# Summary of the IAEA Technical Meeting on Radiation Exposure of Patients from Recurrent Radiological Imaging Procedures, held 4-6 March 2019 at IAEA Headquarter, VIC, Vienna

The IAEA Technical meeting was attended by 53 participants from 26 Member States, international organizations and professional bodies: ICRP, WHO, UNSCEAR, ISR, ISRRT, IOMP, ESR, Image Gently, and DITTA, representing a spectrum of specialties – radiologists, medical physicists, medical radiation technologists, radiation biologists, radiation epidemiologists, manufacturers, radiation protection specialists, and a patient champion from the WHO Patients for Patient Safety network.

The following report summarizes the findings, conclusions and recommendations agreed by participants at the meeting.

Medical imaging and in particular computed tomography (CT) has provided immense benefits in diagnosis and follow-up of disease and management of many health conditions through diagnostic imaging and X ray guided interventional procedures. Millions of patients benefit from X ray examinations each single day. The IAEA initiated a Smart Card project in 2009 with the purpose of providing a methodology for tracking radiation exposure of patients. Currently, tracking has become routine in many countries and systems are available commercially to provide radiation exposure history of patients.

The benefits of tracking have been documented in publications in previous years for strengthening the process of justification and optimization of radiation protection. The use of tracking to assess cumulative radiation dose of individual patients has increased in recent years. Despite the well-known limitations of effective dose, there is currently no better

metric that can relate to the overall risk. Most automatic systems provide effective dose estimates for patients and some are also providing estimates of organ doses.

Publications in the scientific literature have shown that patients undergoing diagnostic and interventional radiological procedures can receive cumulative effective doses (CED) in the range of 50-500 mSv but it was not known if this is a wide spread phenomenon or restricted to isolated situations. Following assessments carried out at the Massachusetts General Hospital (MGH) in Boston, wherein several thousands of patients were found to have CED ≥100 mSv, a joint effort was launched by IAEA and MGH to assess the situation in other parts of the world. In the preparation of the meeting, nominated participants were asked to bring data from their hospitals and countries.

The meeting discussed results available to date and deliberated on interpretation and recommended actions.

It was observed that the number of patients with CED ≥100 mSv is much larger than previously known. Studies were presented in the meeting with data from 2.5 million patients who underwent imaging (mostly CT) procedures over periods of between 1 and 5 years in different hospitals. It was found that more than 1% of patients had CED greater than 100 mSv. The data available was from hospitals in Bulgaria, Croatia, Czech Republic, Egypt, Finland, Greece, Italy, Lithuania, Qatar, Slovakia, Spain, Switzerland, Thailand, UAE and USA. The patients who receives such high cumulative radiation doses typically need radiological imaging exams for multiple clinical indications, for follow-up of malignant disease or chronic conditions. The justification of these exams was not further examined during the meeting and this requires further research. Although the data presented in the meeting is awaiting publications, most conservative estimate shows that at least 0.5% of patients who undergo CT exams are likely getting radiation dose over 100 mSv in a single year. About 10 to 20% of these patients are below 50 years of age.

It was reaffirmed that there is a high degree of confidence among radiation epidemiologists and appropriate bodies for strong evidence on radiation effects at the level of effective dose of 100 mSv or more, although some consider the evidence starting at 50 mSv also to be convincing. Even considering the large uncertainties associated with the estimation of effective dose, at the level of 100 mSv of effective dose or higher, many organs receive high doses at which radiation risk has been demonstrated to increase.

It should be noted that the many findings presented in this meeting might not apply to several low- and lower-middle income countries from where data is not yet available and where the access to CT and newer technologies may not be as readily available as in upper-middle or high-income economies.

While it may be that multiple radiological imaging is justifiably needed in many clinical indications, this creates increased responsibility of authorities, manufacturers and health professionals to develop and implement suitable strategies and solutions with focus on radiation protection for this specific group of patients.

## Main points and Call for Action

1. This being a relatively new observation, there is a need to do further work to fully understand the extent of recurrent exposures, the doses involved and whether any of these exposures could be avoided or further optimised.
2. Important actions are needed to make referring physicians aware of the situation. They should also be reminded of the role and responsibilities they share with other health care providers in relation to radiation protection of patients. This also requires further strengthening and harmonizing of education and training of radiological medical practitioners, medical radiation technologists and medical physicists.
3. Models should be developed for predicting what patients with different clinical conditions are likely to reach high cumulative dose range.
4. There is a need for professional medical societies to develop, adopt or improve appropriateness criteria/ referral guidelines for patients who require multiple and/or long-term imaging studies. This requires a multi-disciplinary consensus to be achieved between the radiological medical practitioners and referring physicians of different specialities.
5. When a series of procedures can be reasonably foreseen, the risks and benefits of the entire series should be considered in the justification process. In these cases, the consideration of alternative non-ionizing techniques is especially important.
6. There is a need to encourage, whenever appropriate, use of non-ionizing imaging modalities (e.g. ultrasound or MRI) in general and also for image guided interventional procedures in particular.
7. Special consideration is needed on optimization of radiation protection for patients with multiple imaging by utilizing the concept of diagnostic reference levels tied to defined clinical imaging task.
8. Industry can play an important role by producing CT scanners capable of achieving adequate image quality at sub-mSv radiation dose. This seems to be an achievable goal through hardware and software development.
9. There should be consideration of inclusion of the concept of patient cumulative radiation dose in radiation protection framework and standards.
10. There is a need to develop a metric that retains the useful aspects of the effective dose but addresses its limitations for use in individual patients. Besides other aspects, it should be related to body habitus, age and gender.
11. There should be standardization and validation of methods to estimate the patient dose in automatic dose monitoring systems. Conversion factors to estimate organ dose should be standardized.
12. Alert values for cumulative radiation exposure of patients should be set up and introduced in dose monitoring systems. Color scales could be adopted for alert values.
13. There is a need for health authorities to implement policies for applying technological solutions for patient exposure monitoring and integrating them into the electronic health records.
14. IAEA should consider developing a position statement on this important topic in cooperation with other relevant bodies.