

## Summary of the IAEA Technical Meeting on Radiation Protection of Patients in the New Era of Medical Imaging

4–6 March 2024

The IAEA Technical Meeting (TM) was held from 4 to 6 March 2024 in Vienna. 50 participants from a wide spectrum of health disciplines and professions involved in the medical uses of ionizing radiation, as well as the medical industry, regulatory bodies, educational and research institutions, and experts, representing 21 IAEA Member States as well as 10 international organizations, professional bodies and safety alliances, participated in the meeting.

The meeting agenda with links to the presentations is provided in Annex 1, and the list of countries and organizations represented in the meeting is contained in Annex 2.

### Meeting objectives and expected output

#### Objectives:

The objective was to exchange information among health professionals, health authorities and regulators with responsibilities in relation to medical exposures about the challenges in radiation protection of patients in the imaging practices in diagnostic, interventional and image guidance in radiotherapy procedures and to assess the needs for the development of guidance and tools.

#### Expected output:

Conclusions that provide advice on the development of and approach for the implementation of guidance and tools in radiation protection when using newer medical imaging technologies and techniques.

### Findings of the meeting

#### 1. The highest number of available equipment, newer imaging technologies and techniques

In the last decade, the availability of medical imaging technologies at the global level has been increasing continuously, leading to an increase in the number of examinations.

There are substantial newer advances in diagnostic and interventional radiology, nuclear medicine, image guidance in radiotherapy and radiopharmaceutical therapy that were not evident some years ago. Meeting highlights are as follows:

- a. Medical imaging **technologies and techniques continue to evolve very fast**. According to the available publications, since 2010, there has been **a new imaging technology using ionizing radiation on the market every five years**. New imaging technologies provide new advancements and applications in clinical practice, ensuring early disease detection, less invasive treatments, and improved patient outcomes. The results of the survey conducted among the participants before the Technical Meeting revealed that a

broad and widespread implementation of a new imaging technology in clinical practice takes an average of 10-15 years after its introduction on the market.

- b. The most common types of new imaging technologies and imaging techniques implemented in **diagnostic and interventional radiology** are photon-counting CT, dual-energy CT and CBCT scanners, and breast tomosynthesis systems.
- c. In **diagnostic nuclear medicine** whole body PET/CT scanners have become more common in clinical practice, while in **nuclear medicine therapy** there is increasing use of **Lu-177** radionuclide for treating metastatic lesions.
- d. **Image-guided radiotherapy** using 4D CBCT, gated CBCT or triggered imaging techniques have increased considerably.
- e. **Artificial intelligence** tools that can help patient dose optimization and image-recognition are being introduced at high speed.
- f. However, an **increased discrepancy between countries** or even within countries pertaining to the implementation of newer imaging technologies and techniques was noticed.

## 2. Does new era of medical imaging mean era of high patient doses?

In the 2009–2018 period, about 4.2 billion medical radiological examinations were performed annually. The collective effective dose was estimated to be 4.2 million-man sieverts (man Sv) for the global population of 7.3 billion people, resulting in an effective dose per caput of 0.57 mSv (excluding radiotherapy), making the medical exposure by far the largest human-made source of radiation exposure of the population.

One of the main concerns from the radiation protection of patients' perspective is the **increase of dose to patients from some newer imaging technologies that go against the prevailing impression that all the newer technologies provide less patient dose.**

- a. **There is increased utilization of CT and CBCT** by replacing the conventional diagnostic X ray procedures. Using CBCT in image guided radiotherapy ensures more accurate delivery of the radiotherapy treatment, but **it may contribute to increasing the patient dose** outside the treated volume.
- b. In nuclear medicine, the use of **PET/CT and SPECT/CT** has increased in the managing of chronic diseases. In nuclear medicine therapy, there is **a lack of uniform protocols for discharging patients** after radiopharmaceutical therapy with new radionuclides and a lack of patient dosimetry in this field.
- c. Expanding the **role of PET/CT imaging** in radiotherapy treatment planning, may also contribute to increasing the patient doses outside the treated volume in radiotherapy.
- d. The findings from the TM indicate that there are remaining challenges, such as:
  - **Missing policies, lack of guidelines, appropriateness criteria and audit programmes** in the new aspects of radiological imaging practices.

- **Lack of human resources in the medical imaging fields, inadequate training, and obsolete educational curricula** may impact the implementation of radiation protection requirements.

## Meeting conclusions and recommendations

This meeting was an excellent opportunity not only for the sharing of information between the experts, representatives of the international organizations, invited speakers, participants from the Member States, and the IAEA, about the status of radiation protection of patients in the new era of medical imaging, but also to assess the need for development of guidance and tools.

The new trends listed above **depict new challenges** in the radiation protection of patients, **and** they also confirm the **persistence of long lasting challenges**, such as the prevailing need for developing or revising guidance. A point was made about the importance of the collaborative effort from multiple stakeholders in providing guidance for radiation protection when using new technologies as well as for existing technologies.

**Emphasizing individual patient clinical indications** when applying the principles of justification of medical exposure, developing guidelines for imaging in clinical trials in the follow up of oncology patients or those with diseases that require recurrent imaging, acquiring knowledge and skills needed for using the advanced features of new technologies, which may have an impact on patient radiation protection, performing dose optimization in the examination procedures, and fostering cooperation between health and radiation protection authorities, were all highlighted as important observations for improving patient protection.

Efforts should be made to upgrade the regulations and guidance materials related to the new radionuclide therapies (ex. Lu-177), artificial intelligence tools and new modalities in radiotherapy (e.g. flash radiotherapy and proton radiotherapy).

All meeting participants agreed that **with the speed of developments, a shorter time frame will be needed for updating referral guidelines, optimization mechanisms, regulations, etc.**

Regarding **the use of artificial intelligence (AI)** in medical imaging and therapy procedures for better clinical outcomes and reduced doses, there is a need to develop quality assurance programmes and interdisciplinary collaboration, including on patient privacy/data security.

The Bonn Call for Action provides a framework for judging how effective the actions and initiatives reported at the meeting, as well as the non actions, are in supporting new technologies. Using Bonn's ten points for exploring essential actions in relation to strengthening radiation protection of patients in the new era of medical imaging, the following observations were highlighted:

- Revisit of the fundamental and the practical aspects of justification.
- Develop new 'holistic' metrics for dose monitoring.
- Revisit how to engage with manufacturers.
- Define, develop and promote strategic research agenda.
- Rethink medical radiation protection system formulation and its communication, particularly with reference to its poor penetration into the medical community.
- Devise and implement a well structured ethics component.
- Re-imagine benefit/harm to be positively based on patient experience.
- Identify the issues arising from the new demographics, particularly older cohorts.
- Develop a significant programme of real patient related outcomes research.
- Acknowledge some level of 'illusion' in the current formulation of benefit/harm analysis for patient related situations.

## ANNEX 1. Meeting agenda



### Technical Meeting on Radiation Protection of Patients in the New Era of Medical Imaging 4–6 March 2024

#### Monday, 4 March 2024

8:30 – 9:30	Registration at the UN Pass Office	[VIC GATE 1]
09:30 – 10:00	<b>Session 1: Opening session</b> <b>Objective:</b> <i>Introductions, welcome, and logistics</i> Opening Introductions Expectations from the meeting, scope, and program	H. Vandenhove, Director/NSRW All O. Holmberg, Co-Scientific Secretary V. Gershan, Co-Scientific Secretary
10:00 – 12:30	<b>Session 2: Setting the scene</b> <b>Objective:</b> <i>Identifying the background information about challenges in Radiation Protection in the New Era of Medical Imaging</i>	Meeting Chair: M. Rehani Rapporteur: E. Samei
10:00 – 10:40	Overview of the topic by the Meeting Chair	M. Rehani
10:40 – 10:50	WHO's role in medical radiation protection	F. Shannoun
10:50 – 11:15	<i>Break</i>	
11:15– 12:15 (10 +2 min each)	Future developments of patient radiation exposure monitoring  Challenges in the optimization of medical radiation protection: from Asian perspective  Balancing Modern Clinical Needs with Radiation Protection  Common challenges in Latin American countries with the introduction of new technologies regarding patient radiation protection issues  Exploring the future of medical radiation protection: International Perspectives on Law, Governance, and Ethics	J. Vassileva  C. H. Yeong  D. Husseiny Salama  P. Mora  J. Malone
12:15 – 12:30	Discussion	All
12:30 – 13:30	<i>Lunch break</i>	
13:30 – 15:00	<b>Session 3: Presentation by Organizations</b> <b>Objective:</b> <i>To include newer guidelines developed or</i>	Session chair: J. Vassileva Session rapporteur: O. Ciraj Bjelac

	<i>issues on radiation protection identified in technologies and procedures added in last four years, 2020-2023</i>	
8 minutes each organization followed by 2-3 minutes for discussion.	AAMP Image Gently and ISR EFOMP HERCA EANM ISRRT ICRP ESR	E. Samei D. Frush E. Boman A. Almén J. Kurth N. Pongnapang S. Gros F. Kainberger
15:00 – 15:20	<i>Coffee break</i>	
15:20 – 17:05	<b>Session 4: Presentation by participants</b>	Session chair: V. Gershan, D.Salama Session rapporteur: F. Shannoun
24 participants (Listed by the order of receiving their nominations)  4 min each PPT template  23 x 4 = 92 min	G.T. Mendez Conde (Uruguay) R. Elek (Hungary) <del>A. Mari (Italy)</del> M. Al-Olayt (Saudi Arabia) S. Noli (Saudi Arabia) S. Awasare (India) V. Artiko (Serbia) J. Cabukovska Radulovska (North Macedonia) C. Bladh (Sweden) E. van Tilburg (Netherland) A. Vodovatov (Russian Federation) L. K.Stein (Germany) E. B.Mille (Germany) H. Schlattl (Germany) H. Salem (Egypt) S. Salama (Egypt) Z. Kayun (Malaysia) A. Ayadi (Tunisia) M.E. Jaquenoud (Switzerland) A. Fik (Denmark) I. Gomola (Slovakia) B. Grieciene (Lithuania) K. Euklid (Norway) F. Simeonov (Bulgaria)	

## Tuesday, 5 March 2024

09:00 – 10:30	<b>Session 5: Radiation Protection Issues in New Technologies and Procedures in Nuclear Medicine</b> <i>Objective: Review the new technologies in the last four years and radiation protection issues detected and/or solved, upcoming challenges, and way forward</i>	Session chair: D. Paez Session rapporteur: C. H. Yeong
09:00 – 09:30	Low Dose PET Imaging using AI	K. Shi

09:30 – 10:00	New Technologies, Procedures and Challenges in Nuclear Medicine	J. Kurth
10:00 – 10:30	Discussion	
10:30 – 11:00	<i>Coffee break</i>	
11:00 – 12:30	<p><b>Session 6 : Radiation Protection Issues in fluoroscopic guided interventional procedures</b></p> <p><i>Objective: Review the new technologies in the last four years and radiation protection issues detected and/or solved, upcoming challenges, and way forward</i></p>	<p>Session chair: M. Rehani Session rapporteur: C. Rizk</p>
11:00 – 11:30	How often skin injuries happen in the FGI procedures	J. Vassileva
11:30 – 12:00	How are newer technologies impacting patient dose and stochastic risks?	M. Rehani
12:00 – 12:30	Discussion	All
12:30 – 13:30	<i>Lunch break</i>	
13:30 – 15:00	<p><b>Session 7 : Radiation Protection Issues in New Technologies and Procedures in CT</b></p> <p><i>Objective: Review the new technologies in the last four years and radiation protection issues detected and/or solved, upcoming challenges, and way forward</i></p>	<p>Session chair: D. Husseiny Session rapporteur: A Almén</p>
13:30 – 14:00		E. Samei
14:00 – 14:30	Newer technologies, auto -protocolling and AI applications	M. Kalra (remotely)
14:30 – 15:00	Discussion	All
15:00 – 15:30	<i>Coffee break</i>	
15:30 – 17:00	<p><b>Session 8 : Experience gained in the use of newer technologies for implementation of Justification in recent years and issues that need attention.</b></p> <p><i>Objective: Review the experience in use of justification tools in recent years, detection of problems, solutions developed, upcoming challenges and way forward</i></p>	<p>Session chair: P. Mora Session rapporteur: D. Frush</p>
15:30 – 16:00	The USA experience (Massachusetts General Brigham)	L. Siegel (remotely)
16:00 – 16:30	Europe experience	F. Kainberger
16:30 – 17:00	Discussion	

Wednesday, 6 March 2024

9:00 – 10:30	<p><b>Session 9: Radiation Protection Issues in New Technologies and Procedures in IGRT and use of imaging in cancer patients</b></p> <p><i><b>Objective:</b> Review the new technologies in the last four years and radiation protection issues detected and/or solved, upcoming challenges, and way forward</i></p>	<p>Session chair: O. Holmberg Session rapporteur: E. Boman</p>
9:00 – 9:30	Radiological Protection Aspects of Imaging in Radiotherapy	S. Gros
9:30 – 10:00	AI in radiotherapy	M. Carrara
10:00 – 10:30	Discussion	
10:30 – 11:00	<i>Coffee Break</i>	
11:00 –12:30	<p><b>Session 10: Closing session</b></p> <p><i><b>Objective:</b> Meeting report, summary, closing</i></p>	Session chair: O. Holmberg
11:00–11:45	Identified challenges	Session rapporteurs (~5 min each)
11:45 – 11:55	Trends observation	J. Malone
1:55- 12:25	Meeting summary	M. Rehani
12:25- 12:30	Meeting closing	O. Holmberg V. Gershan

**ANNEX 2.** List of IAEA Member States and international organizations represented in the meeting.

Represented Countries:

Bulgaria, Denmark, Egypt, Germany, Hungary, India, Lithuania, Malaysia, Netherlands, North Macedonia, Norway, Russian Federation, Saudi Arabia, Serbia, Slovakia, Sweden, Switzerland, Tunisia, Uruguay.

List of Organizations:

WHO, AAPM, Image Gently, ISR, EFOMP, HERCA, EANM, ISRRT, ICRP, ESR

Invited experts:

Madan M. Rehani, USA – Meeting Chair  
Jenia Vassileva, Bulgaria  
Chai Hong Yeong, Malaysia  
Dina Hussein Salama, Egypt  
Patricia Mora, Costa Rica  
Jim Malone, Ireland

Invited speakers:

Kuangyu Shi, Switzerland  
Ehsan Samei, USA  
Mannudeep Kalra, USA  
Lydia Siegel, USA  
Mauro Carrara, IAEA