SURVEY OF ACADEMIC DIVISIONS OF NUCLEAR MEDICINE IN U.S. MEDICAL SCHOOLS, APRIL 1972

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Academic Council of the Society of Nuclear Medicine

A survey was carried out by the Academic Council of the Society of Nuclear Medicine concerning various aspects of academic nuclear medicine divisions or departments. These included physician manpower and other personnel, activities of physicians, reading, training, medical school teaching, technologist training, space and equipment, administrative organization, and major problems. The information obtained serves as a useful baseline for further studies in educational aspects of nuclear medicine.

In previous annual meetings of the Academic Council of the Society of Nuclear Medicine, it became apparent that there was a lack of information on the conduct of academic programs in nuclear medicine in U.S. medical schools. Moreover, it became obvious that the requirements for developing these academic programs were quite different from those of nuclear medicine facilities in community hospitals, particularly in the areas of research, undergraduate medical teaching, and residency training. However, no "data base" was available upon which one could build an understanding of the activities of academic programs. No standards were available by which one could compare the status of development of one center with another, analogous to the published studies on academic radiology (*1,2*) or the annual survey conducted for the Society of Chairmen of Academic Radiology Departments (SCARD) by Eugene Klatte (*3*). Accordingly, the officers of the Council of 1971–72 formulated a 12-page questionnaire which was circulated to the membership. This survey attempted to define the essential characteristics of both an average and ideal academic program in nuclear medicine in 1972. The questionnaire explored the training of physicians, residents, technologists, and medical students in nuclear medicine; physician manpower and support personnel; the distribution of activities of physicians, facilities and equipment; and major administrative problems in academic divisions in nuclear medicine. This report is a summary of the pertinent findings.

RESPONSE TO THE SURVEY

The questionnaire was forwarded to 97 U.S. medical schools, of which 89 were listed by the AMA as approved and the remaining 8 listed as developing operational schools. The lack of response from 28 medical schools was investigated by personal contact. As a result, it was learned that 10 of these institutions had established programs in nuclear medicine with program directors who did not respond to the questionnaire. One institution had recently recruited a new program director but lacked sufficient information to submit a response. The remaining 17 institutions had no identified nuclear medicine program director and their academic programs were either "rudimentary" or not yet established. Five of these 17 institutions were developing operational medical schools. Two institutions without program directors submitted incomplete questionnaires.

The questionnaire was submitted also to the 16 approved or developing medical schools in Canada. However, the response was so poor that the sparse data submitted could not be analyzed.

PHYSICIAN MANPOWER IN ACADEMIC NUCLEAR MEDICINE

No accurate current information is available on the number of physicians in the U.S. with a primary,

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secondary, or tertiary interest in the field of nuclear medicine. These data will become available following the January 1973 census of physicians of the AMA. Approximate estimates of physician manpower in 1972 were made by Richard Peterson (*4*). He estimated a total of 4,500 physicians in nuclear medicine of whom over 1,200 were full-time workers in the field. From projections based on a survey of the College of American Pathologists in June 1970 and by the American College of Radiology in 1971, it was further estimated that 1,913 radiologists and 680 clinical pathologists were working in nuclear medicine. Within recent years, the portion of the physicians' time spent in nuclear medicine increased significantly. The physician membership of the Society of Nuclear Medicine in 1972 totaled 2,800, of whom 42% were radiologists, 33% internists, 15% clinical pathologists, and the remaining 10% were from other specialties. There were 1,096 candidates for the first examination of the American Board of Nuclear Medicine in March 1972.

According to this survey, 80 of 97 U.S. medical schools had established programs in nuclear medicine in 1972, of which 78 had full-time division heads or program directors and the remaining two had part-time directors. One medical school had two separate divisions of nuclear medicine, each with its own program director. The remaining 17 medical schools had no program directors. Of the 80 medical schools with established programs, 18 had only a single physician in nuclear medicine. The average medical school physician staffing pattern was 2.6 full-time equivalent positions and the mode was two full-time physicians and one part-time physician. The physician staff in 69 academic divisions of nuclear medicine is listed in Table 1. The proportion of radiologists who have become division heads of nuclear medicine is slightly greater than that of internists. On the contrary, for the total physician manpower in academic nuclear medicine, both full-time and part-time, the number of internists exceeds the number of radiologists. The total number from other specialties including clinical pathology is relatively small. At the bottom of Table 1, the data obtained from 69 academic divisions were used to estimate by extrapolation the total academic manpower in the 80 medical schools with established nuclear medicine programs. It can be concluded that the total number of physicians in academic nuclear medicine must be small, with an estimate of 178 full-time physicians and 64 part-time physicians. A conservative estimate of additional physician personnel needed is provided on the bottom line of this table, based on the physician vacancies listed in the questionnaires plus one physician for each of 17 medical schools which did not have a program director.

TABLE 1. PHYSICIAN STAFF IN 69 ACADEMIC DIVISIONS OF NUCLEAR MEDICINE

	Division heads	Full-time physicians	Part-time physicians	All
Radiologists	33(49%)	59(39%)	20(36%)	79(38%)
Internists	28(42%)	87(57%)	30(55%)	117(56%)
Clin. Path.	2(3%)	4(2%)	3(5%)	7(3.5%)
Other	4(6%)	3(2%)	2(4%)	5(2.5%)
Totals	67	153	55	208
Additional needed	2	61	10	71
	Estimated academic manpower in nuclear medicine in 97 medical schools, 1972			
Totals	78	178	64	242
Additional needed	19	90	12	102

TABLE 2. PERSONNEL IN ACADEMIC NUCLEAR MEDICINE (65 INSTITUTIONS)

	Avg no. per institution	No. of procedures per individual	
		Present survey	SCARD 1972
Staff physicians	2.4	2,670	3,012
Nonphysician professional staff	2.1	3,030	—
Nuclear medicine technologists	4.6	1,375	1,717
Other technologists	1.5	4,120	—
Other employees	4.9	1,280	1,582
All types trainees	7.1	880	—
Total personnel	22.6	—	—

PERSONNEL IN ACADEMIC NUCLEAR MEDICINE DIVISIONS

The average numbers of personnel of various types working within an academic division of nuclear medicine are listed in Table 2, and the same data expressed as percentages of the total personnel are listed in Table 3. The number of nonphysician professionals, including physicists, radiochemists, and engineers almost equals the number of staff physicians. It would appear that about two nuclear medicine technologists are required for each staff physician and at least an equal number of nontechnical employees (secretaries and clerks, computer programmers, nurses, aides, and orderlies). The number of physician trainees taking a 3-month rotation through nuclear medicine is relatively large compared with the number of physicians obtaining more extensive training over 1 or 2 years. The number of student technologists in a typical program is fairly

TABLE 3. TYPES OF PERSONNEL IN ACADEMIC NUCLEAR MEDICINE DIVISIONS (1,466 IN 65 INSTITUTIONS)

	% of total personnel	
Staff physicians	10.4	
Nonphysician professional staff	9.2	
physicists		4.8
radiochemists		2.9
engineers		1.5
Technologists	27.0	
nuclear medicine		20.2
research		4.2
radiochemistry		1.0
electronics		1.6
Other employees	21.8	
secretaries and clerks		10.1
computer programmers		1.4
nurses		0.7
aides and orderlies		4.2
other		5.4
Trainees	31.6	
physicians 1 yr		1.4
physicians 2 yr		3.7
physicians 3 mo		20.1
student technologists		6.4

small and equivalent to one-third the number of staff technologists.

The average number of all clinical nuclear medicine procedures per individual is listed in a separate column in Table 2, and compared with corresponding figures for nuclear medicine obtained in the SCARD survey of 1972.

ACTIVITIES OF PHYSICIANS IN ACADEMIC NUCLEAR MEDICINE

The clinical workload of physicians in academic nuclear medicine, expressed as the number of procedures per year per physician, is summarized in Table 4, together with comparative figures from the 1972 SCARD survey. It is apparent that wide variations exist from one center to another when the clinical effort is expressed in this fashion. In more than half of the medical centers, however, the number of procedures per year per physician was in the range of 1,000–3,000. On further assessment of the data provided in the questionnaires, it became apparent that the wide variations in staffing patterns became much less if only the in vivo clinical procedures were considered. The average number of in vivo procedures per year per physician was 2,280. The number of physicians needed was more directly related to the number of in vivo procedures performed than to the number of in vitro tests since the latter require less physician time. The findings described above emphasize that clinical nuclear medicine procedures require considerably more physician time than most diagnostic radiological procedures. In many academic diagnostic divisions, from 10,000 to 12,000 procedures annually are performed per staff radiologist, and the optimum "work load" has been stated to be 5,000 per year (*5*).

In Table 5 are listed the various types of clinical procedures performed in 65 academic nuclear medicine divisions. Almost 6,000 clinical procedures are performed in an average academic center annually. An average of two-thirds of all clinical procedures were performed on in-hospital patients (median 72%) and an average of 6.1 procedures per hospital bed were performed per year (or 5.6 in vivo procedures per hospital bed per year). According to the 1972 SCARD survey, an average of one in vivo nuclear medicine procedure is performed for every 30 radiographic studies; 55% of all clinical studies are imaging procedures and 24% are in vitro thyroid tests; 87% of all studies are either imaging procedures or thyroid studies. In compari-

TABLE 4. CLINICAL WORK LOAD OF ACADEMIC NUCLEAR MEDICINE PHYSICIAN

	Present survey	SCARD 1972 survey
No. of centers	66	53
No. of procedures/yr/physician		
Mean	3,190	3,012
Median	2,646	2,600
<1,000	—	5 centers
1,000–2,000	16 centers	9 centers
2,000–3,000	23 centers	19 centers
3,000–4,000	8 centers	9 centers
4,000–5,000	6 centers	
5,000–6,000	6 centers	11 centers
Over 6,000	7 centers	
No. of in vivo procedures/yr/physician		
Mean	2,280	—
Median	2,000	—

TABLE 5. CLINICAL PROCEDURES PERFORMED IN 65 ACADEMIC DIVISIONS OF NUCLEAR MEDICINE

	Annual number	% total
Imaging	211,078	55
Thyroid uptake	31,188	8
Hematological	13,965	3.5
Renal function	7,816	2
Pulmonary function	10,002	2.5
In vitro thyroid	91,957	24
In vitro immunoassay	14,938	4
Therapy	3,123	0.8
Other	2,349	0.5
Total	386,416	

TABLE 6. CONDUCT OF IN VITRO NUCLEAR MEDICINE PROCEDURES (65 ACADEMIC CENTERS)

	Thyroid	Immunoassay
Done by nuclear medicine	36	15
Minority done by others	6	5
Majority done by others	10	10
Zero procedures listed	13	35
Total procedures/yr— 65 centers	111,865	38,448
% performed by nuclear medicine divisions	82%	39%

TABLE 7. FACULTY TIME IN NUCLEAR MEDICINE

	Average hr/wk	
Activity	Division head	Other physicians
Clinical, related to nuclear medicine	13	17
Clinical, not related to nuclear medicine	3	3
Research	8	9
Undergraduate teaching	2	1
Residency, formal teaching	4	6
Technician, formal teaching	1	1
Clinical conferences of department	3	3
Administration of nuclear medicine	8	3
Extra-institutional medical activities	3	1
Total	45	44
No. of divisions	66	41
No. of individuals	66	75

son, relatively few hematological, renal, pulmonary, and in vitro immunoassay procedures are carried out and the number of therapeutic procedures is extremely small.

At the time of the survey, marked differences were apparent in the performance of in vitro procedures in various institutions (Table 6). Twenty percent of these academic divisions were not performing any in vitro thyroid tests and over half were not performing immunoassay procedures. It appeared that the majority of in vitro thyroid tests were being performed by the nuclear medicine divisions, whereas the majority of the immunoassay tests were being performed elsewhere in these medical centers.

The distribution of the academic physician's time in nuclear medicine in the performance of clinical duties, research, teaching, and other activities is listed in Table 7. There was little difference in the distribution of time between division heads and other physicians in academic centers, except for a reduction in the clinical time and corresponding increase in time for administration. Apparently the average physician in academic nuclear medicine spends approximately one-third of his time in clinical nuclear medicine, about one-sixth of his time in research, about one-quarter time in teaching, and the remaining one-quarter time in other activities.

RESIDENCY TRAINING IN NUCLEAR MEDICINE

At the time of the survey, the details of the requirements for certification by The American Board of Nuclear Medicine were apparently not well known by many of the responders but have since been published (*6*). In the initial 5-year period, four different "alternative training requirements" will provide a rather broad qualification of candidates to take the written examination in nuclear medicine. After June 1976 candidates will be required to fulfill the postdoctoral training requirements for certification (Items C, D, and E, Ref. *6*). In essence, the first 2 years of "preparatory postdoctoral training" may be in approved programs in internal medicine, approved residency programs in anatomic or clinical pathology, or a clinical internship (or its equivalent) plus 1 year in an approved residency in radiology, as specified by one of the three sponsoring Boards. Thereafter, a 2-year formal residency in nuclear medicine is required which must include a minimum of 18 months in clinical nuclear medicine plus training in allied sciences. Two years of total patient care responsibility is a specified requirement. In the questionnaire, the responders were invited to approve or disapprove and comment on certain "essentials of training."

There was greatest agreement that the period of training in nuclear medicine itself should be 2 years, and second, that the total duration of residency training be 4 years (Table 8). Nonetheless, six responders favored a total training period of 3 years. Several expressed preference for a "double certification" program of 5 years (3 years of either radiology or internal medicine plus 2 years of nuclear medicine).

TABLE 8. ESSENTIALS OF TRAINING FOR PHYSICIANS IN NUCLEAR MEDICINE (69 REPLIES)

	Approval	Disapproval
Total 4 years residency after M.D. degree	58	11
Minimum 1 year "bedside" residency	56	13
Second year residency internal medicine, radiology, or clinical pathology	49	20
Last 2 years in nuclear medicine	61	8
Equivalent of 6 months of last 2 years in "basic sciences" related to nuclear medicine	51	18

TABLE 9. "IDEAL" RESIDENCY—PRELIMINARY TRAINING

	None	3 mo	6 mo	1 yr	2 yr	Total responses
Mandatory "bedside" residency	9	—	—	52	7	68
Additional internal medicine residency	28	9	11	19	2	69
Diagnostic radiology residency	12	7	19	21	7	66
Clinical pathology residency	30	16	9	7	4	66

2–3 mo residency rotations: Yes—51 No—16
Neuroradiology: 42 Endocrinology: 42 Hematology: 34
Clinical Pathology: 22 Pulmonary: 4 Nephrology: 3
Neurology and Neurosurgery: 3

TABLE 10. "IDEAL BASIC SCIENCE" TRAINING (45 RESPONSES)

	No. of hours		
	Mean	Usual range	Extreme range
Lectures	142	50–150 (27 centers)	30–360
Laboratory	92	0–100 (33 centers)	0–510
Total	234	50–250 (30 centers)	42–720

TABLE 11. IDEAL "BASIC SCIENCE" TRAINING

	No. of responses (total 68)		
	Mandatory	Optional	Not needed
Nuclear instrumentation	66	2	0
Nuclear physics	63	3	2
Radiopharmaceuticals	62	6	0
Radiation dosimetry	60	7	1
Radiation biology	57	11	0
Health physics	53	14	1
Biostatistics	44	24	0
Radiology physics	39	24	5
Electronics	20	46	3
Computer programming	10	52	6

Some differences of opinion were expressed on what constitutes a satisfactory bedside residency during the first year. The requirements for this first year might change, in view of the mandated disappearance of the free-standing internship by 1975. The majority of responders apparently believed that in the first preparatory postdoctoral year the resident must have direct patient care responsibility in such clinical services as internal medicine or surgery whereas a minority felt that a residency in radiology or clinical pathology should constitute a satisfactory first-year of training. The feature which provoked the greatest disagreement was the nature of the second year of training. The majority of responders apparently believed that the content of the second postdoctoral year of residency should be completely optional and left up to the individual resident while others believed that these residents should rotate through a combination of diagnostic radiology, internal medicine, and/or clinical pathology. There was controversy also in the length of time the trainee should spend in the basic sciences related to nuclear medicine.

In commenting on the nature of the first 2 years of residency in an "ideal" program as opposed to minimal requirements for certification, the majority of responders favored a period of mandatory "bedside" residency of 1 year's duration (Table 9). However, there was again considerable conflict of opinion as to the constitution of the second year in an "ideal" program. Many favored rotations through certain clinical services which are more closely related to nuclear medicine, such as neuroradiology, endocrinology, hematology, and clinical pathology. A few desired rotations in oncology, cardiology, and pulmonary services.

Wide variations were given on the duration of training in the basic sciences related to nuclear medicine in an "ideal" program, as shown in Table 10. The time allotment for this basic science teaching could be distributed in any fashion throughout the 2-year period of residency in nuclear medicine. The average preferred duration was 234 hr, 40% of which would be spent in laboratory exercises and 60% in lectures. This total time is roughly equivalent to 6 weeks of full-time training and is obviously much shorter than the 6-month "limit" of the American Board of Nuclear Medicine. Even the plan of the medical center which proposed that the longest program for basic science training be (720 hr) still falls considerably short of 6 months. Furthermore, several program directors stated that they were unable to fulfill their more modest plans for basic science training because of the small size of their faculty.

Eight different subjects in "basic science" were listed as mandatory requirements by the majority of responders. These are listed in their probable order of importance in Table 11. The majority also believed that additional instruction in electronics and computer programming should be optional. A minority expressed the need for instruction in mathematics (in addition to biostatistics) and a review of physiology, particularly of the heart, lung, kidney, nervous, and endocrine systems. The distribution of time between laboratory exercises and lectures in

various subjects in an "ideal" training program is given in Table 12.

There was reasonable agreement among the various program directors about the distribution of the trainees' time in learning the clinical procedures in the last 2 years of the residency program (Table 13). Virtually all agreed that the greatest emphasis should be placed on the conduct of imaging procedures and their interpretation. It is interesting to note, however, that the proportion of time and training devoted to therapeutic applications is more than ten times the actual distribution of radioisotopic therapy procedures in academic departments (Table 5).

Most academic centers of nuclear medicine wished to include an optional period of research training of 3–6 months in their "ideal" nuclear medicine residency and sixteen division heads believed that such research training should be mandatory (Table 14).

Most responders to the questionnaire believed that a maximum ratio should be established between the number of physician trainees in nuclear medicine and the physician staff. The mode for this maximum ratio was 3:1 whereas the mode for an "ideal" program was 2:1 (Table 15).

TABLE 12. IDEAL "BASIC SCIENCE" TRAINING (44 RESPONSES)

Subject	No. of hours: Lecture Mean	Lecture Usual range	Lecture Extreme range	Laboratory Mean	Laboratory Usual range	Laboratory Extreme range	% without lab training
Nuclear physics	22	10–30	0–75	13	0–15	0–96	39
Radiopharmaceuticals	21	10–25	0–100	16	10–30	0–72	20
Nuclear instrumentation	18	10–25	4–36	21	10–36	0–96	7
Radiology physics	16	10–20	0–50	5	0–5	0–25	57
Radiation biology	14	5–20	0–72	3	0–8	0–24	70
Biostatistics	12	5–15	0–108	5	0–10	0–30	55
Radiation dosimetry	10	5–15	0–40	3	0–5	0–24	64
Computer programming	10	2–10	0–54	9	0–20	0–60	43
Health physics	9	3–10	0–30	5	0–10	0–24	46
Electronics	9	0–10	0–36	8	0–10	0–60	41

TABLE 13. "IDEAL" TWO-YEAR RESIDENCY IN CLINICAL NUCLEAR MEDICINE (64 RESPONSES)

	Avg % time
Imaging procedures and interpretation	50
Diagnosis of thyroid diseases	15
Diagnosis of hematological diseases	10
Other diagnostic studies	15
Therapy of thyroid diseases	6
Therapy of other diseases	4

TABLE 14. RESEARCH IN TWO YEARS OF "IDEAL" NUCLEAR MEDICINE RESIDENCY PREFERENCE FOR RESEARCH TRAINING (70 RESPONSES)

None: 2 Optional: 52 Mandatory: 16

Research time	No. of responses
None	2
3 months	17
3 to 6 months	3
6 months	30
6 months to 1 year	3
9 months	3
1 year	3
Over 1 year	1
Total	62

TABLE 15. PHYSICIAN TRAINEE-TO-STAFF RATIO IN NUCLEAR MEDICINE

	(No. of responses) 1:2	1:1	2:1	3:1	4:1	6:1	Total responses
Maximum ratio	0	2	22	27	11	1	63
Ideal ratio	1	13	43	6	3	0	66
Radiology resident-to-staff ratio							
Maximum ratio	1	1	22	18	7	1	50

TABLE 16. DIAGNOSTIC AND THERAPEUTIC RADIOLOGY RESIDENTS' ROTATION THROUGH NUCLEAR MEDICINE (NO. OF RESPONSES)

Continue—Yes: 43 No: 25
Optional additional time—Yes: 65 No: 4
Total time 6 mo: 19 1 year: 37

Other residents' and fellows' rotation through nuclear medicine
Yes: 64 No: 4
Total time 1–3 mo: 17 3 mo: 29 Over 3 mo: 15

NUCLEAR MEDICINE TRAINING OF RADIOLOGY RESIDENTS

The majority of division heads in nuclear medicine favored the continuation of rotations of both diagnostic and therapeutic radiology residents through the nuclear medicine clinical service, usually for a

TABLE 17. MEDICAL STUDENT TEACHING IN NUCLEAR MEDICINE (66 CENTERS)

	(No. of teaching hours/yr)					
	Actual			Ideal		
	Mean	Range	No. with zero hr	Mean	Range	No. with zero hr
Lectures	6	0–30	10	14	0–50	1
Seminars	13	0–100	12	21	0–200	13
Tutorials	10	0–144	29	23	0–320	26
Total	29	—	3	58	—	0

TABLE 18. TECHNOLOGY TRAINING PROGRAMS (71 RESPONSES)

No. of centers		Type of training		Length	
Established	37	On-the-job only	4	1 yr	25
Planned	16	Lectures & labs	49	2 yr	6
Desired	15	AAS	17	2 weeks to	
Not needed	3	B.Sc.	2	4 months	6

Lecture hours—average 218 range 8–820
Number of students—174 in 37 established programs. Average 4.7 per program.

TABLE 19. SPACE IN NUCLEAR MEDICINE

		Present survey (66 responses)	1971 SCARD survey	
			Clinical	Research
Present area (gross sq ft)	mean	3,828	2,550	1,830
	median	2,700	2,000	500
	range	540–14,300	1,000–8,500	200–8,500
Total space "needed" (gross sq ft)	mean	7,343	7,400	3,200
	median	5,900	6,500	2,000
	range	2,197–20,600	1,000–20,000	500–10,000

period of 3 months. Moreover, they favored optional additional training for these residents up to a total time of 6 months or 1 year (Table 16). There was also an almost universal interest in attracting residents or fellows from other services into the nuclear medicine rotation. At the same time, many program directors stated that they already had an excessive number of 3-month trainees and favored a maximum resident-to-staff ratio of 2 or 3 to 1.

MEDICAL STUDENT TEACHING IN NUCLEAR MEDICINE

In 66 medical schools, all except three had some undergraduate instruction in nuclear medicine for medical students (Table 17). The format of this instruction varied from one center to another. Some programs emphasized lectures whereas others preferred seminars or small group tutorials. The actual numbers of teaching hours per year in nuclear medicine was very small (mean, 29 hr) and the majority of centers would like to double this teaching time. In addition, about 85% of the medical schools had electives available in nuclear medicine, of which 62% were part of an elective program in radiology. An average of ten medical students per year took an elective in nuclear medicine. Only about one-third of the reporting institutions used special audiovisual aids for nuclear medicine teaching.

It will be noted that the average of 29 teaching hours per year for the medical students shown in Table 17 is somewhat inconsistent with the greater amount of time for undergraduate teaching listed in Table 7. In the SCARD survey of 1972, the number of hours per year devoted to undergraduate education in radiology averaged 725 (median 500 hr). From this information, it would appear that the time for teaching medical students nuclear medicine represented only about 5% of the teaching time of radiology. From the same survey, 96% of medical schools had an elective in radiology and 25% had a required clerkship in radiology.

NUCLEAR MEDICINE TECHNOLOGY TRAINING

Only 37 centers in this survey had established training programs for nuclear technologists although such programs were being planned in an additional 16 institutions (Table 18). The small total number of 174 students in these ongoing programs explains the manpower shortage in nuclear medicine technology. Twenty-five out of the 37 established programs are 1 year in duration. Of 53 technology training programs which are either established or being planned, four are limited to "on-the-job" experience whereas the majority have or will have lecture and laboratory sessions. The average number of lecture hours existing or being planned is 218. Seventeen institutions have more formalized training programs leading to an AAS degree and two institutions have a bachelor of science program. One of these two institutions has two parallel training programs, one leading to an associate degree and the other leading to a bachelor's degree.

SPACE AND EQUIPMENT

The total space allocated to nuclear medicine in 66 institutions is shown in Table 19. The figures obtained in the present survey were compared with those of the 1971 SCARD survey since space was not considered in the more recent 1972 survey of

SCARD. Differences will be noted between the two surveys, probably because the same institutions were not included in the two studies. Both surveys reveal, nonetheless, that nuclear medicine directors believe that more than twice the existing space is "needed" to adequately accommodate existing activities. In the SCARD survey, research space was considered separately from clinical space and represented about 40% of the total space allocation. According to this 1971 study, the number of clinical diagnostic rooms for nuclear medicine averaged 5.5 (median 5).

The relationship between space requirements in nuclear medicine and the number of clinical procedures is shown in Table 20. In existing facilities, about 2–2.5 clinical nuclear medicine procedures are performed per gross square foot per year but a wide range is apparent among different institutions. If in vivo procedures alone are considered, this variation is considerably less. About 1.4–1.7 in vivo clinical procedures may be performed per gross square foot per year. For an "ideal" facility in nuclear medicine, the responders to the questionnaire would require considerably more space (0.7–1 procedure per gross square foot year year or 0.5–0.75 in vivo procedures per gross square foot per year). Using these values, a facility would have sufficient space for research, teaching, and clinical activities. The space requirements for academic nuclear medicine, in relation to the number of clinical procedures, are considerably greater than for academic radiology. Thus, in previous SCARD surveys, the "ideal" space requirement for radiology averages about 2.5 procedures per square foot per year.

Only major equipment items in nuclear medicine were considered in this survey. The numbers of imaging devices of various types in 70 academic centers are listed in Table 21. It would appear that a typical academic center in 1972 had two rectilinear scanners and two scintillation cameras available for imaging studies. The frequency of distribution of other types of special equipment is provided in Table 22.

TABLE 20. SPACE IN NUCLEAR MEDICINE, IN RELATION TO CLINICAL PROCEDURES

		Present survey (66 responses)	1971 SCARD survey
Actual	mean	2.46	2.0
Procedures/	median	1.97	2.25
gross sq ft/yr	range	0.31–9.95	0.5–3
In vivo procedures/	mean	1.66	1.34
gross sq ft/yr	median	1.44	—
	range	0.25–5.8	—
"Ideal"	mean	1.05	approx 0.7
Procedures/	median	0.78	—
gross sq ft/yr	range	0.25–3.13	—
In vivo procedures/	mean	0.72	approx 0.5
gross sq ft/yr	median	0.75	—
	range	0.21–1.83	—

TABLE 21. NUMBER OF IMAGING DEVICES IN 70 ACADEMIC CENTERS

Scanners		Cameras	
3 in.	72		
5 in.	48	Anger	131
8 in.	2	Other	10
Other	14		
Total	136	Total	141

TABLE 22. SPECIAL EQUIPMENT IN 70 ACADEMIC NUCLEAR MEDICINE CENTERS

	% of institutions with equipment
Multiprobe system	77
Automatic gamma counter	69
Videotape	59
Multichannel analyzer	56
Liquid scintillation counter	54
Spirometer	53
Computer dedicated to gamma camera	50
Automatic film processor	46
Computer, other	34
Radiographic equipment	30
Total-body counter	24
Tomography	21

ADMINISTRATIVE ORGANIZATION OF NUCLEAR MEDICINE

From Table 23 it can be seen that the number of division heads who favor the establishment of nuclear medicine as an independent department slightly exceeded the number who favor continuance of nuclear medicine as a division of radiology. Other administrative arrangements for nuclear medicine were favored by only a few responders. At the time of the survey, nuclear medicine was organized as an independent department in only one medical school. Four division heads were also chairmen of radiology departments, and none of these favored the separation of nuclear medicine. Table 23 demonstrates also that this preference is influenced by the background specialty of the division head. Those with internal medicine training tended to favor creation of an independent department more than those with backgrounds in radiology. Several of those favoring the continuance of nuclear medicine as a part of radiology believed that at the present stage of development of nuclear medicine, independence would be

TABLE 23. PREFERENCE FOR ADMINISTRATIVE ORGANIZATION OF NUCLEAR MEDICINE

		Background of division head		
		Radiology	Medicine	Other
Independent department	32	11	17	4
Division of radiology	29	21	7	1
Div. of internal med.	3	0	3	0
Div. of clin. path.	2	0	0	2
Other	2	1	0	1
Total response	68			

TABLE 24. SUMMARY OF MAJOR PROBLEMS IN ACADEMIC NUCLEAR MEDICINE ELICITED IN SURVEY (68 RESPONSES)

	No. of times listed	Primary problem
Shortage of space	44	19
Shortage of staff	21	14
Low physicians' salaries	19	7
Shortage of N.M. trainees	28	5
Better equipment	27	4
Jurisdiction of in vitro tests	3	1
Shortage of technicians	13	0
Lack of undergraduate teaching	11	0
Low general funding	5	0

"premature" and "unrealistic", but may be feasible in the future.

The principal reasons cited for desiring an independent department were (A) better communication wtih hospital and medical school administrators and improvement of administrative delays by more direct communication; (B) to overcome the excessive polarization of interest in nuclear medicine toward radioisotopic imaging and permit a greater diversification of tracer applications in other medical disciplines; (C) improvement of support for nuclear medicine activities which in many institutions are now subservient or secondary to the needs in diagnostic and therapeutic radiology; (D) to obtain a more direct voice in academic policy and undergraduate curriculum changes; (E) the "ideal" training for residents in nuclear medicine should be distinctly different from that of radiologists. The reasons most commonly given, on the other hand, for remaining as a part of radiology were (A) the close relationship between radioisotopic and radiographic imaging and the interdependence of imaging and radiographic abnormalities in rendering diagnostic interpretations; (B) the sharing of support personnel in health and radiological physics, engineering, radiation biology, and computer programming and the sharing of facilities such as machine shop and electronics maintenance laboratories; (C) the current lack of sufficient faculty members in nuclear medicine to carry out essential educational programs, particularly in the basic sciences related to nuclear medicine; (D) the inability of some nuclear medicine divisions to attain financial independence; and (E) the separation of relatively small faculty groups, such as those in nuclear medicine, into many separate departments increases the complexity of the central administration of the medical school and teaching hospital. Three directors believed nuclear medicine should remain a division of internal medicine because this is generally the strongest department within the medical school. They also thought a complete residency, including nuclear medicine and "bedside experience", could then be offered within a single department.

MAJOR PROBLEMS IN ACADEMIC NUCLEAR MEDICINE

In the last section of the questionnaire, the heads of academic nuclear medicine programs were requested to list their major problems and to identify one as their most serious problem. These data are listed in Table 24. It is evident that in 1972 the shortage of space was identified as the most frequent and most serious problem in academic nuclear medicine. This may be attributed to the rapid scientific advances and increasing clinical utilization of nuclear medicine procedures. The annual increase in clinical procedures in this survey, as estimated in 66 institutions, had a mean value of 23% (median and mode, 15%). In the NACOR report of April 1966 (*1*) the annual growth rate in nuclear medicine procedures was estimated to be at least 15% per year. The shortage of space in nuclear medicine may be attributed also to its relatively recent status as an essential medical service. Its emergence was not anticipated in the planning of many hospitals so that space provided later for its expanding activities by reallocation and renovation has frequently proven inadequate.

Other important problems revealed by the survey included the shortage of staff members, low physician salaries, a shortage of nuclear medicine trainees, and inadequate equipment.

DISCUSSION

It should be recognized that the present survey was limited in scope and covered only certain aspects of academic programs in nuclear medicine in U.S. medical schools. Much of this information will not apply to general hospitals. There is a need for a more inclusive study of facilities and personnel in general

hospitals to establish guidelines for the development of clinical services because little data have been published on this subject since the phase of rapid growth of nuclear medicine. In contrast, definitive information of this type has been available in the fields of diagnostic and therapeutic radiology since at least 1951 (*7*). Certain recommendations on the conduct of radioisotopic cardiovascular procedures have recently been reported (*8*).

The present study reaffirms the shortage of trained academic physicians in nuclear medicine as indicated in a 1971 report of the National Institutes of Health (*9*). In 1972 about one-third of U.S. medical schools had either no physicians in nuclear medicine, or a solitary physician: this is inconsistent with the maintenance of a continuous clinical service, neglecting teaching and research activities. The data from other surveys suggest that the staffing of academic nuclear medicine is slowly improving. In 1967 (*2*) there were only 84 faculty members in nuclear medicine in 78 university hospitals, representing 12% of the total physician faculty in departments of radiology. In 1972 (*3*) nuclear medicine physicians represented 15% of the total physician faculty in radiology.

The survey revealed that the shortage of space was the most serious factor inhibiting the development of nuclear medicine programs in academic centers. The staffing needs for professional, technical, and support personnel and space requirements were shown to be significantly different from other disciplines, including diagnostic radiology.

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