Patricia Wells, CNMT, and Daniel Leahey, CNMT

NMTCB 1997 Task Analysis Report

In 1977, the Nuclear Medicine Technology Certification Board (NMTCB) was established to provide a national certification examination for nuclear medicine technologists. The chief goal of such an exam is to reflect the entire scope of the field as it is currently practiced (*1*). In addition to this goal, the NMTCB has a professional and legal obligation to assure the validity of its examination (*2-7*). For these reasons, the NMTCB regularly performs task analyses.

The task analysis uses a detailed survey to determine which tasks are regularly performed by nuclear medicine technologists throughout the U.S. It also identifies the procedures that are performed, and the equipment and pharmaceuticals that are used. Because the NMTCB is a national certification exam, it must reflect national trends as opposed to regional practices.

The NMTCB completed its latest task analysis in 1997. The test matrix developed from the 1997 survey will be used beginning March 1999.

METHODS

A survey questionnaire was developed by the NMTCB Task Analysis Committee with assistance from American College Testing (ACT). The survey included an inventory of tasks that was developed using the SNM Technologist Section's *Performance and Responsibility Guidelines* (*8*), the Joint Review Commission on Educational Programs in Nuclear Medicine Technology (JRCNMT) *Essentials* (*9*), the current NMTCB Task List (*10*) and input from NMTCB Board of Directors. Each member of the board developed a "Day in the Life of an NMT" list that included all the tasks performed by nuclear medicine technologists (NMTs) in facilities with which they were associated. The tasks from all of the aforementioned documents were combined to produce the initial survey task list. Lists of procedures, equipment and pharmaceuticals were compiled in a similar fashion.

The questionnaire asked respondents to rate the frequency with which they performed each task. Respondents also were asked to indicate which equipment, pharmaceuticals and procedures were routinely employed in their facilities. Equipment, pharmaceuticals and procedures were not subjected to a frequency rating because some of them, by their nature, are not used or performed with great frequency, such as monoclonal antibody scans and ^{125}I RISA. Yet it is essential for an NMT to be able to perform each study correctly, and use equipment and pharmaceuticals properly.

A draft of the questionnaire was sent to 30 certified nuclear medicine technologists (CNMTs) who were chosen based on their knowledge of the task analysis process, their involvement in education and/or their understanding of national trends. Twenty-three of the 30 questionnaires were returned, many with extensive comments. Based on this input the questionnaire was revised. Most importantly, the commonly used frequency scale of daily-weekly-monthly options was abandoned. It was determined that the scale was inappropriate because some essential tasks, such as dose calibrator accuracy and well-counter energy resolution, could be eliminated based on their inherent low frequency of performance. Table 1 shows the scale that was developed for the final questionnaire.

TABLE 1
Frequency Scale

4	An NMT is expected to perform the task regularly.
3	An NMT is expected to perform the task occasionally.
2	Task is performed in the facility, but *not* by an NMT.
1	Task is *not* performed in the facility.

Certain radiation protection tasks also were eliminated from the questionnaire. These tasks are controlled by federal regulations and, therefore, are required knowledge for all NMTs. It was decided that it would be unnecessary to place them on the questionnaire, as they would be included in the exam anyway. This allowed the task list to be shortened without affecting the exam's validity.

The revised questionnaire was sent to 1226 CNMTs. Survey recipients were chosen to represent all states in proportions relative to the number of CNMTs in each state. The questionnaire required about 15-20 minutes to complete.

In addition to frequency, the criticality of each task must be measured (*11*). The criticality estimates the seriousness of the consequences when the task is performed improperly. Past experience has demonstrated that developing a criticality scale that is readily understood and uniformly applied by survey recipients is difficult. After consultation with ACT, it was decided that each of 11 technologist representatives on the NMTCB Board of Directors would determine the criticality of the tasks based on the scale shown in Table 2. The scale was developed during the spring

TABLE 2
Criticality Scale

Quality of performance	Outcome of action	Risk to patient or public
0 No errors. Performance is acceptable. All data are valid.	No negative impact on patient management. No delays or repeats.	None
1 Suboptimal performance or suboptimal study, but data are still valid.	Same as above, but quality assurance or remedial action may be initiated.	Minimal
2 Poor performance or poor quality study. Some data may be suspect or not useable at all. Problem is immediately recognized.	Data are recognized as not useful so it does not contribute to patient management. May cause delays, excess costs, repeats, inefficient patient care.	Moderate
3 Poor performance resulting in hazard to patient or public. Compromised or invalid study, but problem is not immediately recognized.	Data are not recognized as invalid. May contribute to incorrect or missed diagnosis or delays in patient care. May result in hazard to public.	High

1997 Board of Directors meeting and board members practiced with it during the meeting to assure all members understood it and applied it consistently.

The frequency data from the surveys were averaged, as were the criticality scores, and a standard deviation was determined for each task. ACT then combined the frequency and criticality scores for each item using an equation that weighted criticality more heavily than frequency. The resulting score estimates the task's importance in job performance (*11*). The procedures, equipment and pharmaceuticals lists were analyzed by calculating the percent of respondents who stated that they performed the procedures or used the equipment or pharmaceutical.

RESULTS AND DISCUSSION

Of the 1226 surveys, 603 were returned, giving a 49% response rate. At the fall 1997 NMTCB Board of Directors meeting, the board reviewed the analytical data and determined, item by item, which would be included in the new test matrix.

A nominal cutoff point for the importance score for tasks was not used. According to Kane et al (*11*, p 22), "data generated by empirical job analyses . . . can provide guidance in developing test plans and designing educational programs, but should not be used mechanically." Tasks with low importance scores were individually examined to determine if they were essential to proper performance of the job. For example, the task "maintain film processors" was ranked 56 out of 60 tasks. It was eliminated from the task list because most film processors now are maintained by radiology department personnel or out-of-facility vendors. In addition, more facilities are switching to daylight developing systems and color paper printers. The task "elute Mo/Tc generator and perform quality control tests" was ranked 58 out of 60. It was retained on the task list, however, because 27% of respondents stated that they still use these generators. If generators are used, aseptic techniques and good radiation safety practices must be used and required quality control tests must be performed correctly. This task, then, remains an essential part of the job.

Having determined which tasks would be eliminated, the board then combined related activities and rewrote the tasks in broader terms. The final list, which appears at the end of this article, contains only 48 tasks as compared to the current NMTCB list of 93 tasks. In reality, only two tasks were completely eliminated from the current list (Task 36 "conduct temperature checks on water baths and refrigerators" and Task 39 "perform film processor quality control"). Many other tasks were combined, or broken up and added into other tasks. For example Task 3 "maintain accurate, written radiation safety/protection records to comply with regulatory regulations" was removed as a separate task, but record keeping will be included in the pool of test questions for each task that requires written records as per regulation.

Four tasks were added that had not been included or clearly delineated in the past:

- Perform and evaluate quality control for SPECT systems.
- Perform and evaluate dose calibrator geometry tests.
- Prepare for and perform cardiac monitoring and/or stress testing.
- Prepare/administer interventional pharmacologic agent.

For the procedures, equipment and pharmaceuticals list a nominal cut-off of 10% was selected. If fewer than 10% of respondents performed a procedure, or used equipment or a pharmaceutical, the item was not included in the newly published lists seen at the end of this article.

It should be noted that the procedures, equipment and pharmaceuticals lists are updated more frequently than the task list, because a short practice trends survey can be used adjust them. These lists do not affect the actual test matrix and therefore can be changed without a detailed task analysis, as was done in 1994 (*12*).

This is the first time a separate pharmaceuticals list has been included with the NMTCB Task List. Because of the development of many new radiopharmaceuticals, the decreased use of some older radiopharmaceuticals and the increased used of many interventional pharmaceuticals, it was determined that the list would allow educators and certification candidates to identify the pharmaceuticals that would actually appear in questions on the exam.

The new task list retains the same four subgroups used in the current task list. However, because of the change in the number of tasks in each of the groups, the distribution of test items to be drawn from each group has been adjusted. Beginning in 1999 each exam will have test questions appear in the following percentages:

Radiation safety	15%
Instrumentation	20%
Clinical procedures	45%
Radiopharmacy	20%

At the spring 1998 NMTCB Board of Directors meeting, a new components of preparedness (COPs) will be finalized to accompany the new task list. The COPs list the knowledge content needed to properly perform each task. They also give a clear idea of the type of question that would be asked about the task at the various levels of understanding: comprehension, application or analysis. See Table 3 for a sample COP that applies to the current task list. It should be noted that most NMTCB questions are in the application or analysis level.

TABLE 3
Sample Component of Preparedness

Task
Perform spatial resolution check on a scintillation camera on a routine basis.

Content base
1. Scintillation camera
   a. Components
   b. Collimators
   c. Image display
2. Resolution quality control
3. Scintillation camera performance characteristics
4. Phantoms
5. SPECT center of rotation

Comprehension
Define spatial resolution.

Application
Determine the spatial resolution of a scintillation camera.

Analysis
Analyze images to determine any loss of spatial resolution and assess causes for loss of resolution.

The COPs were originally designed as a guide for exam question writers. However, the NMTCB makes the COPs available to all students, educators and exam candidates on request. The COPs can be used as a study guide when preparing for the certification exam. Copies of the new COPs will be sent to the director of each nuclear medicine program as soon as the document is finalized.

CONCLUSION

In 1997 the NMTCB validated its certification examination by performing a national task analysis survey. The new task list with its accompanying procedures, equipment and pharmaceuticals list will be implemented beginning with exams administered in March 1999 (Appendix A). An updated version of the COPs, which can be used as a study guide to prepare for the exam, will be

available in spring 1998.

Exam candidates should be aware that the exam is offered throughout the year as a computer adaptive test. This allows examinees to select test dates and locations that are convenient for them. The exam consists of 70-90 questions based solely on the task list. Because the task list is developed using periodic national task analyses, it accurately reflects the current practice of nuclear medicine technology throughout the U.S. With the 1997 validation of its exam matrix, the NMTCB has continued to meet its founding goal: to provide a national certification examination that reflects current practice and the entire scope of practice for nuclear medicine technology.

ACKNOWLEDGMENTS

The NMTCB Board of Directors would like to thank the CNMTs who participated in the task analysis survey. Special thanks to the NMTCB office staff for all of their work on the project.

APPENDIX A

Task List as of March 1999

Group I: Radiation Safety

1. Post appropriate signs in designated areas to comply with NRC regulations.
2. Prepare and package radioactive materials for transportation.
3. Use personal radiation monitoring devices.
4. Review monthly personnel exposure records.
5. Take appropriate measures to reduce radiation exposure.
6. Notify the appropriate authority of excessive radiation exposure.
7. Notify the appropriate authority of misadministration.
8. Utilize proper methods for the use and storage of radioactive materials.
9. Instruct the patient, family and staff in radiation safety precautions after the administration of therapeutic radiopharmaceuticals.
10. Provide instruction on proper radiation emergency procedures.
11. Perform wipe tests and area radiation surveys.
12. Prepare, survey and clean radiotherapy isolation room.
13. Survey, inspect and inventory incoming radioactive materials.
14. Monitor and dispose of radioactive waste.
15. Use proper procedures for managing a radioactive spill.

Group II: Instrumentation

16. Perform and evaluate quality control on a well counter or probe.
17. Calibrate scintillation camera.
18. Perform and evaluate field uniformity on the scintillation camera.
19. Perform and evaluate detector linearity and spatial resolution on a scintillation camera.
20. Assess performance of image recording equipment.
21. Determine operational status of survey meter.
22. Perform and evaluate linearity of the dose calibrator.
23. Perform and evaluate dose calibrator geometry and accuracy tests.
24. Perform and evaluate dose calibrator constancy test.
25. Perform and evaluate quality control procedures for SPECT camera.

Group III: Clinical Procedures

26. Maintain and operate auxillary equipment (as described in equipment/procedures list).
27. Schedule patient studies, ensuring appropriate sequence of multiple procedures and interact with staff regarding special orders.
28. Receive patient and provide proper nursing care during nuclear medicine procedures.
29. Communicate effectively with patient, family and staff.
30. Provide safe and sanitary conditions.
31. Recognize and respond to emergency conditions.
32. Receive patient, verify patient identification and written orders for study; follow up on inappropriate orders.
33. Obtain pertinent patient history and check procedural contradictions.
34. Prepare patient for procedure.
35. Select and administer the appropriate radiopharmaceutical by the proper route.
36. Prepare proper instrument, computer and auxiliary equipment and acquire imaging procedures as indicated by protocol.
37. Evaluate image appearance and perform any additional views as required.
38. Process and evaluate computer generated data.
39. Prepare and perform cardiac monitoring and/or stress testing.
40. Prepare/administer interventional pharmacologic agent.
41. Obtain samples and/or data for nonimaging studies.
42. Calculate and evaluate results of nonimaging studies.

Group IV: Radiopharmacy

43. Elute radionuclide generator; perform and evaluate quality control tests.
44. Review the daily work schedule to plan radiopharmaceutical needs.
45. Prepare radiopharmaceutical kits, perform quality control and evaluate results.
46. Prepare and dispense diagnostic radiopharmaceuticals.
47. Prepare and dispense therapeutic radiopharmaceuticals.
48. Label blood components with a radiopharmaceutical according to protocol.

Procedures List

Pulmonary

Radioaerosol ventilation
Xenon ventilation
Perfusion
Perfusion/ventilation quantitation
Pulmonary aspiration

Bone/Musculoskeletal

Bone scan, limited, planar
Bone scan, whole-body, planar
Bone scan, two-phase
Bone scan, three-phase
Bone scan, four-phase
Bone scan, SPECT
Bone absorptiometry

Cardiovascular

Myocardial perfusion, planar
Myocardial perfusion, SPECT
First pass for EF and wall motion
Gated cardiac blood pool, rest
Gated cardiac blood pool, stress
Gated cardiac blood pool, SPECT
Myocardial infarct (infarct avid)
Venogram
Major vessel flow
Cardiac shunt

Endocrine

Adrenal imaging
Parathyroid
Thyroid imaging
Thyroid uptake
Whole-body survey for thyroid metastases

Hematopoietic

Bone marrow
Plasma volume
Red cell mass
Red cell sequestration
Red cell survival
Spleen scan with labeled, denatured RBCs

Oncology/Infection/Miscellaneous

Tumor imaging, planar
Tumor imaging, SPECT

Tagged WBC scan
Monoclonal antibody/FAB scan
Somatostatin-receptor imaging
Breast imaging
Lymphoscintigraphy

Gastrointestinal

Esophageal motility/transit
Gastric emptying
Gastroesophageal reflux
Gastrointestinal bleeding
Hepatobiliary
Gall bladder ejection fraction
LeVeen shunt patency
Liver-spleen, planar
Liver-spleen, SPECT
Meckel's diverticulum
Salivary (parotid)
Schilling determination

Radionuclide Therapy

Intracavity
Polycythemia vera/leukemia
Thyroid carinoma
Hyperthyroidism
Metastatic bone pain

Central Nervous System

Brain flow
Brain imaging, planar
Brain imaging, SPECT
Cisternogram
CSF leak
CSF shunt patency

Renal/Genitourinary

Cystogram, direct
Cystogram, indirect
Urinary bladder, residual volume
Effective renal plasma flow (ERPF)
Glomerular filtration rate (GFR)
Renal anatomy, planar
Renal anatomy, SPECT
Renal flow
Renogram
Testicular flow
Testicular imaging

Equipment List

Dose calibrator
Camera, single-head, planar
Camera, single-head, SPECT
Camera, dual-head, planar
Camera, dual-head, SPECT
Camera, multihead (3-4 heads)
Camera, multicrystal
Three-dimensional SPECT phantom

Display Media

Formatter, multi-imager
Video system
Laser printer
Wet film
Dry film
^{99}Mo/^{99m}Tc generator
Teleradiography (modem)
Well counter
Uptake probe
Centrifuge
Pipettes
Fume hood
Laminar flow hood
Intravenous infusion pump
ECG monitor
O_2 saturation monitor
G-M meter
Ionization chamber (Cutie Pie)
Treadmill
Xenon delivery system
Xenon gas trap
Aerosol delivery system
Defibrillator
Bone densitometer

Pharmaceuticals List

Note: Only generic drug names are used in the list and on the NMTCB examination.
^{99m}Tc sodium pertechnetate
^{99}Mo generator
^{99m}Tc HDP
^{99m}Tc MDP
^{99m}Tc pyrophosphate
^{99m}Tc-sestamibi
^{99m}Tc-tetrofosmin
^{201}Tl thallous chloride
Dipyridamole
Adenosine
Dobutamine
Aminophylline
^{99m}Tc-labeled RBCs
^{99m}Tc HSA
^{99m}Tc DTPA
^{99m}Tc glucoheptonate
^{99m}Tc DMSA
^{99m}Tc mertiatide
^{131}I hippuran/OIH
Captopril
Enalopril
Furosemide
^{99m}Tc-HMPAO
^{99m}Tc ECD
Acetazolimide
^{111}In DTPA
^{99m}Tc-HMPAO-tagged WBCs
^{111}In-oxine-labeled WBCs
^{111}In-labeled platelets
Denatured radiolabeled RBCs
^{51}Cr sodium chromate-labeled RBCs
^{125}I RISA
ACD solution
Heparin
Ascorbic acid
Hetastarch
Cyanocobalamin/radiolabeled vitamin B12
Intrinsic factor
Vitamin B12
^{99m}Tc MAA
^{133}Xe gas
^{99m}Tc sulfur colloid
^{99m}Tc disofenin and mebrofenin
Morphine
Cholecystokinen
Cimetidine
^{123}I sodium iodide
^{131}I sodium iodide
^{131}I MIBG
Lugol's solution/SSKI
Potassium perchlorate
^{67}Ga gallium citrate
^{111}In-labeled MAB for prostate cancer imaging
^{111}In somatostanin-analog
^{111}In-labeled MAB for ovarian and colorectal cancer imaging
^{99m}Tc-labeled FAB for small cell lung cancer imaging
^{99m}Tc-labeled FAB for colorectal cancer imaging
^{32}P chromic phosphate colloid
^{32}P sodium chromate
^{89}Sr chloride
^{133}Ba check source
^{137}Cs check source
^{57}Co check source

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