

# ROLE OF MEDICAL PHYSICIST IN RADIOLOGICAL EMERGENCY AND MANAGEMENT

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**Abstract**— This paper presents an overview of the International Conference on Radiological Emergency Management [ICONRADEM-2019], hosted by the Department of Radiological Physics, SMS Medical College and Hospitals, Jaipur, India, during 9-11 February 2019, with 400 delegates from 13 countries.

**Keywords**— radiological emergencies, management of radiological emergencies

## I. BACKGROUND

Ionizing radiation has found its use in almost every sector in the current times; from healthcare and medical field to construction and infrastructure industries, from geological and historical researches to study of ocean currents and water tables, from increasing the food production through genetic modification to increasing the shelf life of the agricultural produce. Such vast applications highlight the need of trained workforce to avoid accidents and unprecedented incidents. In India nuclear power is the fifth-largest source (3%) of electricity in India. As of March 2018, India has 22 nuclear reactors in operation in 7 nuclear power plants, having a total installed capacity of 6,780 MW. More than 4000 X-Ray diagnostic centers with about 80000 X ray machines, 4000 CT Scanners are functional in our country and thousands of people undergo X-Ray and CT scans every day. More than 400 radiotherapy centers and 150 nuclear medicine centers are functioning in India and using high activity radiation sources, delivering very high radiation doses for treatment.

In the present era of information revolution, misleading social-media articles, unreliable information sources on the internet, lack of knowledge about radiation among the masses are some of the major factors that have lead to unnecessary resistance and fear in the public. Such a scenario has highlighted the need for creating awareness in the society and educating them about the justified and beneficial uses of radiation. This task of instilling trust in the public can happen only when the radiation professionals, scientists and researchers are well-trained to deal with any adverse situation and have the confidence in their own abilities. However, with the multitude of applications, radioactive isotopes of varying strengths and physical forms are being extensively used and though the spectrum of benefits has widened, the probability of hazards has also increased. This necessitates development in teaching and training facilities to keep the radiation professionals updated in terms of safety and security measures.

Although nuclear emergencies are rare occurrences, in past we have witnessed to certain nuclear and radiological accidents which have instilled fear in the masses due to their long-term effects. Beginning with the atom bomb in Japan during the World War II, to the Chernobyl Nuclear Disaster in 1986 in Ukraine and the Fukushima accident in Japan in 2011, an air of confusion and distress surrounds the use of nuclear power and radiation. Though trained professionals deal with the safety and protection of the radiation sources and the people, but human error, negligence or even ignorance can lead to such high potential disasters. In India, the incident in Mayapuri, New Delhi in 2010 is an example of a small negligence turning into a radiological emergency and leading to the first death due to radiation injuries in India.

The need of the hour is to frame proper policies and mitigation protocols under the supervision of experts of radiological emergency management. Medical Physicists and Radiation Safety Professionals are trained to deal with any kind of radiological or nuclear emergency and hence are the key persons when it comes to efficient enactment of all-round radiation safety and protection. Also, the role of medical physicists is of pivotal importance in the hospital management of an emergency but is often unrecognized. Looking to the need and to emphasize role of medical physicists & health workers in the eventuality of nuclear and radiological emergency and the need to rekindle and reckon the role of medical physicists as emergency managers is what led to the idea of organizing International Conference on Radiological Emergency Management [ICONRADEM-2019]. The department of Radiological Physics, SMS Medical College and Hospitals, Jaipur hosted this conference during 9-11 February 2019 wherein 400 delegates from 13 countries participated. The theme of the conference was 'Better the awareness and preparedness: Better the emergency management'.

## II. CONFERENCE OBJECTIVES AND ORGANISATION

ICONRADEM-2019 focused on bringing knowledgeable professionals from across the world on a common platform to discuss, dispense and deliberate on radiological safety and protection. The conference dealt with the various myths and misconceptions surrounding the use of ionizing radiation; safety in the medical use; protection of the staff, patients and general public and emergency preparedness in case of a radiological emergency. Currently the role of

medical physicist is confined to radiotherapy, diagnostics and research; but this conference served as a platform to rekindle and reckon their role as radiation safety experts and will be instrumental in dissolving the fear and stigma.

The main objectives of the conference at a glance were,

- To create awareness amongst the professionals, the general public and the media; regarding radiological technologies and their justified use
- To strengthen the awareness regarding possible safety and security issues associated with these technologies
- To eliminate the stigma concerning radiological procedures and professions
- To prepare and train medical/ radiation physicists and medical professionals to support the response to radiological emergencies at the hospital or at a regional or national level
- To promote safe application of radiation in healthcare, industry and applications in other fields for the welfare of mankind
- To impart skills to hold responsibilities and be leaders in case of radiological accidents/ emergencies
- To increase the coordination between the various medical professionals and other communities in face of a radiological emergency
- To promote cooperation and sharing of knowledge and expertise amongst the various scientific communities and agencies.

This conference was organized in cooperation with IAEA (International Atomic Energy Agency), under the auspices of AFOMP (Asia-Oceania Federation of Organizations for Medical Physics) and RUHS (Rajasthan University of Health Sciences) and was endorsed by AAPM (American Association of Physicists in Medicine), IOMP (International Organization for Medical Physics), MEFOMP (Middle East Federation of Organizations for Medical Physics), INS (Indian Nuclear Society), AMPI (Association of Medical Physicists of India), AERB (Atomic Energy Regulatory Board), NMPAI (Nuclear Medicine Physicists Association of India), IARP (Indian Association for Radiation Protection), INSA (Indian National Science Academy) and ISRB (Indian Society for Radiation Biology). DAE (Department of Atomic Energy), Government of India was a knowledge partner.

The inaugural programme was held at 'Sushrut Sabhagar', SMS Hospital auditorium presided by Dr Sudhir Bhandari, Principal and Controller, SMS Medical College and Hospitals, Jaipur. Dr Pradeepkumar K S, Distinguished Scientist, Head, Radiation Safety Systems Division and Associate Director Health, Safety and Environment Group, Bhabha Atomic Research Centre Mumbai was the Chief Guest. Mr. V K Jain, Outstanding Scientist and Director Nuclear Power Corporation India Ltd. [NPCIL], Rawatbhata Atomic Power Plant [RAPP] Kota was Guest of Honor and Ramon De La Vega, Emergency Preparedness Coordinator, IAEA was Special Guest for the inauguration.

Dr. DS Meena, Medical Superintendent, SMS Hospital Jaipur, Dr Arun Chougule, Organizing Chairman, and Mrs. Rajni Verma Organizing Secretary also addressed the gathering.

An exhibition on Radiological Safety, Bio-dosimetry, Emergency response and various radiation monitoring systems was arranged by BARC (Bhabha Atomic Research Centre), Mumbai, AMD (Atomic Minerals Directorate), Jaipur and RAPP, NPCIL (Rajasthan Atomic Power Plant, Nuclear Power Corporation of India Ltd), Kota team for public awareness. An Emergency Response Mobile unit was also at display.

### III. CONFERENCE SCIENTIFIC PROGRAMME

The scientific programme was started with a key-note address by Dr Pradeepkumar K S on Development of Systems and Methodologies for National level preparedness for response to Nuclear and Radiological emergencies/ threats. He has given overview of readiness of India to tackle any kind of nuclear and radiological emergency. He also described and showcased the various equipment developed and laboratories setup, trained and experience human resources and coordination with national disaster response management team to deal with an eventuality.

More than 40 invited talks from renowned radiation safety and management experts and 70 papers from radiological professionals and young researchers on various related fields were the major highlight of the conference. The invited talks covered all relevant topics during the sessions titled introduction to radiological emergencies and incidents, radiation emergencies in radiotherapy and radio-diagnosis, radiation effects and emergency preparedness, IAEA session, cancer epidemiology and radiobiology, potential threats in radiological emergencies - response measures, radiological disaster management and role of armed forces, radiation dosimetry & preparedness for radiological emergencies, Incident reporting, radiation protection & legislations and safety considerations, emergencies & their management in nuclear medicine.

A plenary talk on IAEA safety standards on preparedness and response to nuclear or radiological emergencies by Ramon de la Vega was the highlight of the second day. He gave details of strategies, training programmes, manuals and documents developed by IAEA for member states to tackle with nuclear and radiological emergencies. He described in detail the support and guidance IAEA has provided to member states in this field and the coordination with member states for safeguarding for any kind of eventually and better use of ionising radiation for human welfare. Two teaching sessions for students and young professionals were also arranged, which was attended by not only students, but also majority of the

delegates very enthusiastically. Very active interactions, critical comments and strong discussions made this conference an outstanding one.

We are highlighting some of the invited talks.

The invited talk by Prof. Brad Cassel, radiation expert from Australia titled 'Discussion of a real-time large scale radiation exercise and the lessons learned' emphasized the possibility to properly plan for large-scale radiation events without testing the written plans and response arrangements first hand. His talk examines a government exercise using a simulated release of a radiological agent in a football stadium. An analysis of the lessons learned was discussed and examples of how such lessons translated into revised government arrangements and enhanced standard operating procedures were provided.

The talk by Prof. Franco Milano of University of Florence on 'Medical physicists and their contribution to radiation protection in emergency exposure situations' has referred IAEA publication 1578 radiation protection and safety of radiation sources: International Basic Safety Standards issued in 2014 Medical Physicists were mentioned as specific persons that should have specified responsibilities in relation to protection and safety. He further informed within the same publication 1578 emergency exposure situation are also considered. In many countries the Governments thought specific national organizations have ensured that an integrated and coordinated emergency management system is established and maintained. The international community developed a series of procedures and schemes to face and mitigate the effect on humans and environment of nuclear accidents or incidents. He put forth that a Medical Physicist has a cultural background to deal with many of the points (knowledge of physical law and dosimetry, expertise in radiation detection...) that are needed to be professionally active in radioprotection. Very often Medical Physicist acts for their institution as radiation protection adviser who are also exclusively deputed to radioprotection. In the presentation opinions on the operational role of Medical Physicists, based on the personal experience, were expressed considering events with different level in the international nuclear event scale (INES).

The presentation by Prof. Hugh Wilkins, Vice President, International, Institute of Physics and Engineering in Medicine, UK on "contributions to a global programme developing Medical Physics support for nuclear or radiological emergency response" has underline the training and involvement of Medical physicists in tackling the nuclear and radiological emergency. He referred to the 2016 draft revision of the IAEA safety glossary which defines the emergency as a non routine situation that necessitates prompt action, primary to mitigate a hazard or adverse consequences for human life and health, property and the environment; and emergency arrangements as the

integrated set of infrastructural elements made in advance that are necessary to provide the capability of performing a specified function or task required in response to a nuclear or radiological emergency. These elements may include authorities and responsibilities, organization, coordination, personnel, plans, procedures, facilities, equipment or training. These are significance undertakings, and require a team having appropriate knowledge, skills and experience for successful emergency response. He re-emphasized that clinically qualified medical physicist working in radiation protection, nuclear medicine, diagnostic radiology and radiotherapy have substantial knowledge, skills and experience relevant to medical exposure to radiation, further they have a good understanding of radiological sciences and are familiar with concerns of people exposed to ionizing radiation. They have access to radiation detection instrumentation and contacts through various networks which can facilitate emergency response. They are able to place radiation doses and risks in perspective and know what the numbers mean. Such skills are likely to be in short supply in nuclear or radiological emergency (NRE) response. Whilst such attributes are a necessary ingredient, they are not on their own sufficient for successful NRE response. From his presentation it's clear that medical physicists play leading role in response to a variety of radiation untoward events in healthcare settings, and are a potentially valuable resource in supporting NRE response in other contexts. However, in order to be effective members of the team, they need to have a good understanding of overall emergency arrangements, and their role within them.

In another important and informative talk by Ramon de la Vega, Emergency Preparedness Coordinator, Incident and Emergency Centre, IAEA Vienna, on Main challenges for an effective preparedness and response to nuclear or radiological emergencies has reiterated that nuclear and radioactive applications and facilities are subject to strong safety and security requirements. However, experience showed that, despite this, accidents or malicious acts may lead to emergencies where the population may be subjected to radiation exposure. Experience shows that nuclear or radiological emergencies may have important consequences and are complex to manage, requiring strong preparedness activities to deliver sound response. In his opinion there are aspects that make this kind of emergencies being particularly challenging as:

- They happen rarely, which makes more difficult keeping the response arrangements effective;

- Radiation is not well known at all by the public and even by managers and experts in different technical or scientific fields. There is a lot of misinformation that leads to exaggerated fears that creates a tendency in emergency managers and public opinion to over-react in response to radiation related emergencies;

- These emergencies, if affecting nuclear reactors, involve complex physical phenomena. This makes assessment of the situation and likely evolution quite difficult and involving

significant uncertainties, especially during the initial phase of the emergency;

-They may produce transboundary consequences and raise significant public opinion concern at the international level.

All these features raise relevant challenges to proper preparedness for and response to nuclear or radiological emergencies, as the recent experience of Fukushima has shown, therefore he advised to conduct training programmes for medical physicists in different parts of world to deal with such an eventuality.

Prof. A. Fukumura from National Institutes for Quantum and Radiological Science and Technology (QST), National Institute of Radiological Sciences (NIRS), Japan presented his experience in the “FUKUSHIMA DAI-ICHI nuclear power plant accident – Challenges to medical physicists in Japan”. He made it clear that medical physicists (MPs) and radiological technologists having in-depth knowledge of radiation dosimetry, including medical dose measurements and estimation. They are possibly expected to be potentially able to support and involved in nuclear and radiological emergency (NRE) situation. However, in a major NRE event such as Fukushima Dai-Ichi nuclear power plant accident, these professionals can face many kinds of difficulties that they have to deal with, without enough knowledge and experience in the NRE situation. He informed that after the Fukushima accident, the MPs of NIRS were involved in primarily three kinds of activities such as (a) development of external dose estimation system for Fukushima residents, (b) a survey on actual situation of Japanese MPs with regards to the accidents and (c) collaboration with IAEA to develop a training package for MPs in support of NRE. His presentation mainly described results of the survey on actual situation of Japanese MPs with regards to the accidents. One year after the accident, the survey was carried out for the members of Japan Society of Medical Physics (JSMP) to obtain information on activities and role of MPs for the accident. The survey consisted of simple questionnaire through internet. The principal results of his study are as follows:

The 43 % of respondents were involved in activities related to the accidents and the principal activities of MPs were:

1. Radioisotope contamination survey for residents,
2. Risk communication to the public and
3. Radioactivity measurements in environment.

The respondents thought that MPs should contribute to risk communication to the public and preparation of FAQ and/or material.

His study results showed that the main roles of MPs for the accidents are not only radiation measurements but also risk communication to the public. Even though the external dose estimation has shown the maximum dose of 19 mSv under a limited condition, still residents feared the effect of low dose radiation excessively. Some of the residents worried about the future health of their children and refusal

to be exposed to X-ray in a medical examination. The study reports that the risk communication to the public was quite important and then MPs are expected to provide suitable scientific information with their expertise. He recommended for multidisciplinary training and/or text book including communications as well as radiation protection, biology and ecology etc. should be prepared for MPs to play an important role in a major NRE event.

In a presentation by Dr. Dhruv Kumar Nishad from Institute of Nuclear Medicine & Allied Sciences (DRDO), GoI on “alternative strategies for radioactivity decontamination” explained the radioactive contamination as unwanted radioactive materials on or inside the human body. Radioactive contamination usually spreads when radioactive material is released into the environment and leads to the exposure of living beings and non-living area. Removal of radioactive elements from an individual, object, or place is called decontamination. He emphasized that radioactive material from the body should be removed as soon as possible to lower the risk of harm from radiation exposure and reduce the chance of spreading contamination to others. At INMAS (DRDO) they have developed many novel, effective and economical approaches for radioactivity decontamination from skin, wound, body orifices and non living surfaces. Decontamination products developed by INMAS includes; Dermadecon (skin decontamination kit), Shuddhika (skin decon field kit); Remocon decontamination wipes, Peel off formulations, decontamination lotions and decontamination gel formulations. Apart from radioactivity decontamination many approaches for management of radioactive spill and contaminated biofluid/biowaste management has also been developed by his group. They have performed detailed safety and efficacy of these approaches and established through in vitro and in vivo studies and proven to have potential as the alternate strategies for radioactivity decontamination.

Dr N K Chaudhury from Biodosimetry Division, Institute of Nuclear Medicine and Allied Sciences, DRDO, GoI has presented his experience in “Biodosimetry preparedness for radiological emergency in Indian context”. He explained that radiation incidents or accidents depending upon the nuclear accident magnitude scale have long lasting impacts on society and country. The effective management requires availability of all necessary resources and even though a single country may not be able to manage. He mentioned that India with large population and expanding nuclear capability, management of radiation emergency therefore will be most difficult and complex even if all necessary infrastructures are in place. Biodosimetry laboratories have special role in post accident management. Medical management of exposed individuals will require information on absorbed radiation dose at the earliest. This diagnostic information will guide clinician for treatment, prediction of both short and long term health consequence absorbed radiation and counseling. In his viewpoint

biodosimetry lab will estimate absorbed dose to individuals by using few ml of peripheral blood samples for processing and the method is dicentric chromosomal assay (Gold standard). Simultaneous assessment of clinical and hematological investigations will continue for initial treatment and confirmation of exact absorbed dose will guide clinicians for change of treatment protocol if required so that acute health effects are prevented. According to him large number of laboratories will be required and networking both within and internationally, therefore biodosimetry laboratory of Institute of Nuclear Medicine and Allied Sciences, has initiated a step in this direction for enhancement medical preparedness of radiation emergency.

A panel discussion on "Role of healthcare professionals in radiological emergencies: What is done? What needs to be done?" marked the end of the scientific sessions. Prof R Ravichandran (Medical Physicist, India) moderated the panel discussion. Ramon de la Vega (IAEA), Hugh Wilkins (IPEM), Prof R Charry (Nuclear Scientist, Canada), Dr Nagesh N Bhatt (Biodosimetry expert, BARC, India) and Dr J K Bhagat (Nuclear Medicine Physician, India) were the panellists. From the discussions it is clear that in case of nuclear and radiological emergency, the role of trained medical physicists for effective and efficient mitigation of radiation hazards is indispensable.

The scientific proceedings of the conference have been published as the RUHS Journal of Health Sciences (RUHSJHS) supplementary abstract issue. (Available at: [www.ruhsjhs.in](http://www.ruhsjhs.in)). An e-souvenir of the conference was also released.

#### IV. CONFERENCE AWARDS AND CONCLUSION

A best oral presentation session which included 9 oral presentations and a best poster presentation session which included 12 poster presentations were an important part of the scientific programme. This was arranged to encourage and motivate students and young professionals to involve actively and contribute in academic and research work. Two prizes each comprising of certificate of appreciation and cash award was distributed to the winners

##### Best Poster Awards:

First Prize: Ms. Akanchha Tripathi, INMAS, DRDO, Delhi  
Second Prize: Mr. Lalit Panwar, Defence Laboratory, DRDO, Jodhpur

##### Best Oral Awards:

First Prize: Mr. Sandeep Chaudhary, INMAS, DRDO, Delhi  
Second Prize: Mr. Ram Milan Sahani, Defence Laboratory, DRDO, Jodhpur

Cultural and entertainment night was arranged on first two days of the conference where students as well as professional performers showcased the rich cultural heritage

of Rajasthan. It was highly appreciated and thoroughly enjoyed by everyone.

The organizers highly appreciate the active participation, cooperation and support of the organizations IAEA, AFOMP, RUHS, AMPI, IOMP, AAPM, ICTP, MEFOMP, INS, AERB, NMPAI, IARP, INSA, ISRB, NPCIL-RAPP, BARC, INMAS-DRDO, DLJ-DRDO, IPEM and DAE-GOI and everyone involved in this conference.

ICONRADEM-2019 have enabled us to know the preparedness required for radiological/nuclear emergencies, the techniques of mitigation that already exist, the research going on across the globe to make better strategies to counter the radiation emergency effects, and the role of healthcare professionals, medical physicists, local public and administration in the face of an emergency. The role of the defense sector in managing any radiological or nuclear emergency and their research in this regard was also stressed upon.

The Medical Physicists have been very efficiently planning the radiation treatment for cancer patients, corroborating quality assurance of equipment and procedural protocols, researching on new diagnostic and treatment modalities, ensuring radiation protection and safety of patients and personnel in various streams of healthcare but have not yet taken the lead in field of radiological emergency mitigation and management. It is the need of the hour and we have tried our best to cover each and every aspect related to safety and emergency mitigation in this conference. We are confident that ICONRADEM-2019 will prove to be a milestone for the medical physics community and help us all in developing ourselves as radiation emergency experts. More such activities will be planned to nurture and promote the spirit of being an efficient radiological emergency expert to reach all medical physicists.

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Photos from ICONRADEM-2019



Dr Sudhir Bhandari Principal SMSMC Jaipur inaugurating the public awareness exhibition



Dr Pradeepkumar K S (BARC, Mumbai) and V K Jain (RAPP, NPCIL, Kota) demonstrating the emergency response and monitoring systems



Ramon de la Vega (IAEA, Austria)



Dr Brad Cassels (Australia)