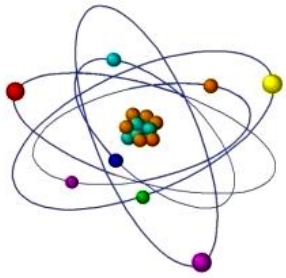
CURRENT CHALLENGES AND INTERNATIONAL ACTIONS IN RADIATION PROTECTION IN MEDICINE



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ABSTRACT**:** *Medical use of ionizing radiation is one of the most rapidly developing areas of radiationapplications. Although the access to the medical radiation technologies varies around the world, an important trend is the rapid introduction of new technologies and new techniques linked to the demand of improved diagnosis and treatment outcomes.The technological developments have led to reduction of some of the previously well-established risks, however, new risks emerged linked to the introduction of new modalities with higher doses, easier access to technologies, increased complexity of equipment, as well as the wider group of medical professionals using radiation imaging outside the traditional radiology profession and without proper radiation protection training. The challenges include justification of medical exposure, practical use of approaches for optimization, such as quality control, patient dosimetry, diagnostic reference levels, proper use of imaging in radiotherapy, all linked to the need of improved education and training of health professionals with different professions. Another important area is the need of improved safety culture and team approach to radiation protection, which compliments the safety standards and regulatory actions. Involvement of different key stakeholders is crucial for successful implementation of the international safety standards and recommendations in the medical applications of ionizing radiation.*

Key words: radiation protection, medical uses of radiation, patient protection, justification, optimization

GLOBAL TRENDS IN MEDICAL USES OF IONIZING RADIATION

Medical use of ionizing radiation is one of the most rapidly developing areas of application of radiation. Latest estimates are for around 4.1 billion of X-ray examinations performed worldwide in diagnostic radiology (including dental), 23 million image guided interventional procedures, 40 million nuclear medicine procedures, and 6.2 million radiotherapy procedures [1]. The use of radiation in medicine has brought tremendous benefits to the global population, and because of these benefits, it is expected the number of radiological procedures performed worldwide will continue to increase [2]. Although the access to the medical radiation technologies varies around the world, an important trendisthe rapid introduction of new technologies and new techniques linked to the demand of improved diagnosis and treatment outcomes. Among all modalities used in medicine, the higher dose techniques such as computed tomography (CT), hybrid imaging in nuclear medicine and fluoroscopy guided interventional (FGI) procedures have higher and increasing contribution to the population dose. An important development of medical application is the digitalization of all modalities and their connectivity through the hospital picture archiving and communication systems (PACS), radiology information systems (RIS) and hospital information systems (HIS), introduction of telemedicine and increasing role of artificial intelligence (AI) in all medical applications. An important trend is the use of imaging at different phases of the complex radiotherapy process, from producing the initial plan, performing treatment with high accuracy, and patient follow-up after treatment. All these trends have an impact on radiation protection, which is the focus of this paper. The technological developments have led to reduction of some of the previously well-established risks and radiation protection priorities in the past, such as a better protection of medical staff and reduced individual staff doses, improved awareness andtraining, improved safety features of equipment and access to dose reduction techniques. At the same time however, new risks emerged linked to the introduction of new modalities with higher doses, easier access to technologies, increased complexity of equipment placing demand on the education and training, as well as the wider group of medical professionals using radiation imaging outside the traditional radiology profession, such as cardiologists, surgeons, vascular surgeons, urologists, etc. All these changed in the benefits and risks place some new challenges and issues that require timely actions at international and regional level, which will be shortly described further.

CURRENT CHALLENGES IN RADIATION PROTECTION IN MEDICINE

Justification of medical exposure is one of the areas providing continuous challenges. According to published studies, a significant fraction (20-50%in some areas) of medical imaging procedures is not well justified, meaning performed without net benefit for patient [3]. This unnecessary part of imaging contributes dose and risk to the patient, but not contributing sufficient potential benefit. Since 2007, the IAEA organized a number of technical meetings and consultancies with the Member States, in which the issues related to justification, have been extensively discussed, and actions needed identified. The difficulties are related to the topic being not just radiation protection, but strongly belonging to the medical domain, a complex issue with many contributing factors, that requires a holistic approach and cooperation of many stakeholders – health authorities, professional bodies, radiation protection authorities, health insurance, as well as patients who are in the centre of care. The barriers are linked to the lack of awareness, self-referral or self-presentation, practicing defencing medicine, or a variety of legal, financial and social pressures. The solutions identified include increased awareness, use of referral guidelines for imaging as required by the International Basic Safety Standard (BSS) [4], and use of clinical audit with involvement of professional societies [3,4, 5].

Another important direction of radiation protection work is optimization of radiation protection, which, according to the International BSS, means management of the radiation dose to the patient commensurate with the medical purpose [4]. There is evidence from published literature that much imaging is not optimized, e.g. giving higher dose than necessary, thus contributing dose and risk to the patient unnecessary [6-8]. The international BSS and the accompanying IAEA Safety Guide SSG-46 [5] provide a solid basis for improving optimization through the utilization of different tools: quality assurance and quality programmes, patient dose assessments and establishment and utilization of diagnostic reference levels (DRLs), optimization of clinical protocols by best use of equipment features and dose saving techniques, and integration of optimization into the clinical audits [4, 5].

A key role in optimization plays the clinically qualified medical physicists who are responsible for calibration and dosimetry and should be involved in the clinical optimization team together with medical radiological practitioners and medical radiation technologists (radiographers) [4, 5].

Lack of proper justification and optimization is documented also in the use of image guided radiotherapy (IGRT) as an essential part of the modern therapy, used to delineate targets and normal tissue, in addition to in-room imaging for the purpose of adjusting for target motion or positional uncertainty [9]. While the radiotherapy treatment doses are targeted at the tumour, the doses from imaging are deposited across much larger volumes within the patient and have the potential to give significant cumulative doses to patients and have become a cause for concern. If IGRT is used frequently and the imaging process is not optimised, the doses to organs and tissues outside the planning target volume could be high, and this can also contribute to increase of the dose delivered to the tumour over the course of treatment. Thus, justification and optimization of the use of imaging in radiotherapy are of utmost importance and linked to availability of standards and guidance, as well as appropriate training of radiotherapy staff.

Unintended and accidental exposure of patients happens due to variety of reasons, many linked to human errors but mostly due to systematic problems. Over the last three decades, at least 3000 patients have been affected by radiotherapy incidents and accidents, and the UNSCEAR concluded that radiation accidents involving medical uses have accounted for more deaths and early acute health effects than any other type of accident [1]. The prevention of unintended and accidental medical exposure includes improved procedures and safety rules, use of incidence reporting and learning, and also improved training of staff. The IAEA Safety reporting and learning online systems Safety in Radiation Oncology (SAFRON) (http://rpop.iaea.org/SAFRON) and Safety in Radiological Procedures (SAFRAD) (http://rpop.iaea.org/SAFRAD) provide opportunities for free learning from incidents that happened in other clinics and assessment of risks at introduction of new techniques. Guidance for incident prevention and mitigation in case of incident are provided in a number of IAEA publications [4, 5].

A new issue recently recognised to need more focus and further studies, is the increasing number of patients who undergo frequent imaging. The recent estimatesare for around 0.9 million patients globally who cumulate radiation doses above 100 mSv, where evidence exists for the cancer risk elevation. Recurrent radiological imaging is used for managing various health conditions and chronic diseases such as malignancies, trauma, end-stage kidney disease, cardiovascular diseases, Crohn’s disease, urolithiasis, cystic pulmonary disease [10-12]. The solutionto find a balance between the benefit of using imaging for these patients and the associated radiation risks, would be to holistically apply improvement of technologies to reduce individual doses, improve clinical appropriateness and justification pathways, and apply specific optimisation tailored to the clinical condition and patient habitus.Actions on this challenge requires involvement of many different stakeholders.

A big challenge is the lacking regulatory system for radiation protection of patients in line with the international BSS, or when it exists, the week framework for the implementation of the regulatory requirements. The IAEA consultancies revealed a number of areas that need strengthening in this regard, including the need of stronger requirements for involvement of clinically qualified medical physicists and their education, training and certification;implementation of a national strategy for education and training in radiation protection and educational standards; implementation of the concept of DRLs and optimisation in diagnostic and interventional procedures; lack of proper quality control programme and calibration of equipment; improved access to referral guidelines for imaging and improved communication and cooperation between the regulatory bodies, health authorities and professional societies.

CONCLUSIONS

Many elements should be in place to successfully respond to the increasing challenges in radiation protection of patients. They include improved access to modern dose reduction technologies, a robust quality assurance and quality control programme, comprehensive training programmes for all health professionals involved in medical applications of ionizing radiation, proper legislation in line with the international standards and good practices, and improved safety culture and teamwork. Both top-down and down-to-top approach should be practiced with the goal to improve radiation protection of patients and medical staff, and the cooperation at all levels is crucial for the success. The IAEA provides safety standards, guidance, training and information resources to support this process. All these resources are freely available from the publcwebsite of the IAEA on Radiation Protection of Patients, http://rpop.iaea.org.

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