7
Recommendations for Using True-False Items 7
The One-Best-Answer Family 8
General Rules for One-Best-Answer Items 10
Recommendations for Using One-Best-Answer Items 10

Chapter 3: Technical Item Flaws 11
Flaws Related to Irrelevant Difficulty 11
Flaws Related to Testwiseness 15
Summary of Technical Item Flaws 19

Chapter 4: Item Analysis and Interpretation of Results 21
Analysis of Item Difficulty 21
Analysis of Item Discrimination 22
Analysis of Item Options 22
Comparative Analysis of Test-taker Groups 23
Example Items and Analysis 24

Section 2: Writing One-Best-Answer Items for the Foundational (Basic) and Clinical Sciences 27

Chapter 5: Basic Rules for Writing One-Best-Answer Items 29

Chapter 6: Testing Application of Foundational (Basic) and Clinical Knowledge 33
Choosing the Topics to Test 33
Writing Clinical Vignettes 33
Guidelines for Clinical Vignette Content 36
Writing Item Lead-ins 37
Item Example With and Without Vignette 37
Additional Points on Vignettes 39
Structuring Items to Fit Task Competencies 40
Writing Items on Difficult Topics 46

Chapter 7: Using Media as Part of Clinical Vignettes 49
Types of Media 50
Selecting Media 53
Content Areas Conducive to the Use of Media 55
Acquiring and Creating Media 58
Tips for Creating Videos 61

Resources and Additional Reading on Item and Test Development 63

Appendix A: NBME Retired Item Formats 67

Appendix B: Sample Lead-ins Based on Provider Task Competencies 77
Medical Knowledge 79
Patient Care: Diagnosis 79
Patient Care: Management 83
Communication and Interpersonal Skills 88
Professionalism and Legal/Ethical Issues 88
Systems-based Practice and Patient Safety 91
Practice-based Learning 92

Preface to the Fourth Edition

In 2015, during the celebration of the centennial of the NBME, we decided it was time to revisit and revise the text affectionately known the world over as "the Red Book." The purpose of this manual is, as it has always been, to help faculty members across the health professions improve the quality of the multiple-choice items they write for their examinations, and to help them better understand the nature of item development, item analysis, and some basics of psychometrics and measurement. This manual provides a general overview of topics such as item and vignette writing for the foundational and clinical sciences (concentrating on the recommended item type of one-best-answer), technical item flaws, item analysis, and other areas that should provide useful guidance to the health sciences test developer. We anticipate that the primary users of this manual will be faculty members who are teaching health sciences students in basic science courses and clinical training. The examples and templates focus on undergraduate health sciences education, though the general approach to item writing should be useful for assessing test-takers at other levels and across various healthcare professions.

This manual reflects lessons that the NBME Test Development Services unit has learned in developing items and examinations over the past 30 years. During this time, NBME staff members have reviewed countless multiple-choice items and have worked with hundreds of test material development, item writing, and item review committees for USMLE Step exams, NBME exams, and specialty board exams. In addition, our staff members have been fortunate to have had the opportunity to conduct item writing workshops for thousands of item writers, including faculty members at hundreds of national and international health science schools who were interested in developing items for their own examinations. We can personally attest that each committee and workshop attendee has helped us examine our methods, rethink our arguments, and better frame our thoughts regarding how to write high-quality test items. We hope the revised version of this manual continues to be a source of wisdom and encouragement for item writers throughout the health professions world. Finally, we are indebted to our editorial predecessors, on whose broad shoulders we have stood in enhancing this text.

Miguel A. Paniagua, MD
Kimberly A. Swygert, PhD
Test Development Services
National Board of Medical Examiners

December 2016

This fourth edition is dedicated to Drs. Donald Melnick and Gerry Dillon
for their tireless efforts in promoting the NBME values
which this book and its predecessors embody.

Section 1:
Issues Related to Format and Structure of Test Items

Chapter 1: Introduction

ASSESSMENT: AN IMPORTANT COMPONENT OF INSTRUCTION

Assessment, also known as testing, is a critical component of instruction. When properly used, it can aid in accomplishing key curricular goals. A primary purpose of testing is to communicate what you, as the instructor and item writer, view as important. Tests are a powerful motivator, and your test-takers or students will learn the educational concepts they believe you value. Assessment also helps to fill instructional gaps by encouraging students to read broadly on their own and participate more as educational opportunities are available. This outcome of testing is especially important in clinical learning environments, where the curriculum may vary from student to student, depending on factors such as the setting and the flow of patients. This outcome may also be important in some basic science settings, where the educational experiences may vary from student to student. As students progress toward mastery or even excellence, they are aided by ongoing feedback from their instructors, and tests are often an important component of that feedback and useful in activating further learning.

Because tests have such a powerful influence on student learning, it is important to develop tests that will properly align with educational goals. This manual focuses on the process of writing high-quality, multiple-choice questions (MCQs), *aka* items, that can be used to assess a wide variety of clinical knowledge and skills within the framework of the basic and clinical sciences.

Two issues are of particular concern when developing and constructing quality MCQ-based exams; these are issues of *content sampling* and *psychometric performance*.

ISSUES OF CONTENT SAMPLING

The purpose of any assessment is to permit *inferences* to be drawn concerning the skills of test takers or examinees. Inferences are defined here as decisions, judgments, or conclusions that extend beyond the particular set of items included in the exam into the larger domain from which the items were sampled. Performance on the test provides a basis for estimating achievement in the broader domain that is actually of interest, and this broader domain should be made explicit with statements about the inferences to be made from the test.

The first decision to be made involves the content to be sampled on the test; content decisions will drive the number and topic areas of the MCQs to be developed. The amount of attention given to evaluating a content area should reflect its relative importance, and it is often impractical to cover all testing topics in equal lengths. Tests are point-in-time

measurements that take a specific and limited amount of time; if one content area contains many items, there is less testing time for other content areas. The nature of the test determines the extent to which the estimate of achievement is reproducible (*aka* reliable or generalizable) and accurate (valid). If the test questions are not adequately representative of the broader domain of interest (e.g., a test of competence in general medical practice includes only cardiovascular-related content), the test results may be biased and may not provide a good basis for estimating achievement in the domain of interest. If the overall test length is too short, the scores may not be sufficiently precise or reliable to ensure they are a good representation of true proficiency. In order to generate a reproducible score, the item writer needs to sample content broadly (i.e., typically 100 or more MCQs or short-answer items for text-based exams).

ISSUES OF PSYCHOMETRIC PERFORMANCE

The process of evaluating the psychometric characteristics of an assessment and weighting their relative importance is determined by the purpose of the test and the decisions that will be made based on the results. For tests with higher stakes, such as those used for promotion or graduation decisions, those used for course grades, or those used in isolation for decisions, the scores must be reasonably reproducible (as demonstrated by high reliability) and evidence should be presented to demonstrate the accuracy of the test (e.g., showing how content outlines for the test match the inferences to be made). For tests with lower stakes, such as those on which the score is but one element of the decision-making process, the amount of required psychometric evidence is less, but attention should be paid to evidence of test reliability and validity of score use nonetheless (see Figure 1 in Chapter 6 for more information).

PURPOSES OF TESTING

- Communicate to students material that is important
- Motivate students to study
- Identify areas of deficiency, in need of remediation, or further learning
- Determine final grades or make promotion decisions
- Identify areas where instruction can be improved

WHAT MATERIAL SHOULD BE TESTED?

- Exam content should align with course or clinical experience objectives
- Important topics should be weighted more heavily than less important topics
- The testing time devoted to each topic should reflect the relative importance of the topic
- The sample of items should be representative of the instructional goals

Chapter 2: Multiple-Choice Item Formats

One of the most crucial aspects of a multiple-choice test item or question (MCQ) is its type or structure. Different item types can be used for different topic areas, and each item type carries with it advantages and disadvantages. One critical aspect to keep in mind when choosing an item type is not only the ease of writing that item type for a given content area, but also the potential flaws that might benefit the savvy test-taker or introduce irrelevant difficulty. This chapter covers the basics of several multiple-choice item formats and introduces some potential flaws that are common to specific formats, while Chapter 3 will discuss specific item flaws in more detail.

TRUE-FALSE VS. ONE-BEST-ANSWER ITEMS

The universe of multiple-choice items can be divided into two families: those that require test-takers to indicate all responses that are appropriate (true-false), and those that require test-takers to indicate a single, most accurate response (one-best-answer). The NBME has used multiple item formats within each family in the past, listed below by designating letter.

True-false item formats that require test-takers select some set of options that are true:

- C-type (A/B/Both/Neither response items)
- K-type (complex true-false items)
- X-type (simple true-false items)

One-best-answer item formats that require test-takers select the single best response:

- A-type (4 or more options, single items or sets)
- B-type (4- or 5-option matching items, in sets of 2 to 5 items)
- F-type (items grouped into sets around specific content, where test-takers cannot return to previously seen items in the set)
- G-type (items grouped into sets around specific content, where test-takers can return to previously seen items in the set)
- R-type (extended-matching items, in sets of 5 to 20 items)

The letters used to label the item formats hold no intrinsic meaning; letters were assigned more or less sequentially to new item formats as they were developed. For an extended list of item types formerly used by the NBME, ordered by their designated letters, see Appendix A: NBME Retired Item Formats.

THE TRUE-FALSE FAMILY

True-false items require test-takers to select all the options that are "true," which could be anywhere from one to all of the listed options. In solving these items, the test-taker must decide where to make the cutoff and determine to what extent a response must be "true" in order to be keyed as "true." While this task requires additional judgment beyond what is required to select the true answer(s), that additional judgment may be unrelated to clinical expertise or knowledge. Too often, test-takers have to guess what the item writer had in mind because the options are not either completely true or completely false.

Which of the following are X-linked recessive conditions?

1. *Cystic fibrosis*
2. *Duchenne muscular dystrophy*
3. *Hemophilia A (classic hemophilia)*
4. *Tay-Sachs disease*

This item is an example of a reasonably acceptable true-false item from a structural perspective. Note that the stem is clear and the options are absolutely true or false with no ambiguity. Following tradition, for true-false items, the options are numbered. Options should be homogenous (all are conditions), clearly worded, and of similar length, and the question should be closed and focused.

The options can be diagrammed as follows.

1	2
4	3
Totally Incorrect	Totally Correct

True statements about cystic fibrosis (CF) include:

1. *CF is an autosomal recessive disease*
2. *Children with CF usually die in their teens*
3. *Males with CF are sterile*
4. *The incidence of CF is 1:2000*

This item demonstrates a commonly seen flaw for true-false items that often occurs when options are not homogenous and vaguely worded. Options 2, 3 and 4 cannot be judged as absolutely true or false, because a group of content experts would not necessarily agree on the answers. For example, for option 4, experts would demand more information to determine incidence: Is this in the United States? Is this among all ethnic groups? Similar issues arise with options 2 and 3, whereas option 1 is clear. Revision of this item would most likely include editing options 2, 3, and 4, to be statements of fact like option 1, and revising the question itself to be closed.

In children, ventricular septal defects are associated with:

1. *cyanosis*
2. *pulmonary hypertension*
3. *systolic murmur*
4. *tetralogy of Fallot*

The problems with this true-false item are more subtle. The difficulty is that the test-taker has to make assumptions about the severity of the disease, the age of the patient, and whether or not the disease has been treated. This is due in part to the vagueness in the question itself ("associated with"). Different assumptions lead to different answers, even among experts. Revising this question would require adding additional text, perhaps a lot of it, in order to allow the test-taker to judge the options as wholly true or wholly false.

GENERAL RULES FOR TRUE-FALSE ITEMS

Because test-takers are required to select all the options that are "true," true-false items must satisfy the following rules:

- Item and option text must be clear and unambiguous. Avoid imprecise phrases such as "is associated with" or "is useful for" or "is important"; words that provide cueing such as "may" or "could be"; and vague terms such as "usually" or "frequently."
- The lead-in should be closed and focused.
- Options must be absolutely true or false; no shades of gray are permissible.
- Options should be homogenous so that they can be judged as entirely true or entirely false on a single dimension.

RECOMMENDATIONS FOR USING TRUE-FALSE ITEMS

We recommend avoiding true-false questions if possible. Although many item writers believe true-false items are easier to write than one-best-answer items, this type can often be more problematic. The writer may have something particular in mind when writing the item, but careful review subsequently reveals subtle difficulties that were not apparent to the item author. Often the distinction between "true" and "false" is not clear, and it is not uncommon for subsequent reviewers to alter the answer key. As a result, reviewers tend to rewrite or discard true-false items far more frequently than items written in other formats. Some ambiguities can be easily clarified, but others cannot. There is a final reason to avoid true-false questions, and that is, in order to avoid ambiguity with this item type, item

writers often lean toward assessing recall of an isolated fact. This is something we recommend item writers avoid. Application of knowledge, integration, synthesis, and judgment questions can be better assessed by one-best-answer questions. As a result, the NBME has completely stopped using true-false formats on its examinations.

THE ONE-BEST-ANSWER FAMILY

In contrast to true-false questions, one-best-answer questions make explicit that only one option is to be selected. These items are the most widely used multiple-choice item format. They consist of a stem (e.g., a clinical case presentation) and a lead-in question, followed by a series of choices, with one correct answer and anywhere from three to five distractors. This question describes a situation (in this instance, a patient scenario) and asks the test-taker to indicate the most likely cause of the problem.

Stem:

A 32-year-old man has a 4-day history of progressive weakness in his extremities. He has been healthy except for an upper respiratory tract infection 10 days ago. His temperature is 37.8°C (100.0°F), pulse is 94/min, respirations are 42/min and shallow, and blood pressure is 130/80 mm Hg. He has symmetric weakness of both sides of the face and the proximal and distal muscles of the extremities. Sensation is intact. No deep tendon reflexes can be elicited. Babinski sign is present.

Lead-in:

Which of the following is the most likely diagnosis?

A. Acute disseminated encephalomyelitis
*B. Guillain-Barré syndrome**
C. Myasthenia gravis
D. Poliomyelitis
E. Polymyositis

Note that the incorrect options are not wholly wrong. The options can be diagrammed as follows:

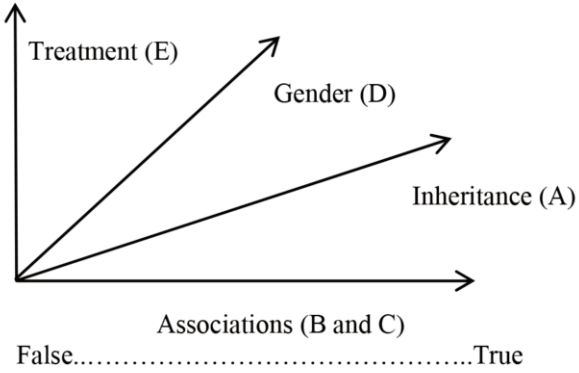
D	C	A	E	B
Least Likely Diagnosis				Most Likely Diagnosis

Even though the incorrect answers are not completely wrong, they are less correct than the "keyed answer" indicated by the asterisk in the option set. The test-taker is instructed to select the "most likely diagnosis." Experts would all agree that the most likely diagnosis is B; they would also agree that the other diagnoses are somewhat likely, but less likely than B. As long as the options can be laid out on a single continuum, in this case from "Least Likely Diagnosis" to "Most Likely Diagnosis," distractors in one-best-answer questions do not have to be totally wrong.

Which of the following is true about pseudogout?

- *A. It is clearly hereditary in most cases*
- *B. It is seldom associated with acute pain in a joint*
- *C. It may be associated with a finding of chondrocalcinosis*
- *D. It occurs frequently in women*
- *E. It responds well to treatment with allopurinol*

Some recommendations for writing one-best-answer types are similar to those for true-false items. Use of a focused lead-in, homogenous options that fall on a single dimension, and avoidance of vague terms are all recommended. This one-best-answer example is a flawed item that can occur when options are not listed on a single dimension. After reading the stem, the test-taker has only the vaguest idea what the question is about. In an attempt to determine the "best" answer, the test-takers have to decide whether "it occurs frequently in women" is more or less true than "it is seldom associated with acute pain in a joint."



The diagram of these options might look like the figure to the left. The options are heterogeneous and deal with miscellaneous facts; they cannot be rank-ordered from least to most true along a single dimension. Although this question appears to assess knowledge of several different points, its inherent flaws preclude this. The question by itself is not clear; the item cannot be answered without looking at the options.

This leads us to another important guideline for writing good one-best-answer items—the "cover-the-options" rule. If a lead-in is properly focused, a test-taker should be able to read the stem and lead-in, cover the options, and guess what the right answer is without seeing the option set. For example, in this next item, after reading the lead-in, the test-taker should be able to answer the question (ibuprofen) without seeing the options. When writing items, covering the options and attempting to answer the item is a good way to check whether this rule has been followed.

A 58-year-old man comes to the office because of pain in the right knee for the past 3 days. He has a history of type 2 diabetes mellitus, hypertension, and hyperlipidemia controlled with an oral hypoglycemic drug and an ACE inhibitor. There is no family history of similar disorders. On physical examination, the knee is swollen, passive motion produces pain, and ballottement discloses an effusion. Synovial fluid is cloudy and contains positive birefringent crystals and no bacteria. X-ray shows chondrocalcinosis. ***Which of the following is the most appropriate pharmacotherapy?***

A. Allopurinol
B. Betamethasone
*C. Ibuprofen**
D. Infliximab
E. Levofloxacin

GENERAL RULES FOR ONE-BEST-ANSWER ITEMS

Because test-takers are required to select the single best answer, one-best-answer items must satisfy the following rules (for more detail, see Chapter 6):

- Item and option text must be clear and unambiguous. Avoid imprecise phrases such as "is associated with" or "is useful for" or "is important"; words that provide cueing such as "may" or "could be"; and vague terms such as "usually" or "frequently."
- The lead-in should be closed and focused, and ideally worded in such a way that the test-taker can cover the options and guess what the correct answer is. This is known as the "cover-the-options" rule.
- All options should be homogeneous so that they can be judged as entirely true or entirely false on a single dimension.
- Incorrect options can be partially or wholly incorrect.

RECOMMENDATIONS FOR USING ONE-BEST-ANSWER ITEMS

We recommend using one-best-answer questions whenever possible. This format helps prevent confusion on the part of the test-taker from having to guess the author's intent. In addition, this format can also be easier and more efficient to write because wrong options do not have to be entirely incorrect, and different lead-ins can be paired with the same stems (a patient scenario stem can include items with lead-ins about diagnosis and management) to create item sets. The NBME currently uses only one-best-answer format items on exams.

Chapter 3: Technical Item Flaws

The purpose of this chapter is to describe two kinds of technical item flaws. The first kind is the flaw that artificially increases the difficulty of the item, which can confuse all test-takers. These flaws related to *irrelevant difficulty* make the item challenging for reasons unrelated to the trait that is the focus of assessment and can add construct-irrelevant variance to the final test score. The second kind cues the more savvy and confident test-takers (*aka*, the "testwise") and aids them in guessing the right answer. These flaws related to "*testwiseness*" make it easier for some students to answer the item correctly based on their test-taking skills alone, without necessarily knowing the content. The item writer's goal is to develop and structure items so as to eliminate both types of flaws as much as possible, in order to create a test that assures a level playing field for all students. A test-taker's probability of answering an item correctly should be determined by his or her amount of expertise on the topic being assessed; ideally, that probability will not decrease due to a suboptimally written item, and will not increase due to test-taking strategies.

FLAWS RELATED TO IRRELEVANT DIFFICULTY

Options are overly long or complicated

The item below has several flaws. The stem contains extraneous information, and in fact, the stem is not needed to answer the question. More importantly, the options themselves are overly long and complicated. The number of words in each option increases the reading load, which can shift the construct that is being measured from content knowledge to reading speed. Please note that this flaw relates only to options. There are many well-constructed test questions that include a long stem, and decisions about stem length should be made in accordance with the testing point of the item. If the purpose of the item is to assess whether or not the student can interpret and synthesize information to determine, for example, the most likely diagnosis for a patient, then it is appropriate for the stem to include a fairly complete description of the situation.

Peer review committees in HMOs may move to take action against a physician's credentials to care for participants of the HMO. There is an associated requirement to assure that the physician receives due process in the course of these activities. ***Due process must include which of the following?***

A. Notice, an impartial forum, council, and a chance to hear and confront evidence
B. Proper notice, a tribunal empowered to make the decision, a chance to confront witnesses, and a chance to present evidence in defense
C. Reasonable and timely notice, an impartial panel empowered to make a decision, a chance to hear evidence and to confront witnesses, and the ability to present evidence in defense

After a second episode of infection, which of the following is the likelihood that a woman is infertile?

A. Less than 20%
B. 20 to 30%
C. Greater than 50%
D. 75%
E. 90%

Numeric data are not presented consistently

When numeric options are used, the options should be listed in numeric order and in a single format (i.e., as terms or ranges). Confusion can occur when formats are mixed or when options are listed in an illogical order. In this example, options A, B, and C are expressed as ranges, whereas options D and E are specific percentages. All options should be expressed as ranges or as specific percentages; mixing them is ill-advised. In addition, the range for option C includes options D and E, which almost certainly rules out options D and E as correct answers for the test-wise examinee.

Severe obesity in early adolescence:

A. has a 75% chance of clearing spontaneously
B. often is related to endocrine disorders
C. shows a poor prognosis
D. usually responds dramatically to dietary regimens
E. usually responds to pharmacotherapy and intensive psychotherapy

Frequency terms that are vague and open to interpretation are used in the options

Vague frequency terms in the options (such as "often" or "usually") are not consistently defined or interpreted by the readers, and sometimes not even by experts. This can lead to multiple correct answers or a set of options that cannot be rank ordered in terms of correctness.

"None of the above" is used as an option

The phrase "None of the above" is problematic in items where judgment is involved and the options are not absolutely true or false. If the correct response is intended to be one of the other listed options, knowledgeable students are faced with a dilemma because they have to decide between the option that the item writer has intended as correct and an option that encompasses everything not listed in the option set. Test-takers can often intuit an option that is more correct than the item writer intended to be correct, which would lead them to use the more expansive option. Use of "none of the above" essentially turns the item into a true-false item; each option has to be evaluated as more or less true than the universe of unlisted options. It is often possible to fix such items by replacing "none of the above" with an option that is more specific. In this item, which asks a test-taker to specify the most appropriate pharmacotherapy, if the correct answer is to administer no pharmacotherapy, option E, "None of the above" should be replaced by "No management is indicated at this time," to eliminate any ambiguity while still requiring the test-taker to commit to a management decision.

A 39-year-old man is brought to the hospital by his brother because he has become forgetful and confused and wanders at night because he cannot sleep. He has been drinking heavily and eating very little and has been slightly nauseated and tremulous for 4 weeks. On admission, 5% dextrose in water is initiated IV. Two hours later, the patient has ophthalmoplegia and is oriented to person only. ***Which of the following is the most appropriate next step in management?***

A. Administration of dabigatran
B. Administration of diazepam
*C. Administration of large doses of vitamin B1**
D. Administration of large doses of vitamin C
E. None of the above

Options are not homogeneous or parallel

The next item illustrates a common flaw where the options are not only too long but the structure of each option is different, both of which add to the reading time. Generally, this flaw can be corrected by careful editing to ensure that the options all have the same format and the same structure. In this particular item, the lead-in can be changed to "Which of the following is the most likely reason no conclusion can be drawn from these results?" Each option can then be edited to fit a logical and parallel answer to the lead-in.

In a vaccine trial, 200 two-year-old boys were given a vaccine against a certain disease and then monitored for 5 years for occurrence of the disease. Of this group, 85% never contracted the disease. ***Which of the following statements concerning these results is correct?***

A. The number of cases (i.e., 30 cases over 5 years) is too small for statistically meaningful conclusions
B. Vaccine efficacy (%) is calculated as 85-15/100
C. No conclusions can be drawn because the trial involved only boys
D. No conclusion can be drawn since no follow-up was done with nonvaccinated children

Stems are unnecessarily complicated

This item, as written, requires that the student (a) understands the concepts of genetics that are represented and (b) is able to rank order Roman numerals (the second of which is an irrelevant and unnecessarily difficult addition to the goal of the item). This item should be rewritten with the karyotypes arranged in the options themselves, so that the student who understands the order of risk of occurrence can more easily identify the correct answer.

Arrange the parents of the following children with Down syndrome in order of highest to lowest risk of recurrence. Assume that the maternal age in all cases is 22 years and that a subsequent pregnancy occurs within 5 years. ***The karyotypes of the daughters are:***

I: 46, XX, -14, +T (14q21q) pat
II: 46, XX, -14, +T (14q21q) de novo
III: 46, XX, -14, +T (14q21q) mat
IV: 46, XX, -21, +T (14q21q) pat
V: 47, XX, -21, +T (21q21q) (parents not karyotyped)

A. III, IV, I, V, II
B. IV, III, V, I, II
C. III, I, IV, V, II
D. IV, III, I, V, II
E. III, IV, I, II, V

Each of the following statements about cholesterol is true EXCEPT:

1. *Cholesterol contains numerous fatty acids*
2. *Cholesterol is not present in any foods of plant origin*
3. *Cholesterol is required in many complex bodily functions*
4. *Endogenous cholesterol is produced within the body*

Stems are negatively phrased

A negative phrasing in the stem asks the test-taker to find the most false or least accurate option, with the rest being accurate, rather than to find the most accurate option. If most of the items on a test are positively phrased, the inclusion of a negatively phrased item stem carries the risk that the student will miss the word "except," even when it is set in bold and/or capitalized.

FLAWS RELATED TO TESTWISENESS

Presence of grammatical cues

This flaw exists when an option does not follow grammatically from the stem or lead-in. In this example, testwise students can eliminate A and C as possible correct answers because they do not follow grammatically or logically from the lead-in. Testwise students then have to choose only between B, D, and E. This can happen when an item writer focuses more attention on writing the correct answer than on the distractors, leading to the potential for grammatical errors. To avoid this flaw, read each option immediately following the stem to ensure that the language is a good fit. Another way to avoid the flaw is to always use closed lead-ins, which helps the item writer avoid this problem.

A 60-year-old man is brought to the emergency department by the police, who found him lying unconscious on the sidewalk. After ascertaining that the airway is open, the first step in management should be intravenous administration of:

A. CT scan of the head
B. diazepam
C. examination of cerebrospinal fluid
*D. glucose with vitamin B1 (thiamine)**
E. phenytoin

Administration of furosemide results in:

A. a decrease in urine potassium
B. an increase in urine potassium
C. improved glucose control in patients with type 2 diabetes
D. no change in urine potassium
E. requires decreasing the dose with renal failure

Presence of grouped or collectively exhaustive options

This flaw exists when a savvy student can identify a subset of options that cover all possible outcomes (are collectively exhaustive) and rule out the options not in that subset. In this item, options A, B, and D are exhaustive – urine potassium can only increase, decrease, or not change – and thus one of the three options must be the correct answer. A less testwise student might spend time considering C and E. Often, item writers add options like C and E only because they want to have a total of five options, but it is not an improvement of the item to add options that have no merit. The item writer should be able to rank order each option on the same dimension, and no subset of options should include all possible outcomes.

In patients with advanced dementia, Alzheimer type, the memory defect:

A. can be treated adequately with phosphatidylcholine (lecithin)
B. could be a sequela of early parkinsonism
C. is never seen in patients with neurofibrillary tangles at autopsy
D. is never severe
E. possibly involves the cholinergic system

Use of absolute terms

In this item, options A, B, and E contain terms that are less absolute than those in options C and D. The testwise student will eliminate options C and D as possibilities, because they are less likely to be true than something stated less absolutely, and so this item is flawed with the inclusion of those terms. This flaw tends to arise when verbs are included in the options rather than in the lead-in. Focusing the stem, placing the verb in the stem, and shortening the options are possible ways to correct this flaw.

Secondary gain is:

- *A. a complication of a variety of illnesses and tends to prolong many of them**
- *B. a frequent problem in obsessive-compulsive disorder*
- *C. never seen in organic brain damage*
- *D. synonymous with malingering*

The correct option is longer, more specific, or more complete

In this item, the correct answer, option A, is longer than the other options, and is the only "double" option. This flaw is another potential outcome when item writers pay more attention to constructing the correct answer than the distractors. One reason for this is that item writers likely create the correct answer first and then write the incorrect distractors. Another potential reason is that because item writers are often teachers, they will construct long correct answers that include additional instructional material, parenthetical information, caveats, and so on. This flaw can be avoided by reviewing the entire item set for length and removing language that is purely for instructional purposes only.

Presence of word repetition ("clang clues")

This flaw arises when language used in the lead-in is repeated in the options. Here, the word "unreal" in the stem can clue test-takers to the fact that the correct answer, "derealization," is the only option that also includes the word "real." The same flaw can appear even if a word is repeated only in a metaphorical sense, such as when a stem mentions bone pain and the correct answer begins with the prefix "osteo-." Item writers should scan the options and item stem to check for this word or phrase repetition.

*A 58-year-old man with a history of heavy alcohol use and previous psychiatric hospitalization is confused and agitated. He speaks of experiencing the world as unreal. **This symptom is called:***

- *A. depersonalization*
- *B. derailment*
- *C. derealization**
- *D. focal memory deficit*
- *E. signal anxiety*

Local anesthetics are most effective in the:

- *A. anionic form, acting from inside the nerve membrane*
- *B. cationic form, acting from inside the nerve membrane**
- *C. cationic form, acting from outside the nerve membrane*
- *D. uncharged form, acting from inside the nerve membrane*
- *E. uncharged form, acting from outside the nerve membrane*

Presence of convergence

This item flaw might be less obvious than the others, but it occurs frequently and is worth noting. The underlying flaw is that the correct answer is the option that has the most in common with the other options, and thus the testwise student can converge on the right answer just by counting the number of times certain terms appear. In this example, the testwise student would eliminate "anionic form" as unlikely because "anionic form" appears only once; that student would also exclude "outside the nerve membrane" because "outside" appears less frequently than "inside." The student would then have narrowed the options to B and D. Since three of the five options involve a charge, the testwise student would then select option B, which is in fact the correct answer. This flaw can also occur without being directly reflected in the language; for example, if an item is asking which pharmacotherapy is most effective, and three of the five options are in one class of drugs, the savvy student may rule out the other two as less likely. This flaw occurs when item writers start with the correct answer and write the distractors as permutations of the correct answer. The correct answer will then be more likely to have elements in common with the rest of the options, and the incorrect answers are more likely to be outliers. A useful check is to review all options and see if words or terms are repeated across options.

SUMMARY OF TECHNICAL ITEM FLAWS

Flaws Related to Irrelevant Difficulty

- Options are overly long or complicated
- Numeric data are not stated consistently
- Terms in the options or the stem are vague
- Language or structure of the options is not homogeneous
- Options are not in a logical order
- "None of the above" is used as an option
- Stems are unnecessarily complicated
- Stems contain negative phrasing

Flaws Related to Testwiseness

- Grammatical cues exist because one or more distractors don't follow grammatically from the stem
- Options are cued by being paired or exhaustive, where some options can be eliminated because other options cover all possible outcomes
- Absolute terms such as "always" or "never" are in some options
- The correct answer is longer, more specific, or more complete than the other options
- A word or phrase is included both in the stem and in the correct answer
- Convergence (the correct answer includes the most elements in common with the other options) is present

Chapter 4: Item Analysis and Interpretation of Results

Item analysis can provide very useful information about the performance of items or questions for a given group of test-takers. Item analysis includes a routine set of analyses that should be done before final test scores are calculated and before grades are provided to students. This chapter covers the most common types of item analyses used in testing, as listed below, and provides some illustrative examples.

- Analysis of item difficulty
- Analysis of item discrimination
- Analysis of item options
- Comparative analysis of test-taker groups

ANALYSIS OF ITEM DIFFICULTY

Often during the item writing process, item authors make assumptions about how easy or hard a particular item will be, based on the content area or clinical scenario used in the item. However, test-takers often confound these expectations and respond to questions in unexpected ways. Thus the first analysis for any test item is to calculate the difficulty level of that item, using the response data. The most common classical test theory index of difficulty is the *P-value*, or *percent-correct value*. This is defined as the percent of overall test-takers who got a certain item correct. Lower P-values indicate lower percentages and more difficult items, while higher P-values indicate easier items. These values are always positive and can be represented as a percent or a proportion, so that "20" and ".20" are both acceptable ways of reporting that 20% of the test-takers got a certain item correct (the chosen method should be used consistently across all items). After the observed P-value is computed, it should always be compared with the item writer's or test developer's expectations. Was the item as easy or difficult as expected? Was the item unusually easy or hard? Items that are very easy (P-value>.95) or very hard (P-value<.30) do not provide much information about the population as a whole, and may indicate that the item content is not a good match for the test-takers' proficiency. Are unusually high or low P-values showing up on certain topics or content areas? This can result from test-takers who have completely mastered the material or not learned it at all. A high-quality assessment will contain items that, in addition to covering an appropriate range of topic areas, will represent a range of difficulties as well.

ANALYSIS OF ITEM DISCRIMINATION

A good item is one that discriminates between test-takers who know the material and those who do not. In practical terms, the index of discrimination can be computed as the correlation of test-taker performance on the item with performance on the test as a whole (where the overall test score might include or exclude that item). Indices of item discrimination include correlation coefficients such as the *biserial* and *point-biserial correlation*; either estimate is appropriate for correlating performance on a single item, scored right-wrong, with a continuous test score. These are also known as *item-total correlations*. Biserial and point-biserial estimates range from −1.0 (perfect negative discrimination) to + 1.0 (perfect positive discrimination).

Large, positive item-total correlation values indicate that test-takers who get that item correct tend to do well on the test as a whole, so the item discriminates well. These are the most desirable types of items. When an item-total correlation is close to zero, there is little to no relationship between item performance and overall test performance, meaning that the item does not provide much additional information for rank-ordering test-takers on the performance scale. When an item-total correlation is negative, this indicates that test-takers who did worse on the test overall actually have a higher chance of getting the item right than those who did better on the test. There are several factors that can explain a zero or negative item-total correlation. The item might be measuring something different from the rest of the test, so that performance on that item essentially has no relation to performance on the other items. There might be an obvious flaw in the item that lower-scoring test-takers are using to guess effectively, or that is causing most of the test-takers to have to guess the answer (rightly or wrongly). Finally, an item that is keyed incorrectly will have, in addition to a very low p-value, a negative correlation estimate.

ANALYSIS OF ITEM OPTIONS

An item writer should always review the performance of the incorrect options; this is known as *option analysis*. There are several questions to be asked during option analysis. Were any of the options not selected? This is a sign that these options were not plausible or could be ruled out due to a structural flaw or by a savvy test-taker, and thus may need to be rewritten. Was any wrong option chosen more often than expected, or more often chosen than the key? If somewhat more likely, this is an indication that the item could have more than one right answer; if much more likely, this is a sign that the item is probably miskeyed. Just as the keyed option should perform as expected (in the sense that the item difficulty should be in line with expectations), so should the other options. While test-takers can learn how to

review and rule out incorrect options, the test developer should take notice if large numbers of test items have many distractors that are so implausible they are rarely or never chosen. If an option that is expected to be an easy exclusion or is expected to be a challenging, plausible distractor performs contrary to expectations, the item should be reviewed for structural soundness and content.

COMPARATIVE ANALYSIS OF TEST-TAKER GROUPS

Comparative analyses of test-taker groups fall into two categories: (1) grouping test-takers within item by overall test performance, and (2) comparing item performance across test-taker groups. The first type, *within-item analysis*, involves classifying students by overall test performance into a small set of groups, where sample sizes are sufficiently large for each group. A common grouping is known as High/Low, where the top 50% of the students are placed in the High group and the bottom 50% are placed in the Low group, and item difficulty and option analysis are evaluated separately by group within items. Another type of High/Low grouping compares those test-takers at the very top and bottom of the score distribution. Some item analysis research suggests that comparing the top 27% and bottom 27% provides the most useful information; in practice, this is often rounded off to the top 25% and the bottom 25%. For very large numbers of test-takers, groups can also be divided into quartiles (four groups of 25% each) or quintiles (five groups of 20% each) and each group can be compared with all the others. While item-level estimates of difficulty and discrimination are usually done on the total group, option analysis is most informative if conducted on subgroups such as High/Low.

The second type of comparative analysis, *cross-group analysis*, requires the grouping of students by some type of variable that would be expected to impact overall test performance; for example, in a class of first- and second-year students, the groups could be based on student year. Then, students within each year could be further grouped by performance, so that (for example) P-values and option analysis for the High groups could be compared across first- and second-year students. Another way to classify test-takers is to calculate item analysis statistics for the same items over time, using equivalent groups of test-takers. A big change in P-value or discrimination for an item over time for first-year students taking the same course in subsequent years could indicate that the item has become "exposed" (known beforehand to test-takers), that the clinical information in the item is no longer accurate, or that the topic is no longer being taught.

EXAMPLE ITEMS AND ANALYSIS

The following are example item analysis results from five items; each illustrates a common scenario. The item text is not presented here, only the analysis. For each example, students were divided into High and Low groups based on being in the top 25% and bottom 25% of performance on the total test (where performance includes the item in question). Typically, item analysis output includes all the estimates mentioned in this chapter—comparative grouping of students, a measure of item difficulty, a measure of discrimination, and responses by option to allow for option analysis. For each sample item below, the percentage of test-takers in the High and Low groups selecting each option is shown. The total row shows the percentage of the total group who selected each option.

Item #1

GROUP	A	B*	C	D	E	F
HIGH	1	**1**	91	4	1	2
LOW	20	**6**	51	14	6	3
TOTAL	9	**2**	76	8	3	2

P-value: 2 **discrimination index: -.21**

Interpretation (Item #1): The asterisk on option B indicates that B was keyed as the correct answer, but only 2% of the students answered correctly, and only 1% of the High group answered correctly. This is the typical option pattern observed for an item that is miskeyed. If the answer is truly option B, the item is very difficult and the discrimination index is negative. The correct answer is almost certainly C, but a content expert should review the item for verification. If the correct answer is keyed as C, the P-value becomes 76% and the discrimination index becomes positive. These are both excellent values from a statistical perspective, and there is no reason to make any further changes before scoring the item or using it in future tests.

Item #2

GROUP	A	B	C*	D	E	F
HIGH	0	1	**90**	3	3	3
LOW	0	1	**60**	25	8	6
TOTAL	0	1	**74**	12	7	6

P-value: 74 **discrimination index: +.33**

Interpretation (Item #2): 90% of the High group and 60% of the Low group selected the correct answer, with an overall percent-correct of 74%. These are good statistics, because this item is of appropriate difficulty and does a good job of discriminating between those who know the material and those who don't. The responses to the keyed option (C) suggest the same. One conclusion of the option analysis is that A and B do not appear to be very plausible or useful distractors, so these could potentially be rewritten for future versions of the item. Keep in mind that revising options to make them more plausible can change the difficulty of the item.

Item #3

GROUP	A	B	C*	D	E	F
HIGH	44	1	**50**	2	1	2
LOW	20	15	**21**	22	20	2
TOTAL	32	7	**34**	14	11	2

P-value: 34 **discrimination index: +.30**

Interpretation (Item #3): 50% of the High group and 21% of the Low group selected the correct answer. This is a difficult item, and so a content expert should review it to ensure that the key is correct—there is the potential for option A to be a second correct answer. If the item was not intended to be this difficult, it is important to review the structure of the item, as there may be flaws that make the item confusing for the test-taker. However, if the item was intended to be this difficult and the content expert agrees that the keyed option is the single correct answer, the item can be scored as is.

Item #4

GROUP	A	B	C*	D	E	F
HIGH	18	10	**51**	17	2	2
LOW	24	24	**21**	25	4	2
TOTAL	22	17	**34**	22	3	2

P-value: 34 **discrimination index: +.30**

Interpretation (Item #4): The High/Low group breakdown on option C is identical to Item #3, but this item is less likely to have potential problems. In contrast to the previous sample item, those test-takers who don't know the correct answer are more evenly spread across the other distractors. For the three distractors, A, B, and D, more test-takers in the Low group chose the distractor than test-takers in the High group. Of course, if the item was not intended to be difficult, it would still be desirable to review options A, B, and D for correctness and clarity.

Item #5

GROUP	A	B	C	D*	E
HIGH	10	43	5	**40**	2
LOW	23	36	12	**26**	3
TOTAL	17	43	7	**31**	2

P-value: 31 **discrimination index: −.09**

Interpretation (Item #5): The P-value is low and the discrimination is negative, indicating that there is a problem with the item. Both the High and Low groups are more likely to select option B than the option keyed as correct, which is D. This is a classic example of an item that likely has two correct answers. This item should be reviewed by a content expert and should not be scored until it is reviewed, since something about the item stem or options is convincing even the High performers that the key is an answer other than D.

Section 2:
Writing One-Best-Answer Items for the Foundational (Basic) and Clinical Sciences

Chapter 5: Basic Rules for Writing One-Best-Answer Items

Rule 1: Each item should focus on an important concept or testing point.
As a healthcare provider and educator assisting in the development of an examination, you may be asked to write items to assess test-taker knowledge of a particular domain. What do you want the test-taker to know or demonstrate? The topic of the item usually results from the blueprint, which is the outline of the major topics to be covered on the examination. For instance, if an examination is developed to assess knowledge of the cardiovascular system, the blueprint might have two dimensions: 1) disease-based (e.g., hypertension, ischemic heart disease, systolic heart failure), and 2) task-based (e.g., assessment of foundational science principles, diagnosis, history, prognosis). The blueprint would likely include items along both dimensions, and might call for six items on hypertension, four on systolic heart failure, two on diastolic heart failure, ten on ischemic heart disease, and so on. Along the task dimension there might be a similar distribution of topics. A clear and comprehensive blueprint or other set of test specifications should always be available so that item writers can stay focused on the important topics and write sufficient numbers of items for each topic.

Rule 2: Each item should assess application of knowledge, not recall of an isolated fact.
The first step in writing an item is to develop an appropriate stimulus to introduce the topic, such as a clinical or experimental vignette, to provide context to the question being asked. If there is no such stimulus, the resulting item will generally be assessing knowledge recall. These types of items make it difficult for the educator to assess any higher level within Bloom's taxonomy, such as "application of knowledge." For instance, an item consisting of one sentence, "Which of the following medications is used to decrease preload in systolic heart failure?" would assess only the recall on the mechanisms of action of a list of pharmacotherapeutic agents.

It can be helpful to use actual cases previously encountered as a source of ideas for items and vignettes. However, you should avoid relying on or adhering too closely to actual patient cases because these often have atypical features that may divert from a typical or representative case and lead to confusion. Additionally, in some instances, such as the example with systolic heart failure, there will be an additional step that you must keep in mind: you should consider the underlying cause of the heart failure. Patient demographics, past medical history, and other factors will differ depending on the etiology of the condition. Patients with systolic heart failure from a viral cardiomyopathy versus from ischemic heart disease may have different demographics and a different history; e.g., a younger patient with a viral illness preceding the onset of heart failure symptoms as compared to an older patient with risk factors for ischemic heart disease.

The details of the vignette should be guided by the level of the test-taker. A systolic heart failure vignette for a novice, such as a second-semester first-year medical student, would include very typical features and classic symptoms: shortness of breath with physical activity that improves with rest; awakening at night short of breath, relieved by sitting up; pedal edema; and pertinent negatives such as the absence of chest pain. Risk factors might include an upper respiratory illness two weeks ago, or a history of heavy alcohol ingestion over 20 years. For more advanced test-takers, such as those sitting for a specialty certifying examination, the vignette could include some atypical features, as is the case with many actual patients. The demographic information may or may not be significant for the more advanced test-takers. For instance, every patient lives somewhere and many will have a current or past occupation that may or may not be related to the cause of their illness. In a vignette for a 30-year-old man with shortness of breath and wheezing in which the diagnosis is asthma, the demographic information might or might not be related to the diagnosis. The patient might be a farmer, but the most likely diagnosis is still asthma and not farmer's lung or silo-filler's lung.

Rule 3: The item lead-in should be focused, closed, and clear; the test-taker should be able to answer the item based on the stem and lead-in alone.

The next step is to ask the question with the use of a lead-in, and the accompanying vignette allows lead-ins to be focused on the patient, such as, "Which of the following is the next step in the management of this patient?" or "Which of the following is the most likely diagnosis?" An open-ended lead-in such as, "The diagnosis in the patient is:" should be avoided. The lead-in should be a single, closed, clear question. Ideally, after reading the vignette and the lead-in, a test-taker should be able to answer the item without seeing the options. Another reason to use a closed lead-in is because it helps to avoid certain item flaws, such as grammatical cueing.

Rule 4: All options should be homogeneous and plausible, to avoid cueing to the correct option.

Next, generate the correct or keyed answer for the lead-in. For questions regarding diagnosis, the topic area may be the answer—if you are assigned to write two items on community acquired pneumonia (CAP), one item on the diagnosis and one item on management, the assignment has already generated the keyed answer for the lead-in, "Which of the following is the most likely diagnosis?" Often, generating the correct answer is the easier step; generating plausible and parallel yet incorrect distractors is more challenging. For example, reasonable distractors in an item where the correct diagnosis is CAP could include pulmonary embolus, lung cancer, and pneumothorax.

Rule 5: Always review items to identify and remove technical flaws that add irrelevant difficulty or benefit savvy test-takers.

Once you have written your item, you should take a step back and look closely at its structure. The bulk of the text (vignette or case information) should precede rather than follow the lead-in. The clinical or experimental vignette should make sense and follow a logical sequence: first list patient demographics, then history, physical examination, laboratory data, and so on. The lead-in should be closed, and the wording of the lead-in should logically generate a homogeneous option set. The use of a template to ensure all of these sections are in place and correctly structured is highly recommended. As you review your item, ask yourself the following questions. If the options were removed, could a knowledgeable test-taker answer the question correctly? Is there anything in the phrasing or text that would confuse the knowledgeable test-taker? Are there any clues to help a testwise student guess the item correctly? Finally, you should ask a colleague to review the items you have written, in particular for content, clarity, and appropriateness for your particular test-taker population.

Chapter 6: Testing Application of Foundational (Basic) and Clinical Knowledge

CHOOSING THE TOPICS TO TEST

The content of an exam should be driven by the purpose of that exam and the test-taker population. Who is being tested and how will the scores be used? For example, the USMLE system is designed for use by state medical licensing authorities in their decision to grant a general licensure for allopathic and international graduate physicians in the United States. The focus is to assess knowledge of content that is necessary for the practice of medicine by the undifferentiated physician; items might be included on USMLE that assess knowledge not uniformly taught in medical school. Conversely, topics that are the focus in some medical schools might be omitted from the exam. The analogy for individual schools and courses within schools is to determine the student test-taker population and purpose of the scores. An exam that is intended for formative feedback at a mid-point of a course will have a different focus and different content than an exam to determine end-of-clerkship grades.

WRITING CLINICAL VIGNETTES

As mentioned previously, in addition to considering topics that are important to include on a test, the item writer should think about how to structure those questions to test more than just recall of isolated facts. Traditionally, test questions have been classified as requiring recall, interpretation, or problem solving (memory, comprehension, and reasoning), depending on the cognitive processes required to answer the question. Typical definitions of "Recall Questions" are those that assess student knowledge of definitions or facts. "Interpretation Questions" require students to review some information (e.g., a vignette), and reach some conclusion, such as a diagnosis. "Problem-Solving Questions" present a situation and require students to take some action (e.g., decide the next step in patient management). The difficulty with these classifications is that the cognitive processes required to answer a question are as dependent on the background of the student as they are on the question content. Additionally, the selection of item types depends on the intent of their use: for a medium- to high-stakes summative examination, the use of vignettes that require higher-order thinking skills and application of knowledge would be preferable to simple recall items. Use of recall items may be best utilized for formative assessment purposes and the evaluation of simpler concepts that might not lend themselves to clinical or experimental scenarios (see Figure 1 for the advantages of each item type in each assessment type).

Figure 1. Promoting Versatility in Item Creation: Recall vs. Vignette

ITEM TYPE	FORMATIVE ASSESSMENT	SUMMATIVE ASSESSMENT
Recall	• Useful for assessing efficiency of classroom instruction • Provides "rapid fire" stimulation of learning • Attention-keeping strategy	• Allows for large quantity of items • Best for single-step questions and single concepts/facts
Vignette/Experimental	• Item format familiarization • Problem-based learning • Team-based learning • Clinical or experimental correlations during instruction	• Good for assessing higher-order thinking skills • Provides better approximation of real-life practice • Allows for integration and differentiation • Amenable to multi-step question formats

Experts in a content area may simply recall an answer with little or no conscious thought, whereas others may need to reason out the answer from basic principles. The cognitive processes involved in responding to a question are student-specific, making the taxonomic approach difficult to use. An alternate approach divides items into two categories: *application of knowledge* vs. *recall of a fact*. If a question requires a test-taker to reach a conclusion, make a prediction, or select a course of action, it is classified as an *application of knowledge* question. If a question assesses only rote memory of a fact (without requiring its application), it is classified as a *recall* question.

Items asking for recall of isolated facts often begin by citing a disease and then asking what patient findings are expected. For example, "Which of the following findings is most likely to be seen in postsurgical patients with pulmonary embolism?" is an item structured similarly to most textbook questions; the test-taker could look up the disease and find the answer in a single paragraph. From a practical standpoint, these items seem clinically backwards – patients rarely tell their physician what disease they have and then ask the physician to determine the signs and symptoms.

Which of the following is an indication for fetal karyotyping in a 28-year-old woman?

A. Fetal cystic hygroma on ultrasound exam
B. Paternal age 55
C. Previous child with spina bifida
D. Previous miscarriage of a triploid fetus
E. Trisomy 21 in the woman's brother

Another type of recall item is known as the "waiting room item." Here, the test-taker is asked to select one of five patients for whom fetal karyotyping is most appropriate, almost as if he or she is charged with performing fetal karyotyping on someone and needs only to look into the waiting room and select the patient who is most appropriate.

In contrast, the following item describes a patient and asks which study is most appropriate. The inclusion of the vignette leads to a more realistic task, because the test-taker would need to be able to both recall specific information and synthesize that information to know which studies should be ordered.

A 28-year-old primigravid woman is at 11 weeks' gestation. Medical history is unremarkable. Family history is unremarkable except that both of her brothers have intellectual developmental disorder, her mother died of breast cancer at age 55, and her father is estranged. No family health records are available. ***Which of the following studies is appropriate?***

A. Amniocentesis for α-fetoprotein
B. Blood test for fragile X carrier status
C. Blood test for phenylketonuria carrier status
D. Chorionic villus sampling for chromosome analysis
E. Chorionic villus sampling for Duchenne's muscular dystrophy

Questions with a clinical vignette as part of the item stem have several benefits. First, the authenticity of the examination is greatly enhanced by using questions that require test-takers to "solve" clinical problems. Second, the questions are more likely to focus on important information, rather than trivia. Third, these questions help to identify those test-takers who have memorized a substantial body of factual information but are unable to use that information effectively in clinical situations.

Writing application of knowledge questions is relatively straightforward in the clinical sciences. The one instance in which use of a clinical vignette involves simple recall of an isolated fact is if the vignette describes a patient identical to one the student previously has read about or has participated in the patient's care (e.g., using a patient vignette from a textbook or one discussed in class).

GUIDELINES FOR CLINICAL VIGNETTE CONTENT

- Test application of knowledge using clinical vignettes to pose medical decisions in patient care situations
- Focus items on common or potentially catastrophic problems; avoid "zebras" and esoterica
- Pose clinical decision-making tasks that would be expected of a successful test-taker
- Avoid clinical situations that would be handled by a specialist if not writing for a specialty exam
- Focus on specific tasks that the successful test-taker must be able to undertake at the next stage of training
- Focus on areas in which clinical reasoning mistakes are often made

The following can be used as a template for a patient vignette; not all of the following components are necessary, but when present should be in the order indicated:

- Age, gender (e.g., 45-year-old man)
- Site of care (e.g., the emergency department)
- Presenting complaint (e.g., headache)
- Duration of complaint (e.g., 2 days)
- Patient history, including past medical history, family history, psychosocial history, and review of systems if important and plausible for the scenario
- Physical findings
- Results of diagnostic studies
- Initial treatment, subsequent findings

Make sure the item stems adhere to the following rules:

- Focuses on important concepts rather than trivial facts
- Can be answered without looking at the options
- Includes all relevant facts; no additional data should be provided in the options
- Is not "tricky" or overly complex
- Is not negatively phrased (e.g., avoid using *except* or *not* in the lead-in)

WRITING ITEM LEAD-INS (SEE APPENDIX B FOR MORE DETAIL)

The vast majority of items should be written with a clinical or experimental vignette. The stem should begin with the presenting problem of a patient, followed by the history (including duration of signs and symptoms), physical findings, results of diagnostic studies, initial treatment, subsequent findings, and so on. Each vignette may include only a subset of this information, but the information should be provided in a consistent order across items. The stem should consist of a single, clearly formulated question. The lead-in of the stem must pose a clear question so that the test-taker can answer without looking at the options. As mentioned previously, satisfying the "cover-the-options" rule is an essential component of a good question. The following stem provides sufficient information and can be answered without referring to the options.

> *A 52-year-old man has had increasing dyspnea and cough productive of purulent sputum for 2 days. He has smoked one pack of cigarettes daily for 30 years. His temperature is 37.2° C (99° F). Breath sounds are distant with a few rhonchi and wheezes. Leukocyte count is 9000/mm^3 with a normal differential. Gram stain of sputum shows numerous neutrophils and gram-negative diplococci. X-ray films of the chest show hyperinflation.* ***Which of the following is the most likely diagnosis?***

ITEM EXAMPLE WITH AND WITHOUT VIGNETTE

The following trio of items were administered on USMLE and performed quite differently across the various formats, especially for low-performing test-takers. The grid under each item shows the percentage of High (top 20%) and Low (bottom 20%) students who selected each option. Almost all of the High group (99%) and the Low group (90%) selected the correct option (indicated by the asterisk) in the non-vignette format. The short- and long-vignette formats were not markedly more difficult for the High group, but were for the Low group; the correct answer was selected by 82% of the Low group in the short-vignette format and 66% in the long-vignette format. See Chapter 4 for a more in-depth discussion of item analysis.

No Vignette

The most likely renal abnormality in children with nephrotic syndrome and normal renal function is

A. acute poststreptococcal glomerulonephritis
B. hemolytic-uremic syndrome
*C. minimal change nephrotic syndrome**
D. nephrotic syndrome due to focal and segmental glomerulosclerosis
E. Schönlein-Henoch purpura with nephritis

	A	B	C*	D	E
HIGH	1	0	**99**	0	0
LOW	8	1	**90**	1	0

Short Vignette

A 2-year-old child has a 1-week history of edema. His blood pressure is 100/60 mm Hg, and there is generalized edema and ascites. Serum concentrations are: creatinine 0.4 mg/dL, albumin 1.4 g/dL, and cholesterol 569 mg/dL. Urinalysis shows 4+ protein and no blood. Which of the following is the most likely diagnosis?
(Same option set as above)

	A	B	C*	D	E
HIGH	0	0	**98**	2	0
LOW	6	2	**82**	9	1

Long Vignette

A 2-year-old child developed swelling of his eyes and ankles over the past week. Blood pressure is 100/60 mm Hg, pulse 110/min, and respirations 28/min. In addition to swelling of his eyes and 2+ pitting edema of his ankles, he has abdominal distention with a positive fluid wave. Serum concentrations are: creatinine 0.4 mg/dL, albumin 1.4 g/dL, and cholesterol 569 mg/dL. Urinalysis shows 4+ protein and no blood. Which of the following is the most likely diagnosis?
(Same option set as above)

	A	B	C*	D	E
HIGH	0	1	**98**	1	0
LOW	10	9	**66**	10	5

Although the third item listed is labeled "long vignette," it is still relatively short in length. Clinical knowledge and science exams require test-takers to demonstrate proficiency in sorting through patient information, synthesizing the important findings, and reaching a conclusion. As a result, these items may have extraneous information as well as the essential information to answer the question. If there is concern about the vignette length, it is possible to synthesize findings with a statement such as, "The family history is noncontributory."

ADDITIONAL POINTS ON VIGNETTES

Verbosity, Window Dressing, and Red Herrings

Many educators stress the importance of writing items that are as short as possible, as a method of avoiding excessive verbosity, "window dressing" (extraneous material not needed to answer the item), and "red herrings" (information designed to mislead the test-taker). However, it is possible to avoid these traps while writing good-quality clinical vignettes that stress application of knowledge by asking test-takers to make clinical decisions, rather than to simply recall isolated facts. These items are designed to reflect "real-life tasks" by challenging test-takers to first identify the findings that are important, and then integrate those findings into a diagnosis or clinical action. These items often require multiple steps in the cognitive process. The vignettes tend to follow a standard structure and pose questions that are clinically natural, and the use of a template allows for development of high-quality vignettes with a lower risk of adding too much verbiage or unnecessary or confusing information.

Use of Real Patients

As mentioned previously, item writers should be careful when basing vignettes on real patients, particularly for tests aimed at students. As a general rule, real patients are complicated, and the elements that are complicated are not always those that are important for assessment. As noted earlier, it is fine to sometimes include window dressing, such as incidental findings, but item writers should note that real patients often have "red herrings" among their findings.

Patients Who Lie

Ideally, patients in vignettes should tell the truth, or the physician's interpretation of the patient's story should be provided. Physicians use multiple cues to determine how truthful a patient is and many of these cues cannot be translated into written form. Thus, an item may describe a patient's alcohol consumption as, "The patient drinks 16 ounces of beer with dinner each night" or, "The patient's description of his alcohol consumption is contradictory." Do not write something that requires an interpretation of veracity, such as, "The patient 'claims' to drink only one bottle of beer each night."

STRUCTURING ITEMS TO FIT TASK COMPETENCIES

A set of defined task competencies will assist the item writer in focusing his or her intended testing point. Each competency requires a slightly different approach to item writing. Some sample lead-ins and example items to guide item-writing efforts for each physician (or other provider) task competency are provided below. Additional lead-ins can be found in Appendix B, Sample Lead-Ins Based on Provider Task Competencies.

Foundational (Basic) Science

Foundational science comprises items that require understanding and application of basic science. These items should require clinical knowledge as well as knowledge of one or more foundational science principles that would likely have been learned during preclinical study and reinforced during clinical rotations. The following lead-ins are examples of those used in this category:

- *Which of the following is the most likely cause/mechanism of this effect?*
- *Which of the following is the most likely causal infectious agent?*
- *This patient most likely has a defect in which of the following?*
- *This patient most likely has a deficiency in which of the following enzymes?*
- *Which of the following cytokines is the most likely cause of this condition?*
- *Which of the following structures is at greatest risk for damage during this procedure?*
- *The most appropriate medication for this patient will have which of the following mechanisms of action?*

Diagnosis

The diagnosis competency is subcategorized into more detailed concepts: Obtaining and Predicting History and Physical Examination, Selecting and Interpreting Diagnostic Studies, Formulating the Diagnosis, and Determining Prognosis/Outcome. Sample lead-ins for the various subcategories are shown.

Obtaining and Predicting History and Physical Examination

- *Which of the following factors in the patient's history most increased her risk for developing this condition?*
- *Which of the following additional information regarding this patient's history is most appropriate to obtain at this time?*
- *Which of the following is the most appropriate focus of the physical examination at this time?*

Selecting and Interpreting Diagnostic Studies

- *Which of the following is the most appropriate diagnostic study to obtain at this time?*
- *Which of the following laboratory studies is most likely to confirm the diagnosis?*
- *Which of the following is the most likely explanation for these laboratory findings?*
- *Arterial blood gas analysis is most likely to show which of the following sets of findings?*

Formulating the Diagnosis

- *Which of the following is the most likely diagnosis?*
- *Which of the following is the most likely working diagnosis?*

Determining Prognosis/Outcome

- *Based on these findings, this patient is most likely to develop which of the following?*
- *Which of the following is the most likely complication of this patient's current condition?*

A 28-year-old woman has palpitations that occur approximately once a week, last 1 to 5 minutes, and consist of rapid, regular heart pounding. The episodes start and stop suddenly and have not been associated with chest discomfort or dyspnea. There is no history of heart problems. She drinks two to three cups of coffee daily. She rarely drinks alcohol and does not smoke. Her blood pressure is 120/88 mm Hg, and pulse is 96/min and regular. A stare and lid lag are noted. The thyroid gland is firm and 1.5 times larger than normal. There is a midsystolic click at the apex and a grade 2/6 early systolic murmur at the left upper sternal border. An ECG is normal except for evidence of sinus tachycardia.
Which of the following is the most appropriate next step in diagnosis?

A. Ambulatory ECG monitoring
B. Echocardiography
*C. Measurement of serum thyroid-stimulating hormone level**
D. Measurement of urine catecholamine level
E. MUGA scan

Management

The management competency contains a range of concepts, such as Health Maintenance and Disease Prevention, Pharmacotherapy, and Clinical Interventions/Treatment. In most items that focus on the testing point of management, the patient's diagnosis is inferred so that the appropriate management can be determined.

Health Maintenance and Disease Prevention: Items in this topic area assess the ability to evaluate risk factors, understand epidemiologic data, and apply preventive measures. Health Maintenance and Disease Prevention items commonly fall into one of the following categories: 1) screening tests, 2) constructive interference, 3) immunizations/travel medicine, or 4) emergency intervention. In general, the writer should open the items with a clinical vignette that describes a patient. In addition to physical examination findings, these vignettes may include information about immunization history, risk factors, and family history. Information about the community may be relevant and therefore included, but the question should focus on the individual patient. Questions should NOT focus on the direct assessment of isolated facts. For example, avoid asking about the leading cause of death in some subpopulation; instead, focus on the application of this knowledge. In asking about immunizations or screening tests, consider providing a chart of customary practices to avoid memorization of conflicting recommendations. The following lead-ins are examples of those used in this category:

- *Which of the following immunizations should be administered at this time?*
- *Which of the following is the most appropriate screening test?*
- *Which of the following tests would have predicted these findings?*
- *Which of the following is the most appropriate intervention?*
- *For which of the following conditions is this patient at greatest risk?*
- *Which of the following is most likely to have prevented this condition?*
- *Which of the following is the most appropriate next step in management to prevent [morbidity/mortality/disability]?*
- *Which of the following should be recommended to prevent disability from this patient's injury/condition?*
- *Early treatment with which of the following is most likely to have prevented this patient's condition?*
- *Supplementation with which of the following is most likely to have prevented this patient's condition?*

A 15-year-old boy has had two episodes of severe anaphylactic shock following bee stings. ***Which of the following is the most appropriate intervention?***

A. *Administration of corticosteroids during the summer*
B. *Desensitization with bee venom extract**
C. *Long-term prophylactic antihistamine therapy*
D. *Protective clothing*
E. *Restrict him to the house during the summer months*

A healthy, moderately active 75-year-old woman is found on routine screening to have a total serum cholesterol concentration of 208 mg/dL and serum HDL-cholesterol concentration of 70 mg/dL. ECG shows no abnormalities. ***Which of the following dietary recommendations is most appropriate?***

A. *Decreased intake of cholesterol*
B. *Decreased intake of saturated fat*
C. *Decreased intake of simple carbohydrates*
D. *Increased intake of fiber*
E. *No change in diet**

A 33-year-old woman, gravida 1, para 1, spontaneously delivers a 2460-g (5 lb 7oz) female newborn at 38 weeks' gestation. The newborn has hepatosplenomegaly, patent ductus arteriosus, and cataracts. At 8 weeks' gestation, the mother developed a maculopapular rash, enlarged cervical lymph nodes, sore throat, and arthralgias that spontaneously resolved in 1 week. The subsequent prenatal course was uncomplicated. ***Which of the following tests during pregnancy is most likely to have predicted the findings in the fetus?***

A. *Amniocentesis to determine karyotype*
B. *Culture for herpes simplex virus*
C. *Serial rubella titers**
D. *Urinalysis for cytomegalovirus*
E. *VDRL test*

An asymptomatic 33-year-old man has a blood pressure of 166/112 mm Hg. Serum electrolyte levels are within normal limits. ***Effective antihypertensive treatment is most likely to reduce the likelihood of which of the following?***

A. *Aortic aneurysm*
B. *Congestive heart failure*
C. *Myocardial infarction*
D. *Renal failure*
E. *Stroke**

Pharmacotherapy/Clinical Interventions and Treatments: These items assess principles of chronic and acute in inpatient and outpatient care. When writing these items, it is especially important to focus on aspects of care relevant to the level of practice of the test-taker (supervised, limited supervision, independent practice, subspecialist). Some lead-ins that can be used are:

- *Which of the following is the most appropriate initial or next step in patient care?*
- *Which of the following is the most effective management?*
- *Which of the following is the most appropriate pharmacotherapy?*
- *Which of the following is the first priority in caring for this patient?*

A hospitalized 55-year-old woman with decompensated cirrhosis of the liver is being treated with spironolactone, potassium chloride elixir, and furosemide. She is now barely responsive and is hypotensive without respiratory distress. She has signs consistent with chronic hepatic disease, ascites, and minor peripheral edema. ECG shows a regular, slow rhythm (55/min), no P waves, and a wide, slurred QRS complex running into a wide, slurred ST and T wave. ***Which of the following should be administered intravenously?***

*A. Calcium**
B. Lidocaine
C. Magnesium
D. Potassium
E. 0.9% Saline

A previously healthy 15-year-old boy has cramping periumbilical pain; after several hours, the pain shifts to the right lower quadrant and becomes constant. He vomits several times and is brought to the emergency department. There is tenderness on deep palpation of abdomen in the right lower quadrant. Findings on chest and abdominal x-ray films are normal. Leukocyte count is 15,000/mm^3. Urinalysis shows 3 leukocytes/hpf. ***Which of the following is the most appropriate initial management?***

A. Barium enema
B. CT scan of the abdomen
C. Intravenous pyelography and cystography
D. Supportive treatment at home; return at once if the pain increases
*E. Surgical exploration of the abdomen**

Mechanisms of Disease

The items in this competency should evaluate test-takers' knowledge of pathophysiology in its broadest sense, including etiology, pathogenesis, natural history, clinical course, associated findings, complications, severity of illness, and intended or unintended effects of therapeutic interventions. These items should be framed in a clinical context. In general, the writer should open items on mechanisms of disease with a clinical vignette of a patient and his/her symptoms, signs, history, and lab study findings, and use lead-ins such as the following:

- *Which of the following is the most likely explanation for these findings?*
- *Which of the following is the most likely location of this patient's lesion?*
- *Which of the following is the most likely pathogen?*
- *Which of the following findings is most likely to be increased/decreased?*
- *A biopsy specimen is most likely to show which of the following?*

A 10-year-old girl develops gross hematuria 14 days after a sore throat. She has a blood pressure of 170/100 mm Hg and 2+ pedal and pretibial edema. Serum urea nitrogen (BUN) level is 3.2 mg/dL. ***Which of the following is the most likely cause?***

*A. Acute postinfectious glomerulonephritis**
B. Microscopic polyangiitis
C. Minimal change disease
D. Thin basement membrane nephropathy
E. Tubulointestinal nephritis

A 32-year-old man has a purulent urethral discharge. A culture grows Neisseria gonorrhoeae *sensitive to penicillin. One week after cessation of penicillin therapy, the patient has a recurrence of the urethral discharge. A culture again shows* N. gonorrhoeae *sensitive to penicillin. Both the patient and his sexual partner are HIV negative. Examination of the patient's sexual partner shows an anal fissure; urethral culture does not grow* N. gonorrhoeae. ***Which of the following is the most likely cause of the recurrence of urethral infection?***

A. Concurrent herpesvirus infection
B. Emergence of bacterial resistance
C. Inadequate treatment with penicillin
*D. Reinfection from sexual partner**

WRITING ITEMS ON DIFFICULT TOPICS

A common belief is that many topics do not lend themselves to a multiple-choice format. When working with difficult topics, it can be helpful to review sources of test material and select any questions on the topic that you think are acceptable. Next, identify the key features of these items and try to develop a template that would enable others to write similar items. For topics where no sample items are available, think about what you want to assess. Go beyond the list of topics by outlining tasks related to the topic that are essential for medical students to know.

To illustrate this process, the following paragraphs outline a process similar to one that was used to write NBME items on medical ethics and jurisprudence. The content outline included the following topics: 1) consent and informed consent to treatment (e.g., full disclosure, alternate therapies, risks and benefits, conflict of interest); 2) physician-patient relationship (e.g., boundaries, truth-telling, confidentiality including HIPAA, privacy, autonomy, justice, beneficence); 3) death and dying and palliative care (e.g., diagnosing death, life-support, organ donation, and euthanasia and physician-assisted death); 4) legal issues related to abuse (e.g., child, elder, intimate partner); 5) birth-related issues; and 6) research issues (e.g., consent, placebos, conflict of interest, vulnerable populations).

The legal basis for the eased restrictions on abortions in the United States can be traced most closely to:

A. AMA rulings
B. a federal court ruling
C. federal legislation
D. state court rulings
E. state legislations

The difficulty of this topic area tends to influence item writers to use simple recall items ("Which of the following is the definition of informed consent?") or "waiting room" items ("Which ethical principle is being illustrated by the scenario?"). This sample item shows why these were often irreverently referred to as "Who cares?" questions.

After reviewing the item pool, the NBME decided that it was not important to assess whether students know definitions; instead, the goal became assessment of whether or not test-takers could apply ethical principles in their decisions related to patient care. A group of item writers reviewed model questions and then generated new items for the exam. All questions involved a patient vignette and required the student to indicate what the physician should do or asked the student to evaluate the appropriateness of the physician's actions indicated in the vignette. No questions focused just on the definition of terms. The following are two sample items that use genuine vignettes to test application of knowledge.

A nurse is hospitalized for an appendectomy at the medical center where she is employed. One week after discharge, the assistant hospital administrator asked the surgeon what the final diagnosis was. ***Which of the following is the most appropriate response on the part of the surgeon?***

A. Answer, because as an employee of the medical center the administrator has access to information about patients
B. Answer, because it will expedite handling of insurance issues at the medical center
C. Answer, because of the possibility of spreading misinformation about the patient
D. Decline to answer, because the administrator is not a medical doctor
*E. Decline to answer, because the information is confidential**

An 8-year-old boy with acute lymphoblastic leukemia has experienced three relapses in the past 2 years. The only available treatment is experimental chemotherapy. Without treatment, the child is unlikely to survive for more than 6 weeks; with treatment, his prognosis is unknown. The parents do not want further treatment for their son and wish to take him home; the child also says he wants to go home. ***Which of the following is the most appropriate course of action?***

A. Discharge the child against medical advice
*B. Discharge the child routinely**
C. Petition the court for an order for treatment
D. Report the parents to social services for medical neglect

Chapter 7: Using Media as Part of Clinical Vignettes

The computer-based administration of a multiple-choice exam makes it straightforward to add media to test items. There are many advantages to adding media, most notably the opportunity that images, videos, and other media provide for adding authenticity to the assessment of knowledge and skills. While text-based vignettes are well-suited to the assessment of the foundational and clinical sciences, it is clear to see how the addition of media can improve an item that describes the appearance of a patient or a physical exam. In addition, the presence of media allows the item writer to assess skills that purely text-based items cannot measure well (many noncognitive skills may fall into this area). Finally, long clinical vignettes that fully describe the patient condition may be challenging to write without including textual cues that benefit the savvy test-taker. Using media in the place of this text not only provides authenticity but also avoids giving the answer away in the description.

When writing test items that use media, the goal should be to select the media that best simulates what happens in practice. There are many media types for the item writer to consider. All the types presented in this chapter are appropriate for assessment of foundational and clinical sciences, and many have been used in NBME exams. In order to determine if a particular media type is a good simulation for what happens in practice, it is important to consider the following:

- The content area covered or the skills being assessed: For example, if the topic area is about findings on cardiac auscultation, the image of an ECG is a natural fit for that skill.
- The novelty of the media: Very novel media may require a learning curve or additional tutorial information to orient the test-takers, so simplicity in accessing media is a desirable factor.
- The memorability of the media: Media may be more easily remembered by students, which can be problematic if a limited sample of different images or videos is used for multiple classes or exams. Ideally, students would not be able to easily memorize notable features of the test item and share that information with the next set of test-takers (e.g., the patient with the moustache has aortic stenosis). One option for avoiding this is to write multiple items for each piece of media.
- The richness of the patient description required: A long clinical vignette combined with media such as a video clip can provide a rich description of the patient that is more authentic to clinical practice, as it requires the students to interpret findings. However, this item now requires more time for the student to explore the media before reviewing the options. Item writers should be aware of the trade-offs between the desirable level of richness and the additional time or effort required.

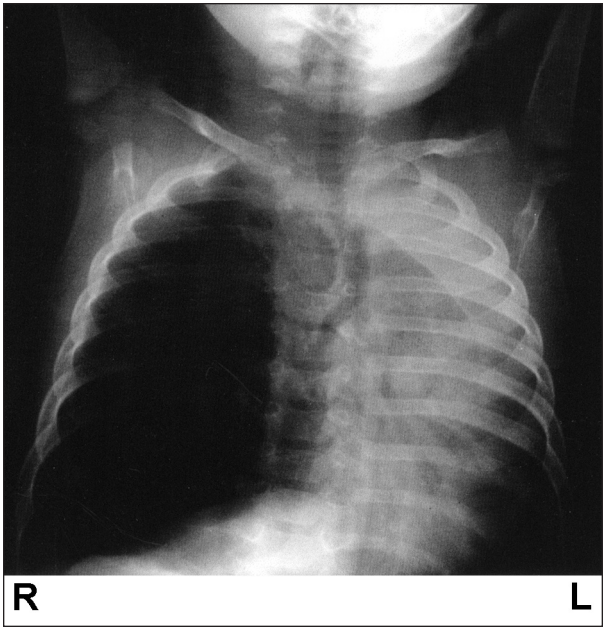
TYPES OF MEDIA

There are several types of media commonly used in clinical science examinations:

- Images (static)
- Patient photographs
- Videos
- Interactive media (e.g., avatars)

Images

Radiographic studies, such as x-rays, CT scans, and MRIs, are common image types included in multiple-choice questions. Students may be asked to interpret the studies and decide on a diagnosis or management plan. Two examples are shown here.



Patient Photographs

Patient photographs add authenticity and provide a means of conveying information accurately and succinctly to the student. Two example photographs are shown here.

Videos

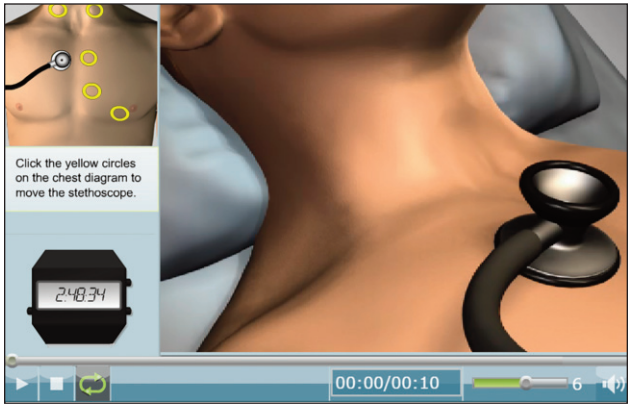
Findings from a neurologic examination are much better shown than described. In general, videos can be useful to show physical examination findings as well as patient-doctor interactions. A screenshot of a video is shown below with an accompanying item. The video shows the resting tremor of Parkinson's disease.

A 70-year-old man comes to the clinic because of difficulty writing over the past 3 months. He says that he fell once without injury this past week. He works as an accountant. He has a history of hypertension and hyperlipidemia. His medications include hydrochlorothiazide and atorvastatin. His vital signs are within normal limits. The remainder of the examination is remarkable only for the findings shown. Play the video to view the exam. ***Which of the following is the most likely diagnosis?***

A. Benign essential tremor
B. Dementia, Alzheimer's type
*C. Parkinson's disease**
D. Subclavian steal syndrome

Interactive Media

Media can also be interactive, requiring students to select different areas to see and/or hear different examination findings that are similar to actual examinations. An example screenshot of an avatar simulating placement of a stethoscope with corresponding heart sound is shown here.



SELECTING MEDIA

In multiple-choice examinations, media should be purposefully selected to help the student answer the question and not included without a good reason; otherwise, it is simply extraneous information. Do not describe with text that which can be easily demonstrated in the media itself. In the example below, three similar items are shown with differing lead-ins and media; no graphics (Example A), a graphic depicting heart rhythms or sounds (Example B), and an avatar simulating placement of the stethoscope (Example C). Other possibilities include showing both the ECG and the avatar, or presenting the audio file of the corresponding heart sounds with or without a live patient video.

Consider the following stem for a cardiology multiple-choice question:

> *A 27-year-old Gulf War veteran with no documented medical history comes to the office because of periodic dizziness, palpitations, and chest tightness over the past 3 weeks. The episodes occur when he remembers "the roadside bomb that took my friend." He has had difficulty sleeping and drinks 1 pint of vodka daily to help with "nerves." He takes no medications. His blood pressure is 128/80 mmHg, pulse is 90/min, respirations are 20/min, and temperature is 36.7°C (98.1°F).*

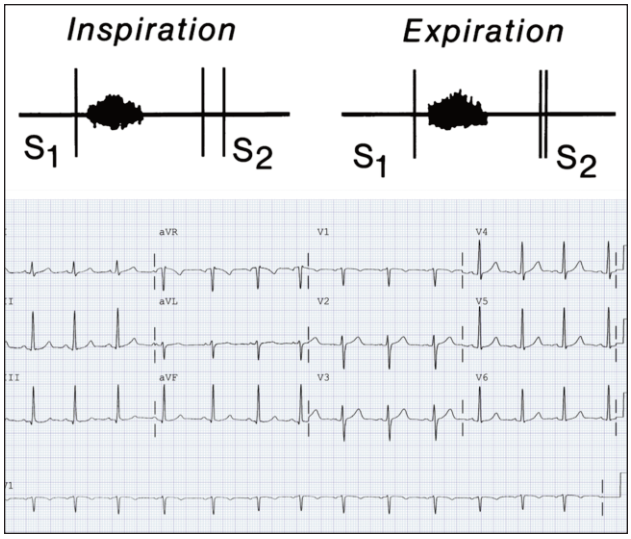
Below are three possible lead-ins and media selections for the above stem.

Example A (no image)

> *Which of the following is the most likely finding on cardiac auscultation of this patient with post-traumatic stress disorder?*
>
> *A. Normal examination**
> *B. Opening systolic snap*
> *C. S4 gallop*
> *D. S3 gallop*
> *E. Systolic flow murmur*

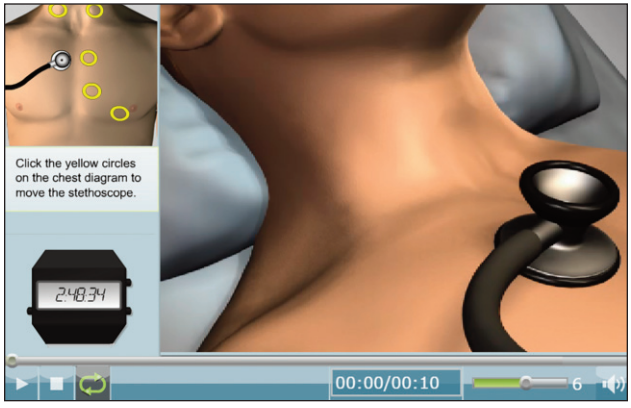
Example B (with ECG image)

An ECG is shown. ***Which of the following is the most likely finding on cardiac auscultation?*** *(same options as above)*



Example C (with avatar that allows auscultation of actual heart sounds through headphones)

An avatar is shown. Click the yellow circles to hear the cardiac examination. ***Which of the following is the most likely finding on cardiac auscultation?*** *(same options as above)*



CONTENT AREAS CONDUCIVE TO THE USE OF MEDIA

Certain content areas lend themselves well to the use of media, such as:

- Dermatologic and musculoskeletal examination findings
- Cardiology (such as heart sounds)
- Neurologic examination findings
- Ethical and communication scenarios

Examples of two of these areas follow.

Dermatologic and Musculoskeletal Examination findings

Dermatologic and musculoskeletal examination findings in particular benefit from the use of media. Showing findings, rather than describing the findings with text, simulates real clinical practice. Further, research has shown that response time is faster with the use of media compared with text for dermatologic findings. Consider the two following examples.

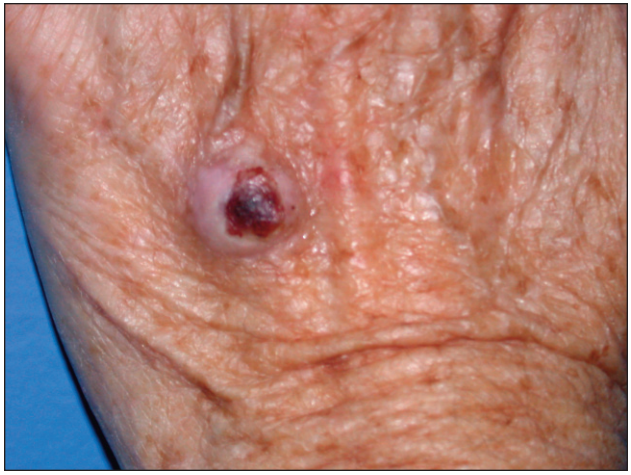
Example item using text

A 79-year-old woman comes to the office 8 weeks after noticing a nontender nodule on the back of her left hand. She initially thought it was an insect bite but it has grown in size over the past week. It bleeds when she picks at it. She has no history of serious illness. She lives in a retirement community in Texas and is an avid gardener. Examination of the dorsum of the left hand shows a 2-cm lesion that is well-demarcated, raised, and flesh-colored at the margins, with a necrotic center. ***Which of the following is the most appropriate next step in management?***

A. Cryotherapy
B. Electrocautery ablation
*C. Excision of the lesion**
D. Observation
E. Topical ketoconazole

Example item using multimedia

A 79-year-old woman comes to the office 8 weeks after noticing a nontender nodule on the back of her left hand. She initially thought it was an insect bite but it has grown in size over the past week. It bleeds when she picks at it. She has no history of serious illness. She lives in a retirement community in Texas and is an avid gardener. Examination of the dorsum of the left hand shows a 2-cm lesion. A photograph of the lesion is shown. ***Which of the following is the most appropriate next step in management?*** *(Same options as the preceeding example)*



Ethical and Communication Scenarios

Text-based multiple-choice questions related to ethical and communication scenarios tend to be easy for the student to answer because intonation and body language cannot be demonstrated well through text. Consider the next two examples.

Example item using text

An 83-year-old woman is hospitalized for pneumonia and renal failure. She has a history of dementia and resides in a nursing home. She has been offered but has refused dialysis. The patient has not designated a durable power of attorney, but she does have an advance directive that states, "No CPR, no intubation, no dialysis, and no surgery." The patient's niece, who is her closest relative, has a discussion with the physician about her aunt's refusal of treatment. She states, "Dialysis isn't aggressive, right? I have a neighbor who has been getting dialysis for 5 to 6 years! I want my aunt to get dialysis." ***Which of the following is the most appropriate physician response to the niece?***

A. "I can see you are upset. Would you like to speak with one of our chaplains or social workers?"
B. "I know it's difficult, but you're going to have to accept that your aunt will not be getting dialysis or any other aggressive treatment. We would be breaking the law to treat her against her wishes."
C. "I understand how you feel. Last year, I had a dear friend who died of cancer. It can be so hard to watch and not do anything."
*D. "I'm so sorry we can't do what you want. Let's discuss what we can do to make sure your aunt is comfortable."**
E. "You do not need to worry; even though we can't do dialysis, we will try to make sure your aunt doesn't suffer. Do you have anyone to turn to for support right now?"

Example item using multimedia (screen shot of an approximately 30-second interaction)

An 83-year-old woman is hospitalized for pneumonia and renal failure. She has a history of dementia and resides in a nursing home. She has been offered but has refused dialysis. The patient has not designated a durable power of attorney, but she does have an advance directive that states, "No CPR, no intubation, no dialysis, and no surgery." The patient's niece, who is her closest relative, has a discussion with the physician about her aunt's refusal of treatment. Play the video to view the conversation. ***Which of the following is the most appropriate physician response to the niece?*** *(Same options as the preceeding example)*

ACQUIRING AND CREATING MEDIA

When determining new media needs, a subject matter expert group can be helpful as part of the process to oversee and monitor the acquisition process. This group can develop a list of diseases, conditions, and/or physician tasks and skills that are best illustrated with media. Once media are acquired, this group can develop exemplars to distribute for item-writing assignments. A good media image is one to which multiple test items can be written; this allows for the highest chance of the image being suitable for the exam and helps address the issue of memorability. It can also offset the cost of acquiring media.

When acquiring media, two important considerations are patient confidentiality and the metadata (the information that accompanies and identifies each media image). If actual patient images or videos are used, it is important to maintain patient confidentiality. Ensure that neither the patient nor the institution can be identified from any clues in the media. For guidance, refer to your institution's patient confidentiality policy and HIPAA guidelines (http://www.hhs.gov/hipaa/for-professionals/index.html).

Metadata is the identifying information that accompanies each piece of media. It is important to obtain as much metadata as possible about the media to help with indexing/searching and reuse in the future. Think about search terms and metadata that will help with identification of images that will be used more than once. It is advisable to set standards for media and copyright of media and to use a form to record as much metadata as possible during the acquisition stage. The following is a sample list of information to collect and record for video material:

Search Terms/Metadata

- Administrative details
- Age of the patient
- Diagnosis
- Keywords
- Description of the test being performed
- Normal or abnormal results
- Descriptive file name
- Patient ID/Name
- Indication patient signed a consent form
- In/out cut points for individual clips
- Whether the clip contains important audio

Remember: Your media are only as good as their metadata! Media have little value in item writing if they cannot be retrieved easily in search results.

There are several locations from which to acquire media. The subject matter or content experts' personal libraries and/or patients are often a ready option, but the issues of patient confidentiality and memorability should be addressed. Furthermore, this is limited by the available patient population (item writers may not have access to a patient with the symptoms that are best to show). A second option is to purchase existing media from vendors. This is the more expensive option, but it often allows the test developer to request specific content areas and types of media, along with specific instructions that will help decrease memorability. A third option is to create new media, either in-house or with a vendor. One example would be to record a specific set of videos for use in test items related to communication skills, using actors to portray both physicians and patients.

When collecting media, there are some rules of thumb to help avoid technical issues. Select a specific format that will work with your exam software, and verify that the media are in that format. Converting or editing files can be problematic, so it is better to have media created in the format you need rather than to have to convert a format. For static

images, do not use media that is already embedded in other software (e.g., Microsoft PowerPoint, Microsoft Word) or screenshots. The more an image or video is manipulated, the more chance it has of losing its original quality; ideally media in an exam should be as high quality as possible.

With any media, the creation process should focus on protecting patient confidentiality (if real patients are used) and minimizing distractions for test-takers. A distraction is a specific type of cue that may remove the test-taker's focus from the important aspect of the video (e.g., busy background, clothing with logos) and increase the time it takes for them to respond to the items, resulting in a more difficult item than intended. Distractions can also add to the memorability of the item. Even professional media content vendors are unlikely to be savvy about test development or to understand the impact that novelties and distractions can have on test-taker performance. The item writer and test developer should provide guidelines to help media content providers develop and provide videos that maintain patients' anonymity and minimize distractions.

Review the screenshot below taken from a video. List the things in the image that provide visual cues (distractions) for test-takers [hint: there are 12 visual cues in the image].

The following are the visual cues (e.g., distractions) to the test-taker:

1. Setting (auditorium; could aid with memorability)
2. Socket is specifically identifiable within the auditorium (could aid with memorability)
3. Clothes in the aisle
4. Patient's watch
5. Green shirt
6. Doctor's ring
7. Blue and white striped shorts
8. Doctor's watch
9. Doctor's face/expression
10. Doctor's shirt (white coat is preferable)
11. Doctor wearing shorts
12. Bearded man in the background (mysterious; could aid with memorability)

TIPS FOR CREATING VIDEOS

DO:

- Use a plain background
- Avoid visual cues (e.g., office equipment, paintings)
- Record in a well-lit room
- Have the patient wear plain clothes or a hospital gown with no logos
- Keep background and clothing consistent if there are multiple patients or exams
- Have the provider talk to the patient as they would in a normal exam
- Have the provider avoid using names when addressing the patient
- Leave the videos as you record them and provide instructions for editing
- Limit the video length to 30 seconds
- Provide a signed patient consent form

DON'T:

- Pick a brightly colored room, a room with identifiable pictures on the wall, or a room with unique (non-clinical) furniture
- Allow the patient or provider to wear brightly colored clothes, clothes with logos, or jewelry
- Show the faces of the provider(s) or patient(s) if it is not essential
- Explain everything in detail or add narration
- Add transitions (e.g., fade-in, fade-out) to video files
- Resize or change the dimensions of the video

Resources and Additional Reading on Item and Test Development

Resources and Additional Reading on Item and Test Development

Case SM. Assessment of truths we hold as self-evident and their implications. In: Scherpbier AJJA, van der Vleuten CPM, Rethans JJ, van der Steeg AFW, eds. *Advances in Medical Education*. Dordrecht, The Netherlands: Kluwer Academic Publishers; 1997:2-6.

Gronlund NE, Linn, RL. *Measurement and Evaluation in Teaching*. 6th ed. New York, NY: Macmillan Publishers; 1990.

Haladyna TM. *Writing Test Items to Evaluate Higher-Order Thinking*. Needham Heights, MA: Allyn & Bacon; 1997.

Haladyna TM, Downing SM. A taxonomy of multiple-choice item-writing rules. *Applied Measurement in Education*. 1989a;1:37-50.

Haladyna TM, Downing SM. The validity of a taxonomy of multiple-choice item-writing rules. *Applied Measurement in Education*. 1989b;1:51-78.

Haladyna TM, Downing SM, Rodriguez MC. A review of multiple-choice item-writing guidelines for classroom assessment. *Applied Measurement in Education*. 2002;15(3):309-333.

Haladyna TM, Rodriguez MC. *Developing and Validating Test Items*. New York, NY: Routledge; 2013.

Henrysson S. Gathering, analyzing, and using data on test items. In: Thorndike RL, ed. *Educational Measurement*. Washington, DC: American Council on Education; 1971.

Hubbard JP. *Measuring Medical Education*. Philadelphia, PA: Lea & Febiger; 1971.

Hubbard JP, Clemens WV. *Multiple-Choice Examinations in Medicine*. Philadelphia, PA: Lea & Febiger; 1961.

Kelley TL. The selection of upper and lower groups for the validation of test items. *Journal of Educational Psychology*. 1939;30:17-24.

Linn RL, Gronlund NE. *Measurement and Assessment in Teaching*. 7th ed. New York, NY: Macmillan Publishers; 1995.

Millman J, Greene J. The specification and development of tests of achievement and ability. In: Linn RL, ed. *Educational Measurement*. 3rd ed. Phoenix, AZ: Oryx Press; 1989:335-366.

Newble DI, Dauphinee D, Woolliscroft JO, et al. Guidelines for assessing clinical competence. *Teaching and Learning in Medicine*. 1994;6(3):213-220.

Norman G, Swanson DB, Case SM. Conceptual and methodological issues in studies comparing assessment formats. *Teaching and Learning in Medicine*. 1996;8(4):208-216.

Osterlind SJ. *Constructing Test Items: Multiple-choice, Constructed-response, Performance, and Other Formats*. Norwell, MA: Kluwer Academic Publishers; 1998.

Parshall CG, Harmes JC, Davey T, Pashley PJ. Innovative items for computerized testing. In: *Elements of Adaptive Testing*. New York, NY: Springer; 2009:215-230.

Rodriguez, MC. Selected-response item development. In: Lane S, Raymond MR, Haladyna TM, eds. *Test Development*. 2nd ed. New York, NY: Routledge; 2015:259-273.

Shen L, Li F, Wattleworth R, Filipetto F. The promise and challenge of including multimedia items in medical licensure examinations: some insights from an empirical trial. *Academic Medicine*. Oct 2010;85(10 suppl): S56-S59.

Swanson DB, Case SM. Assessment in basic science instruction: Directions for practice and research. *Advances in Health Sciences Education: Theory & Practice*. 1997;2:71-84.

Appendix A:

NBME Retired Item Formats

Appendix A: NBME Retired Item Formats

In order to move forward with innovations in assessment, it is necessary to look back on item types previously used on NBME exams and better understand item content or format flaws that can negatively impact the measurement of test-taker ability. Multiple item types were used on NBME exams beginning in the mid-1980s in order to provide sufficient variety for the relatively lengthy examinations, with four predominant types: A-type, B-type, C-type, and K-type items. The current USMLE Step examinations now include only one of these original four, the A-type item, along with the more recently developed F-type and G-type items. Other NBME-produced exams, such as subject and specialty board examinations, may include R-type items as well, which are newer than those mentioned above. These item types are summarized below:

- A-type – Standard one-best-answer item type
- R-type – Single option sets that are associated with multiple items/vignettes
- F-type – Items grouped into sets around specific content, where test-takers cannot return to previously seen items in the set
- G-type – Items grouped into sets around specific content, where test-takers can return to previously seen items in the set

Limiting the number of acceptable item types that appear on USMLE and other exams provides several advantages. First, it allows item authors to spend less time thinking about item types and more time concentrating on the most important aspects of item writing, such as clinical decision-making to test reasoning and problem-solving rather than recall. Second, it reinforces the standardized nature of the items within test forms, thus simplifying the process for test-takers and supporting the validity evidence of the exams. Third, it allows for more efficient production, editing, and approval of items.

Examples of retired item types and their flaws are described on the following pages, in alphabetic order by the letter used to designate item type. Please note that while these item types are no longer used on NBME exams, they may still be of potential use in the classroom or on course exams, but item writers should carefully review the potential flaws in order to properly evaluate the advantages and disadvantages of using each item type.

B-Type Items

Noted Flaws:

B-type items are matching sets that were assumed to widen the scope of the examination by testing a number of related subjects in a series of items. Because each response could be used more than once or not at all, B-type items could not be solved by elimination. Unlike the matching formats used today, B-type items did not typically include a lead-in, and as a result, the question being asked was sometimes unclear.

Sample B-type item

DIRECTIONS: Each set of matching questions in this section consists of a list of three to five lettered options (some of which may be in figures), followed by several numbered items. For each numbered item, select the ONE lettered option that is most closely associated with it. Each lettered option may be selected once, more than once, or not at all.

A. Aortic vascular ring
B. Coarctation of the aorta
C. Patent ductus arteriosus
D. Tetralogy of Fallot
E. Tricuspid atresia

1. Benefited by systemic-pulmonary artery anastomosis
2. Hypertension in the arms and hypotension in the legs
3. Most common type of congenital cyanotic heart disease
4. Possible cause of dysphagia in infants and children
5. Surgically corrected by resection and end-to-end anastomosis

C-Type Items

Noted Flaws:

C-type items are similar to B-type items in appearance, but are actually multiple true-false. The primary problem with C-types was in test-taker effort to conclude to what extent something had to be "true" to be selected. Using the example below, if one of the numbered options was associated with both A and B, but was more strongly associated with A, the test-taker would have to decide whether an appropriate response was A only or both A and B. These judgments were less about the medical knowledge and more about the test-taker having to guess the item writer's intent.

Sample C-type item

DIRECTIONS: Each set of matching questions in this section consists of a list of four lettered options followed by several numbered items. For each numbered item, select the ONE lettered option that is most closely associated with it. Each lettered option may be selected once, more than once, or not at all.

A. Plasmodium vivax malaria
B. Plasmodium falciparum malaria
C. Both
D. Neither

1. A combination of primaquine and chloroquine is treatment of choice for acute attack
2. Clinical attacks suppressed by administration of chloroquine once a week while in treatment
3. Infection prevented by administration of chloroquine once a week
4. Permanently cured by administration of chloroquine

D-Type Items

Noted Flaws:

D-type items are complex matching sets in which each item consists of three functional disturbances (designated by a letter) and five situations (in a numbered list). It was believed that these items required discriminatory understanding of a number of similar factors. However, D-type items were difficult to write, and the directions tended to be confusing to test-takers. In addition, these items did a poor job of discriminating among test-takers' level of knowledge.

Sample D-type item

DIRECTIONS: There are two responses to be made to each of the following questions. There are three lettered categories. Exactly four of the five numbered items are related in some way to ONE of these categories. (1) Choose the letter of the category in which these four items belong. (2) Then choose the number of the item that does NOT belong in the same category with the other four.

A. Eosinophilia of diagnostic significance
B. Lymphocytosis of diagnostic significance
C. Plasmacytosis of diagnostic significance

1. Hodgkin disease
2. Löeffler syndrome
3. Multiple myeloma
4. Schistosomiasis
5. Trichinosis

H-Type Items

Noted Flaws:

H-type items consist of paired statements describing two entities to compare in a quantitative sense. The test-taker was directed to select A if A was greater than B; B if B was greater than A; and C if the two were approximately equal. The H-type item was believed to be useful for those instances where recall of quantitative information is important, but it was challenging for test-takers to decide how great the difference needed to be in order to be relevant.

Sample H-type item

DIRECTIONS: The following paired statements describe two entities that are to be compared in a quantitative sense. For each numbered statement, choose

A if (A) is greater than (B)
B if (B) is greater than (A)
C if the two are equal or very nearly equal

1. *(A) The usual therapeutic dose of epinephrine*
   (B) The usual therapeutic dose of ephedrine

2. *(A) Life expectancy with glioblastoma of the occipital lobe*
   (B) Life expectancy with glioblastoma of the frontal lobe

I-Type Items

Noted Flaws:

The I-type item is similar to the H-type. It consists of pairs of phrases that describe conditions or quantities that might vary in relation to each other. I-type items had two notable flaws. First, there were fewer options than in other item types, so there was an increased chance for the test-taker to guess the correct answer, which affected both item difficulty and discrimination. Second, the items tended to focus on minor details rather than on more relevant scientific concepts.

Sample I-type item

DIRECTIONS: Each of the following pairs of phrases describes conditions or quantities that may or may not be related. For each numbered statement, choose

A *if increase in the first is accompanied by increase in the second or if decrease in the first is accompanied by decrease in the second*

B *if increase in the first is accompanied by decrease in the second or if decrease in the first is accompanied by increase in the second*

C *if changes in the first are not necessarily accompanied by changes in the second*

1. *(A) Urine volume*
(B) Urine specific gravity

2. *(A) Plasma protein concentration*
(B) Colloid osmotic pressure of plasma

K-Type Items

Noted Flaws:

K-type items are multiple true-false sets that were once a common format at NBME. Because the items could include only absolutely true or false facts, K-type items could not be used to assess clinical judgment except in comparisons (e.g., "Drug X is better than Drug Y in treating disease K"). Thus, they could appear too complicated and require the test-taker to constantly keep the answer code in mind. In addition, the possible response combinations introduced a cueing effect that decreased item discrimination.

Sample K-type item

Directions Summarized

A	*B*	*C*	*D*	*E*
1, 2, 3 only	*1, 3 only*	*2, 4 only*	*4 only*	*All are correct*

A child experiencing an acute exacerbation of rheumatic fever usually has:

1. *a prolonged PR interval*
2. *an increased antistreptolysin O titer*
3. *an increased erythrocyte sedimentation rate*
4. *subcutaneous nodules*

Appendix B:
Sample Lead-ins Based on Provider Task Competencies

Appendix B: Sample Lead-ins Based on Provider Task Competencies

Medical Knowledge: Applying Foundational Science Concepts

Foundational (basic) science comprises items that require understanding and application of basic science principles to answer the question. Foundational science items should not be answerable based simply on clinical knowledge alone or on pattern recognition (for example, providing a list of symptoms and asking what drug to prescribe). These items should require clinical knowledge and also knowledge of one or more foundational science principles that would have likely been learned in pre-clinical education and hopefully reinforced during clinical rotations.

Patient Care: Diagnosis - Causes and Mechanisms

Identifies the cause/causal agent or predisposing factor(s) or, given an effect, determines the cause.

- *Which of the following pathogens is the most likely cause of this patient's condition?*
- *Which of the following is the most likely causal agent?*
- *This patient most likely acquired the causal organism via which of the following modes of transmission?*
- *This patient most likely has a defect in which of the following?*
- *Which of the following is the most likely cause/mechanism of this effect?*

Identifies the underlying processes/pathways that account for, or contribute to, the expression or resolution of a given condition.

- *Which of the following is the most likely underlying cause of this patient's condition?*
- *Which of the following is the most likely explanation for this patient's condition?*
- *Which of the following cell types most likely played a primary role in the development of this lesion?*
- *Which of the following immune system mediators plays a critical role in the pathogenesis of this patient's current condition?*
- *This patient most likely has a deficiency in which of the following enzymes?*
- *Which of the following cytokines is the most likely cause of this condition?*
- *Which of the following processes is most likely impaired in this patient?*

Recognizes or evaluates given clinical or physical findings to identify the underlying anatomic structure or physical location.

- *The most likely cause of the findings in this patient is damage to which of the following structures?*
- *Which of the following structures is at greatest risk for damage during this procedure?*
- *Which of the following nerves is most likely carrying the sensation for this patient's pain?*
- *The most likely cause of these findings is dysfunction of which of the following structures?*
- *Which of the following developmental abnormalities is the most likely cause of the findings in this patient?*

Recognizes the mechanisms of action of various drugs; selects from an option set list of drugs based on mechanism of action.

- *Which of the following is the most likely mechanism of the beneficial effect of this drug?*
- *Which of the following is the most appropriate management? (response options would be drug classes or mechanisms of action)*
- *Which of the following is the most likely mechanism of action of the therapeutic effect of this drug?*
- *The most appropriate medication for this patient will have which of the following mechanisms?*

Patient Care: Diagnosis - Obtaining and Predicting History and Physical Examination

Knows signs/symptoms of selected disorders. Response options are signs and symptoms. The item asks which signs and symptoms are characteristic of the patient's condition. Typically used when patient presents with the condition.

- *Which of the following signs/symptoms is most consistent with the underlying diagnosis in this patient?*

Knows individual's risk factors for development of condition. Given current symptoms in presented history, identifies pertinent factor in the history. Typically used when patient presents with the condition.

- *Which of the following factors in this patient's history most increased the risk for developing this condition?*

Given a specific problem, knows what to ask to obtain pertinent additional history. The response options should not be referenced in the vignette and should not include details that would be obtained during initial history-taking. If asking about information that was already obtained and is mentioned in the vignette, use the following lead-in.

- *Specific additional history should be obtained regarding which of the following?*

Predicts the most likely additional physical finding; selects either the finding itself or the appropriate examination technique that would result in the finding. The options are findings or directed physical examination techniques.

- *The remainder of the physical examination is most likely to show which of the following? (ensure all options are portions of the physical examination that would not yet have occurred in the patient scenario)*
- *The physical examination should be directed toward which of the following? (sample options: "Auscultation of the lungs", "Palpation of the abdomen", "Rotation of hip joints")*
- *Which of the following signs or symptoms is most indicative of the need for further studies?*

Patient Care: Diagnosis - Selecting and Interpreting Laboratory and Diagnostic Studies

Selects most appropriate laboratory or diagnostic study, including neuropsychiatric testing, or study most likely to establish/confirm the diagnosis. Options can include "no further testing is indicated."

- *Which of the following is the most appropriate diagnostic study at this time?*
- *Which of the following is the most appropriate initial diagnostic study?*
- *Which of the following is the most appropriate next step in evaluation?*
- *Which of the following studies is most likely to establish a diagnosis?*
- *Which of the following laboratory studies is most likely to confirm the diagnosis?*
- *Which of the follow-up studies is most appropriate to order?*
- *Which of the following studies should be obtained periodically to monitor the patient's long-term care?*

Interprets laboratory or other study findings. Response options are interpretations of the laboratory/diagnostic data.

- *Which of the following is the most likely explanation for these laboratory findings?*
- *Based on these findings, this patient's condition is most likely attributable to which of the following?*

Predicts the most likely laboratory or diagnostic study result. Response options are clinical studies or predicted study results.

- *Results of which of the following laboratory studies are most likely to be abnormal in this patient?*
- *Measurement of serum electrolyte concentrations is most likely to show which of the following?*
- *An x-ray of the _____ is most likely to show which of the following?*
- *Arterial blood gas analysis is most likely to show which of the following sets of findings?*

Selects most appropriate laboratory or diagnostic study after change in patient status.

- *Prior to changing this patient's therapy, which of the following is the most appropriate diagnostic study?*

Patient Care: Diagnosis - Formulating the Diagnosis

Selects the most likely diagnosis.

- *Which of the following is the most likely diagnosis?*
- *Which of the following is the most likely working diagnosis?*
- *Which of the following best explains these findings? (options would be diagnoses); correct answer could be "Normal finding(s)".*
- *Which of the following organisms is the most likely cause of this patient's pneumonia?*

Patient Care: Diagnosis - Determining Prognosis/Outcome

Recognizes factors in the history, or physical or laboratory study findings that affect patient prognosis or outcome, or that determine therapy.

- *Which of the following factors in this patient's history most strongly indicates a poor/good prognosis?*
- *Which of the following factors is most critical in determining the patient's ability to remain at home?*

Interprets laboratory or other diagnostic study results and identifies current/future status of patient.

- *Based on these findings, this patient is most likely to develop which of the following?*
- *Based on these findings, this patient is most likely to develop which of the following during _____ (period of time)?*

Recognizes associated conditions of a disease, including complications, or indicators of potential complications.

- *Which of the following is the most likely complication of this patient's current condition?*
- *Without treatment, which of the following is most likely to develop in this patient?*

Recognizes characteristics of disease relating to natural history or course of disease, including progression, severity, duration, and transmission of disease for a specific patient.

- *Which of the following is the most likely clinical course for this patient?*
- *This patient should be informed of which of the following risk factors?*

Patient Care: Management - Health Maintenance & Disease Prevention

Knows risk factors for conditions amenable to prevention or detection in an asymptomatic patient or knows the potential condition itself.

- *Which of the following is the strongest predisposing factor in this patient for developing a chronic condition?*
- *This patient should be counseled that he/she is at greatest risk for which of the following?*
- *If untreated, this patient is at greatest risk for which of the following disorders?*

Knows pertinent incidence statistics and identifies patient groups at risk; knows incidence of symptomless/dangerous disorders among various groups. Response options compare patient's risk factors for disease with those of the general population.

- *Which of the following factors is most appropriate to consider in assessing the need for additional screening in this patient population?*

Knows common screening tests for conditions amenable to prevention or detection in an asymptomatic patient or population.

- *In addition to a (screening test) annually, which of the following screening studies is most appropriate?*
- *Which of the following is the most appropriate screening test for this patient at this time?*
- *At this time, which of the following is the most appropriate next step in the evaluation of this patient? (response options would be screening tests)*

Selects appropriate preventive agent or technique (e.g., contraception, vaccines, vitamins). Knows timing of vaccinations.

- *Which of the following is the most appropriate recommendation for vaccination?*
- *[To reduce the likelihood of recurrence,] it is most appropriate to (prescribe/administer) which of the following?*
- *Which of the following is the most appropriate vaccine to administer at this time?*

Knows appropriate counseling (and reassuring, comforting) of patient or family regarding current and future problems, including risk factors related to present encounter. The response options focus on features and course of disease as they relate to a specific patient.

- *This patient should be counseled regarding which of the following?*
- *Which of the following is the most appropriate management to prevent the spread of this patient's illness?*

Educates patients on screening, health maintenance, and self-care options such as nutrition, weight loss, breast self-examinations, home blood pressure monitoring, or breast-feeding. The response options are a variety of patient actions.

- *Which of the following is the most appropriate recommendation?*
- *This patient should be advised to do which of the following?*

Patient Care: Management - Selecting and Monitoring Pharmacotherapy

Selects most appropriate pharmacotherapy. Response options are all drugs or "No pharmacotherapy at this time." Drugs include substances such as vitamins and supplements.

- *Which of the following is the most appropriate pharmacotherapy at this time?*
- *The most appropriate next step is to administer which of the following?*

Assesses patient adherence to treatment regimen, recognizes techniques to increase compliance with or understanding of the disease state, and knows how adherence may be affected by providing instructions with therapy. Options can include "No further testing is indicated."

- *To assess adherence and therapeutic efficacy in this patient, which of the following studies should be ordered after initiation of therapy?*
- *Which of the following methods is most appropriate to assess adherence to treatment in this patient?*

Recognizes factors that alter drug requirements for a patient, such as disease, age, pregnancy, BMI, renal failure, liver disease, or female gender. Response options are factors about the patient that affect the choice of a drug regimen.

- *Which of the following variables is most appropriate to consider in determining the appropriate dose of medication for this patient?*
- *Which of the following factors is most likely to influence therapy for this patient?*
- *Which of the following is most appropriate to consider before selecting pharmacotherapy?*

Knows adverse effects of various drugs or recognizes signs and symptoms of drug (and drug-drug) interactions resulting from polypharmacy in the therapeutic regimen, and knows steps to prevent polypharmacy including laboratory studies to monitor drug therapy. Vignette includes description of the simultaneous use of drugs prescribed by another physician, over-the-counter drugs, prescribed opioids and other Schedule IV medications taken illegally or in greater than prescribed doses, illegal opioids, alcohol, and certain foods.

- *Which of the following is the most likely cause of this patient's symptoms?*
- *Which of the following is the most likely complication of the addition of this medication?*
- *Which of the following is the most likely explanation for this patient's current condition?*
- *The most likely cause of this patient's condition is interaction between which of the following drugs?*

Knows contraindications of various medications.

- *Which of the following medications is contraindicated in this patient?*
- *Which of the following medications is most likely to increase the risk for development/progression of _____ (diagnosis) in this patient?*

Knows modifications of a therapeutic regimen within the context of continuing care.

- *Which of the following is the most appropriate next step in pharmacotherapy?*
- *Which of the following is the most appropriate change/modification in this patient's drug therapy?*

Knows appropriate monitoring to evaluate effectiveness of drug therapy or to monitor for the adverse effects of drug therapy in a patient who has not had a recurrence or progression of disease.

- *Which of the following studies is most appropriate to monitor the effectiveness of therapy in this patient?*

Patient Care: Management - Clinical Interventions/Treatment

Knows most appropriate management of selected conditions, including recognizing use/misuse of medications, illicit drugs, or alcohol. Response options would be a list of management steps.

- *Which of the following is the most appropriate next step in management?*
- *Which of the following is the most appropriate initial management/recommendation?*

Knows immediate management or priority in management, specifically in emergency or acute cases. This objective is most appropriate in life-threatening emergencies or cases of potential organ failure.

- *Which of the following is the most appropriate immediate/initial/next step in management?*
- *Which of the following is the priority in management?*
- *Which of the following is the most critical factor in formulating a management plan for this patient?*

Knows most appropriate follow-up or monitoring approach regarding the management plan.

- *Which of the following is the most appropriate monitoring/follow-up plan?*

Knows current/short-term management of patients.

- *Which of the following is the most appropriate next step following treatment?*
- *Which of the following is the most appropriate next step in monitoring this patient?*

Evaluates severity of patient condition in terms of need for referral for surgical treatments/procedures versus other nonsurgical options.

- *Which of the following findings in this patient indicates the need for surgical intervention/intubation/transplantation/admission to another department?*

Knows appropriate surgical management. The response options are all surgical procedures.

- *Which of the following is the most appropriate surgical management?*

Knows pre/post surgical or procedural management.

- *Which of the following is the most appropriate postoperative management?*
- *Which of the following is the most appropriate preoperative preparation?*
- *Prior to the procedure (or specify the procedure), it is appropriate to first obtain/do which of the following?*

Knows indications for admission to the hospital or to other appropriate setting. Knows appropriate nonhospital health care settings, such as a nursing care facility, hospice care, or at-home care with assistance of health aide.

- *Placement in a/an _____ is recommended based on which of the following factors?*
- *This patient should be transferred to which of the following inpatient facilities?*

Knows most appropriate discharge planning.

- *In discussing discharge plans with this patient, it is most appropriate to advise him/her of which of the following?*
- *Before this patient is discharged, he/she should be counseled regarding which of the following?*
- *Which of the following is the most appropriate goal for follow-up?*

Knows components of rehabilitation program, such as prostheses, psychosocial factors, or motor dysfunction. The response options are rehabilitation management steps.

- *Which of the following components of his/her overall care is most appropriate to consider?*

Knows appropriate use and procedures regarding hospice care.

- *Which of the following is the most appropriate step regarding hospice care for this patient?*
- *Which of the following is the most appropriate next step? (hospice referral is correct answer).*

Educates patient or family regarding self-care, such as breast-feeding, or at-home blood pressure measurement and glucose monitoring. The response options can be a variety of patient actions.

- *Which of the following is the most appropriate recommendation?*
- *This patient should be advised to do which of the following?*

Knows relevant roles of allied health personnel.

- *The most appropriate next step is to arrange consultation with which of the following?*
- *This patient should be referred to which of the following?*

Patient Care: Management - Selecting Clinical Interventions (Mixed Management)

Selects most appropriate option from set of mixed management options (e.g., mix of diagnostic studies, pharmacotherapy, procedures, or no intervention at this time, observation, referral).

- *Which of the following is the most appropriate next step?*
- *Which of the following is the most appropriate initial step in management?*

Patient Care: Management - Monitoring/Surveillance for Disease Recurrence or Progression

Knows the indications for surveillance for recurrence or progression of disease following treatment.

- *Which of the following is the most appropriate annual monitoring study?*

Knows how to monitor a chronic disease in a stable patient where a change in patient status might indicate a need to change therapy.

- *Which of the following is the most appropriate diagnostic study at this time?*

Knows most appropriate long-term treatment or management goals, including continued treatment of a known patient. In a patient with a chronic condition, knows preventive medicine.

- *Which of the following is the most appropriate long-term management?*
- *This patient should be advised of which of the following long-term management goals?*

Communication and Interpersonal Skills

- *Which of the following is the most appropriate opening remark to this patient?*
- *Which of the following is the most appropriate response by the physician?*
- *Which of the following statements by the physician is most appropriate to...?*

Professionalism and Legal/Ethical Issues

Knows the guidelines for obtaining informed consent for treatment including those for children and adolescents, third-party permission, and emergent situations.

- *Which of the following is the most appropriate method to facilitate patient informed consent?*

Recognizes need for third-party permission for treatment in medical emergencies.

- *In requesting an autopsy, consent must be given by which of the following individuals?*

Knows guidelines for treatment of minors with/without notification of parents.

- *Regarding obtaining consent for treatment today, which of the following is the most accurate conclusion for providing services to this patient?*
- *Until the parents can be reached, management should consist of which of the following?*
- *Before examining this patient, informed consent needs to be obtained from which of the following individuals?*
- *Which of the following is the most appropriate response to the request for services for this child/adolescent?*

Knows definitions of competence and sanity.

- *Determination of this patient's competency to make decisions should be based on which of the following factors?*
- *Which of the following is the most significant indication that this patient may not have sufficient capacity for informed consent or refusal?*
- *Which of the following factors or findings renders this patient incompetent to make health care decisions on her/his own behalf?*
- *The information that is most decisive in determining this patient's mental capacity to refuse treatment is which of the following?*

Knows the guidelines for involuntary admission (e.g., third-party permission, court order).

- *Which of the following is the most appropriate next step? (answer is involuntary admission)*
- *In considering commitment of this patient to _____, which of the following is the most appropriate next step?*

Knows guidelines for such things as confidentiality of medical records (e.g., regarding patient's relatives, employer, insurance/legal agents), boundaries, privacy, and truth-telling.

- *Which of the following is the most accurate statement concerning the confidentiality of this patient's medical record?*

Knows guidelines for physician/patient relationship.

- *Regarding this colleague's behavior, which of the following is the most appropriate advice to this patient?*

Assesses degree of disclosure to terminally ill patients.

- *Which of the following is the primary consideration regarding informing this patient of his/her condition/prognosis?*

Recognizes patient's right to refuse treatment or testing (patient autonomy); knows issues of advance directives and living wills.

- *Which of the following is the most appropriate advice to the family regarding their wishes for this patient?*
- *Given your knowledge of this patient and her past wishes, which of the following is the most appropriate recommendation?*
- *In reaching an opinion about whether do-not-resuscitate status should be ordered, which of the following information has the highest priority?*
- *The best method of ensuring that this patient's wishes will be honored is to do which of the following?*

Assesses quality of life decisions (especially in the elderly patient).

- *In considering treatment options for this patient, which of the following is the most compelling consideration?*
- *Which of the following is the most appropriate next step regarding this patient's end-of-life needs?*

Knows appropriate prescriptive practices; knows appropriate use of opioids in terminally ill patients.

- *Which of the following is the most effective intervention to minimize this patient's pain?*

Knows definition of and legal issues regarding brain death.

- *Which of the following is the most critical ethical consideration in deciding whether to withdraw life support in this patient?*
- *Which of the following is the most accurate statement regarding the physician's decision to discontinue life support in this patient?*
- *In order for a clinical diagnosis of brain death to be made in this child, documentation of which of the following is needed?*

Knows management of terminally ill patients related to treating chronic pain, and recognizes patient's expression of fear of pain, injury, or death; knows how to comfort patient or family during crisis such as trauma or death.

- *Which of the following is most appropriate to manage this patient's pain?*
- *Which of the following is the most appropriate advice for this patient regarding his/her pain?*
- *Which of the following is the most likely underlying cause of this change in behavior?*
- *In addressing this patient's (fear), which of the following is the most appropriate counseling?*

Knows guidelines for reporting findings to proper authorities, such as social services, police medical society, or coroner.

- *Which of the following is the most appropriate action in patient care?*

Knows Good Samaritan laws.

- *Regarding your colleague's liability associated with this patient's actions at the scene of the collision, which of the following is the most accurate conclusion?*

Recognizes physician error and negligence.

- *With regard to the possibility that this situation represents medical malpractice, it is most critical to do which of the following?*
- *The most appropriate response to this situation is to do which of the following?*
- *After you document the error, the most appropriate management is to do which of the following?*
- *Which of the following is the most appropriate response to this allegation?*

Recognizes and deals appropriately with impaired physicians.

- *The most appropriate response to the licensing board is to recommend which of the following?*
- *Which of the following is the most appropriate action (where options describe dealing with impaired colleague)?*

Systems-based Practice and Patient Safety

Understands basic concepts and terminology, principles, and application of quality improvement science and outcome analysis.

- *Which of the following is the most appropriate description of the deviation from official procedure?*

Recognizes and optimizes human and environmental factors such as workplace design, standardization, and processes.

- *Which of the following is the most appropriate next step in designing a standard process for...?*
- *Which of the following is most likely to improve patient satisfaction?*
- *Which of the following strategies is most likely to achieve this goal?*
- *Which of the following is the most appropriate next step by this hospital to improve its system of care?*
- *Which of the following is the most appropriate initial recommendation by the task force?*
- *Which of the following is most likely to improve outcomes in this situation?*
- *Which of the following is most likely to decrease morbidity/mortality in this situation?*

Understands the role and characteristics of teams and communication strategies.

- *Which of the following is most appropriate to ensure the success of this project?*
- *Which of the following actions is most likely to improve communication within this health care team?*

Anticipates, recognizes, analyzes, and mitigates risk (sources of error).

- *Which of the following is the most appropriate method to prevent/reduce the risk of transmission of this infection?*
- *Which of the following is most likely to prevent recurrence of this type of error?*
- *Which of the following is the most likely cause of the error?*
- *Which of the following is most likely to decrease the likelihood of this error happening again?*
- *Which of the following is the most appropriate next step?*

Evaluates, reports, and responds to near-misses and system errors.

- *Which of the following is the most appropriate action by the hospital staff immediately following the incident?*

Practice-based Learning - Applied Biostatistics and Clinical Epidemiology

Understands and can apply principles of epidemiology and population health, including health status indicators, outbreak investigation, points of intervention.

- *Which of the following is the most likely effect on estimates of disease incidence and prevalence?*
- *Which of the following is the annual incidence of _____ in this study?*

Understands and can apply principles of study design/flaws, such as bias and confounding, and methods to address these flaws; understands and can apply statistical principles.

- *The most likely cause of the study results is an error related to which of the following?*
- *Which of the following features of this study is of greatest potential concern?*
- *Which of the following potential flaws is most likely to invalidate this study?*
- *Which of the following best describes this study design?*
- *Which of the following is the major advantage of this study design?*

Understands and can apply the principles of screening and other tests (e.g., sensitivity, specificity, predictive value).

- *Which of the following is the most likely effect on sensitivity and specificity?*
- *Which of the following is the most likely effect on the predictive value?*
- *If the prevalence of the disease is increased to __%, which of the following would be the most likely outcome?*
- *According to these results, which of the following represents the sensitivity of _____ for detecting _____ within this population?*
- *According to these results, which of the following is closest to the predictive value of a positive test result?*
- *If _____ were decreased to _____, which of the following would be the most likely result?*
- *Changing the screening population is most likely to have which of the following effects on this test?*
- *In determining the appropriate diagnostic test for this patient, which of the following characteristics of the test is most appropriate to consider?*
- *Which of the following is the most appropriate conclusion regarding the test?*
- *Which of the following combinations of sensitivity and specificity would be characteristic of the most appropriate confirmatory/screening test?*

Understands use and interpretation of statistical principles and measures of association.

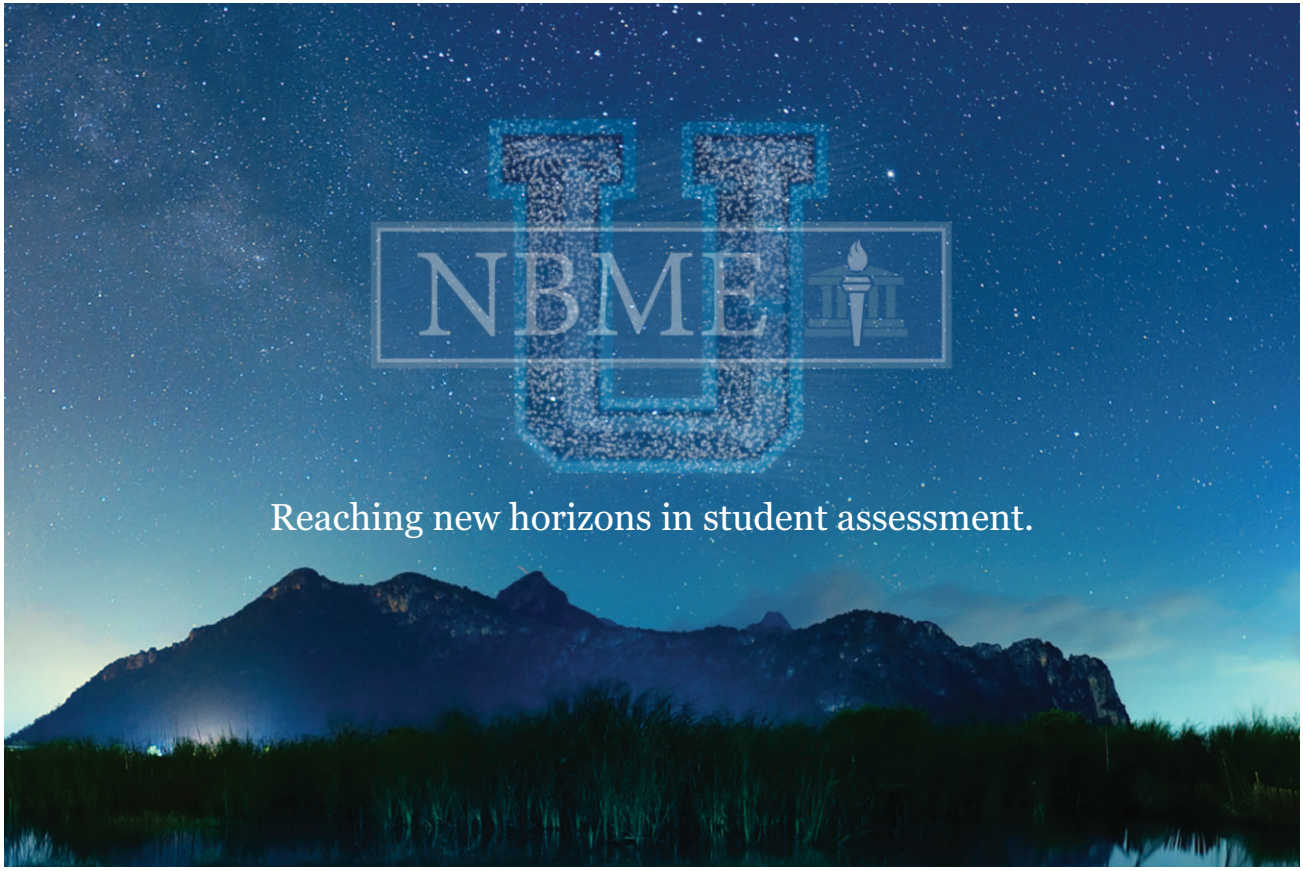
- *Which of the following conclusions can be drawn from these data?*
- *Which of the following is the most appropriate conclusion about these data?*

- *Which of the following is the most accurate interpretation of these data?*
- *Based on these additional data, it is most appropriate to conclude which of the following?*
- *Which of the following conclusions is most strongly justified based on this information/study?*
- *Which of the following is the most accurate interpretation of the author's conclusion regarding these study results?*
- *Which of the following is the most likely explanation for this finding?*
- *Which of the following represent the results of a meta-analysis?*
- *In determining the validity of the meta-analysis, which of the following is the most appropriate factor to consider?*
- *Which of the following is the best interpretation of this confidence interval? Compared with _____, which of the following is the relative risk for _____ in _____?*
- *Which of the following is the estimated odds ratio of _____ in _____ compared with _____?*
- *Which of the following is the best estimate of the relative risk of _____ for those with _____ compared with those with _____?*
- *Which of the following is the relative risk for _____ 5 years following _____?*
- *Which of the following is the attributable (excess) risk per _____ patients for development of _____ 5 years following _____?*
- *Which of the following variables is measured on a nominal scale?*
- *Which of the following is the mean (or mode or standard deviation) in the sample shown in the graph?*
- *Assuming a normal (Gaussian) distribution, which of the following best represents the median _____ for this group? According to these results, how many patients would need to be treated with the new drug to prevent mortality in one patient?*
- *Which of the following is the number needed to treat with _____ instead of _____ to prevent _____ in one patient?*
- *Based on these data, which of the following best represents the number of patients that must be treated with _____ to prevent one episode of _____?*
- *The outcome of this study is statistically significant because of which of the following?*
- *Which of the following statistics is most likely to establish the difference among the _____ of these groups?*
- *Which of the following is the case-fatality rate for _____?*
- *Which of the following is the expected number of false negatives (OR false positives) in this population of _____ women/men?*

- *Which of the following best explains the lack of a significant difference in _____?*
- *Which of the following is the likelihood of survival?*

Makes decisions about patient care based on results of studies or other written materials (e.g., pharmaceutical advertisements, abstracts, results of literature searches).

- *Which of the following information from the literature is most relevant to the management of this patient?*



NBME U is a series of short, self-guided, interactive online lessons to help educators create and deliver consistent, valid, reliable, and high-quality student assessments.

NBME® | Federation of STATE MEDICAL BOARDS

This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the Federation of State Medical Boards and the National Board of Medical Examiners. The Federation of State Medical Boards is accredited by the ACCME to provide continuing medical education for physicians.

The Federation of State Medical Boards designates this enduring material for a maximum of *0.25 AMA PRA Category 1 Credit(s)™*. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

NBME U is not an educational institution, and the information and services provided through the NBME U website are not part of an accredited or state-approved educational program.

© 2016 National Board of Medical Examiners®. All Rights Reserved.