Train the Trainers Workshop on Medical Physics Support for Nuclear or Radiological Emergencies

Fukushima Medical University

Fukushima, Japan

IAEA International Atomic Energy Agency · FUKUSHIMA MEDICAL UNIVERSITY · NIRS · JSMP

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IAEA

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Contents

1. Introduction

Although medical physicists, especially clinical medical physicists working in hospitals, have in-depth knowledge in radiation dosimetry, including dose reconstruction and dose measurements, they are usually not involved in Nuclear or Radiological Emergency (NRE) situations. However, in a few instances where medical physicists were involved in NREs, it appeared that many lacked specific knowledge and some skills that are required in such situations. This lack of specific knowledge and skills is probably due to the fact that most current medical physics curricula do not include a specific module on this topic. As a response to this finding, the IAEA, in consultation with the World Health Organization (WHO), the International Organization for Medical Physics (IOMP) and the International Radiation Protection Association (IRPA), decided to initiate a project to develop a specific training package to help prepare medical physicists to support NRE situations. The training package was developed with the kind support of the Government of Japan and in collaboration with Fukushima Medical University (FMU) and the National Institute of Radiological Sciences (NIRS), and is endorsed by the Japan Society of Medical Physics (JSMP).

The first International Workshop to test the training package will be held in Fukushima, with the support of FMU and NIRS. This workshop has been designed to provide specific comprehensive training on NRE response for clinical radiation medical physicists. It also aims to:

- Encourage/facilitate the embedding of medical physicists in NRE preparedness teams, in cooperation with other professions and organizations, at strategic and operational levels, both within hospitals and in the wider emergency planning structure;
- Recognize the essential contributions of medical physics staff (technicians, dosimetrists etc.) in NRE preparedness programmes and to ensure appropriate training;
- Promote the interaction of medical physicists with other professional groups involved in NRE preparedness, including through participation in regular training and exercises; and
- Encourage consideration of the potential of appropriately trained medical physicists to contribute to multidisciplinary NRE training of other professional groups, both within and outside health care settings.

2. Objective and Structure of the Workshop

2.1. Objective of the Workshop

The objective of the workshop is to provide the participants with a good understanding of their potential complementary roles in Nuclear or Radiological Emergency (NRE) situations, and to prepare them to contribute effectively to support the response to an NRE situation as identified in emergency preparedness plans. The participants are also expected to contribute to the training of other health care professionals in the response to NRE situations.

This workshop will also introduce the participants to a multidisciplinary team approach in dealing with NRE situations.

2.2. Structure of the Workshop

This five day workshop will consist of lectures, demonstrations, simulation, role play, and practical sessions followed by discussions with the workshop participants. The topics to be covered include the following 14 Modules:

- Module 1: Introduction
- Module 2: Nuclear and Radiological Emergencies
- Module 3: Radiation Measurements and Instrumentation
- Module 4: Dose Assessment and Dose Reconstruction
- Module 5: Monitoring and Decontamination of People – Scene and RMU
- Module 6: Monitoring and Decontamination of People – Hospital
- Module 7: Large Area Surveys – Monitoring of Food and Water
- Module 8: Biological Effects of Radiation – Cell and Tissue Effects
- Module 9: Biological Effects of Radiation – Stochastic Effects
- Module 10: Protection Strategies for the Public
- Module 11: Protection Strategies for Workers
- Module 12: Medical Management
- Module 13: Psychosocial Effects and Impacts on Mental Health
- Module 14: Effective Risk Communication

The detailed contents of each module are given in section 3: "Training modules"

2.3. Target Audience and Participants' Qualifications

The workshop addresses clinical medical radiation physicists working in hospitals, in one of the following areas: radiation oncology, diagnostic radiology, nuclear medicine and/or radiation protection. The specific requirements for participation are given below:

- Postgraduate degree at the Master degree level or equivalent,
- Completion of a residency or specialized clinical training programme in radiation oncology, diagnostic radiology or nuclear medicine;
- Minimum of three years' experience as a clinical medical radiation physicist, with a radiation protection function in their employment;
- Involvement in education and training in radiation protection;
- Previous involvement in regional or national emergency response activities is highly desirable.

2.4. Expected Output

Participants will gain the skills and knowledge necessary to contribute effectively to the response to an NRE situation as identified in emergency preparedness plans. They will have a better understanding of their potential roles in NRE situations and be in a position to contribute to the training of others in the response to NRE situations.

2.5. Workshop Programme

	Monday, June 22, 2015	Tuesday, June 23, 2015	Wednesday, June 24, 2015	Thursday, June 25, 2015	Friday, June 26, 2015
08:00	08:00 - 09:00: Registration **Bus pick-up time: 08:00 in front of the Richmond Hotel**	**Tuesday to Friday bus pick-up time: 08:00 in front of the Richmond Hotel**			
09:00	09:00 - 09:30: Opening remarks, A Meghzifene, H Ohto, M Akashi 09:30 - 10:00: 1. Introduction, A Meghzifene, F Nüsslin	09:00 - 10:30: 4. Dose Assessment and Reconstruction, M Isaksson, K Akahane	09:00 - 11:00: 5. Monitoring and Decontamination of People - Scene and RMU, H Wilkins, A Hasegawa	09:00 - 11:00: 7. Large Area Monitoring (Surveys), Food, Water, S Yoshida	09:00 - 10:00: 13. Psycho-social Effects and Impacts on Mental Health, M Maeda
10:00	10:00 - 11:00: 2. Nuclear radiological Emergencies, E D Herrera-Reyes, M Akashi	10:30 - 10:45: Short break 10:45 - 12:15: 4. Dose Assessment and Reconstruction (+ practical training), M Isaksson, K Akahane			10:00 - 10:15: Short break 10:15 - 12:15: 14. Effective Risk Communication, K H Ng, R Kanda, A Kumagai
11:00	11:00 - 11:15: Short break 11:15 - 12:15: 2. Nuclear radiological Emergencies, E D Herrera-Reyes, M Akashi		11:00 - 11:15: Short break 11:15 - 13:15: 5. Monitoring and Decontamination of People - Scene and RMU (+ practical training), H Wilkins, A Hasegawa, O Kurihara, E Kim, K Tani	11:00 - 11:15: Short break 11:15 - 12:45: 10. Protection Strategies for the Public, E D Herrera-Reyes	
12:00	12:15 - 13:30: Lunch Break	12:15 - 13:30: Lunch break		12:45 - 14:00: Lunch break	12:15 - 13:30: Lunch break
13:00	13:30 - 15:30: 3. Radiation Measurements and Instrumentation (+demo), O Kurihara	13:30 - 15:30: 8. Biological Effects - Cell and tissue Effects, W Dörr	13:15 - 14:30: Lunch break		13:30 - 14:30: 14. Effective Risk Communication (+training), K H Ng, R Kanda, A Kumagai
14:00			14:30 - 16:00: 6. Monitoring and Decontamination of People - Hospital, H Wilkins, A Hasegawa	14:00 - 14:30: 11. Protection Strategies for Workers, D Gilley 14:30 - 15:30: 12. Medical Management, E D Herrera-Reyes	14:30 - 15:30: Short break
15:00	15:30 - 16:00: Short break	15:30 - 15:50: Short break 15:50 - 17:50: 9. Biological Effects - Stochastic Effects, H Tatsuzaki, M Nenoi		15:30 - 15:50: Short break 15:50 - 16:50: 12. Medical Management-Experience of FMU, A Ohtsuru, Y Suzuki	15:30 - 17:30: Conclusion, evaluation, plenary
16:00	13:30 - 15:30: 3. Rad. Meas. and Instrumentation (+demo), O Kurihara, E Kim, K Tani		16:00 - 16:15: Short break 16:15 - 17:45: 6. Monitoring and Decontamination of People - Hospital, H Wilkins	16:50 - 17:50: Result of Fukushima Health Management Survey, K Nollet, T Ishikawa	
17:00			19:00: Reception*		

*Reception will take place at 19:00 at the Celecton Hotel, Fukushima (http://celecton-fk.jp/)

2.6. Contributors to Drafting and Review

Berris, T.	International Atomic Energy Agency
Carr, Z.	World Health Organization
Dörr, W.	Medical University of Vienna, Austria
Engel-Hills, P.	Cape Peninsula University of Technology, South Africa
Fukuda, S.	National Institute of Radiological Sciences, Japan
Fukumura, A.	National Institute of Radiological Sciences, Japan
Gilley, D.	International Atomic Energy Agency
Hefner, A. Q. E.	International Radiation Protection Association
Henderson-Suite, V.	National Radiotherapy Center, Trinidad and Tobago
Herrera-Reyes, E.	International Atomic Energy Agency
Holmberg, O.	International Atomic Energy Agency
Imai, R.	International Atomic Energy Agency
Isaksson, M.	University of Gothenburg, Sweden
Ishikawa, T.	Fukushima Medical University, Japan
Kanda, R.	National Institute of Radiological Sciences, Japan
Kumagai, A.	Fukushima Medical University, Japan
Lafortune, J. F.	International Atomic Energy Agency
Meghzifene, A.	International Atomic Energy Agency
Ng, K. H.	University of Malaya, Malaysia
Nüsslin, F.	Technische Universität München, Germany
Takashi, O.	Fukushima Medical University, Japan
Wilkins, H.	Royal Devon and Exeter Hospital, United Kingdom
Wolbarst, A.	University of Kentucky, United States of America

3. Training Modules

3.1. Module 1: Introduction

Table 1. Contents of Module 1

Objective	The aim of this module is to introduce the participants to the content of the modules of the NRE training workshop in order to orientate them to the topics and prepare them for the course
Pre-requisites (Learning in Place)	The participants are expected to meet the pre-requisites for admission to the training workshop and to have the prior learning in place as required by each Module
Learning Outcomes	Participation in Module 1 will enable: • Awareness of the general concept and medical physics related aspects of preparedness and response to NRE • Understanding of the role of the medical physicist within an emergency response plan and the requirements to act efficiently and effectively • Knowledge of the various types and planning categories of NRE • Familiarity with the IAEA Safety Standards and Guidelines
Core knowledge and Competencies	In preparation for other modules, this module will introduce: • Nuclear and Radiological Emergencies • Radiation measurement and Instrumentation • Dose Assessment and Reconstruction • Monitoring and Decontamination (People, Area) • Radioactive Waste Management • Large Area Surveys and Monitoring of Food and Water • Biological Effects of Radiation • Protection Strategies for Public and Workers • Medical Management and Psycho-social Effects of NRE • Risk communication
Teaching and Learning Activities	Lecture
Reading list	[1]. INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements Part 3. No. GSR Part 3, IAEA, Vienna, 2014 [2]. INTERNATIONAL ATOMIC ENERGY AGENCY, Arrangements for Preparedness for a Nuclear or Radiological Emergency: Safety Guide, Safety Standards Series No. GS-G-2.1., IAEA, Vienna, 2007 [3]. INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for a Nuclear or Radiological Emergency: Safety Requirements, Safety Standards Series No. GS-R-2, IAEA, Vienna, 2002 [4]. INTERNATIONAL ATOMIC ENERGY AGENCY, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency: General Safety Guide, IAEA Safety Standards SERIES No. GSG-2, IAEA, Vienna 2011 [5]. INTERNATIONAL ATOMIC ENERGY AGENCY, Roles and Responsibilities, and Education and Training, Requirements for

Clinically Qualified Medical Physicists, IAEA Human Health Series No 25, IAEA, Vienna, 2013
[6]. INTERNATIONAL ORGANIZATION FOR MEDICAL PHYSICS, Policy Statements 1-3, 2012-2013, http://iomp.org/?q=node/5, Accessed on April 23, 2015
[7]. INTERNATIONAL ORGANIZATION FOR MEDICAL PHYSICS/INTERNATIONAL RADIATION PROTECTION ASSOCIATION, Statement of Collaboration between IOMP and IRPA on the Use of Ionizing Radiation in Health Care, 2012, http://iomp.org/?q=node/5, Accessed on April 23, 2015
[8]. INTERNATIONAL ATOMIC ENERGY AGENCY, Postgraduate Medical Physics Academic Programmes, TCS no. 56, IAEA, Vienna 2013
[9]. INTERNATIONAL LABOUR ORGANIZATION: International Standard Classification of Occupations (ISCO-08; 2008), http://www.ilo.org/public/english/bureau/stat/isco/, Accessed on April 23, 2015

3.2. Module 2: Nuclear and Radiological Emergencies

Excerpt from interview with medical staff at Fukushima Medical University

"I anticipate that whatever skills are necessary with regard to handling radioisotopes would probably have to be strengthened. As I said, I was among the people who never imagined a nuclear power plant incident in Japan. So I suspect nobody else imagined that... But I think we have to be more aware of the possibilities of bad things happening including bad things involving nuclear facilities. Of course, that kind of knowledge should be enhanced".

Table 2. Contents of Module 2

Objective	This module aims to provide an overview of nuclear and radiological emergencies (NRE)
Pre-requisites (Learning in Place)	Awareness of national emergency response plans
Learning Outcomes	Participation in Module 2 will enable the participant to: • Describe nuclear and radiological emergencies • List the types of emergencies and emergency planning categories • Discuss general aspects of preparedness and response to NRE • Apply the IAEA Safety Standards to a known context
Core knowledge and Competencies	Module 2 will enable the learner to acquire knowledge in: • Fundamentals of nuclear and radiological emergencies • Framework for emergency response criteria • Types of emergency • Emergency planning categories • Areas and zones • Basic responsibilities for emergency preparedness and response (ICS) • Goals of emergency Preparedness and Response • Interventional levels and operational criteria • Previous incidents and accidents • Identification of response teams and communication between

	different groups • Role of the medical physicist in response teams (may vary, depending on circumstances)
Teaching and Learning Activities	Lecture, case studies, group discussion
Reading list	[1]. INTERNATIONAL ATOMIC ENERGY AGENCY, Arrangements for Preparedness for a Nuclear or Radiological Emergency: Safety Guide, Safety Standards Series No. GS-G-2.1., IAEA, Vienna, 2007 [2]. INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for a Nuclear or Radiological Emergency: Safety Requirements, Safety Standards Series No. GS-R-2, IAEA, Vienna, 2002 [3]. INTERNATIONAL ATOMIC ENERGY AGENCY, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency: General Safety Guide, IAEA Safety Standards SERIES No. GSG-2, IAEA, Vienna, 2011 [4]. INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Goiânia Expand reading list, IAEA, Vienna, 1988 [5]. INTERNATIONAL ATOMIC ENERGY AGENCY, Lessons learned from Accidental Exposures in Radiotherapy, Safety Report Series 17, IAEA, Vienna, 2000 [6]. INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements Part 3. No. GSR Part 3, IAEA, Vienna, 2014

3.3. Module 3: Radiation Measurements and Instrumentation

Excerpt from interview with medical staff at Fukushima Medical University

"Our information first came by watching the television. Then I started to receive information from our team. My colleagues measured the radioactivity themselves because they were equipped with dosimeters and understood how to screen and so on, so they could measure the radioactivity. It was a very chaotic and challenging time. There were complicating logistical issues as well".

Table 3. Contents of Module 3

Objectives	The aim of this module is to provide an overview of the main types of monitoring instrumentation used in nuclear or radiological emergency (NRE) situations and to provide an opportunity for participants to acquire the knowledge and skills to be able to measure radiation levels with proper selection of instrumentation
Prerequisites (Learning in Place)	Knowledge of fundamental radiation physics (e.g. interaction with matter, radiation detection, quality control, calibration, uncertainties)

Learning Outcomes	Participation in Module 3 will enable the participant to: • Describe how different detector types can be used to measure radiation • Correctly interpret the output from radiation detection instrumentation • Perform a variety of radiation measurements with a range of instruments • Perform functional and calibration checks • Discuss the difficulties in alpha, beta, low-energy photon, and neutron measurements • Select appropriate monitoring instrumentation for NRE situations
Core knowledge and Competencies	Module 3 will enable the learner to acquire knowledge in: • Radiation Measurement Systems specific to and suitable for NRE (e.g. Detectors, Dose Rate Meters, Contamination Monitors, In-vivo Monitoring, Personal Dosimeters, Gamma-Spectroscopy, Portal Monitors) • Use of Nuclear Medicine Instrumentation in events of NRE • Quality control of measurement (e.g. calibration, uncertainty) • Surface contamination measurements Module 3 will enable the learner to have competence in: • Ambient dose rate measurements with survey meter • Activity measurements with NaI or Ge spectrometers • In-vivo activity measurements with Whole-Body Counter
Teaching and Learning Activities	Lectures, demonstrations and practical training
Reading list	[1]. INTERNATIONAL ATOMIC ENERGY AGENCY, Measurement of Radionuclides in Food and the Environment A Guidebook. Technical Reports Series 295. STI/DOC/010/295, IAEA, Vienna, 1989 [2]. INTERNATIONAL ATOMIC ENERGY AGENCY, Individual Monitoring, Practical Radiation Technical Manual, IAEA-PRTM-2 (Rev. 1), IAEA, Vienna, 2004 [3]. KNOLL, G. F., Radiation Detection and Measurement, 4th edn, John Willey & Sons, (2011) 860 pp [4]. BURGESS P., CORBY, R., DELAHUNTY, D., et al, Practical Radiation Monitoring, Measurement Good Practice Guide No. 30, NATIONAL PHYSICAL LABORATORY, 2014 [5]. INTERNATIONAL ATOMIC ENERGY AGENCY, Workplace Monitoring – Volume 1: Radiation Dose Rates and Surface Contamination (draft), IAEA-TECDOC-XYZ, IAEA, Vienna [6]. BURGESS, P. H., Guidance on the Choice, Use and Maintenance of Hand-Held Radiation Monitoring Equipment, NATIONAL RADIOLOGICAL PROTECTION BOARD, NRPB R326, Chilton, Didcot, 2001

3.4. Module 4: Dose Assessment and Dose Reconstruction

Excerpt from interview with medical staff at Fukushima Medical University

"The concern about radiation exposure created extreme anxiety. I say extreme, because it was too much anxiety for radiation exposure. As doctors specializing in this area, we understand that we are exposed to natural radiation every day in low doses. We are therefore not anxious about low-dose radiation exposure. But most people don't understand this well and so they became far too nervous and anxious than warranted for low dose radiation exposure".

Table 4. Contents of Module 4

Objectives	The aim of this module is to provide underpinning theory to enable participants to: • Understand the radiation measurement quantities and units necessary to perform dose assessment and reconstruction • Understand ICRP-models used for estimation of external and internal dose from directly, as well as indirectly ionizing radiation • Recognize the personal dosimetry in emergency situations
Prerequisites (Learning in Place)	Knowledge of the ICRU report 60 and ICRP report 103 Basic knowledge of internal dose calculation models
Learning Outcomes	Module 4 will enable participants to: • Describe how the quantities are applied to estimations of radiation dose • Describe how the model limitations and uncertainties may affect the dose estimations • Estimate radiation dose when data may be incomplete
Core knowledge and Competencies	Module 4 will enable the learner to acquire knowledge in: • Physical Quantities, Protection Quantities, Operational Quantities (ambient dose equivalent, personal dose equivalent) • Quantities used for external radiation dose • Quantities used for internal radiation dose (committed equivalent dose/committed effective dose) • Models used to estimate radiation dose from intake of radionuclides (lung model, GI-tract model, systemic models for retention and excretion) • Phantoms for radiation dose estimation • The use of dose assessments and reconstructed doses • The concept and limitation of collective dose
Teaching and Learning Activities	Lecture, examples of estimation of radiation dose from published dose coefficients (data from direct measurements)
Reading list	[1]. INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements Part 3, No. GSR Part 3, IAEA, Vienna, 2014 [2]. INTERNATIONAL ATOMIC ENERGY AGENCY, Calibration of radiation protection monitoring instruments, Safety Report Series No. 16, IAEA, Vienna, 2008 [3]. INTERNATIONAL COMMISSION ON RADIATION UNITS &

MEASUREMENT, Fundamental Quantities and Units for Ionizing Radiation (Report 60), ICRU, 1998
[4]. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, The 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4), ANNEX B. QUANTITIES USED IN RADIOLOGICAL PROTECTION, ICRP, 2007
[5]. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Compendium of Dose Coefficients based on ICRP Publication 60, ICRP Publication 119, Ann. ICRP 41(Suppl.), ICRP, 2012
[6]. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Conversion Coefficients for Radiological Protection Quantities for External Radiation Exposures, ICRP Publication 116, Ann. ICRP 40(2-5), ICRP, 2010
[7]. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Human Respiratory Tract Model for Radiological Protection, ICRP Publication 66, Ann. ICRP 24 (1-3), ICRP, 1994
[8]. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Age-dependent Doses to Members of the Public from Intake of Radionuclides - Part 1, ICRP Publication 56, Ann. ICRP 20 (2), ICRP, 1990
[9]. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Conversion coefficients for use in radiological protection against external radiation. ICRP Publication 74, Ann. ICRP 26 (3/4), ICRP, 1996
[10]. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Application of the Commission's Recommendations for the Protection of People in Emergency Exposure Situations, ICRP Publication 109, Ann. ICRP 39 (1), ICRP, 2009
[11]. INTERNATIONAL COMMISSION ON RADIATION UNITS & MEASUREMENT, Quantities and Units in Radiation Protection Dosimetry (Report 51), ICRU, 1993

3.5. Module 5: Monitoring and Decontamination of People – Scene and RMU

Excerpt from interview with medical staff at Fukushima Medical University

"Unfortunately during this disaster, Fukushima Medical University's water supply shut down leaving us with no access to tap water... But decontamination is achieved by washing – so we needed water. There is no equipment for decontamination, no shower system -nothing. We reached out to Japan's Self Defence Forces and implored that they please bring us decontamination equipment and water tank, and to then please stay and build us a decontamination system in the university".

Table 5. Contents of Module 5

Objectives	This Module will guide the participants to: • Acquire knowledge about radiation monitoring units • Identify the roles and responsibilities of medical physicists in a radiation monitoring unit
Prerequisites (Learning in Place)	Participants must revise the content of previous Modules, in particular "Radiation Measurements and Instrumentation" (Module 3)
Learning Outcomes	On completion of this Module the participant will be able to: • Design a radiation monitoring unit • Develop monitoring procedures based on the scale of the event and resources available • Establish segregated radiation zones • Take a leading role in setting up a radiation monitoring unit (e.g. operational planning, staffing, layout design, arrangements to prevent contamination of facility and communication with the members of the team) • Recognize criteria for decontamination of people in a radiation emergency • Generate appropriate records of the monitoring/decontamination of individuals • Provide radiation protection training of staff assigned to the radiation monitoring unit • Use equipment for the detection and quantification of possible external contamination on people in an NRE situation (hand-held monitors, automatic hand and foot monitors, portal monitors)
Core knowledge and Competencies	Module 5 will enable the learner to acquire knowledge and competence in the: • Design and establishment of a radiation monitoring unit • Fundamentals of radiation monitoring and decontamination procedures. National, regional and local NRE emergency preparedness schemes. Management of radioactive waste and associated radiation protection • Training of staff in radiation protection
Teaching and Learning Activities	Lectures, demonstrations, practical use of monitors, individual and group exercises
Reading list	[1]. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for monitoring in a nuclear or radiological emergency, IAEA-TECDOC-1092, IAEA, Vienna, 1999 [2]. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for medical response during a nuclear or radiological emergency, IAEA-EPR Medical, IAEA, Vienna, 2005 [3]. INTERNATIONAL ATOMIC ENERGY AGENCY, Medical Preparedness and Response for a Nuclear or Radiological Emergency Training Materials, EPR-Medical/T 2014, Use of Detection Equipment, Lecture 18, IAEA, Vienna, 2014 [4]. INTERNATIONAL ATOMIC ENERGY AGENCY, Medical Preparedness and Response for a Nuclear or Radiological Emergency Training Materials, EPR-Medical/T 2014, Hospital Preparedness and Management of Persons Accidentally Exposed to Ionizing Radiation, Lecture 23, IAEA, Vienna, 2014

[5]. INTERNATIONAL ATOMIC ENERGY AGENCY, Medical Preparedness and Response for a Nuclear or Radiological Emergency Training Materials, EPR-Medical/T 2014, Medical Response to a Radiation Mass Casualty Event, Lecture 24, IAEA, Vienna, 2014
[6]. INTERNATIONAL ATOMIC ENERGY AGENCY, Medical Preparedness and Response for a Nuclear or Radiological Emergency Training Materials, EPR-Medical/T 2014, Planning and Preparedness for Medical Response to Malicious Events with Radioactive Material, Lecture 26, IAEA, Vienna, 2014
[7]. OHBA, T., MIYAZAKI, M., SATO, H., et al., A strategy for a rapid radiological screening survey in large scale radiation accidents: a lesson from an individual survey after the Fukushima Daiichi nuclear power plant accidents, Health Phys. 2014; 107(1): 10-17
[8]. ROJAS-PALMA, C., LILAND, A., JERSTAD, et al., Triage, Monitoring and Treatment of people exposed to ionising radiation following a malevolent act, TMT Handbook, 2009.
[9]. THOMPSON, N. J., YOUNGMAN, M. J., MOODY, J., et al., Radiation Monitoring Units: Planning and Operational Guidance. HEALTH PROTECTION AGENCY, HPA-CRCE-017, HPA, Chilton, Didcot, 2011

3.6. Module 6: Monitoring and Decontamination of People – Hospital

Excerpt from interview with medical staff at Fukushima Medical University

"Unfortunately we didn't plan for a scenario where everything becomes contaminated. After the nuclear power plant accident, literally everywhere in the Fukushima Prefecture became contaminated. The ground was contaminated. Cars were contaminated. When we were 'imagining' a scenario for a potential accident, we imagined a small accident inside the power plant where contaminated patients would be transported to our clean hospital. Only the patient, in our practice scenario, was contaminated... Of course, the reality was different. Everything was contaminated. The 'radiation dose levels' we were dealing with were completely different from what we had predicted. We realized at that moment that we had to revise our thinking and devise a new plan that fit the reality we were facing. It was very difficult. We were trying to sort this out and keep our patients and ourselves protected. We had to change our procedures based on the new knowledge that we were developing in the moment".

Table 6. Contents of Module 6

Objectives	The aim of Module 6 is to enable participants to acquire knowledge in measurement strategies and methods used to survey the levels of radioactivity and radiation in indoor environments after a release of radioactive substances and to apply radioactive waste management principles in NRE situations
Prerequisites (Learning in Place)	Participants must have learning in place from previous Modules, in particular "Radiation Measurements and Instrumentation" (Module 3)
Learning Outcomes	On completion of Module 6 participants will be able to: • Make a survey of the radiation levels within a building • Localize a radiation source, identify the radionuclide(s) and quantify the activity

	• Establish radiation zones
Core knowledge and Competencies	Module 6 will enable the learner to acquire knowledge and competence in the: • Choice of appropriate instrumentation and techniques for localization, identification and quantification of radiation sources • Survey and decontamination strategies • Proper management of radioactive waste
Teaching and Learning Activities	• Lecture, demonstration, observation, individual and group exercises • Mapping of radiation levels within a building • Search exercises with different kinds of instruments • Localizing of a radiation source, identifying the radionuclide(s) and quantifying the activity • Examples of adequate decontamination
Reading list	[1]. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for monitoring in a nuclear or radiological emergency, IAEA-TECDOC-1092, IAEA, Vienna, 1999 [2]. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic procedures for assessment and response during a radiological emergency, IAEA-TECDOC-1162, IAEA, Vienna, 2000

3.7. Module 7: Large Area Surveys – Monitoring of Food and Water

Excerpt from interview with medical staff at Fukushima Medical University

"Many Fukushima residents are worried about food contamination. These fears were compounded greatly by the spread of misinformation and harmful rumours. The rumours in particular have had huge economic implications and have led to discrimination against those who are believed to be contaminated".

Table 7. Contents of Module 7

Objectives	The aim of this Module is to: • Provide fundamental knowledge of the sampling and measurement strategies and methods used to survey the levels of radioactivity in the environment after a release of radioactive substances • Provide basic knowledge of the strategies and methods used to decontaminate buildings or land areas after a release of radioactive substances in the environment • Provide basic knowledge of the sampling and measurement strategies and methods used to survey the levels of radioactivity in food and water after a release of radioactive substances in the environment
Prerequisites (Learning in Place)	Learning from previous Modules, in particular "Radiation Measurements and Instrumentation" (Module 3) and also Modules 4, 5 and 6 must be revised
Learning Outcomes	Participants will be able to: • Conduct dose-rate surveys • Perform sample preparation methods for soil • Briefly describe the migration of radionuclides in the ground • Collect and measure air and fallout samples • Use gamma spectroscopy instrumentation including calibration

	• Explain the basic principles of vehicle and aerial monitoring of contamination levels • Describe decontamination strategies and methods in the recovery phase following an NRE event • Describe sampling and sample preparation methods for food and water (fresh & sea water). Explain the rationale for intervention levels for food and water • Discuss the difficulties encountered when monitoring large volumes of food and water • Describe the strategies and methods used for decontamination of arable land, as well as the efficiency of these countermeasures • Discuss the strategies and methods used for decontamination of urban areas, as well as the efficiency of these countermeasures
Core knowledge and Competencies	Module 7 will provide content and practice for increasing knowledge and competence in: • Contamination measurements for soil, air, water and food (including milk) • Dose assessment based on radiation monitoring and sample results • Models for radionuclide migration in the ground • Field gamma spectroscopy (*in situ*) • Relative amounts of radioactive elements on contaminated buildings and land areas (e.g. roofs, walls, pavements) • Strategies and methods used for decontamination of the environment • Internationally agreed intervention levels for water • Food embargo and animal quarantine strategies
Teaching and Learning	• Practical examples of estimating dose based on radiation measurements and sampling results • Demonstration of deposition maps
Reading list	[1]. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Monitoring in a Nuclear or Radiological Emergency, IAEA-TECDOC-1092, IAEA, Vienna, 1999 [2]. INTERNATIONAL ATOMIC ENERGY AGENCY, Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Terrestrial and Freshwater Environments, Technical Reports Series no. 472, IAEA, Vienna, 2010 [3]. ANDERSSON, K. G., AMMANN, M., BACKE, S., et al., Decision support handbook for recovery of contaminated inhabited areas. Nordic Nuclear Research report NKS-175, NKS, 2008 [4]. INTERNATIONAL ATOMIC ENERGY AGENCY, Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor, EPR-NPP Public Protective Actions, IAEA, Vienna, 2013 [5]. INTERNATIONAL ATOMIC ENERGY AGENCY, Measurement of Radionuclides in Food and the Environment A Guidebook, IAEA Technical Reports Series 295, IAEA, Vienna, 1989 [6]. WORLD HEALTH ORGANIZATION, Guidelines for drinking-water quality, fourth edition, WHO, Geneva, 2011

3.8. Module 8: Biological Effects of Radiation – Cell and Tissue Effects

Excerpt from interview with medical staff at Fukushima Medical University

"We want nurses to come to our hospital. However, Nurses are typically young and women and they are fearful of radiological effects. Or they have small children so they don't believe it is safe to return to our hospital… Generally people have come back to Minamisoma. But of those under 15, only about half have returned… We want the children in our city. But we can understand the parents' fearfulness and over-thinking of the potential harm of radiological effects".

Table 8. Contents of Module 8

Objectives	The aim of Module 8 is to facilitate: • Understanding of the effects of ionizing radiation on cells and tissues and their medical consequences • Characterization and quantification of these biological effects with respect to relevant dose assessment, including biological dose indicators and dose response • Acknowledgement of factors impacting on cell/tissue effects
Prerequisites (Learning in Place)	Participants will be expected to have: • A basic understanding of relevant anatomy and physiology • Basic knowledge about radiation effects on biological systems at the cellular, tissue/organ and whole organism level
Learning Outcomes	The learning in this Module will enable the participant to: • Describe radiation-response assessment and quantification • Discuss biological dose indicators • Explain dose response analyses • Understand tissue tolerance and relevant influencing factors
Core knowledge and Competencies	Module 8 will enable the learner to acquire knowledge in: • The concept of internal contamination • The transformation of physical interaction to biological effects • DNA damage and biological consequences • Cell survival and influencing factors (intrinsic radiosensitivity, cell cycle effects, radiation quality, dose rate/fractionation, overall exposure time, oxygenation), modes of cell death • Quantities and units (absorbed, equivalent dose) • Equieffective dose calculations (LQ model, EQDx) • Retrospective biological dose indicators (ESR, gene expression, cytogenetics (dicentrics, FISH, PCC), micronuclei, comet assay) • General pathogenesis of early, late, consequential late tissue effects, including latent times and typical examples • Atypical tissue effects (e.g. eye lens, gonads, embryo/fetus) • Radiation syndromes (cerebrovascular, gastrointestinal, mucocutaneous, haematopoietic) and relevant dose indicators (early clinical symptoms, lymphocytes, hair follicles, spermatogenesis) • Dose-effect relationships, tolerance doses • Factors influencing tissue effects (instrinsic radiosensitivity, recovery, repopulation, redistribution)

	• The impact of dose inhomogeneities (within organs, partial vs. total body exposure)
Teaching and Learning Activities	Lectures, examples, demonstration, exercise to calculate equieffective doses for specific examples
Reading list	[1]. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, The 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4), ANNEX B. QUANTITIES USED IN RADIOLOGICAL PROTECTION, ICRP, 2007 [2]. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, ICRP Statement on Tissue Reactions / Early and Late Effects of Radiation in Normal Tissues and Organs – Threshold Doses for Tissue Reactions in a Radiation Protection Context, ICRP Publication 118, Ann. ICRP 41(1/2), ICRP, 2012 [3]. JOINER, M., VAN DER KOGEL, A., Basic Clinical Radiobiology, 4th edn, Hodder Education (2009), 288 pp [4]. SHRIEVE, D. C., LOEFFLER, J. S., Human radiation injury, 1st edn, Lippincott Williams & Wilkins, (2011) 533 pp [5]. DÖRR, W., SCHMIDT, M., Normal tissue radiobiology, Comprehensive Biomedical Physics, Vol. 7, Chapter 7.05, Elsevier, Amsterdam-Oxford-Waltham, (2014) pp 4056 [6]. INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Biology: a Handbook for Teachers and Students. IAEA Training Course Series No. 42, IAEA, Vienna, 2010 [7]. BENTZEN, S. M., DÖRR, W., GAHBAUER, R., et al., Bioeffect modeling and equieffective dose concepts in radiation oncology – Terminology, quantities and units. Radiother. Oncol. 2012; 105: 266-268 [8]. INTERNATIONAL ATOMIC ENERGY AGENCY, Cytogenetic Dosimetry: Applications in Preparedness for and Response to Radiation Emergencies, Emergency Preparedness and Response, EPR-Biodosimetry, IAEA, Vienna, 2011 [9]. HALL, E.J. and A.J. GIACCIA, Radiobiology for the radiologist, 7th edn, Lippincott Williams & Wilkins (2012) 576 pp

3.9. Module 9: Biological Effects of Radiation – Stochastic Effects

Excerpt from interview with medical staff at Fukushima Medical University

"In Nagasaki we see many Hibakusha – atomic bomb survivors. The population in the city is now almost 450 000. In our clinic at Nagasaki University we see patients – not only Hibakusha but also the non-Hibakushas. Some Hibakushas have special conditions. Sometimes they are difficult to diagnose. If Hibakusha get cancer, (and their incidence is very high compared to the non-Hibakushas) they can apply for a special grant to receive special support, so we see many such cases coming to our clinic for diagnosis".

Table 9. Contents of Module 9

Objectives	The aim of this Module is to guide the participant to: • Understand the processes of carcinogenesis and genetic radiation effects and their influencing factors • Acknowledge these biological effects with respect to dose response and risk models • Acknowledge factors impacting on the quality and quantity of these effects
Prerequisites (Learning in Place)	The assumed learning in place is a: • Basic understanding anatomy and physiology • Basic understanding of epidemiological methodology and its limitations • Knowledge of biology related to carcinogenesis
Learning Outcomes	At the completion of this Module participants will be able to: • Describe the methodology for assessing probability of occurrence of stochastic effects • Discuss requirements regarding exposure data selection and quality • Discuss dose-response and risk models • Interpret epidemiological data
Core knowledge and Competencies	Module 9 will enable the learner to acquire knowledge in: • Multi-step carcinogenesis theory, initiating and promoting factors • Tumor incidence and mortality • Dose-effect relationships and risk models • Tissue weighting factors and effective dose • Factors influencing risk (incl. exposure conditions, e.g. Dose-Rate, radiation quality, age at exposure, sex, genetic factors, lifestyle related factors, exposed organ) including examples • Genetic radiation effects and consequences, with relevant examples
Teaching and Learning Activities	Lectures, demonstration of examples of calculations
Reading list	[1]. OZASA, K., SHIMIZU, Y., SUYAMA, A., et al., Studies of the mortality of atomic bomb survivors, Report 14,1950-2003: an overview of cancer and noncancer diseases. Radiat Res. 2012; 177(3):229-243. [2]. JOINER, M., VAN DER KOGEL, A., Basic Clinical Radiobiology, 4th edn, Hodder Education (2009) 288 pp [3]. SHRIEVE, D. C., LOEFFLER, J. S., Human radiation injury, 1st edn, Lippincott Williams & Wilkins, (2011) 533 pp [4]. UNITED NATIONS SCIENTIFIC COMMISSION ON THE EFFECTS OF ATOMIC RADIATION, Sources, Effects and Risks of ionizing radiation, UNSCEAR 2013 Report, Volume I, Annex A, Levels and effects of radiation exposure due to the nuclear accident after the 2011 great east-Japan earthquake and tsunami, UNSCEAR, New York, 2014 [5]. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, The 2007 Recommendations of the International

	Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4), ANNEX B. QUANTITIES USED IN RADIOLOGICAL PROTECTION, ICRP, 2007 [6]. UNITED NATIONS SCIENTIFIC COMMITTEE ON THE EFFECTS OF ATOMIC RADIATION, Effects of ionizing radiation, UNSCEAR 2006 Report: Volume II, Annex C - Non-targeted and delayed effects of exposure to ionizing radiation, UNSCEAR, New York, 2006

3.10. Module 10: Protection Strategies for the Public

Excerpt from interview with medical staff at Fukushima Medical University

"The second recommendation is around radiation protection based on knowledge established by ICRP and the LNT model. This knowledge includes dose estimation, risk estimation, concept of protection, application of protection level and so on. … Medical doctors seldom know radiation protection because they rarely study this field. But this knowledge is very important for risk management in existing exposure situation after the nuclear accident".

Table 10. Contents of Module 10

Objective	The aim of this Module is to enable the participant to understand the basic concepts, techniques and importance of protecting the public during all phases of a NRE
Prerequisites (Learning in Place)	Knowledge of the (BSS) Basic Safety Standards (see reference list)
Learning Outcomes	This Module will enable the participant to: • List methods used to reduce exposure appropriately to the public using protective actions and other appropriate actions in the aftermath of a NRE • Recognize the situations when sheltering, evacuation and relocation are recommended • Recognize when the response may include actions to reduce inadvertent ingestions, decontamination of individuals, and prevention of ingestions of potentially contaminated food, milk or water, or reduce uptake of radioactive iodine • Describe the strategy to prevent the spread of contamination through embargo and quarantine of food crops and livestock • Explain the restriction of transportation of goods from the impacted area
Core knowledge and Competencies	Module 10 will enable the learner to acquire knowledge in the: • Preventative actions to avoid the spread of contamination • Methods to reduce public exposure including countermeasures • Pathways of exposure through food, milk and water • Techniques and strategies to reasonably reduce public exposure and dose during an emergency
Teaching and Learning Activities	Lectures, examples, case studies
Reading list	[1]. INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements Part 3. No. GSR

Part 3, IAEA, Vienna, 2014

[2]. INTERNATIONAL ATOMIC ENERGY AGENCY, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency: General Safety Guide, IAEA Safety Standards SERIES No. GSG-2, IAEA, Vienna, 2011

[3]. INTERNATIONAL ATOMIC ENERGY AGENCY, Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor, EPR-NPP Public Protective Actions, IAEA, Vienna, 2013

[4]. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION. Application of the Commission's Recommendations for the Protection of People in Emergency Exposure Situations. ICRP Publication 109. Ann. ICRP 39 (1), ICRP, 2009

[5]. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for medical response during a nuclear or radiological emergency, IAEA-EPR Medical, IAEA, Vienna, 2005

[6]. INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Report on Preparedness and Response for a Nuclear or Radiological Emergency in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant, IAEA, Vienna, 2013

3.11. Module 11: Protection Strategies for Workers

Excerpt from interview with medical staff at Fukushima Medical University

“Physicians at the other sites felt that they did not have knowledge or the experience to know how to safely manage the contaminated workers, so they refused to accept them... We realized our first step was to teach the doctors. We taught them how to think; it depends on the dose degree, dose level, meaning of Sieverts, meaning of background, meaning of decontamination, so we told them step by step”.

Table 11. Contents of Module 11

Objective	The aim of Module 11 is to facilitate understanding of the basic concepts, techniques and importance of protecting workers during all phases of a NRE
Prerequisites (Learning in Place)	Knowledge of the Basic Safety Standards (BSS)
Learning Outcomes	On completion of this Module the participants will be able to: • Explain the components of the ALARA concept and how it is implemented in an emergency situation • Describe the concept of universal precautions and its value to reducing worker contamination • Discuss radiation protection measures that may be used in emergency response for workers • Make dose estimates of workers from elevated radiation levels in the environment and of radioactive contamination of people and buildings • Explain knowledge of the arrangements for controlling, and guidance values for restricting, exposure of emergency workers (BSS- No. GSR Part 3, Requirement 45; Table IV.2)

Core knowledge and Competencies	Module 11 will enable the learner to acquire knowledge and competence in: • Universal precautions • ALARA principles and implementation in an emergency • Calculating individual dose estimates from radiation measurements in the environment • Techniques and strategies to minimize practical worker dose reasonably during an emergency • Estimating measurable quantities (ambient dose equivalent, personal dose equivalent)
Teaching and Learning Activities	Lecture
Reading list	[1]. INTERNATIONAL ATOMIC ENERGY AGENCY, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency: General Safety Guide, IAEA Safety Standards SERIES No. GSG-2, IAEA, Vienna, 2011 [2]. INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements Part 3. No. GSR Part 3, IAEA, Vienna, 2014 [3]. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION. Application of the Commission's Recommendations for the Protection of People in Emergency Exposure Situations. ICRP Publication 109. Ann. ICRP 39 (1), ICRP, 2009 [4]. INTERNATIONAL ATOMIC ENERGY AGENCY, Manual for first responders to a radiological emergency, Emergency Preparedness and Response, EPR-First Responders, IAEA, Vienna, 2006 [5]. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for medical response during a nuclear or radiological emergency, IAEA-EPR Medical, IAEA, Vienna, 2005 [6]. INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Report on Preparedness and Response for a Nuclear or Radiological Emergency in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant, IAEA, Vienna, 2013

3.12. Module 12: Medical Management

Excerpt from interview with medical staff at Fukushima Medical University

"Transferring patients was a challenge. About 3 thousand patients were admitted from the evacuated area but of these, half of them were difficult to transfer because of severe illness and being confined to bed rest. Transferring 1000 to 2000 very severe patients all at once is very difficult. Getting to what was classed as dangerous restricted areas was handled by only approved transportation systems like army helicopters or army buses. The patients were unstable... Some patients died during transport due to unstable diseases. It wasn't only the trauma or tsunami or acute radiation diseases, but during transport, that some died. It was really difficult to figure out how to evacuate to an area hospital, how to transfer and of course how to treat when more than 1000 patients had to be evacuated".

Table 12. Contents of Module 12

Objective	This Module aims to provide general knowledge about radiation emergency medicine (incident site, reception centre/emergency ward, advanced care)
Prerequisites (Learning in Place)	Participants are expected to have learning covered in Modules 2-9
Learning Outcomes	This Module will enable participants to: • Discuss the basic concepts of radiation emergency medicine • Explain the Physicians' perspective in triage and treatment • Describe the role of the physicist in the evaluation and follow-up of contaminated or overexposed patients
Core knowledge and Competencies	Module 12 will enable the learner to acquire knowledge of: • Levels of response to an incident (on site, reception centre, hospital) • Acute radiation syndrome, Cutaneous Radiation Syndrome (CRS, Local radiation injury), and contaminated patients (internal and external) • Role of the medical physicist in the treatment of overexposed or contaminated patient • Chelating agents • Zoning for radiation controlled areas and prevention of the spread of contamination • Basic concepts of radiation emergency medicine • Clinical flow of treatment and management for emergency cases • Monitoring of the healthcare team • Surface contamination survey in emergency situations (which part, when, priority) in accordance with clinical flow
Teaching and Learning Activities	Lectures, review of practical clinical cases/accidents
Reading list	[1]. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for medical response during a nuclear or radiological emergency, IAEA-EPR Medical, IAEA, Vienna, 2005 [2]. INTERNATIONAL ATOMIC ENERGY AGENCY, Training Material for Medical Preparedness and Response to a Nuclear or Radiological Emergency, IAEA/WHO, http://www-ns.iaea.org/tech-areas/emergency/technicalproducts.asp?s=1#6, Accessed on April 23, 2015 [3]. INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Publications on Accident Response, http://www-pub.iaea.org/books/IAEABooks/Publications_on_Accident_Response, Accessed on April 23, 2015 [4]. ROJAS-PALMA, C., LILAND, A., JERSTAD, et al., Triage, Monitoring and Treatment of people exposed to ionising radiation following a malevolent act, TMT Handbook, 2009. [5]. TAZRART, A., BERARD, P., LEITERER, A., MENETRIER, F., Decontamination of radionuclides from skin: an overview, Health Phys. 2013; 105(2): 201-207

3.13. Module 13: Psychological Effects and Impacts on Mental Health

Excerpt from interview with medical staff at Fukushima Medical University

"As we worked with the nuclear plant employees over the next few months, conducting research helped us understand that they were experiencing basically four types of stressors; workplace trauma (like plant explosion or irradiation, etc.), disaster victim experience, grief experience and criticism from the public. Our analysis told us that it was discrimination that was hurting them the most".

Table 13. Contents of Module 13

Objective	The aim of Module 13 is to facilitate an understanding of socio-psychological stress due to NRE
Prerequisites (Learning in Place)	N/A
Learning Outcomes	At the completion of this Module the participants will be able to: • Describe some major psychological effects resulting from the NRE • Discuss the concept of risk perception
Core knowledge and Competencies	Module 13 will enable the learner to acquire knowledge of: • Risk perception for individuals, the population and groups of interest • Psycho-sociological effects of NRE. Type and level of mental stress depending on the situations of evacuation (e.g. temporary housing, voluntary evacuation) • Short and long term psychological effects after the NRE (e.g. Fukushima health survey) • Mental health consequences of NPP workers, clean-up workers and healthcare staff after NRE • Social, cultural and economic consequences of NRE
Teaching and Learning Activities	Lecture, review of practical cases
Reading list	[1]. SLOVIC, P., Informing and educating the public about risk, Risk Anal. 1986; 6(4) :403-15 [2]. BROMET, E. J., Mental health consequences of the Chernobyl disaster, J. Radiol. Prot. 2012; 32(1): N71-75 [3]. THE CHERNOBYL FORUM: 2003–2005, Chernobyl's Legacy: Health, Environmental and Socio-Economic Impacts and Recommendations to the Governments of Belarus, the Russian Federation and Ukraine, Second Revised Edition, Printed by IAEA, 2006 [4]. YABE, H., SUZUKI, Y., MASHIKO, H., et al., Psychological distress after the Great East Japan Earthquake and Fukushima Daiichi Nuclear Power Plant accident: results of a mental health and lifestyle survey through the Fukushima Health Management Survey in FY2011 and FY2012, Fukushima J. Med. Sci. 2014; 60(1): 57-67 [5]. INTERNATIONAL ATOMIC ENERGY AGENCY, Health in Disasters: A Science and Technology Studies Practicum for Medical Students and Health Care Professionals, IAEA (in preparation)

3.14. Module 14: Effective Risk Communication

Excerpt from interview with medical staff at Fukushima Medical University

"We knew we needed to get this message out beyond the scientific or academic community...We had to learn how to reduce an important scientific message into a 10 second media sound bite. And we had to do this in a context where the public were experiencing sensationalised media reports. It was so difficult for the layperson to understand that there is no '100% safety' or '100% danger'...I think the scientific community and the media both need to work together and I believe this is an important educational opportunity for our country".

Table 14. Contents of Module 14

Objective	The aim of this Module is to present an overview of effective risk and crisis communication in response to NRE situations and to facilitate the participants to acquire practical knowledge and skills for effective risk and crisis communication
Pre-requisites (Learning in Place)	Participants will be expected to have experience in interacting with healthcare professionals such as medical doctors and nurses and to have fundamental knowledge in radiation protection principles
Learning Outcomes	At the end of this Module participants will be able to: • Describe communication, with particular reference to risk and crisis communication • Explain the principles and strategies of effective communication • Discuss public perception of risk • Adjust effective communication style to different social and economic background and regulatory framework • Describe the role of medical physicists in the multi-disciplinary NRE response team • Recognize the barriers to risk communication, such as the lack of communication before NRE, radiation quantities and units, insufficient evidence of low-dose risk assessment, and public perception of risks
Core Knowledge and Competencies	Module 14 will enable the learner to acquire knowledge in: • The fundamental knowledge of risk communication • The basic techniques of risk communication • The 3Cs (consensus, care, crisis) of communication • The principles of communicating risk to the public • Various communication tools such as social media • The role of risk communication as a component of risk analysis (the other components are risk management and risk assessment) • Interview strategies / guidelines
Teaching and Learning Activities	Lecture, role play, video clips, case studies
Reading list	[1]. INTERNATIONAL ATOMIC ENERGY AGENCY, Communication with the Public in a Nuclear or Radiological Emergency, Emergency Preparedness and Response, EPR-Public Communications, IAEA, Vienna, 2012 [2]. INTERNATIONAL ATOMIC ENERGY AGENCY, Manual for first

responders to a radiological emergency, Emergency Preparedness and Response, EPR-First Responders, IAEA, Vienna, 2006
[3]. WORKING GROUP ON PUBLIC COMMUNICATION OF NUCLEAR REGULATORY ORGANISATIONS, Nuclear Regulatory Organisations, the Internet and Social Media: The What, How and Why of Their Use as Communication Tools, OECD, NEA, 2014
[4]. ENVIRONMENTAL PROTECTION AGENCY, Communicating Radiation Risks: Crisis Communications For Emergency Responders, EPA 402-R-07-008, EPA 2007, Revised June 2008
[5]. AGENCY FOR TOXIC SUBSTANCES & DISEASE REGISTRY, A Primer on Health Risk Communication, ATSDR, 1987
[6]. SCOTLAND & NORTHERN IRELAND FORUM FOR ENVIRONMENTAL RESEARCH, Communicating understanding of contaminated land risks, SNIFFER, 2010
[7]. COVELLO, V. T., Risk communication, radiation, and radiological emergencies: strategies, tools and techniques, Health Phys. 2011; 101(5): 511-530
[8]. RISK AND REGULATION ADVISORY COUNCIL, A Practical Guide to Public Risk Communication: The Five Essentials of Good Practice, RRAC, 2009
[9]. ROPEIK, D., Risk communication: More than Facts and Feelings, IAEA Bulletin 2008; 50-1: 58-60
[10]. CENTERS FOR DISEASE CONTROL AND PREVENTION, Crisis Emergency & Risk Communication, CDC, 2012
[11]. INTERNATIONAL ATOMIC ENERGY AGENCY, Health in Disasters: A Science and Technology Studies Practicum for Medical Students and Health Care Professionals, IAEA (in preparation)

Excerpt from interviews with medical staff at Fukushima Medical University

“Hopefully our approach will be applicable to other populations in the future. For example, what will happen if a nuclear disaster breaks out in another country? What happens if biological or chemical terrorism happens somewhere? As you know, there is a similarity on public responses between nuclear and biochemical threats. The agents are invisible, and public responses can be overwhelming. We have a lot to apply our experiences to similar accidents in the future”.

4. Reading List

[1]. ACKEY, H., YAGER, R.E., The impact of a Science/Technology/Society teaching approach on student learning in five domains, Journal of Science in Educational Technology 2010;(19):602-611.
[2]. AOKI, T., Experiencing ethnicity as a Japanese Canadian teacher: Reflections on a personal curriculum, Curriculum Inquiry 1986;13(3): 321-335.
[3]. AOKI, T., Rethinking curriculum and pedagogy. Kappa Delta Pi Record 1999, Summer, 180-186.
[4]. CHHEM, R. K., CLANCEY, G. K., (Eds.) (2014). Health in Disasters: A Science and Technology Studies Practicum for Medical Students and Healthcare Professionals. (In preparation)

[5]. HACKET, E. J., AMSTERDAMSKA, O., LYNCH, M., WAJCMAN, J., (Eds.), The Handbook of Science and Technology Studies (3rd ed), MIT Press, London, UK, 2008.
[6]. MANSOUR, N., Science-Technology-Society (STS): A new paradigm in Science education. Bulletin of Science, Technology & Society 2009;29(4):287-297.
[7]. MINGAT, A. (1998). The strategy used by high-performing Asian economies in education: Some lessons for developing countries". World Development, 26(4): 695-715.
[8]. NATIONAL SCIENCE TEACHERS ASSOCIATION, Science/Technology/Society: A new effort for providing appropriate science for all. In YAGER, R., (Ed.), What research says to science teacher: the science, Technology & Society Movement (3-5), Washington DC, National Science Teachers Association. Vol. 7, 3-6 (1993).
[9]. RIP, A., STS in Europe, Science, Technology and Society 1999;4(1):73-80.

5. Additional Resources

[1]. FMU-IAEA International Academic Conference Archives of presentations http://www.fmu.ac.jp/radiationhealth/conference-workshop/, Accessed on May 15, 2015.
[2]. STIEGHORST, C., HAMPEL, G., Communication with the Public after Fukushima – Social Media and Conventional Media. http://www-pub.iaea.org/iaeameetings/cn224p/Session10/Stieghorst.pdf, Accessed on May 15, 2015.

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