Brief Communication

Implementation of a radiation injury management curriculum for health-care professionals in Taiwan

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Aim: Radiation-related injury in the general population due to accidents or incidents is a rare but significant event that merits serious study and planning in the health-care system. Therefore, we developed different levels of training courses targeting medical emergency response and treatment for radiation-related injury in patients, for different health-care professionals and medical students.

Methods: The curriculum, teaching instructions, and objectives were based on the working group consensus of first responders of radiation-related injury. The working group included different specialists from hospitals, medical schools, and government radiation emergency response agencies.

Results: Several different course levels, including lectures, group discussions, case and scenario discussions, hands-on practice, tabletop drills, and drills were included. The curriculums have shown that developing different levels of courses for medical students and health-care professionals was feasible.

Conclusion: Through the cooperation of different specialties and different interactive courses, the training programs were able to meet the initial education goals for medical emergency and radiation-related injury for medical students and health-care professionals.

Key words: Curriculum development, disaster response, multidisciplinary course, public health

INTRODUCTION

Radiation-related injury in the general population due to accidents or incidents is a rare but significant event that merits serious study and planning in the health-care system. A radiation accident is defined by the International Atomic Energy Agency (IAEA) as “an event that has led to significant consequences to people, the environment or the facility.” They can be related to a wide spectrum of practices, including industrial use, use of radiation sources in hospitals, activity in nuclear facilities, and transport of radioactive material. The main scenario of a “major nuclear accident” is one in which a reactor core is damaged and large amounts of radiation are released, such as the Chernobyl Disaster in 1986, or more recently, the Fukushima nuclear power plant accident in March 2011.1

Taiwan is located in the Asia-Pacific region, and is at one of the highest risks of natural hazards, such as typhoons and earthquakes.2,3 Taiwan has three operable nuclear power reactors, which account for approximately 15% of the island’s electricity generation.4 In the past, only designated hospitals near nuclear power plants need to have medical emergency response and treatment plans. After the Fukushima nuclear power plant accident in March 2011, the emergency preparedness and response for emergency nuclear incidents has been recognized as one of the important issues for health-care professionals and students. The Regional Emergency Medical Operation Center (REMOC), under the Ministry of Health and Welfare (MOHW) in Taiwan, adapted and implemented the national standard course of medical response and treatment plans in the emergency

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department. The medical school also initiated the basic course for medical students. This study aimed to evaluate the outcomes of different levels of training courses of medical emergency response and treatment for radiation-related injury patients among health-care professionals and medical students.

METHODS

Knowledge framework

The strategy of the IAEA for nuclear safety includes the implementation of education and training activities. The training activities will enforce to facilitate the further development of capability building and to strengthen regional and global cooperation as much as possible.5–7

The Atomic Energy Council (AEC) in Taiwan, in cooperation with the MOHW, set up several levels of emergency response plans and nuclear safety and training programs.8 These two agencies referred the key components from IAEA and held the consensus conference for the radiation-related injury curriculum development. The REMOC, local health agencies, and health-care facilities set up the knowledge-based management and management systems protocols. Each year, knowledge-based training is also implemented in main response hospitals; tabletop and on-site emergency response drills take place as well to train health-care professionals and review the protocols.

Course and participants

The curriculum included a basic course, advanced course, instructor course, and drill. The curriculum was targeted to medical students and all clinical health-care providers and related workers and 6th-year medical students. With different levels of the medical knowledge background of trainees, different levels of the curriculum were designed. The classroom and the e-learning based basic course for remote education were for those participants who were unable to come to class and are also interested in the course. The advanced course was used to target the skills and practices of patient care. Drills included tabletop and on-site drills, carried out to review the protocols they setup.

RESULTS

Detailed course curriculum

The South Emergency Medical Operation Center adapted the national curriculum and set up the education programs for medical students and health-care professionals. In order to distinguish the context of the course and assist participants to be familiar with the materials, the current educational curriculum was divided into a basic course (including e-learning), advanced course, instructor course, and drill (Table 1, Fig. 1). The contents and purposes of each educational curriculum are listed in Table 1. The 6th-year medical students received a 2-h basic course including basic medical physics, radiation detection, and PPE and decontamination. Didactic and hand-on practices were carried on to achieve the teaching goals.

Course evaluation and outcomes

There were nine basic courses in total, nine e-learning courses, 13 advanced courses, six drills, and one instructor course held from 2013 to 2016 for health-care professionals. Over this time, 1,866 persons joined the courses. The occupations of participants included doctors (14.2%), nurses (40.6%), other health professionals (33.0%), and emergency medical technicians (3.3%).

The cognitive-based exam was used as the course evaluation for the basic course. Each student needed to pass the examination to get the certificate. The mean scores of the tests were 77.20 ± 21.97. Most of the people (85%) passed the cognitive test for the basic course. The interactive response system was used during the basic course to discuss some controversial issues before the class started. Advanced courses and instructor courses were led by senior health-care workers with at least 3 years of teaching and drill response experience. The objective structured clinical examination-based checklist and feedback were used for skill-based techniques such as personal protective equipment (PPE) wearing and decontamination. Specialists were invited to evaluate the performance of tabletop exercise and drills; video recording was also used in advanced courses, instructor courses, and drills.

Sixty-five medical students participated in the medical student training course. The mean scores of the tests were 86.0 ± 15.3.

DISCUSSION

This study detailed the current training curriculum of radiation-related injury management in Taiwan. This education system is led by REMOCs under supervision of the MOHW and AEC of Taiwan. This education and training is carried out with the assistance of radiation-related injury response hospitals in Taiwan. Relevant staff from the fire department, health-care professionals, and students received different levels of training in order to get familiar...
| Module                      | Topic                                                                 | Content                                                                                     | Time (h) |
|-----------------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------|----------|
| Basic/e-learning (Web-based on-line course) | National radiation accident and radiation-related injury system and types of radiation-related injury accidents | Introduction of radiation response system, Relevant laws and regulations for radiation-related injury | 1        |
|                             | Basic radiation physics, pathophysiology, and radiation protection concepts | Introduction of basic physics                                                               | 1        |
|                             | Prehospital treatment principles                                     | Introduction of radiation-related injury, On-site response of radiation-related injury       | 1        |
|                             | Radiation accident response system responsibility and medical treatment in the hospital | Basic radiation-related injury treatment                                                   | 1        |
|                             | Types of radiation-related injury and treatment principles            | Decontamination, radiation exposure, and complex injury management                          | 1        |
|                             | Principles of and introduction to radiation detection instruments     | Radiation detection instrument and use                                                      | 1        |
|                             | Demonstration of the practice of radiation detection instruments      | Radiation detection instrument practices                                                   | 1        |
|                             | Radiation contaminants and environmental issues                        | Radiation-contaminated waste and the environment                                           | 1        |
| Advanced Classroom-based lectures and hand-on practices | Advanced management part I                                           | Estimations of radiation exposure doses and biologic doses                                  | 1        |
|                             | Advanced management part II                                           | Acute radiation injury syndrome and management                                             | 1        |
|                             | Advanced management part III                                           | External contamination management, Internal contamination management and medications       | 1        |
| Social support and risk communication |                                                                 | Psychological issues and support for radiation-related injury                              | 1        |
| Advanced management (grouped practice) |                                                                 | Radiation-related injury risk communication                                              | 3        |
| Case discussion             |                                                                 | Personal protective equipment, Decontamination for radiation-related injury patients     |          |
|                             |                                                                 | Transport for radiation-related injury patients                                           |          |
|                             |                                                                 | How to set up a radiation-related injury unit: experiences from Fukushima Medical University |          |
| Instructor Course (Small groups teaching, scenario and project discussion, hand-on practice) | Radiation-related injury management system | Radiation-related injury management system, Set up an emergency response system for radiation-related injury patients in the hospital | 1        |
|                             | Procedures of decontamination for radiation-related injury            | Detailed procedures of decontamination for radiation-related injury                        | 2        |
|                             | Practice of procedures of decontamination for radiation-related injury | Practice of detailed procedures of decontamination for radiation-related injury            | 3        |
| Drills                      | Hospital based and coordinated with EMTs, ambulance                  | Patients with radiation-related injury profiles                                           | 1        |
|                             | Scenario released                                                     |                                                                                           |          |
with the emergency response protocols and cooperate mutually in the event of radiation-related accidents.

The IAEA’s suggestion for education and training in nuclear safety strategies requires a statutory guideline to build up standards of safety for protection of health and minimization of danger to life and property. Thus, the plan is favored to be considered at a governmental level as well as each relative organization to operate and support the system. Our education and training course, led by the REMOC, cooperated with the fire department, local health-care facilities, response hospitals, and atomic energy agency to provide national and regional resources to work on possible situations. After the series of courses, many of the hospital were aware of the importance and set up the protocols.

The trainees of our training program included medical students, physicians, nurses, other medical staff, and other non-medical staff. Most were from hospitals, others from public health agencies, fire departments, and other institutes. Teaching objectives should be based on the levels of students. After the Fukushima Daiichi nuclear power plant accident in 2011, several radiation-related courses were carried out. Konishi et al. has set the five themes for undergraduate nursing students, including awareness of ignorance about radiation, problems produced by the mass media, becoming knowledgeable about radiation, public health nurses’ role, and trustful and enjoyable lectures. Hachiya and Akashi conducted training courses for healthcare professionals, school teachers, general students, and

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**Table 1.** Knowledge framework of radiologic management training program.

| Module                  | Topic                           | Content                                                                                     | Time (h) |
|-------------------------|---------------------------------|----------------------------------------------------------------------------------------------|----------|
| Response to scenario    |                                | Drill evaluation including:                                                                  | 2        |
|                         |                                 | Radiation response team activation: hospital team and radiation safety officers’ notification |          |
|                         |                                 | Team assembly and workflow                                                                  |          |
|                         |                                 | Environment safety preparedness                                                             |          |
|                         |                                 | PPE wearing and teamwork cooperation                                                        |          |
|                         |                                 | Radiation detection and decontamination                                                     |          |
|                         |                                 | Patient management and patient safety                                                       |          |
|                         |                                 | Working environment clearing and maintenance, team and environment safety maintenance      |          |
| Post drill discussion   |                                | Feedback and discussion                                                                     | 1        |

EMT, emergency medical technician; PPE, personal protective equipment.
risk communicators with different course content. The IAEA Action Plan on Nuclear Safety has developed the concepts, including education and training, human resource development, knowledge management, and knowledge networks. These concepts were believed to be needed for those who worked in radiation-related injury. Our goal of the training courses was to provide knowledge and practices regarding radiation detection and treatment through didactic lectures, group discussions, hand-on practice, and most importantly, drills. Trainees were able to convert what they learned into practical exercises during the drills and were able to earn credits of continuing education for a radiation technician.

Our course was the first to actively include medical students in Taiwan. Few practice courses included medical students. After the Fukushima Daiichi nuclear power plant accident, radiation-related injury issues were included in the medical education for medical students. Our course adapted the methods used for flipped classrooms, where medical students were required to read and watch the study material before the class, followed by hands-on practice on PPE donning, doffing, and disposing and detection instruments. The setting was appropriate for the limited teaching time to achieve the maximal teaching effects.

CONCLUSION

IN CONCLUSION, WE have set up different levels of education and training programs for radiation-related injury patients with cooperation from local health-care facilities, fire department, regional response center, and national authorities such as MOHW and AEC. Medical students, health-care professionals, medical physicists, and first responders were able to acquire knowledge and engage in practical experiences on the management of radiation-related injury.

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DISCLOSURE

Approval of the research protocol: N/A.
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Registry and the registration no. of the study/trial: N/A.
Animal studies: N/A.
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