Practice Analysis Report: Nuclear Medicine Technology - Effective January 2022

Introduction

The ARRT establishes the job relatedness of an examination via a practice analysis (also called a job analysis). Practice analyses document the role to be credentialed, the topics to be covered by the examination used in the credentialing decision, as well as the degree of emphasis that each topic receives. The rationale for practice analyses is outlined in *The Standards for Educational and Psychological Testing* (American Educational Research Association, American Psychological Association, National Council on Measurement in Education, 2014) and in the National Commission for Certifying Agencies (NCCA) *Standards for the Accreditation of Certification Programs* (NCCA, 2021). Legislation and legal precedent also stress the importance of practice analysis in the development and validation of certification exams. The ARRT conducts a practice analysis for each discipline approximately every five years. Regular updates are important for professions that continually evolve due to advances in technology because they help ensure that the content specifications and other certification requirements reflect current practice.

This report describes the practice analysis for Nuclear Medicine Technology (NMT) conducted from September 2019 to October 2020. The project sought to identify tasks currently required of the typical nuclear medicine technologist and to determine what knowledge and cognitive skills are required to effectively perform those tasks.

To accomplish this task, ARRT hosted several meetings with a committee of subject matter experts (SMEs) to develop a survey of job tasks; evaluate survey results; and revise the content specifications, content outline, and clinical competency requirements. ARRT selected six SMEs for this committee from across the United States and from a range of practice settings (e.g., hospitals, clinics, educational programs). All six SMEs were certified and registered nuclear medicine technologists.

All statistical analyses were performed by trained statisticians employed by ARRT and meetings were primarily conducted by ARRT's Exam Development Coordinators with psychometric support provided by ARRT psychometric staff.

The ARRT Board of Trustees reviewed all changes to exam content and eligibility requirements before giving approval in January 2021. The first exam under the new content and eligibility requirements was administered in January 2022.

Task Inventory

Survey Development

ARRT begins the practice analysis process by revising the task inventory, which is a listing of clinical and supporting procedures related to practice. The committee reviewed the previous task inventory and content outline before creating an updated list of job tasks by adding, deleting, or rewording tasks as necessary to reflect changes in the profession.

The committee used the updated job task list to create a survey for distribution to individuals working in the profession. The first section of this survey consisted of 134 questions asking current nuclear medicine technologists how frequently they perform each task utilizing a six-point scale with the following options: *Never Perform, Yearly, Quarterly, Monthly, Weekly,* and *Daily*. Based on past research, ARRT uses a frequency scale with absolute anchors because data from scales like importance and criticality, which use subjective anchors, have inferior statistical properties (Babcock, Risk, & Wyse 2020). The data gathered by absolute anchor frequency scales also correspond well to medical imaging practice as defined by external data sources (Babcock & Yoes, 2013) and add value beyond advisory committee members' judgement without data (Wyse & Babcock, 2018).

To reduce the length and burden of the practice analysis survey, the committee identified tasks from the previous task inventory that they believed were so ubiquitous in practice that over 90% of respondents would report that they do perform the task. The following tasks were omitted from the survey and included in the new task inventory without further discussion:

- Sequence imaging procedures to avoid affecting subsequent examinations
- Verify the patient's identity
- Obtain pertinent medical history
- Explain the procedure instructions to patient, patient's family, or authorized representative
- Monitor the patient's auxiliary medical equipment
- Follow environment protection standards for handling and disposing of bio-hazardous materials
- Demonstrate and promote professional and ethical behavior
- Recognize abnormal or missing lab values
- Practice Standard Precautions
- Use positioning aids, as needed, to reduce patient movement and/or promote patient safety
- Use proper body mechanics and/or ergonomic devices to promote personnel safety
- Use sterile or aseptic techniques when indicated
- Clean and disinfect or sterilize facilities and equipment
- Document required information on patient's medical record
- Take appropriate measures to minimize radiation exposure to patient
- Take appropriate precautions to minimize occupational radiation exposure
- Perform radiation surveys and wipe tests in indicated areas and record as prescribed by governing regulations
- Manage radioactive spills to reduce risk of contamination
- Order appropriate unit dose from pharmacy
- Perform required procedures for receipt and return of radioactive materials
- Prepare and store radiopharmaceutical/pharmaceutical as directed in the kit instructions provided by the manufacturer or according to department protocol

- Store radioactive material in appropriate shielding
- Determine radiopharmaceutical required to perform study
- Verify that the radiopharmaceutical is correct for the procedure to be performed prior to administering the dose
- Determine appropriate radiopharmaceutical dosage to be administered
- Withdraw the appropriate volume of radiopharmaceutical using aseptic technique and radiation safety precautions
- Verify activity to be administered using a dose calibrator
- Administer oral dose of radiopharmaceutical
- Administer intravenous injection of radiopharmaceutical
- Observe patient for adverse reactions to radiopharmaceutical or other medications
- Inspect inventory of radiopharmaceuticals, pharmaceuticals, and supplies to ensure that adequate quantities are available to complete scheduled procedures
- Record patient and radiopharmaceutical information to comply with regulatory requirements
- Store and/or dispose of radioactive waste according to regulations
- Deface radioactive labels and survey all containers that no longer contain radioactive materials
- Perform constancy test on a survey meter with a check source
- Perform constancy test on a dose calibrator
- Perform uniformity test on a gamma camera using a radioactive source
- Perform center of rotation test on a SPECT system
- Interpret results of instrumentation quality control tests to assure that performance standards are met
- Record and maintain results of instrumentation quality control tests to comply with governing regulations
- Process images
- Operate a medical information system
- Observe patients during imaging to detect motion
- Evaluate patient images for technical quality
- Annotate images with information necessary for identification and interpretation

To better understand the tasks performed by nuclear medicine technologists, the second section of the survey asked recipients to report how frequently their department administers 73 different radiopharmaceuticals and other pharmaceuticals. This section utilized the same conceptual scale as the first, adapted slightly to fit the new question: *Not Administered in Department, Yearly, Quarterly, Monthly, Weekly,* and *Daily.*

The third section of the survey included 12 questions regarding the respondent's role and workplace such as hours worked, primary job title, and department composition.

Survey Sample

ARRT staff identified an initial population from the population of all individuals with an active R.T.(N)(ARRT) certification according to the following criteria:

- R.T. did not receive a survey as part of the 2015 practice analysis
- R.T. reported NMT as their primary discipline
- R.T. was working as a technologist

- R.T. was working full or part time as an NMT technologist
- R.T. had 10 or fewer years of experience as an NMT technologist
- R.T. was not retired
- R.T. was not dead
- R.T. was not on probation
- R.T. was not currently sanctioned
- R.T. was not currently restricted
- R.T. did not have an active adverse action
- R.T. had not requested “no contact”
- R.T. had a valid address on file for any of the 50 US states.

After narrowing the potential survey population, ARRT staff randomly selected 1500 individuals, stratified by years working in nuclear medicine (60% 0-3 years, 20% 4-5 years, 20% 6-10 years) to ensure that the results were representative of entry-level practice.

ARRT’s survey vendor mailed the survey in January 2020. The post office returned 15 surveys as undeliverable and 281 recipients returned their survey by close in March 2020, for an absolute response rate of 18.9%. ARRT staff screened responses to ensure that the intended population properly completed the survey, retaining 220 surveys for an effective response rate of 14.8%.

The survey closed prior to the COVID-19 pandemic declaration in the United States, so ARRT does not believe that the results of this survey would have been affected by pandemic-related practice changes.

Analysis

ARRT psychometric staff first calculated the percentage of respondents who report performing the task and the percent who report performing the task daily or weekly (Table 1). ARRT allows tasks performed by 40% or more of respondents to be included on the task inventory without further discussion so that committees may focus on discussions most likely to impact task inclusion. However, committees still review all survey results and may choose to include tasks below the threshold or reject tasks above the threshold as they see fit based on their joint expertise.

Staff then calculated the percentage of respondents who report their department administers each pharmaceutical as well as the percent administering daily/weekly in the same manner (Table 2).

Finally, ARRT staff summarized results for the 12 items that covered the respondent’s role and workplace (Tables 3 - 14).

Table 1.
Percent of technologists performing tasks

Item	Task	% Performing	% Daily/Weekly
1	Evaluate the patient's ability to understand and comply with requirements for the requested procedure	100.0	99.1
2	Manage interpersonal interactions in an effective manner	98.6	98.2
3	Explain and confirm the patient's preparations (e.g., diet restrictions, preparatory medications)	99.5	98.6
4	Review the examination request to verify information is accurate, appropriate, and complete (e.g., patient history, clinical diagnosis, physician's order)	99.5	99.5
5	Respond as appropriate to procedure inquiries from the patient, the patient's family, or authorized representative (e.g., scheduling delays, exam duration, other imaging modalities)	100.0	98.6
6	Follow environmental protection standards for handling and disposing of hazardous materials (e.g., disinfectants)	98.2	97.3
7	Provide for the patient's safety, comfort, and modesty	100.0	100.0
8	Notify appropriate personnel of adverse events or incidents (e.g., patient fall, wrong patient injected).	93.5	44.7
9	Verify informed consent as necessary	97.7	87.6
10	Communicate relevant information to appropriate stakeholders (e.g., nursing staff, clinic, and ancillary personnel)	99.5	97.7
11	Follow appropriate precautions and procedures when caring for patients with communicable diseases (e.g., MRSA, Clostridium difficile)	99.1	84.0
12	Prior to administration of a medication other than a radiopharmaceutical, review pertinent information to prepare appropriate type and dosage	94.5	87.6
13	Prior to administration of a medication other than a radiopharmaceutical, determine if the patient is at risk for an adverse event	90.4	78.0
14	Obtain vital signs	70.2	49.1
15	Recognize and communicate the need for prompt medical attention	99.1	67.3
16	Provide emergency care	77.5	22.5
17	Screen female patients of childbearing age for the possibility of pregnancy and take appropriate action	98.2	87.6
18	Screen female patients of childbearing age to determine if she is breastfeeding and take appropriate action	96.3	81.3
19	Advocate radiation safety and protection	99.5	98.6
20	Wear personnel radiation monitoring devices appropriately while on duty	99.5	99.1

Item	Task	% Performing	% Daily/Weekly
21	Evaluate individual occupational exposure reports to determine if values for the reporting period are within established limits	83.2	18.6
22	Ensure that appropriate signs are posted in radiation areas	83.9	56.4
23	Identify a medical event according to governing regulations (e.g., NRC)	69.6	30.0
24	Label and record the radiopharmaceutical/pharmaceutical indicating date, type, activity, concentration, and other data as required by governing regulations	90.4	85.3
25	Check all radiopharmaceutical/pharmaceutical kit and dose preparations for color and clarity	76.7	68.9
26	Perform chromatography on a radiopharmaceutical kit as applicable	14.1	7.7
27	Perform venipuncture	96.8	94.5
28	Administer or assist in the administration of interventional pharmaceuticals (e.g., Lugol solution, Regadenoson, morphine sulfate)	80.5	67.7
29	Store and/or dispose of pharmaceutical waste according to regulations	99.1	90.9
30	Perform accuracy test on a dose calibrator	83.9	58.3
31	Perform linearity test on a dose calibrator	66.4	12.1
32	Perform geometry test on a dose calibrator	41.6	4.2
	Perform quality control on the following scintillation detection systems	---	---
33	well counter	87.7	79.9
34	uptake probe	76.1	65.6
35	Calibrate scintillation well counter to appropriate photopeak using a radioactive source	66.5	51.4
36	Calibrate uptake probe to appropriate photopeak using a radioactive source	57.9	40.3
37	Determine the efficiency of the scintillation well counter to calculate the disintegrations per minute	53.5	34.1
38	Prepare radioactive aerosol systems in accordance with regulations	56.0	42.1
39	Prepare radioactive gas delivery systems in accordance with regulations	38.0	30.6
40	Peak gamma camera to appropriate photopeak using radioactive point or sheet source	83.9	65.6
41	Prepare radioactive sources/phantoms for gamma camera quality control using radiation safety precautions	82.7	55.9
42	Perform spatial linearity and resolution tests of a gamma camera using a radioactive source and an appropriate phantom	79.8	55.0
43	Perform high count uniformity correction on a gamma camera according to manufacturers' guidelines	76.7	22.8
44	Perform tomographic resolution/uniformity test using an appropriate SPECT phantom	62.7	25.3
45	Perform PET scanner quality control	40.0	37.3
46	Perform CT scanner quality control	55.3	50.2

Item	Task	% Performing	% Daily/Weekly
47	Initiate corrective action for deficiencies demonstrated on instrumentation quality control tests	74.2	29.5
48	Operate a gamma camera to obtain high quality images	99.5	98.6
49	Operate a PET or PET/CT scanner to obtain high quality images	45.2	39.7
50	Monitor equipment to detect and report malfunctions	97.7	94.1
51	Restore/import electronic images	88.5	80.7
52	Perform image fusion/registration from two separate disciplines using software (e.g., PET and MR)	45.0	39.1
53	Determine correct placement of electrocardiographic (ECG) leads on a patient	96.3	92.7
	Set-up equipment and position patient to obtain the following diagnostic procedures:	---	---
	Infection and inflammation	---	---
54	Ga-67 Gallium Citrate	40.6	6.8
55	In-111 WBCs	59.8	10.5
56	TC-99m WBCs	59.1	12.7
57	F-18 FDG	38.5	33.0
	Bone	---	---
58	3-phase	85.9	60.9
59	Planar/Whole body	85.0	77.7
60	SPECT	75.9	43.2
61	SPECT/CT	38.8	28.8
62	PET	20.5	17.8
63	PET/CT	37.4	32.4
	Brain	---	---
	Flow	---	---
64	Brain Death	51.8	4.5
65	Other	15.3	4.1
66	Planar	40.4	7.8
67	SPECT	38.1	14.7
68	SPECT/CT	20.2	7.8
69	PET	15.2	7.4
70	PET/CT	31.5	12.5
	CSF Cisternogram	---	---
71	Routine Planar	36.8	2.3
72	CSF Leak	38.2	1.8

Item	Task	% Performing	% Daily/Weekly
73	SPECT	17.4	0.9
74	SPECT/CT	15.1	0.9
	Shunt Patency	---	---
75	Head (e.g., VP Shunt)	32.0	3.2
76	Abdomen (e.g., Denver, LeVeen)	24.2	2.3
	Cardiac	---	---
77	Gated Blood Pool (e.g., MUGA)	86.4	23.6
	Myocardial Perfusion with Attenuation Correction or Shift (Prone)	---	---
78	SPECT	78.6	72.3
79	SPECT/CT	29.8	25.2
80	PET	11.9	8.2
81	PET/CT	17.9	10.6
	Myocardial Perfusion without Attenuation Correction and possibly shift (Prone)	---	---
82	SPECT	59.4	53.0
83	PET	6.4	4.6
84	Myocardial Planar (e.g., Tc-99m PYP)	41.5	15.7
85	Myocardial Viability with TI-201 thallous chloride (SPECT or SPECT/CT)	49.8	4.6
86	Myocardial Viability with F-18 FDG (PET or PET/CT)	15.1	4.1
87	Myocardial Sarcoidosis with F-18 FDG (PET or PET/CT)	13.2	3.7
88	Myocardial Imaging with I-123 MIBG	5.0	0.5
	Gastrointestinal	---	---
89	Gastric Emptying	85.5	70.9
90	Gastroesophageal Reflux	25.9	5.5
91	Meckel Diverticulum Detection	64.7	2.3
92	GI Bleed	77.5	27.1
	Genitourinary	---	---
93	Renal Function without Pharmacological Intervention	69.5	22.3
94	Renal Function with Pharmacological Intervention (e.g., Diuretic, ACE Inhibitor)	80.5	40.9
95	Renal Morphology with Tc-99m DMSA (Planar)	20.1	5.0
96	Renal SPECT or SPECT/CT	13.6	2.7
97	Voiding Cystogram	12.3	1.8
	Liver	---	---
98	Hepatobiliary Function	79.9	68.5

Item	Task	% Performing	% Daily/Weekly
	RBC Hemangioma	---	---
99	Planar	33.6	4.1
100	SPECT or SPECT/CT	25.7	1.8
101	Damaged/Denatured RBC Spleen	22.7	0.9
	Liver/Spleen (Tc-99m Sulfur Colloid)	---	---
102	Planar	54.5	2.3
103	SPECT or SPECT/CT	35.6	1.8
	Lung	---	---
104	Perfusion	80.9	69.5
105	Quantitative Perfusion	64.8	19.2
106	Ventilation - Gas	38.5	29.8
107	Ventilation - Aerosol	60.5	45.9
108	Hepatic Artery Perfusion Study (HAPS) for Pretherapy Lung Shunt Function	17.7	5.5
	Lymphoscintigraphy	---	---
	Sentinel Node	---	---
109	Breast	74.1	50.9
110	Skin Lesion (e.g., Melanoma)	66.7	29.7
111	Lymphoscintigram (Extremity)	46.5	10.2
	Endocrine	---	---
112	Thyroid Uptake	81.8	51.8
113	Thyroid Imaging	81.3	51.1
114	Parathyroid (Planar)	74.9	42.0
115	Parathyroid SPECT or SPECT/CT	63.1	35.9
	Tumor	---	---
116	Planar/Whole Body (Ga-67 Gallium Citrate)	35.5	3.6
117	Planar/Whole Body (Other Radiopharmaceutical)	37.2	7.4
118	Neuroendocrine SPECT or SPECT/CT	44.5	4.1
119	PET or PET/CT	36.5	29.2
120	Breast (e.g., Tc-99m Sestamibi, Tc-99m Tetrofosmin)	12.3	4.1
121	Breast Positron Emission Mammography (PEM)	1.4	0.9
	Perform the Following	---	---
122	CT for Attenuation Correction/Anatomic Correlation with SPECT	38.2	32.7
123	CT for Attenuation Correction/Anatomic Correlation with PET	39.9	34.4

Item	Task	% Performing	% Daily/Weekly
124	Standalone CT Procedures in conjunction with SPECT or PET	18.2	14.5
125	Standalone CT Procedures without SPECT or PET	9.5	5.5
126	PET/MR	0.9	0.9
	Administer or Assist with the Administration of the following Therapeutic Procedures:	---	---
127	Bone Therapy	25.9	3.2
128	Thyroid Therapy for Ablation	60.0	15.9
129	Thyroid Therapy for Hyperthyroidism	61.4	14.5
130	Non-Hodgkin Lymphoma Therapy	19.3	3.2
131	Selective Internal Radiation Therapy (SIRT) with Hepatic Artery Perfusion Study (HAPS)	15.9	4.5
132	Neuroendocrine Therapy	9.5	2.3
133	Adrenal Therapy	1.8	0.5
134	Prostate Therapy	15.5	1.8

Table 2.
Percent administering Radiopharmaceuticals and other Pharmaceuticals

Item	Substance	% Performing	% Daily/Weekly
	Radiopharmaceuticals	---	---
1	Tc-99m sodium pertechnetate (TcO4-)	87.2	61.6
2	Tc-99m oxidronate (HDP)	13.2	10.5
3	Tc-99m medronate (MDP)	77.7	72.7
4	Tc-99m pyrophosphate (PYP)	59.4	23.7
5	Tc-99m sestamibi (Cardiolite)	81.7	73.1
6	Tc-99m tetrofosmin (Myoview)	40.0	35.9
7	Tc-99m pentetate (DTPA)	68.6	45.9
8	Tc-99m succimer (DMSA)	21.1	6.0
9	Tc-99m mertiatide (MAG3)	81.8	43.6
10	Tc-99m exametazime (HMPAO, Ceretec)	52.7	9.5
11	Tc-99m bicisate (ECD, Neurolite)	23.4	2.8
12	Tc-99m exametazime (HMPAO) labeled WBCs	40.9	7.7
13	Tc-99m labeled RBCs	82.7	35.9
14	Tc-99m macroaggregated albumin (MAA)	81.8	72.3
15	Tc-99m sulfur colloid	83.6	68.9
16	Tc-99m sulfur colloid (filtered)	64.8	45.2

Item	Substance	% Performing	% Daily/Weekly
17	Tc-99m disofenin (Hepatolite)	4.6	2.7
18	Tc-99m mebrofenin (Choletec)	84.1	76.8
19	Tc-99m tilmanocept (Lymphoseek)	35.8	23.4
20	In-111 pentetate (DTPA)	43.8	11.4
21	In-111 oxyquinoline (oxine) labeled WBCs	47.7	9.1
22	In-111 pentetreotide (OctreoScan)	54.5	5.0
23	Tl-201 thallous chloride	51.8	5.0
24	Xe-133 gas	36.4	28.6
25	I-123 sodium iodide	75.9	42.7
26	I-131 sodium iodide (diagnostic dose)	56.4	21.8
27	I-123 ioflupane (DaTscan)	29.5	15.2
28	I-123 iobenguane MIBG	30.0	3.6
29	I-131 iobenguane MIBG (diagnostic dose)	11.9	1.4
30	Ga-67 gallium citrate	40.5	5.5
31	F-18 fluorodeoxyglucose (FDG)	42.3	39.5
32	F-18 sodium fluoride (F-18 NaF)	17.7	4.5
33	F-18 Florbetapir (Amyvid)	10.9	4.5
34	F-18 Flutemetamol (Vizamyl)	1.8	0.9
35	F-18 Florbetaben (Neuraceq)	4.1	2.3
36	F-18 Fluciclovine (Axumin)	24.5	14.5
37	Ga-68 Dotatate (Netspot)	19.6	9.6
38	N-13 ammonia	2.7	2.7
39	Rb-82 chloride (e.g., Cardiogen-82)	10.0	8.6
	Interventional Pharmaceuticals	---	---
40	Acetazolamide (Diamox)	5.5	0.5
41	Adenosine	26.9	12.8
42	Aminophylline	67.0	28.8
43	Atropine sulfate	20.3	4.1
44	Dipyridamole (Persantine)	16.5	8.3
45	Dobutamine	50.7	7.3
46	Regadenoson (Lexiscan)	91.8	88.6
47	Beta blocker (e.g., Metoprolol)	21.6	4.6
48	Nitroglycerin	40.6	6.0

Item	Substance	% Performing	% Daily/Weekly
49	Glucagon	8.7	0.0
50	Cimetidine (e.g., Tagamet, Zantac)	8.3	0.9
51	Enalaprilat (e.g., Vasotec)	7.8	1.4
52	Captopril (Capoten)	19.0	0.5
53	Furosemide (Lasix)	83.1	44.7
54	Sincalide (Kinevac)	79.5	63.9
55	Morphine sulfate	41.1	16.0
56	Potassium iodide solution (e.g., Lugol solution, SSKI)	37.9	12.8
57	Heparin	66.8	28.6
58	Lidocaine (EMLA) cream	17.3	10.0
59	Insulin	5.9	1.8
60	Potassium perchlorate	6.9	2.3
61	Recombinant human TSH (Thyrogen)	21.9	8.7
62	Buffered lidocaine	11.2	7.4
63	Fatty meal substitute (e.g., Ensure)	56.9	19.3
64	Oral CT contrast media (e.g., Visipaque, Omnipaque, Barium sulfate)	22.0	17.4
65	IV CT contrast media (e.g., Visipaque, Omnipaque)	18.7	14.2
	Therapeutic Radiopharmaceuticals	---	---
66	I-131 iobenguane MIBG (e.g., Azedra)	7.4	0.0
67	I-131 Sodium iodide (Therapeutic Dose)	56.6	16.9
68	Lu-177 Dotatate (Lutathera)	20.3	11.6
69	Ra-223 Dichloride (Xofigo)	32.1	5.0
70	Sm-153 Lexidronam (EDTMP, Quadramet)	5.9	0.0
71	Y-90 Ibritumomab tiuxetan (Zevalin)	10.0	0.5
72	Y-90 Microspheres (e.g., TheraSphere, SIR Spheres)	30.9	7.7
73	I-125 Seeds	9.6	4.6

Table 3.
Which of the following best describes your primary place of employment?

Response	Count	Percentage
Hospital less than 100 beds	20	9.4
Hospital 100-250 beds	48	22.6
Hospital 251-500 beds	63	29.7
Hospital more than 500 beds	37	17.5
Free-standing cardiology center	13	6.1
Free-standing imaging center	11	5.2
Physician's office	14	6.6
Mobile or locum tenens	3	1.4
Other	3	1.4

Table 4.
How many years have you worked as a nuclear medicine technologist?

Response	Count	Percentage
Less than 1 year	10	4.5
1-3 years	86	39.1
4-5 years	65	29.5
6-10 years	43	19.5
More than 10 years	16	7.3

Table 5.
What is your primary job title?

Response	Count	Percentage
Staff technologist	185	84.1
Lead technologist	35	15.9

Table 6.
How many hours per week do you work as a nuclear medicine technologist?

Response	Count	Percentage
Less than 16 hours	11	5.0
16-31 hours	48	21.8
32 hours or more	161	73.2

Table 7.
In the last year, has the number of approved full time equivalent (FTE) positions for nuclear medicine technologists at your facility changed?

Response	Count	Percentage
Yes, increased FTEs	41	18.6
Yes, decreased FTEs	18	8.2
No change	161	73.2

Table 8.
In the last year, has the number of employed nuclear medicine technologists at your facility changed?

Response	Count	Percentage
Yes, number increased	57	25.9
Yes, number decreased	31	14.1
No change	132	60.0

Table 9.
Does your department have any cameras with cadmium zinc telluride (CZT) detectors (e.g., D-SPECT)

Response	Count	Percentage
Yes	25	11.4
No	194	88.6

Table 10.
What capabilities do your facility's PET scanner(s) have? (mark all that apply)

Response	Count	Percentage
My facility does not have a PET scanner	106	49.3
PET only (dedicated)	48	22.3
CT	96	44.7
MR	6	2.8
2D	20	9.3
3D	45	20.9
Time-of-flight	32	14.9
Respiratory gating	20	9.3
Cardiac gating	39	18.1

Table 11.
How does your facility obtain technetium-based radiopharmaceuticals? (mark all that apply)

Response	Count	Percentage
Do not use Tc-99m products	2	0.9
Use a Mo-99/Tc-99m generator	10	4.5
Receive a bulk dose of Tc-99m sodium pertechnetate to prepare kits	58	26.4
Receive a bulk dose of radiopharmaceuticals (e.g., Tc-99m MDP)	18	8.2
Receive unit doses from a radiopharmacy	210	95.5

Table 12.
Has your facility achieved compliance with the following standards? (mark all that apply)

Response	Count	Percentage
USP 797	74	34.1
USP 825	44	20.3
Neither	14	6.5
Unsure	127	58.5

Table 13.
If not currently complaint, is your facility working toward compliance with the following standards? (mark all that apply)

Response	Count	Percentage
USP 797	11	5.1
USP 825	32	14.8
Neither	5	2.3
Unsure	125	57.9
Currently Compliant	53	24.5

Table 14.
How do you tag RBCs with Technetium-99m?

Response	Count	Percentage
Use an in vitro kit (e.g., UltraTag)	150	75.0
Pyp - in vivo	23	11.5
Pyp - in vitro	7	3.5
Other method	0	0.0
Don't tag RBCs	20	10.0

Changes to Task Inventory

The practice analysis committee met in August 2020 to review the practice analysis survey data and determine whether any tasks should be dropped from or added to the task inventory. The committee also clarified the wording of several tasks.

The following tasks were removed:

- Set-up equipment and position patient to obtain the following diagnostic procedures:
    - Radionuclide Cystogram
    - Damaged RBC Spleen
- Administer or assist with the administration of the following therapeutic procedures:
    - Non-Hodgkin Lymphoma

The following tasks were added:

- Evaluate the patient's ability to understand and comply with requirements for the requested procedure
- Manage interpersonal interactions in an effective manner
- Explain and confirm the patient's preparations
- Respond as appropriate to procedure inquiries from the patient, the patient's family, or authorized representative
- Follow environmental protection standards for handling and disposing hazardous materials
- Provide for the patient's safety, comfort, and modesty
- Notify appropriate personnel of adverse events or incidents
- Verify informed consent as necessary
- Communicate relevant information to appropriate members of the care team
- Follow appropriate precautions and procedures when caring for patients with communicable diseases
- Prior to administration of a medication other than a radiopharmaceutical, review pertinent information to prepare appropriate type and dosage
- Prior to administration of a medication other than a radiopharmaceutical, determine if the patient is at risk for an adverse event
- Recognize and communicate the need for prompt medical attention
- Screen female patients of childbearing age to determine if she is breastfeeding and take appropriate action

- Advocate radiation safety and protection
- Wear personnel radiation monitoring devices appropriately while on duty
- Evaluate individual occupational exposure reports to determine if values for the reporting period are within established limits
- Perform chromatography on a radiopharmaceutical kit as applicable
- Perform venipuncture
- Store and/or dispose of pharmaceutical waste according to regulations
- Operate a gamma camera to obtain high quality images
- Operate a PET or PET/CT scanner to obtain high quality images
- Perform image fusion/registration from two separate disciplines using software
- Set-up equipment and position patient to obtain the following diagnostic procedures:
    - Myocardial Viability
    - Amyloid Imaging
    - Hepatic Artery Perfusion Study (HAPS) for Pretherapy Lung Shunt Fraction
- Administer or assist with the administration of the following therapeutic procedures:
    - Targeted radiotherapy

The Board of Trustees approved the final task inventory in January 2021. The final task inventory may be found on the ARRT website: https://www.arrt.org/pages/arrt-reference-documents/by-document-type/task-inventories

Content Specifications and Clinical Competency Requirements

Changes to Content Specifications

The practice analysis committee updated the content specifications based on changes to the task inventory and the field. The committee considered the knowledge and cognitive skills required to successfully perform the tasks in the final task inventory and verified that those topics were covered in the content specifications, adding additional content as necessary. The committee also removed any topics that could not be linked to the updated task inventory.

The updated content specifications were then made available for public comment in August 2020 and the committee met again in October 2020 to discuss the comments before making any final adjustments.

The most notable changes from the previous version of the content specifications were:

- Patient Care
  - Added handling and disposal of toxic or hazardous material
  - Added a pharmacology subsection that includes patient history and technologist's response and documentation
- Safety
  - Added patient dose reduction and optimization
- Image Production
  - Added cardiac gating and air calibration to the "PET/CT scanner" area
  - Added imaging informatics
- Procedures
  - Added chromatography
  - Added cardiac amyloid imaging
  - Removed non-Hodgkin lymphoma therapy
  - Added targeted radiotherapy
  - Removed damaged RBC spleen and radionuclide cystogram from the "gastrointestinal and genitourinary" area
  - Moved lymphoscintigraphy from the "endocrine and oncology" area to "other imaging procedures" and divided into three different areas: breast, skin lesion, and extremity
- Appendix A: Nuclear Medicine Pharmaceuticals
  - Removed four pharmaceuticals
  - Added thirteen pharmaceuticals

In addition, the committee edited all sections of the content specifications for clarity and updated terminology to reflect current practice.

The Board of Trustees approved the final content specifications in January 2021. The final content specifications may be found on the ARRT website: https://www.arrt.org/pages/arrt-reference-documents/by-document-type/examination-content-specifications

Content Weighting

The practice analysis committee determined the number of items that should be assigned to each section of the exam through a process known as content weighting. First, the committee performed a bottom-up exercise where members individually estimated the number of unique items that should be included in each section. Second, the committee performed a top-down exercise where members individually estimated the relative proportion of the exam that should be dedicated to each section. Finally, ARRT staff provided the committee with summary values from the two exercises and the committee held a discussion to finalize their recommendation for the number of items assigned to each section (Table 15).

Table 15.
Number of Items per Section

Content Area	Number of Scored Items
Patient Care	**24**
Patient Interactions and Management (24)	
Safety	**25**
Radiation Physics, Radiobiology, and Regulations (25)	
Image Production	**33**
Instrumentation (33)	
Procedures	**118**
Radionuclides and Radiopharmaceuticals (28)	
Cardiac Procedures (25)	
Endocrine and Oncology Procedures (25)	
Gastrointestinal and Genitourinary Procedures (18)	
Other Imaging Procedures (22)	
Grand Total	**200**

Changes to Clinical Competency Requirements

The purpose of the clinical competency requirements is to document that individuals have demonstrated competence performing the clinical activities fundamental to a particular discipline. Competent performance of these fundamental activities, in conjunction with mastery of the cognitive knowledge and skills as documented by the examination requirement, provides the basis for the acquisition of the full range of procedures typically required in a variety of settings. Demonstration of clinical competence means that the candidate has performed the procedure independently, consistently, and effectively during the course of his or her formal education.

The practice analysis committee reviewed and updated the previous clinical competency requirements considering the final task inventory and content specifications. The updated clinical competency requirements were then made available for public comment in August 2020 and the committee met again in October 2020 to discuss the comments before making any final adjustments.

The most notable changes from the previous version of the clinical competency requirements were:

- Added “assisted patient transfer” to general patient care procedures
- Added “maintain and care for patient ancillary equipment” to general patient care procedures

- Added amyloid imaging to the cardiovascular category
- Added “other” to the infection category
- Added lung, parathyroid, renal, and tumor (other) to the SPECT and SPECT/CT category
- Added “other” and selective internal radiation therapy (SIRT) to therapy category
- Removed planar from the central nervous system category
- Removed damaged RBC spleen from the gastrointestinal category
- Removed radionuclide cystogram from the genitourinary category
- Removed cardiac from the SPECT category
- Removed non-Hodgkin lymphoma from therapy category
- Removed lymphoscintigraphy from the tumor category and created a new lymphatics category with three procedures: breast, skin lesion, and extremity
- Moved “PET or PET/CT” procedures to a dedicated category

The Board of Trustees approved the final clinical competency requirements in January 2021. The final clinical competency requirements may be found on the ARRT website: https://www.arrt.org/pages/arrt-reference-documents/by-document-type/didactic-and-clinical-competency-requirements

Conclusion

Numerous individuals contributed to this project, as committee members, document reviewers, or as survey respondents. Periodic practice analysis is a necessary step in the life cycle of an exam program to ensure that the content of the exam and the eligibility requirements remain relevant with current practice. This study noted significant changes to the field of nuclear medicine technology, and thanks to the efforts of all involved it assures that the ARRT Nuclear Medicine Technology exam program will continue to be an excellent assessment of nuclear medicine technologists wishing to demonstrate their qualifications by seeking certification and registration.