Nuclear Cardiology Training

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Objective: The Cardiovascular Technologist Working Group of the American Society of Nuclear Cardiology and the Society of Nuclear Medicine–Technologist Section are interested in working to improve the skills of technologists performing nuclear cardiology by developing guidelines for training.
Methods: A survey was sent to NMT educational programs to obtain information on the current status of student training.
Results: While related course work is being covered, the depth is hard to assess. Clinical hours of experience vary greatly.
Conclusion: Due to the extensive scope of nuclear cardiology and the amount of attention to technical detail required, training guidelines are warranted.
Key Words: nuclear cardiology; training; guidelines

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During the past 20 years, nuclear cardiology has experienced tremendous growth and development both technically and in clinical applications. The introduction of the computer into the nuclear medicine department 20 to 25 years ago facilitated the development of nuclear cardiology perhaps more than any other area of nuclear medicine. In the 1970s, multiple-gated acquisition, list mode first-pass cardiac imaging and myocardial perfusion imaging with ^{201}Tl were introduced. Single-photon emission computed tomography (SPECT) imaging gained popularity and widespread use in the 1980s.

Today nuclear cardiology protocols are technically demanding. Multihead dedicated SPECT cameras for cardiac perfusion imaging are common in nuclear medicine departments. Treadmills are often located within the nuclear medicine department. Several agents for pharmacological stress and perfusion imaging are available. Gated SPECT is gaining wide acceptance and use. Software currently undergoing development and/or FDA approval include quantitative transmission/emission attenuation and scatter correction, quantitative methods for calculating volumes and ejection fraction from SPECT imaging (*1–3*).

First-pass imaging for left and right ventricle ejection fraction is routinely performed. There are systems available for rest/stress first pass analysis. Du Pont Pharma states, "Left ventricle ejection fractions obtained by various techniques of radionuclide ventriculography (first-pass and multiple-gated acquisition) correlate highly with those obtained during cardiac catheterization whereas other competing modalities do not" (*4*).

The indications for nuclear cardiac imaging continue to grow. The availability of pharmacologic stress testing agents has increased the number of patients that can be evaluated for coronary artery disease (CAD). Advances in the treatment of CAD such as medications and angioplasty have increased the use of perfusion imaging for follow-up of these patients. Determining myocardial viability in patients with known CAD guides the physician in the appropriate cost effective management of the patient. Presurgical risk assessment of patients with suspected CAD can minimize post-surgical complications. The demand for myocardial perfusion imaging for the assessment of emergency room patients with acute chest pain is now feasible and growing due to the availability of ^{99m}Tc perfusion agents. Myocardial perfusion imaging is also used for risk assessment of patients post myocardial infarction.

Gated SPECT imaging with technetium perfusion agents provides functional information as well. Patients who need precise serial ejection fractions, such as those undergoing chemotherapy, patients with congestive heart failure, or other forms of treatment which can effect the heart, remain candidates for radionuclide ventriculography. The combination of data from perfusion and function studies increases the sensitivity and specificity on non-invasive assessment of CAD (*3*).

Between 1987 and 1991 the number of myocardial perfusion studies performed in the U.S. increased by almost 2 1/2 times (*4*). The demand for nuclear cardiac studies is likely to increase as the post-war baby boomers reach the age where the risk of CAD increases. Technical advances and clinical applications of nuclear cardiology continue to grow and develop. PET imaging with ^{18}F-deoxyglucose is considered to be the standard for assessment of myocardial viability, but the cost of PET prohibits its widespread use at this time. Cameras and

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collimators designed to accommodate high-energy PET tracers are now both available and promising (*5,6*). Promising areas of nuclear cardiology include imaging of clots and plaques and imaging of myocardial innervation. Neither technique is currently in widespread use for clinical cardiac imaging but could represent areas of growth in the future (*4*).

Key comments made about nuclear cardiology in recent articles are included in this paragraph and the next. DePuey says, "Perhaps more than any other nuclear imaging study, SPECT myocardial perfusion imaging requires great attention to technical detail by both the technologist and physician. The level of expertise among technologists and physicians and the time they are willing and able to devote to mastering this art will vary greatly. Consequently, there is considerable variability in confidence and diagnostic accuracy in reporting myocardial perfusion SPECT" (*7*).

The challenge for nuclear cardiology today is to determine whether its techniques can provide more information than competitive modalities at comparable or lower costs (*8*). When choosing the most appropriate noninvasive imaging test, a clinician must consider published accuracies, local expertise, new developments within established modalities and new technologies (*9*). For nuclear medicine to maintain a strong hold and thrive in a highly cost-competitive healthcare environment, studies must be acquired and processed accurately and reproducibly (*7*).

The Cardiovascular Technologist Working Group of the American Society of Nuclear Cardiology and the Society of Nuclear Medicine–Technologist Section is working to improve the skills of technologists performing nuclear cardiology. This working group consists of 17 technologists from across the U.S. and Canada that have extensive experience in nuclear cardiology. Recognizing the extensive technical scope of nuclear cardiology today, guidelines for extensive training or speciality training may be helpful and even necessary.

METHODS

In April of 1995, a survey was sent to 119 NMT educational programs in the U.S. and Canada to obtain information on the current status of didactic education and clinical training in nuclear cardiology.

The survey included questions on:

1. What is covered in the course work?
2. What computer applications are covered?
3. Who teaches the related didactic course work?
4. Are students introduced to other competing diagnostic methods?
5. How many clinical hours of hands-on training are students receiving?
6. Is a competency exam used?
7. Are students trained in cardiac emergencies?
8. Do students sit in on reading sessions to learn how the physician interprets and uses the nuclear cardiology data?
9. Educators comments and suggestions as to whether or not they think training guidelines would be helpful.

TABLE 1
Instructors of Didactic Course Work*

	Number	Percent
Number of programs in which didactic course work is taught by only one person	15	31
Number of programs in which didactic course work is taught by only one and that person is the program director	12	24
Number of programs in which didactic course work is taught by two or more people	33	67
Faculty listed and frequency:		
Program director	30	61
Physician	19	39
Technologist	25	51
Nuclear cardiology specialist	12	25
Nurse	2	4
Other	3	6

*Total respondents = 49

RESULTS

A total of 49 (41%) of the surveys was returned. Related course work (cardiac anatomy and physiology, radiopharmaceuticals, pharmacological stress, computer acquisition and techniques, procedures, etc.) is being covered by all programs as might be expected.

Table 1 describes who is teaching the didactic course work. Table 2 describes what ECG basics and other cardiac evaluation methods are covered. The number of clinical hours of hands-on training students obtain in nuclear cardiology varied greatly; see Table 3 and comments in Appendix 1. Of the programs reported, 77% said that they give a competency exam; 72% of the respondents reported that students do sit in on scan reading sessions. Comments in general were few and several are listed in Appendix 2.

DISCUSSION

Fourteen (12%) of the respondents sent copies of the related course work objectives. Some are more descriptive and

TABLE 2
ECG Basics Covered in the Didactic Lectures*

	Number	Percent
Number of programs reporting each of the following:		
Lead placement and setup	43	88
Treadmill stress testing	39	80
Recognition of normal and abnormal rhythms	37	76
Other cardiac evaluation methods covered:		
Cardiac catheterization	20	41
Electrophysiology	10	21
Echocardiography	22	45

*Total respondents = 49

TABLE 3
Nuclear Cardiology Hands-On Training*

	Number of hours	Number of weeks
Number of respondents	42	—
Average	321.3	8.03
Range	32–1630	0.8–40.75
Median	250	6.25

*See comments in Appendix 2.

informative than others. The depth of knowledge and training provided is hard to assess.

Nuclear cardiology comprises up to 50% of the volume of nuclear medicine studies. Nuclear cardiology studies are among the most technically demanding. In only 25% of the programs is a nuclear cardiology specialist teaching didactic coursework.

In the current economic climate and health care marketplace, we must recognize the need for multicompetency. Since stress testing is an important part of so many nuclear cardiology procedures, knowledge and skill in electrocardiography complements nuclear medicine technology training. This is an area where training programs could increase their focus. It is also important to understand complementary and competing cardiac evaluation methods to better appreciate what nuclear cardiology has to offer to patient care and management.

The *Curriculum Guide for Nuclear Medicine Technologists*, published by the Society of Nuclear Medicine, (*10*) provides the broad scope of what should be included in the curriculum. A curriculum outline and behavioral objectives are provided for each unit. The guide states that the list of imaging procedures in the guide represents those currently considered to be routine imaging procedures. It is not an exhaustive list, but does include those procedures the students should master during the time of study in a basic level nuclear medicine technology program.

The *Curriculum Guide* is an excellent reference source. The outlines and objectives could be extensively fleshed out to provide greater detail and depth, particularly for nuclear cardiology, enabling consistency in education.

Six to eight weeks of clinical experience in nuclear cardiology techniques may seem adequate for entry-level technologists. However, some programs are providing much less according to our survey.

CONCLUSION

The technologist must provide technically reliable data. Guidelines for technologist training and practice are needed to ensure optimal patient care and management. The results of the survey demonstrate the need for guidelines for training in nuclear cardiology to ensure consistency and comprehensiveness. Guidelines should be updated as often as needed to reflect state-of-the-art technology, new methods, new radiopharmaceuticals and acceptable practice.

The Joint Review Committee on Educational Programs in Nuclear Medicine Technology (JRCNMT) periodically revises the *Essentials* for educational programs to reflect technical and occupational changes. Professionals in the field should be guiding the JRCNMT with the *Essentials* by providing them with appropriate information.

When an extended curriculum outline and training objectives for nuclear cardiology have been developed, educators and other professionals could decide if an advanced certification status is warranted, as was suggested by one of the survey respondents in Appendix 2.

APPENDIX 1

Comments written about clinical hours of nuclear cardiology hands-on training:

1. Not specific numbers, it's part of their overall training, probably one area they spend the most time on.
2. 45 hr or more specifically devoted to nuclear cardiology, however, students are encouraged to participate with cardiology exams throughout their training.
3. The students are rotated to nuclear cardiology continuous 30 hr per week.
4. 40% of hands-on training.
5. Included in total imaging training of 1200 hr.
6. 12 hr per week for 1 yr (30 wk).
7. In addition to 4 wk cardiology rotation, students do cardiac studies on other rotations.
8. Approximately 1000 hr in 2 yr.
9. 40 hr/wk (approximately 8 wk per term).
10. Minimum 9 wk additional time may be spent in radiology studies when students are at affiliated hospitals.
11. Varies at clinical sites; quite extensive.

APPENDIX 2

Other comments:

1. Remember that schools teach entry-level students and have to teach all areas of nuclear medicine, so there isn't a lot of extra time for cardiology, although it does receive a strong emphasis. Many of the questions you asked would be very applicable to an advanced course for technologist and some schools are getting into the advanced work.
2. The *Curriculum Guide for Nuclear Medicine Technologists*, 2nd edition, adequately establishes educational guidelines for entry level training for nuclear medicine technology students in the area of nuclear cardiology.
3. Remember, for an NMT program to be accredited, the areas of nuclear cardiology are required. Also, don't forget radiation safety and interventionals.
4. First pass, shunt evaluation, venography also covered.

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