Identification and Ranking of Stressors in Nuclear Medicine Technology

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This study was performed to identify the most significant stressors in the field of nuclear medicine technology. Sixty-three randomly selected nuclear medicine technologists responded to a questionnaire which asked them to assess the relative stressfulness of each of 35 items on a scale of "0 to 1000". Data from 59 valid responses indicated that equipment malfunctions, add-on exams, uncooperative physicians, lack of staff, and uncooperative patients were the most significant stressors. Pooled variance t-tests indicated 14 significant mean differences between demographic subgroups within the composite instrument. Gender, job title, and years of experience were areas of greatest difference. The reliability of the stressor ranking questionnaire, as determined by Cronbach's alpha, was 0.87. Results of this study may be used by hospital administrators, supervisors, and technologists to identify stressors in the nuclear medicine department. Once identified, efforts can then be directed towards the management of these stressors.

Stress has been defined as "the nonspecific response of the body to any demand made upon it" (*1*). An essential part of life, stress may produce both positive and negative responses. In Selye's General Adaptation Syndrome Theory, the body adapts to the stresses of everyday life through a series of neural and hormonal changes in an attempt to maintain homeostasis, a "healthy" balance of structure and function (*2*). When stimulation or stress exists which exceeds the body's ability to cope, both psychologic and physiologic illnesses may occur (*3*). Stress-induced diseases may include coronary heart disease, asthma, colitis, ulcers, hypertension, alcoholism, depression, suicide, anxiety, drug abuse, sexual dysfunction, mental ill health, stomach pains, arrythmias, insomnia and nausea (*4–8*). An individual's perception of stress plays a large role in his reaction to that stress. Individuals react in terms of their own cognitive, personality and behavioral characteristics to life's stresses. Some individuals "thrive" in stressful environments, while others cannot function under similiar conditions.

Since a considerable portion of one's life is spent at work, occupational stress and its relationship to illness has been the subject of much research (*9–23*). A National Institute of Occupational Safety and Health (NIOSH) study examined the relationship between job stress and worker health and found that hospital and health care occupations had the highest incidence of stress-related disease of the 130 occupations studied (*21*). The consequences of stress-induced illness can include increased absenteeism, decreased productivity, and increased health care costs (*8*). Moreover, stress-induced "burnout" of health professionals can lead to increasing numbers of individuals leaving the field altogether, exacerbating the current personnel shortages in many allied health care fields (*22*).

To document the link between job stress and illness, the identification of specific stressors, or events which cause or elicit stress reactions, is of interest to all health care providers and administrators. The major sources of stress for those employed in the health care industry are as diverse as the fields themselves, although five general areas have been identified: (a) work content; (b) work organization; (c) responsibility; (d) role conflict/ambiguity; and (e) career development (*4, 6, 7, 9, 15*).

While researchers have attempted to identify the specific stressors in the fields of nursing (*15*), respiratory therapy (*18*), radiography (*3*), medical records administration (*16*), physical therapy (*17*) and medical technology (*19*), very little information exists concerning the stressors found in the field of nuclear medicine technology (NMT), a relatively new area of diagnostic imaging. Hospitals are faced with a shortage of qualified nuclear medicine technologists (NMTs) for a number of reasons: (a) a decrease in the number of schools training NMTs, due to the closing of many hospital-based programs, and (b) a nationwide decrease in the enrollments in existing NMT schools (*23*). Hospitals must not only attempt to locate and hire new technologists to care for their patients but they must, perhaps even more importantly, retain those technologists currently employed.

Thus, the purpose of this study was to identify the work stressors of nuclear medicine technologists, and to determine the relative amount of stress exerted on these professionals by these stressors.

MATERIALS AND METHODS

Two research questions were analyzed in this study:

1. What are the most significant stressors in the nuclear

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medicine technology workplace as perceived by practicing nuclear medicine technologists?
2. What is the relative stressfulness of each of these work site stressors?

Twenty-five nuclear medicine technologists from Virginia, Maryland and Kentucky were each asked to identify five of the most significant stressors they encountered in the workplace as practicing nuclear medicine technologists. The sample included technologists from four hospitals in the Tidewater area of Virginia and from two hospitals in Lexington, Kentucky. Technologists attending nuclear medicine technology seminars in Annapolis, Maryland and Richmond, Virginia also completed the initial questionnaire. The responses were listed and then consolidated, yielding a total of 35 items.

For the second part of the study, a sample of 300 technologists, secured from a directory of certified nuclear medicine technologists (CNMTs), was selected using a systematic sampling method of random designation sampling without replacement. The 300 CNMTs were mailed questionnaires asking them to provide magnitude estimations of the 35 stressors previously identified. The technologists were asked to compare each of the 35 stressors listed to an activity common to all nuclear medicine technologists, which the researchers identified as performing a routine bone scan. The technologists were to assign a value between 0 and 1000 to each of the stressors. If a stressor item listed was less stressful than performing a bone scan, the technologist was to rate it between "1 and 499". If the stressor listed was equally stressful as performing a bone scan, it was to be rated as a "500". Items which were perceived as more stressful than performing a bone scan were to be rated between "501 and 1000". If the activity was not considered stressful, the respondent was instructed to record a "0".

This stress assessment methodology has been used to identify stressors and their respective magnitude estimations in a variety of health care environments. Their reliability and construct and concurrent validity had been previously established (*24–27*).

RESULTS

A response rate of 21% was achieved with 49 technologists responding to the initial mailing and 14 technologists reponding to the follow-up questionnaire. Of the 63 responses, four were not filled out, yielding 59 usable responses.

Magnitude Estimations of the Stressors

The initial questionnaire provided 124 possible crude responses which were subsequently consolidated into 35 separate, identifiable stressors. The most stressful items identified were equipment malfunctions (x = 690.833) followed by add-on exams (x = 686.517), uncooperative physicians (x = 680.00), lack of staff (x = 676.271), uncooperative patients (x = 667.00). The least important stressors were being pulled to other departments (x = 188.875), followed by the uncertain future of the NMT field (x = 320.207), teaching students (x = 327.632), patient preparation (x = 374.200), lack of appreciation by the public (x = 383.729). The mean rating on all 35 items was 530.933. The 35 stressors are well dispersed with 15 stressors ranked higher than the mean and 18 ranked lower. From the adjusted ratings it can be seen that the amount of stress attributed to equipment malfunctions (adjusted rating = 100) is essentially twice that of teaching students (adjusted rating = 47). The stressors and their respective magnitude estimations are presented in Table 1.

The amount of variance attributed to each stressor was

TABLE 1. Rank of Stressors in Nuclear Medicine Technology

Rank	Stressor	Rating Mean	Rating Adjusted
1	Equipment malfunctions	690.833	100
2	Add-on exams	686.517	99
3	Uncooperative physicians	680.000	98
4	Lack of staff	676.271	98
5	Uncooperative patients	667.000	97
6	Work load	654.898	95
7	Salary	654.271	95
8	Very ill patients	645.167	93
9	Patients with AIDS	639.583	93
10	Difficult procedures	634.833	92
11	Interruptions	609.767	88
12	Poor communication with physicians	601.593	87
13	Being on call	591.121	86
14	Exposure to diseases	582.633	84
15	Lack of staff cooperation	580.864	84
16	Pediatric patients	553.847	80
17	Paperwork	550.200	80
18	Uncooperative radiologists	524.569	76
19	Lack of equipment	519.155	75
20	Learning new procedures	510.700	74
21	Radiation exposure	507.683	73
22	Scheduling patients	504.117	73
23	Work hours	502.533	73
24	Death of a patient	502.069	73
25	Improperly completed requisition	487.333	71
26	Supervisor pressure	481.267	70
27	Old equipment	453.610	66
28	Lack of cont. education	444.650	64
29	Conflicts with other NMTs	435.186	63
30	Performing quality control	420.867	61
31	Lack of public appreciation	378.200	55
32	Patient preparation	374.200	54
33	Teaching students	327.632	47
34	Uncertain NMT future	320.207	46
35	Pull to another dept.	188.875	27

determined using factor analysis. Principal component analysis without iteration was used to generate those stressors which had eigenvalues greater than unity based upon the mean ratings given to each of the 35 stressors (*28*). Eigenvalues measure the relative importance of a function such that the sum of all eigenvalues measures the total variance existing in the discriminating variables, i.e., the stressors. The top five stressors, all having eigenvalues greater than 2.0, accounted for 49.5% of the variance. The variance signifies the amount of explainable response differences. Those stressors which accounted for the most rating variance were add-on exams, administrative pressure, being on call, being pulled to other departments, and conflicts with other nuclear medicine technologists. The next seven stressors with eigenvalues greater than unity were death of a patient, equipment malfunction, exposure to disease, interruptions, paperwork, learning new procedures, and lack of public appreciation. These seven stressors accounted for 30.1% of the variance. The total amount of variance accounted for by the 12 stressors was 77.0%. A list of the eigenvalues and percent of variance attributed to each stressor is presented in Table 2.

TABLE 2. Principal Component Analysis For Stressors in Nuclear Medicine Technology

Stressor	Eigenvalue	% Variance	Cumulative %
Add-on exams	7.22	20.6	20.6
Administrative pressure	3.44	9.8	30.5
Being on-call	2.56	7.3	37.8
Pull to other departments	2.09	6.0	43.8
Conflicts with NMTs	2.01	5.7	49.5
Death of a patient	1.83	5.2	54.7
Equipment malfunction	1.70	4.9	59.6
Exposure to diseases	1.46	4.2	63.8
Interruptions	1.27	3.6	67.4
Improperly completed forms	1.21	3.5	70.8
Learning new procedures	1.15	3.3	74.1
Lack of public appreciation	1.01	2.9	77.0
Lack of staff support	0.92	2.6	79.6
Lack of continuing ed.	0.83	2.4	82.0
Lack of equipment	0.69	2.0	84.0
Lack of staff	0.65	1.8	85.8
Patients with AIDS	0.56	1.6	87.4
Pediatric patients	0.54	1.5	88.9
Radiation exposure	0.49	1.4	90.3
Old equipment	0.46	1.3	91.6
Paperwork	0.42	1.2	92.8
Patient preparation	0.36	1.0	93.9
Difficult procedures	0.33	0.9	94.8
Performing QC procedures	0.30	0.8	95.6
Poor comm. with physicians	0.25	0.7	96.4
Salary	0.22	0.6	97.0
Scheduling patients	0.21	0.6	97.6
Teaching students	0.18	0.5	98.1
Uncertain NMT future	0.15	0.4	98.5
Uncooperative patients	0.13	0.4	98.9
Uncooperative physicians	0.12	0.4	99.2
Uncooperative radiologists	0.09	0.3	99.5
Working with very ill	0.08	0.2	99.7
Work hours	0.05	0.1	99.9
Work load	0.04	0.1	100.0

Pooled variance t-tests indicated 14 significant mean differences within the composite instrument. Gender, job title, and years of experience were the areas showing the greatest differences. Other areas with significant differences were marital status, hospital size and lack of call duty. A listing of the 14 significant mean differences is presented in Table 3.

Instrument Reliability

The internal consistency for the 35 stressors, as measured by Cronbach's alpha (*29*), was 0.87. Novick and Lewis (*30*) noted that coefficient alpha is the average value of the alpha coefficients created by all the possible combinations of questionnaire items divided into hypothetical half-tests. Alpha coefficient values range from 0.00 to 1.00. An alpha value of 1.00 would indicate the most reliable instrument. Carmines and Zeller (*31*) stated that alpha values must be greater than 0.80 for a scale to be considered sufficiently reliable for wide usage.

Demographics

The respondents were 65.5% female (n = 38) and 34.5% male (n = 20). One respondent did not fill in a response. Thirty-six (61.0%) of the respondents reported that they worked in a nuclear medicine department which employed

TABLE 3. Significant Demographic Subgroup Mean Differences

Stressor	Group	t	df	Sig.
Equipment malfunctions	1/3 vs. 4/6 yr experience	−3.85	16	0.001
Pull to other departments	Hospital vs. Other	−3.08	51	0.003
Difficult procedures	Staff vs. Chief Tech	2.77	48	0.008
Being on call	No call vs. Every week	−2.92	20	0.009
Work load	Male vs. Female	−2.71	55	0.009
Patient preparation	Hospital vs. Other	2.62	55	0.011
Paperwork	Staff vs. Chief Tech	−2.49	48	0.016
Work load	Married vs. Single	2.43	49	0.023
Scheduling patients	1/3 vs. 4/6 yr experience	−2.46	16	0.026
Uncooperative patients	200–300 vs. 300–400 beds	−2.20	17	0.029
Add-on exams	1/3 vs. 4/6 yr experience	−2.29	16	0.036
Paperwork	Male vs. Female	2.15	56	0.036
Difficult procedures	200–300 vs. 300–400 beds	−2.38	17	0.042
Performing QC procedures	Staff vs.Chief Tech	−2.02	48	0.049

four or less NMTs. Eighteen (30.5%) technologists reported that they took no emergency call, while 41 (69.5%) reported taking some amount of call, ranging from every week (10.2%) to every sixth week (5.1%). The majority of the respondents (87.9%) reported that they worked in a hospital or medical center, while only six (10.2%) reported working in an outpatient clinic. Hospital size was assessed according to the number of beds the hospital or medical center possessed. Of the 52 respondents who indicated the number of beds at their institution, 11 (21.2%) reported a size of 100 to 199 beds, 8 (15.4%) with 200 to 299 beds, 11 (21.2%) with 300 to 399 beds, 4 (7.7%) with 400 to 499 beds, 6 (11.5%) with 500 to 599 beds, 1 (1.9%) with 600 to 699 beds and 11 (21.2%) with greater than 700 beds. Technologist experience was assessed via years of experience in the field. Ten respondents (16.9%) reported as having 1–3 yr of nuclear medicine technology experience, eight (13.6%) reported 4–6 yr, nine (15.3%) stated they had from 7 to 9 yr experience, 10 (16.7%) had 10 to 12 yr, and 11 (18.6%) reported having between 13 and 15 yr of experience in the field. The remaining eight respondents (13.6%) had 16 or more years of experience in nuclear medicine technology.

Seventeen (28.8%) technologists were from 21 to 29 years of age, 23 (39.0%) were from 30 to 38 years of age, and 19 (32.2%) reported an age greater than 39. With regards to marital status, 18 of 58 technologists (31.0%) claimed to be single, 34 (58.6%) reported they were married, and 6 (10.3%) were divorced. Thirty-seven of the respondents (62.7%) classified themselves as staff technologists, while 17 (28.8%) reported that they were either senior or chief technologists. One respondent (1.6%) indicated "administrator" as current job title, one respondent marked "educator", and one questionnaire was blank on this item.

The characteristics of gender, worksite, number of years of experience and job title for these respondents are comparable to those of NMTs as a group as reported in a recent survey published by the Nuclear Medicine Technology Certification Board (NMTCB) (*32*). The majority of the technologists (91.4%, n = 53) who responded indicated they worked on a full-time schedule, and five (8.6%) indicated they worked part-time. The largest number of respondents earned between $24,000 and $27,999, with 20 individuals (33.9%) reporting this salary range. Eight individuals (13.6%) earned less than $24,000 per year. Seven respondents (11.9%) reported earning between $28,000 to $31,999, twelve (20.3%) between $32,000 and $35,999, and 12 (20.3%) earn more than $36,000 per year.

Concerning the academic preparation of the respondents, 39 individuals (66.1%) reported that they held certificates in nuclear medicine technology, 11 (18.6%) noted that they had an associate's degree in the field, and nine (15.2%) reported a bachelor's degree in nuclear medicine technology. Six respondents (10.2%) reported that on-the-job training was their primary education in nuclear medicine technology. While six (10.2%) of the respondents held only the certification from the NMTCB, 22 (37.3%) held the NMTCB certification as well as the American Registry of Radiologic Technologists (ARRT) radiographic subgroup certification. Twenty-three technologists (39.0%) held the NMTCB as well as the ARRT(N) nuclear medicine subgroup certification. Four technologists (6.8%) held the NMTCB as well as both ARRT subgroup certifications.

DISCUSSION

The purpose of this study was to identify and rank the worksite stressors in nuclear medicine technology. Research into occupational stress has, by and large, overlooked nuclear medicine technology, with the closest research dealing with radiographers or medical technologists. The 25 technologists who completed the stressor identification questionnaire voluntarily participated and provided anonymous information. The technologists who provided the 59 completed ranking questionnaires were randomly selected, participated voluntarily and remained anonymous throughout the study.

The low response rate (19.6%) was in part due to late mailings of both the initial and follow-up questionnaires. Use of the t-test was performed since the sample size was so small and none of the conditions for its use were violated (*33, 34*). A review of the ten most significant stressors reveals that NMTs are primarily affected by activities which are considered part of the work content. Add-on exams, equipment malfunctions, uncooperative patients, salary, very ill patients, AIDS patients, and performing difficult procedures represent seven of the top ten stressors. Since these stressors are inherent in the occupation, it is imperative that educators in the field be aware of and acknowledge these job characteristics to those individuals considering nuclear medicine technology as a career. Completing the list of the ten most significant stressors are two stressors from the work organization area, lack of staff and work load, and a role conflict stressor, uncooperative physicians. It was expected that the stressor "being on call" would rank higher than thirteenth. The stressor "uncooperative radiologists" ranked relatively low on the stress scale (18th), while in Shulruff's (*19*) study of medical technologists, pathologists were major causes of job stress. This study, as well as Shulruff's, identified equipment malfunction as the top stressor. Polworth's (*3*) study of radiographers, the most closely related occupational field to nuclear medicine technology, revealed that stressors related to values systems (role conflicts, responsibilities, role ambiguities, lack of appreciation) were the most significant factors contributing to job stress. As mentioned previously, work content stressors were ranked most significant in nuclear medicine technology. Many items may have been rated low because relatively fewer technologists experienced the stressor. A technologist who does not teach or is not subject to being pulled to another imaging department is not likely to rank those particular stressors very highly. Despite recent increases in technologist compensation nationwide, salary was identified as one of the top ten stressors. Twelve stressors were identified as accounting for 77.0% of the variance for the composite instrument. The amount of variance attributed to the items falling at the bottom two-thirds of the list of stressors are those items which the respondents found more uniformly stressful or not stressful, without much variation between raters. Since the largest amount of the overall variance can be accounted for by the first 12 stressors, future rating scales can be shortened.

In conclusion, to adequately address occupational stress, the identification of those events which are perceived most stressful by individuals working in the field is an important first step. This research was performed to identify the most significant stressors in nuclear medicine technology. Administrators, managers, supervisors, and technologists may use this information as part of their efforts to identify, manage, reduce, and prevent stress in their nuclear medicine departments.

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