Swift Journals

Swift Journal of Medicine and Medical Sciences
Vol 2(4) pp. 0039-044 August, 2016.
http://www.swiftjournals.org/sjmms
ISSN: 2986-9803

Original Research Article

Assessment of Radiation Emergency Preparedness in Nuclear Medicine

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Accepted 2nd August, 2016.

ABSTRACT

Radiological accidents can have a lasting impact on public health. Because of the increasing risk of radiological emergencies, public health agencies and first-response organizations are working to increase their capability of responding. Nuclear medicine technologists (NMTs) have expertise in certain areas, such as radiation safety, radiobiology, decontamination, and the use of radiation detection and monitoring equipment, that could be useful during the response to events that involve radiological materials. Medical staff and worker personnel in the nuclear medicine department and in other department using radioactive materials needs to increase their knowledge about how to deal safely with the equipment, early and late hazards of exposure to radiation, and how to save patients and themselves from radiation exposure or from contamination to a radioactive substance. The purpose of this study was to assess the willingness and knowledge of NMTs, medical staff and an emergency medical response team to participate in radiological emergency preparedness and response operations and to determine what radiation detection, measuring, and imaging equipment they would have access to during an event at their workplace. The study also assessed whether years of work experience or past radiological emergency preparedness training had an effect on the willingness and knowledge. A survey was sent electronically to the 500 members in the Department of Nuclear Medicine and Molecular Imaging in different medical centers, to some laboratory that use nuclear material and to the emergency department in some hospitals. 57 respond to the survey with response rate 11.4%. Survey results suggest that NMTs are having some knowledge and willing to respond to radiological emergencies, regardless of the number of years of work experience. But this knowledge needs more study and exercising. The current study concluded that the initial response to a radiological emergency may include radiation detection, population monitoring, decontamination, and dose assessment. Knowledgeable, willing, and prepared individuals will be needed to assist with a response of this nature. Public health agencies will need to coordinate with NMTs and draw on their expertise and knowledge to strengthen the community's capability of responding to a radiological or nuclear emergency. Public health agencies and first-response organizations are working to build the capacity to respond to emergencies involving radiological materials. It is important that NMTs be included in preparedness efforts. Recommendations regarding the Continuous education programs shall be designed to increase the awareness about the emergency preparedness and response to radiation accident. Increase the alertness between medical worker and staff about the radiation hazards and its safety measures that prevent these hazards. However, International organizations can provide support to other countries in the education programs. Communities must try to increase the ability of the public health system to handle radiological events of any nature.

Keywords: Assessment, radiation emergency preparedness, nuclear medicine.

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INTRODUCTION

All radiation devices in use nowadays are subject to cause serious incidents and accidents, with potential risks in exposed population groups. These risks may have immediate or long-term health implications. Prevention, mitigation, and treatment of the radiation effects are done by anticipating the moment of exposure and by establishing new efforts for investigation of radioprotective products (Lim et al., 2011; Martín et al., 2011). Hospitals should be prepared to respond to potential radiation emergencies as determined by risk assessments based on local and regional radioactive hazards, threats and vulnerabilities. Approach to hospital management of multiple combined radiation injury victims requires attention to casualty triage, decontamination, and prevention of secondary contamination, healthcare personnel radiation safety, trauma care system, medical staff knowledge of radiation-related injuries and availability of pharmacotherapeutic options (Lim et al ., 2011).

The general objectives of emergency response are: (a) To reduce the risk or mitigate the consequences of the accident at its source. (b) To prevent deterministic health effects (e.g. Early deaths and injuries) by taking action before or shortly after exposure and by keeping the public and emergency worker individual doses below the thresholds for deterministic health effects. (c) To reduce the risk of stochastic health effects (e.g. cancer and severe hereditary effects) as much as reasonably achievable by implementing protective actions in accordance with IAEA guidance and by keeping emergency worker doses below the levels established in IAEA guidance (IAEA-TECDOC-1162., 2000).

Medical personnel, particularly NMTs, are a source of radiological expertise that can be utilized during a public health crisis involving radioactive materials. NMTs are a valuable resource because of their knowledge and daily dealings with radioactive materials, and the education of NMTs in health physics, radiation biology, radiation safety, decontamination, and patient care can be helpful during a radiological emergency (Miller et al., 2007; Society of Nuclear Medicine and Molecular Imaging Web site., 2008/2013). NMTs can participate as part of a local radiological emergency response team. In this capacity, an NMT can provide expertise to assist with radiological dose assessments, population monitoring, development of radiological emergency response plans, and determination of the extent of contamination (Miller et al., 2007). NMTs who work in a hospital setting can also serve as a resource to their hospital when it is planning for, and responding to, a radiological emergency.

There is a significant need for training and informational resources tailored to a hospital setting (Becker, 2011), and NMTs can assist in developing these resources and in training hospital staff (Van Dyke et al., 2013). For radiological incidents, Coleman and Lurie (2012) have developed and continue to refine detailed plans and tools for medical responders, which also serve in any type of radiological incident. The plans are based on the best available basic science with the goal of providing planners and responders with just-in-time information and tools. A major consideration in the development of new diagnostics, medical treatment and countermeasures for radiation injury is that of 'dual utility' with potential for routine medical use for cancer care.

The current study aimed to assess the willingness and knowledge of NMTs, medical staff [Doctors & worker personnel in the department using γ-cameras, radiotherapy (teletherapy and brachytherapy), radioisotopic scanning, and radioimmunoassay substance in hospitals, laboratories and radiological centers] and Emergency medical response team to participate in radiological emergency preparedness and response operations and to determine what radiation detection, measuring, and imaging equipment they would have access to during an event at their workplace. The study also assessed whether years of work experience or past radiological emergency preparedness training had an effect on the willingness and knowledge

MATERIAL AND METHODS

A 28-question survey (Appendix) was developed to assess the knowledge about radiological emergency preparedness and willingness to participate in a response to an emergency. The knowledge of radiation protection principles was assessed. Finally, they were asked if they had participated in continuing education in radiological emergency procedures in the last 5 y or other continuing education programs included training on radiological emergency preparedness and response. The survey was distributed in September 2014 and was open for 6 weeks. A reminder email was sent approximately 3 weeks after the start date of the survey. Demographic information, including the license, regional location, years of experience, work setting, work facility preparedness, and recentness of radiation emergency preparedness training was collected. All responses were anonymous. Statistical analyses using Chi-square test was done for detecting the efficacy of experience time on increasing the awareness and knowledge of the responder regarding the radiological emergency preparedness and the radiation protection measures.

RESULTS

There were 57 only who responded to the survey, for a response rate of 11.4%. Table (1) shows the net results of the descriptive data of the survey. Nearly, 88% of the responders are working in Private Center / Hospital. Many of them (43.8%) worked in laboratories & the others in Radiological centers (35.1%) and Hospitals (21.1%). Teletherapy and brachytherapy was the equipment used in 35.1%, Radio-isotopic scanning in 26.3%, Radioimmunoassay substance in 29.8%, and γ-camera in 8.8%.

Seventy nine percent of the respondents in the present study, having radiation protection measures, and 56% of them were using these measures. On the other hand, Survey meter was available in 96.5% of the respondents and 93% were receiving the radiation protection courses. The 22.8% of the respondents, only having information about radiation emergency preparedness, 10.5% of them were found to be aware with its measures. Many of respondents (64.9%) having an emergency plan, but 3.5% only receiving training course within the last 5 years. However, continuing education in radiological emergency preparedness occurs in one responder only. Also, no one having a re-training course or doing scenarios and drills in radiation emergency preparedness within the last 5 years. Additionally, the current study represents a significantly statistical difference regarding the effects of years of experience on increasing the radiological emergency preparedness and the radiation protection knowledge and awareness at the responders (Table 2&3).

DISCUSSION

Medical care providers are expected to provide care to patients because of a multitude of scenarios. One of those scenarios involves the patient who has been exposed to and/or contaminated with radioactive materials. The most important consideration in the medical evaluation of people involved in a radiation incident is the medical stability of the affected individuals. The relative magnitude of the situation and the resources needed to address the emergency are also important considerations. Small-scale incidents are those occurring in laboratories, hospitals, nuclear power plants, etc., involving small amounts of radioactive materials with the potential exposure and/or contamination of one or a few individuals.

Large-scale incidents are those involving relatively large quantities of radioactive materials and the potential exposure or contamination of large numbers of people, e.g., terrorist attacks with radiological weapons, nuclear weapons detonation, and large-scale nuclear power plant disasters. High-level acute external doses of ionizing radiation typically pose the greatest danger to people. Low-levels of internal or external contamination with radioactive material generally poses little risk. As with all emergency response situations, the safety of the responder is a primary concern. A site known to be radiologically contaminated should be assessed before general entry and responders should be advised to limit their time in high-dose-rate areas.

There is minimal risk typically associated with handling a radiologically-contaminated casualty (Radiation Emergency Assistance Center/Training Site REAC/TS., 2013). Radiological and nuclear incidents are low probability but very high-risk events. Measures can be, and have been, implemented to limit or prevent the impact on the public. Preparedness, however, remains the key to minimizing morbidity and mortality. Incidents may be related to hospital-based misadministration of radiation in interventional radiology or nuclear medicine, industrial or nuclear power plant accidents. Safety and security measures are in place to prevent or mitigate such events.

Despite efforts to prevent them, terrorist-perpetrated incidents with, for example, a radiological dispersal devices (RDD) are also possible. Due to a misunderstanding of, or lack of, formal education regarding things in this realm, there can be considerable anxiety, even fear, about radiation-related incidents (Katz et al., 2014). In the current study, the responder was fond of having a radiation protection measures and information. On the other hands, they need to increase the knowledge and awareness regarding the information about the radiation protection measures and radiation emergency preparedness.

However, the study found that the experience and practicing increases the awareness to some extent. Multiple studies evaluating health care provider willingness to report to work rank radiation as the hazard that will keep the largest number of workers at home. Even incidents that do not constitute a disaster can spiral out of control quite rapidly, placing considerable demands on community resources. Our communities will face these threats in the future and it is the responsibility of physicians and allied healthcare personnel to be trained and ready to care for those affected. The scope of resources needed to prepare for and respond to such incidents is indeed vast. It encompasses the coordinated effort of first responders and physicians, the preparedness of national agencies involved in responding to such events, and individual community cooperation and solidarity (Katz et al., 2014). However, Katz et al. (2014) reviewed the approach to the short- and long-term effects of a radiological or nuclear incident on an affected population, with a specific focus on the medical and public health issues. It also summarizes the strengths and weaknesses of our current ability to respond effectively and makes recommendations to improve these capabilities. Approximately 10 million “sealed sources” of radioactive material (eg, cesium-137, cobalt-60) are used for medical, industrial, agricultural, and research purposes worldwide. Fortunately, untoward events involving radioactive material, either accidental or intentional, are potentially devastating (Weinstock et al., 2008).

Events involving radioactive material either intended or not, are an undeniable possibility and potentially catastrophic (Carter et al., 2007). Ultimately, communities are trying to increase the ability of the public health system to handle radiological events of any nature. To do so effectively, they need to identify and coordinate with their own members who have existing expertise. NMTs are a perfect example of an untapped resource that public health agencies can recruit to assist with these important issues (Van Dyke et al., 2013).

CONCLUSION

The initial response to a radiological emergency may include radiation detection, population monitoring, decontamination, and dose assessment. Knowledgeable, willing, and prepared individuals will be needed to assist with a response of this nature. Public health agencies will need to coordinate with NMTs and draw on their expertise and knowledge to strengthen the community’s capability of responding to a radiological or nuclear emergency. Public health agencies and first-response organizations are working to build the capacity to respond to emergencies involving radiological materials. It is important that NMTs be included in preparedness efforts and recruited to volunteer through programs such as MMRS, MRC, and ESAR-VHP (Van Dyke et al., 2013).

Efforts to include radiological response procedures in NMT continuing education and training should be examined. There are apparent gaps in NMTs’ knowledge and familiarity with response resources. Therefore, it is suggested that radiological emergency preparedness courses be designed for appropriate continuing education credit for NMTs. This step is becoming increasingly important as this study and others show that training increases the willingness to respond (Van Dyke et al., 2013). Hospitals should consider capitalizing on their NMT staff’s knowledge and willingness to help with planning and training efforts within the hospital. This measure can help fill gaps in a hospital’s planning and ability to respond to patients contaminated with radiological materials (Van Dyke et al., 2013). The most important consideration in the medical evaluation of people involved in a radiation incident is the medical stability of the affected individuals. The relative magnitude of the situation and the resources needed to address the emergency are also important considerations.

Table 1: Descriptive Data

Descriptive Variables		NO.	%
Type of Center / Hospital Work setting	- Private Center / Hospital - Government Center / Hospital	50 7	87.7 12.3
Working place	- Hospitals - Radiological centers - laboratories	12 20 25	21.1 35.1 43.8
Years of experience	-< 10 years - > 10 years	15 42	26.3 73.7
Equipment used	- γ-camera - Radiotherapy (teletherapy and brachytherapy) - Radio-isotopic scanning - Radioimmunoassay substance	5 20 15 17	8.8 35.1 26.3 29.8
Radiation protection measures	- Present - Absent	45 12	78.9 21.1
Using the radio-protective measures	-Yes -No	32 25	56.1 43.9
Radiation protection course	- Present - Absent	53 4	93.0 7.0
Availability of survey meter	- Present - Absent	55 2	96.5 3.5
Information about Emergency preparedness	- Present - Absent	13 44	22.8 77.2
Good emergency preparedness measures	- Present - Absent	6 51	10.5 89.5
Emergency plane	- Present - Absent	37 20	64.9 35.1
Training Course in emergency preparedness within the last 5 years	- Present - Absent	2 55	3.5 96.5
Continues education in emergency preparedness	- Present - Absent	1 56	1.8 98.2
Re-training Course in emergency preparedness within the last 5 years	- Present - Absent	0 57	0 100
Scenarios and drills	- Present - Absent	0 57	0 100

Table 2: Effects of years of experience on the increasing the radiation protection knowledge

Radiation Protection Measures	Below 10 years		Above 10 years		Total		P- value
	No.	%	No.	%	No	%	
Present	7	12.3	31	54.4	38	66.7	0.0556
Absent	8	14.0	11	19.3	19	33.3	
Total	15	26.3	42	73.7	57	100	

Table 3: Effects of years of experience on the increasing the radiation emergency preparedness knowledge

emergency preparedness knowledge	Below 10 years		Above 10 years		Total		P- value
	No.	%	No.	%	No.	%	
Present	4	7.0	9	15.8	13	22.8	0.024
Absent	29	50.9	15	26.3	44	77.2	
Total	33	57.9	24	42.1	57	100	

ABBREVIATIONS

NMTs: Nuclear medicine technologists.
IAEA: International Atomic Energy Agency.
RDD: radiological dispersal device.

APPENDIX

1. Demographic Information:
o The working place
- Hospital
- Radiological centers
- laboratories
o work setting
- Government Center / Hospital
- Private Center / Hospital
2. The license
o Present
o Absent
3. How many years of nuclear medicine experience do you have? (Select one)
o 0–5 years
o 5–10 years
o 10–15 years
o 15–20 years
o 20+ years
4. The type of the equipment used
o γ-camera
o Radiotherapy
o Radio-isotopic scanning
o Radioimmunoassay substance
5. Have you a radio-protective measure in your working place? (Yes/No)
6. Did you continuously use this radio-protective measure in your working place? (Yes/No)
7. Have you received a radiation protection course? (Yes/No)
8. Is there a survey meter available for use in your department? (Yes/No)
9. Are the available survey meter calibrated on a regular basis? (Yes/No)
10. If there is any accident. Are you agreeing to perform the decontamination of radiological disaster victims in the event of a radiological disaster? (Yes/No)
11. If you have any information about the decontamination process after exposure to radiological accidents? (Yes/No)
12. If there is any accident. Are you able and comfortable in performing the decontamination of radiological disaster victims in the event of a radiological disaster? (Yes/No)
13. Did you know how to deal with the radiation accident? (Yes/No)
14. Did you know about the methods responding to radiation emergency? (Yes/No)
15. In the radiation emergency event /accident, who is the first responder?
16. Are you having an emergency response team in there working place? (Yes/No)
17. Did you know what the composition of the emergency response team is? (Yes/No)
18. What is the function of the emergency response team?
19. Did you have a medical health physicist in your working place? (Yes/No)
20. A regular urine bioassay using a well counter can test for internal contamination of which of the following ionizing radiation? (Select one)
o Gamma radiation
o Low-energy alpha radiation
o Neither low-energy alpha nor gamma radiation
o Both low-energy alpha and gamma radiation
21. A scintillation gamma-camera is best used for which of the following during a radiological disaster? (Select one)
o To scan a large amount of people for possible radiation exposure
o To identify unknown internal radiation contamination
o To assess radioiodine uptake

22. A Geiger counter is best used for which of the following during a radiological disaster? (Select one)
o To scan a large amount of people for possible radiation exposure
o To identify unknown internal radiation contamination
o To assess radioiodine uptake
o To assess the radiation exposure rate of an area or patient
o To assess the radiation exposure rate of an area or patient
23. In the event of an accident, are you willing to assist with radiation detection/monitoring at your facility? (Yes/No)
24. As a professional with a nuclear medicine background, do you feel prepared to work as a part of a response team in a hospital setting during a radiological disaster? (Yes/No)
25. Has the facility in which you work adopted and implemented an emergency preparedness plan that includes radiological disaster preparedness? (Yes/No)
26. Do you think continuing education programs should include training for radiological disaster procedures? (Yes/No)
27. Have you received radiological disaster preparedness training within the last 5 years? (Yes/No)
28. Have you received radiological disaster preparedness re-training within the last 5 years? (Yes/No)

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