

NMTCB 2003 Task Analysis Report

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Rationale: The Nuclear Medicine Technology Certification Board (NMTCB) undertook a task analysis survey in the summer of 2002 as a part of its ongoing efforts to maintain the validity of its entry-level examination.

Methods: A task analysis survey, including sections on demographics, procedures, equipment, pharmaceuticals, and tasks performed or used by nuclear medicine technologists, was prepared and sent to 1,800 certified nuclear medicine technologists (CNMTs). Survey recipients were asked to indicate the frequency with which specific tasks are performed in their departments and whether these tasks are performed by nuclear medicine technologists or by other professionals. Criticality ratings for each task were determined by the NMTCB Board of Directors. These data were combined using the Kane weighting method to determine an importance rating for each task. Survey recipients were also asked which procedures are performed and which equipment and pharmaceuticals are used in nuclear medicine procedures in their institutions.

Conclusion: A new task analysis for nuclear medicine technology is presented. It will form the basis for the NMTCB's entry-level examination, beginning in March 2004. Lists of procedures, equipment, and pharmaceuticals used in the practice of nuclear medicine technology are also presented.

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Task analysis is the process used to determine the scope of practice for a particular profession. Task analysis is an important component of evaluation of professionals, particularly in the context of certification examinations. The Nuclear Medicine Technology Certification Board (NMTCB) regularly performs a task analysis for validating the content of its entry-level certification examination. Previous task analyses have been published in 1979, 1982, 1984, 1986, 1988, 1992, and 1998 (1-7). In the summer of 2002, the NMTCB conducted a task analysis to determine the current scope of practice in nuclear medicine technology.

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MATERIALS AND METHODS

The survey questionnaire developed by the NMTCB's Task Analysis Committee included demographic information, a procedure list, an equipment list, a pharmaceuticals list, and a task list. The survey was tested on a small group of certified nuclear medicine technologists (CNMTs), revised, and mailed to 1,800 CNMTs. It was also made available electronically to recipients through the NMTCB's web site. Approximately half of the survey recipients had 5 or fewer years of experience in nuclear medicine technology.

For the procedure, equipment, and pharmaceutical lists, respondents were asked to indicate all procedures performed and equipment/pharmaceuticals used by nuclear medicine technologists in their institutions, even if performed or used infrequently. For the task list, respondents were asked to indicate the frequency with which tasks were performed and by whom, according to the scale shown in Table 1. Criticality of tasks was determined by the expert opinion of NMTCB directors, according to the scale shown in Table 2.

The task list was analyzed according to a statistical method developed by Kane et al. (8), resulting in the ordering of tasks by their overall importance to job performance. A total of 66 tasks were included on the task list; the resulting Kane weights ranged from 1.912 to 0.432. The ordered list was used as the basis for determining the final task list. Rather than using a definitive cutoff, the list was examined from the bottom (the lowest ranked items) to identify tasks that are not essential to job performance in nuclear medicine technology.

The responses to the procedure, equipment, and pharmaceutical lists were used to develop the associated lists in these practice areas. A nominal value of 10% (i.e., <10% of respondents use the item) was used as the starting point for analysis of these responses. Again, a definitive cutoff was not used. Based on comparison with previous task analyses and on the expert opinion of the NMTCB directors, the Task Analysis Committee considered trends in utilization before deciding to remove an item from one of these lists, to retain flexibility in the lists as the profession changes.

RESULTS

A total of 746 responses were received (response rate, 41.4%). The demographic data indicated a representative

TABLE 1
Frequency Scale

Score	Description of frequency
4	NMT is expected to perform task regularly (daily, weekly)
3	NMT is expected to perform task infrequently (monthly, quarterly)
2	Task is performed in my facility but NOT by NMT
1	Task is NOT performed in my facility

response from the standpoints of geographic distribution and years of practice in nuclear medicine. The Task Analysis Committee analyzed the results of the survey as described above to produce the 2003 task list (Appendix A) and associated procedure, equipment, and pharmaceutical lists (Appendix B).

Compared with the previous task analysis published in 1998 (7), the new task list combines 2 tasks (tasks 22 and 23 on the 1998 list become task 22) and adds a task on PET systems in the instrumentation subgroup:

- Task 25: perform and evaluate quality control procedures for PET system.

All other tasks remain the same. The subgroups and their percentages on the NMTCB entry-level examinations also remain the same:

- Radiation safety = 15%.
- Instrumentation = 20%.
- Clinical procedures = 45%.
- Radiopharmacy = 20%.

Maintaining the same overall structure of the task list facilitates not only the administration of the examinations but also the durability of job descriptions and educational practices. The associated lists provide the detail of the scope of practice; these are updated more frequently than the task list.

DISCUSSION

The definition of a profession's scope of practice is significant in several ways. In the early days, as a new profession arises out of an older profession or combination

of professions, the scope of practice is the first formal description of the new profession. As the profession advances and changes, the scope of practice is used by legal and regulatory bodies to demarcate boundaries between professions. It is also used by educational institutions to determine curriculum and required educational experiences. Most pertinent to the NMTCB, the scope of practice forms the basis for examinations designed to evaluate an individual's preparedness for practice in the profession.

The NMTCB entry-level examination is a criterion-referenced examination, meaning that passing is determined by one's ability to meet specific criteria. (This is in contrast to a norm-referenced examination, in which passing is determined by the group's scores, based on an assumed bell-shaped curve.) The task list, augmented by the associated lists, forms the criteria for this examination. Task analysis, therefore, is a critical responsibility of the NMTCB—one that must be performed regularly if the examination is to be relevant to current practice.

In the field of plant and animal taxonomy, there is a saying: "There are 2 kinds of people in the world, the lumpers and the splitters." So it is in task analysis as well. We can choose to see tasks in their smallest identifiable units or we can choose to group tasks together, viewing the small individual tasks as aspects or subtasks within a larger category. In its earlier days, the NMTCB leaned distinctly toward the "splitter" side of this dichotomy: The first 2 task analyses (1,2) listed >230 tasks. In more recent years, the NMTCB has followed the "lumper" philosophy, combining tasks into larger entities that encompass several related individual tasks. This has distinct advantages for examination administration purposes. First, it makes the task list more flexible as the field changes. The particular questions on the examination can change with time, but the task list and, therefore, the overall blueprint of the examination stays the same. Second, it allows examination questions to be written more broadly, rather than requiring them to pertain only to a narrowly defined task.

The chief disadvantage of a broadly defined task list is that the learner may not be aware of all aspects of each task. To this end, the NMTCB publishes a set of Components of Preparedness (COP) statements. These provide the content base and give examples of learning objectives for each task.

TABLE 2
Criticality Scale

Score	If task is done incorrectly	Outcome	Risk to patient
4	Data are compromised or invalid, but problem is not recognized immediately	May contribute to incorrect diagnosis or delays in patient care	High
3	Data may be suspect or not usable, but problem is recognized immediately	Data are recognized as not usable, so do not contribute to patient management; may cause delays, increased costs, inefficient patient care	Moderate
2	Data are suboptimal but still valid study	No impact on patient management, but remedial action may be initiated	Low
1	All data are valid	No negative impact on patient management	None

The most recent set of COP statements was published in 1999 (9) and is available at the NMTCB web site (www.nmtcb.org). It is anticipated that the COP statements will be revised and republished in the next year.

The associated lists serve to "flesh out" the task list by identifying the specific procedures, equipment, and pharmaceuticals to which the task list is applied. These lists are revised on the basis of the results of the task analysis process but may also be revised more frequently according to the expert opinion of the NMTCB directors. There are times when the task list and the associated lists are somewhat out of sync, and the next year happens to be one of those times.

The most significant change in the newly prepared task list is the addition of quality control of PET systems. In the task analysis, 21.85% of respondents indicated that PET studies are regularly performed in their institutions. The NMTCB believes that this number will continue to increase and, therefore, has added evaluation of PET systems to the task list. Due to the need to publicize the new task list before implementing it on the examination, however, questions specific to new Task 25 will not appear until March of 2004.

The procedure list, on the other hand, can change more quickly. In fact, ^{18}F -FDG was added to the pharmaceutical lists and ^{18}F -FDG imaging was added to the procedure list in 1999. At that time, imaging of ^{18}F using specially modified gamma cameras was common. More recently, ^{18}F -FDG imaging with true PET imaging systems has become dominant, due in large part to reimbursement policies established by the federal Centers for Medicare and Medicaid Services, so it becomes appropriate to include the operation of PET systems on the entry-level examinations. Persons intending to take the entry-level examination before March of 2004 should be aware that questions may be included on ^{18}F -FDG and procedures using it, even though questions about PET systems per se will not be included. The equipment list given in Appendix B does not include PET systems at this time, but a new list taking effect in March 2004 will include PET systems.

Several changes were made in the procedure list. Among the most notable are the removal of bone densitometry, myocardial infarction (infarct-avid) imaging, and testicular imaging. Notable additions to the procedure list include myocardial perfusion, gated SPECT; infection imaging; cardiac PET; brain PET; urea breath testing; and monoclonal antibody therapy. Changes were made to the equipment and pharmaceutical lists as well; the most significant are the addition of the glucose meter and the removal of the bone densitometer from the equipment list. The most up-to-date versions of the task list and associated lists are included in each examination application booklet and are always available on the NMTCB's web site.

CONCLUSION

The overall conclusion of the task analysis process is that our profession continues to change rapidly. The determina-

tion of the scope of practice for nuclear medicine technology is vital to our corporate identity and the determination of readiness to practice. The NMTCB extends its appreciation to those who assisted in preparation of the survey, those who filled out and returned the survey, and all who continue to support the profession of nuclear medicine.

APPENDIX A: NMTCB TASK LIST (EFFECTIVE MARCH 2004)

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 accuracy, linearity, and geometry tests of the dose calibrator.
23. Perform and evaluate dose-calibrator constancy test.
24. Perform and evaluate quality control procedures for SPECT camera.
25. Perform and evaluate quality control procedures for PET system.

Group III: Clinical Procedures

26. Maintain and operate auxiliary equipment (as described in equipment/procedure 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 contraindications.
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 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.

APPENDIX B: PROCEDURE, EQUIPMENT, AND PHARMACEUTICAL LISTS AS OF MARCH 2003

Procedure List

Pulmonary

- Radioaerosol ventilation
- Xenon ventilation

- Perfusion
- Perfusion/ventilation quantitation

Bone/Musculoskeletal

- Bone scan, limited, planar
- Bone scan, whole-body, planar
- Bone scan, 2-phase
- Bone scan, 3-phase
- Bone scan, 4-phase
- Bone scan, SPECT

Cardiovascular

- Myocardial perfusion, planar
- Myocardial perfusion, SPECT
- Myocardial perfusion, gated SPECT
- First pass for EF and wall motion
- Gated cardiac blood pool, rest
- Gated cardiac blood pool, stress
- Gated cardiac blood pool, SPECT
- Venogram/thrombus localization
- Cardiac shunt

Endocrine

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

Oncology

- ^{67}Ga tumor imaging, planar
- ^{67}Ga tumor imaging, SPECT
- Monoclonal antibody imaging
- Peptide imaging
- Breast imaging
- Lymphoscintigraphy/sentinel lymph node localization
- Tumor imaging, ^{18}F -FDG

Infection

- ^{67}Ga infection imaging
- Tagged WBC imaging

Hematopoietic

- Bone marrow imaging
- Plasma volume
- Red cell mass
- Red cell sequestration
- Red cell survival
- Spleen scan with denatured RBCs

Renal/Genitourinary

- Cystogram, direct
- Effective renal plasma flow (ERPF)
- Glomerular filtration rate (GFR)

- Renal anatomy, planar
- Renal anatomy, SPECT
- Renal flow
- Renogram

Gastrointestinal

- Esophageal motility/transit
- Gastric emptying (liquid/solid)
- Gastroesophageal reflux
- Gastrointestinal bleeding
- Hemangioma
- Hepatobiliary imaging
- Gallbladder ejection fraction
- LeVeen shunt patency
- Hepatic pump patency
- Liver–spleen, planar
- Liver–spleen, SPECT
- Meckel’s diverticulum
- Salivary (parotid)
- Schilling determination
- *Helicobacter pylori* breath test

Central Nervous System

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

Radionuclide Therapy

- Intracavitary
- Polycythemia vera/leukemia
- Thyroid carcinoma
- Hyperthyroidism
- Metastatic bone pain
- Monoclonal antibody therapy

Equipment List

Camera/Computer Systems

- Camera, planar only
- Camera, with SPECT
- Camera, dual-head, planar
- Camera, dual-head, SPECT
- Camera, multihead (3 or 4 heads)
- Camera, multicrystal
- Attenuation correction for SPECT
- Nuclear medicine–specific computer

Display Media

- Formatter, multiimager
- Laser printer
- Wet film
- Dry film

- Video system
- Teleradiography (modem)

Quality Control Equipment

- Flat-field flood source (fillable)
- ⁵⁷Co sheet source
- Planar spatial resolution phantom
- 3-Dimensional SPECT phantom
- Sealed sources, including check sources and transmission sources

Nonimaging Equipment

- Dose calibrator
- Ionization survey meter
- G–M meter (Geiger counter)
- Xenon delivery system
- Xenon gas trap
- Aerosol delivery system
- Thyroid probe
- Well counter
- ⁹⁰Mo/^{99m}Tc generator

Laboratory Equipment

- Centrifuge
- Pipettes
- Fume hood
- Laminar flow hood
- Microscope/hemocytometer

Patient Care Equipment

- Intravenous infusion pump
- ECG monitor
- Treadmill
- O₂ saturation monitor (pulse oximeter)
- Defibrillator
- Glucose meter



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Pharmaceutical List (Note: Only generic and/or commonly known drug names are used on the NMTCB examination.)

^{99m}Tc-Labeled Radiopharmaceuticals

- ^{99m}Tc-Sodium pertechnetate
- ^{99m}Tc-HDP/MDP
- ^{99m}Tc-DTPA
- ^{99m}Tc-MAA
- ^{99m}Tc-Sulfur colloid
- ^{99m}Tc-Disofenin/mebrofenin
- ^{99m}Tc-Mertiatide/MAG3
- ^{99m}Tc-Pyrophosphate/PYP
- ^{99m}Tc-Sestamibi
- ^{99m}Tc-Tetrofosmin
- ^{99m}Tc-DMSA
- ^{99m}Tc-HMPAO
- ^{99m}Tc-ECD
- ^{99m}Tc-Gluceptate

- ^{99m}Tc -Labeled RBCs
- Denatured ^{99m}Tc -labeled RBCs
- ^{99m}Tc -HMPAO-labeled WBCs
- ^{99m}Tc -Labeled FAB for colorectal cancer imaging (ar-citumomab)
- ^{99m}Tc -Apcitide
- ^{99m}Tc -Depreotide

Iodine-Labeled Radiopharmaceuticals

- ^{123}I -Sodium iodide
- ^{131}I -Sodium iodide
- ^{131}I -MIBG
- ^{125}I -Serum albumin/RISA

Indium-Labeled Radiopharmaceuticals

- ^{111}In -DTPA
- ^{111}In -Oxine-labeled WBCs
- ^{111}In -Labeled MAB for prostate cancer imaging (ca-promab pendetide)
- ^{111}In -Pentetreotide
- ^{111}In -Ibritumomab tiuxetan

Miscellaneous Diagnostic Radiopharmaceuticals

- ^{201}Tl -Thallous chloride
- ^{67}Ga -Gallium citrate
- ^{133}Xe gas
- ^{51}Cr -Sodium chromate-labeled RBCs
- Radiolabeled vitamin B₁₂ (cyanocobalamin)
- ^{18}F -FDG

Therapeutic Radiopharmaceuticals

- ^{32}P -Chromic phosphate colloid
- ^{32}P -Sodium chromate
- ^{89}Sr -Chloride
- ^{153}Sm -EDTMP
- ^{131}I -Sodium iodide
- ^{90}Y -Ibritumomab tiuxetan

Interventional Pharmaceuticals

- Dipyridamole
- Adenosine
- Dobutamine

- Aminophylline
- Captopril
- Enalaprilat
- Furosemide
- Acetazolamide
- Cholecystokinin/sincalide/CCK
- Morphine
- Cimetidine/pentagastrin/glucagon

Miscellaneous Nonradioactive Agents

- ACD solution
- Heparin
- Ascorbic acid
- Hetastarch
- Intrinsic factor
- Vitamin B₁₂
- Lugol's solution/SSKI
- Potassium perchlorate
- TSH
- EDTA
- Lidocaine
- Lidocaine (EMLA) cream
- Atropine

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