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Overview of ICRP Committee 3 'Protection in Medicine'

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Abstract–According to the 2011–2017 strategic plan, Committee 3 develops recommendations and guidance for protection of patients, staff, and the public against radiation exposure when ionising radiation is used for medical diagnosis, therapy, or biomedical research. This paper presents an overview of the work that Committee 3 has accomplished in recent years and describes its current work. The International Commission on Radiological Protection reports dealing with radiological protection in medicine from 2000 to the present cover topics on education and training in radiological protection; preventing accidental exposures in radiation therapy; doses to patients from radiopharmaceuticals; radiation safety aspects of brachytherapy; release of patients after therapy with unsealed radionuclides; and managing radiation dose in interventional radiology, digital radiology, computed tomography, paediatrics, cardiology, and other medical specialties. Current work deals with radiological protection in ion beam therapy, occupational protection in brachytherapy, justification in imaging, radiological protection in cone-beam computed tomography, occupational protection in interventional procedures, diagnostic reference levels for diagnostic and interventional imaging, and an update of an earlier publication on doses to patients and staff from radiopharmaceuticals. Committee 3 is also involved in preparation of a document on effective dose and its use in medicine.

Keywords: Radiological protection; Diagnostic; Interventional radiology; Nuclear medicine; Radiation therapy

This paper does not necessarily reflect the views of the International Commission on Radiological Protection.

1. INTRODUCTION

Committee 3 of the International Commission on Radiological Protection (ICRP) is concerned with protection of persons and unborn children when ionising radiation is used for medical diagnosis, therapy, or biomedical research. According to the 2011–2017 strategic plan, Committee 3 develops recommendations and guidance for protection of patients, staff, and the public against radiation exposure in medicine. For the 2013–2017 term, Committee 3 (http://www.icrp.org/icrp_group.asp?id=9) is composed of 16 members, seven of whom are new to the Committee. The members have expertise in different areas of radiological protection in medicine (medical physics, nuclear medicine, radiology, and radiation oncology). The primary qualification for membership is demonstrated expertise in radiological protection. The membership of the committee demonstrates a wide geographical distribution: Belgium (P. Scalliet); Canada (S. Demeter); China [P. Khong (Hong Kong) and B. Yue]; France (M. Bourguignon); Germany (R. Loose); India-Austria (M.M. Rehani); Japan (Y. Yonekura); the Republic of Korea (K. Kang); Spain (P. Ortiz and E. Vañó); Sweden (K.Å. Riklund); the UK (C. Martin); and the USA (K. Applegate, L. Dauer and D.L. Miller).

International organisations and stakeholders are encouraged to propose topics of interest for new publications. In addition, a new mechanism, introduced at the 2013 ICRP symposium, provides opportunities for symposium participants to provide input on suggested topics to the Commission's committees. The members of each committee review the proposals relevant to their committee's area of responsibility, and evaluate the need to produce reports on specific topics. Each committee forwards its recommendations to the Main Commission of ICRP. The work suggested by the committees is subject to approval by the Main Commission.

This paper presents an overview of the work that Committee 3 has accomplished in recent years and describes its current work.

2. ICRP PUBLICATIONS ON PROTECTION IN MEDICINE

Since 2000, Committee 3 has produced, either alone or in conjunction with other ICRP committees, 18 reports dealing with radiological protection in medicine (abstracts are available at http://www.icrp.org/publications.asp):

- *Publication 121*: Radiological protection in padiatric diagnostic and interventional radiology (ICRP, 2013b).
- *Publication 120*: Radiological protection in cardiology (ICRP, 2013a).
- *Publication 117:* Radiological protection in fluoroscopically guided procedures performed outside the imaging department (ICRP, 2010).
- *Publication 113:* Education and training in radiological protection for diagnostic and interventional procedures (ICRP, 2009b).
- *Publication 112:* Preventing accidental exposures from new external beam radiation therapy technologies (ICRP, 2009a).

- *Publication 106:* Dose to patients from radiopharmaceuticals: a third amendment to ICRP *Publication 53* (with an annex on radiation exposure of hands in radiopharmacies) (ICRP, 2008).
- *Publication 105:* Radiological protection in medicine (ICRP, 2007b).
- *Publication 102:* Managing patient dose in multi-detector computed tomography (ICRP, 2007a).
- *Publication 98:* Radiation safety aspects of brachytherapy for prostate cancer using permanently implanted sources (ICRP, 2005b).
- *Publication 97:* Prevention of high-dose-rate brachytherapy accidents (ICRP, 2005a).
- *Publication 94:* Release of patients after therapy with unsealed radionuclides (ICRP, 2004b).
- *Publication 93:* Managing patient dose in digital radiology (ICRP, 2004a).
- *Publication 87:* Managing patient dose in computed tomography (ICRP, 2000d).
- *Publication 86:* Prevention of accidents to patients undergoing radiation therapy (ICRP, 2000c).
- *Publication 85:* Avoidance of radiation injuries from medical interventional procedures (ICRP, 2000b).
- *Publication 84:* Pregnancy and medical radiation (ICRP, 2000a).
- *Supporting Guidance 2:* Radiation and your patient: a guide for medical practitioners (ICRP, 2001a).
- *Supporting Guidance 2:* Reference levels in medical imaging: review and additional advice (ICRP, 2001b).

3. WORK IN PROGRESS

In 2012, Committee 3 updated a work plan that included 10 topics and presented it to the Main Commission. The Committee proposed to carry out this work through four new and two existing task groups and four working parties.

Due to the change in membership of Committee 3 in 2013, the 10 topics in the 2012 work plan were refined during the 2013 Committee 3 meeting, and condensed to eight (four task groups and four working parties). One benefit of this revised work plan is the involvement of the new members of Committee 3. The eight topics in the revised work plan are as follows.

- Task Group 36: Dose to patients from radiopharmaceuticals. Chairs: Sören Mattsson and Dietmar Nosske (from Committee 2)

A compilation of the most relevant information from both current work and published reports on this topic. Several annexes are ready for review by the Main Commission before public consultation: Rb-82 chloride and I-123, I-124, I-125, and I-131 iodide. Other work in progress deals with I-123 FP-CIT (ioflupane), C-11 PiB, F-18 flutemetamol, and C-11 choline.

- Task Group 87: Radiological protection in ion beam radiotherapy. Chair: Yoshiharu Yonekura

This document deals with radiotherapy using protons and carbon ions. The objective is to give recommendations and guidance for the safe operation of medical facilities that use high-energy beam accelerators and for protection of patients and staff at these facilities. Potential incidents and measures for prevention, detection, and mitigation are also provided. The target audience is users, facility planners, and radiation protection specialists. A final draft of this document was discussed at the Main Commission meeting in October 2013 in Abu Dhabi, United Arab Emirates and was accepted by the Main Coimmission for public consultation after some minor changes.

- Task Group 88: Radiological protection in cone-beam computed tomography. Chair: Madan Rehani

This document contains recommendations and guidance on radiological protection for the use of cone-beam computed tomography (CT) in medical and interventional applications. Dental applications are also discussed briefly. The target audience is physicians, other medical staff, and medical physicists. Applications covered include interventional radiology, intra-operative surgery, radiotherapy, breast imaging, and head and neck imaging. The report includes data on radiation doses to patients and workers, and provides guidance and recommendations in accordance with the Commission's principles. Links to other ICRP publications are noted. Committee 3 approved the draft of this document during its 2013 meeting in Abu Dhabi, and it was submitted to the Main Commission for review and consideration for public consultation.

- Task Group 89: Occupational radiological protection in brachytherapy. Chair: Lawrence Dauer

This document will compile existing recommendations and provide guidance to staff on radiological protection in brachytherapy. External beam radiation therapy, when administered in an appropriately shielded facility, results in minimal occupational doses. Brachytherapy is different because of the need for active management of occupational dose. In modern centres, brachytherapy-related occupational dose from a variety of activities is unavoidable (e.g. loading of seeds, plaques, caesium implants, associated fluoroscopy). There is substantial variation in the practice of brachytherapy throughout the world. Some facilities still use older techniques with the potential for high staff doses (e.g. radium use, iridium wires). Technological developments and newer techniques present new occupational radiological protection concerns that need to be addressed. The target audience is clinicians, other medical staff, medical physicists, radiological protection officers, and regulatory authorities. The table of contents and an initial draft outline were discussed during the 2012 Committee 3 meeting in Vienna, Austria. A working draft was prepared for the 2013 Committee 3 meeting in Abu Dhabi.

- Working Party: Justification – framework for justification in medical uses of ionising radiation (including imaging of asymptomatic individuals). Chair: Katrine Åhlström Riklund

In the last decade, the use of ionising radiation for imaging of asymptomatic individuals has increased. A substantial amount of data has been published recently on cardiac CT, positron emission tomography (PET)/CT, and CT colonography. In 2009, Committee 3 began a review to analyse the risks and benefits of imaging asymptomatic individuals. Committee 3 reviewed available guidance, including the position statements of professional societies. The evidence for this practice appears to be weak and difficulties were encountered in providing concrete comments on justification. The focus for this working party is the process of and framework for justification. The target audience is referring physicians (referring medical practitioners) and imaging specialists (radiological medical practitioners). The document will provide practical guidance on level 2 and level 3 justifications for medical professionals. It should not overlap with the work of professional bodies, and will emphasise that radiological protection is neither the only nor the main issue that professionals need to consider. The table of contents was revisited and approved at the 2013 Committee 3 meeting in Abu Dhabi.

- Working Party: Radiological protection in therapy with radiopharmaceuticals. Chairs: Sören Mattsson and Yoshiharu Yonekura

The document is intended to identify situations with unique radiological protection aspects and to provide a framework for quantitative imaging and dosimetry for current and novel treatment approaches. This framework may include: individual dosimetry for planning therapy; test activities and pre-treatment tracers; measurement of whole-body/tumour/organ kinetics; analysis of urine or blood samples; dose calculation based on three-dimensional patient images or patient-like phantoms; evaluation of methods to scale up to therapeutic activity levels; and written directives for the therapy. Variations in patient kinetics at therapeutic levels of activity will be discussed. The target audience is oncologists, other clinicians, nuclear medicine physicians, medical physicists, other staff members, radiation protection officers, and regulatory authorities.

- Working Party: Occupational protection issues in interventional procedures (fluoroscopically guided). Chair: Pedro Ortiz-López

The Commission has provided practical advice, in specific ICRP reports aimed at physicians, on the protection of workers involved in interventional cardiology, paediatric radiology, and fluoroscopic procedures outside the imaging department. There is also a need for advice on occupational protection in interventional procedures directed at other audiences, such as hospital radiological protection officers, medical physicists, professionals involved in dosimetry services, and regulatory authorities. This report will integrate information that is scattered among different reports and publications, and provide detailed information on specific dosimetric aspects of

radiological protection (e.g. active dosimetry, radiological protection tools, radiological protection methods, tests of protective devices). This report will also place occupational protection in interventional procedures into the context of the framework of occupational protection in general. The preliminary draft includes the following: purpose and scope; issues and problems; statistics of interventional procedures; trends and overview of exposures; reported tissue effects (eyes, hands, legs); existing problems in monitoring; application of radiological protection principles to occupational exposures in interventions; staff protection, dose constraints and investigation levels for occupational protection (body, eyes, hands); protection of pregnant workers; and exposure monitoring (number and placement of dosimeters, assessment of staff exposure, assessment of doses to the eyes).

- Working Party: Diagnostic reference levels for diagnostic and interventional imaging. Chair: Eliseo Vañó

The Commission introduced diagnostic reference levels (DRLs) in 1991, and published additional supporting guidance in 2001. In 2004, *Publication 93* stated that DRLs for non-digital imaging tasks are not necessarily applicable to specific, similar digital imaging procedures. It recommended a re-evaluation of local DRLs when digital techniques replace conventional analogue imaging techniques. In 2007, *Publication 105* recognised the benefit of DRLs in fluoroscopically guided procedures, but noted the need to take into account the complexity of the procedure when setting these levels. In addition to digital techniques and interventional procedures, new combined imaging techniques such as PET-CT may also benefit from the use of DRLs (this may require different patient-dose-related quantities for PET and CT and different image quality and diagnostic information). Appropriate use of DRLs within the medical community is still rather poor. Committee 3 proposed a document updating existing information and addressing these new aspects of DRL use in interventional imaging, digital radiology, and PET-CT. The document will include different existing methodologies for determining DRL values, including use of full patient dose distributions for optimisation (not just the third quartile). The target audience is medical physicists, radiologists, nuclear medicine specialists, radiographers, industry, and regulatory authorities. The table of contents was discussed and refined during the 2013 Committee 3 meeting in Abu Dhabi. Current Commission recommendations on DRLs will be summarised in an introductory chapter. Some of the topics identified for clarification include: the use of phantoms vs patient dose values; the link between DRLs and image quality or diagnostic information (including post-processing) for different clinical tasks; standardisation and consensus on the levels of complexity for some common procedures and their impact on DRLs; deriving trigger (alarm) levels from DRLs for investigation of high dose values; use of full patient dose distributions, in addition to DRLs, to help with optimisation; balancing the relevance of several dose-related quantities used to set DRLs (e.g. kerma-area product, cumulative air kerma, number of cine or DSA images, fluoroscopy time); recommendations for the use of multiple dose-related

quantities simultaneously; and the recommended time interval for updating DRLs and factors to be considered when establishing the time interval.

Committee 3 is also involved in the Task Group on Effective Dose launched by Committee 2 (Pedro Ortiz-López is the member of Committee 3 nominated for this task).

4. TOPICS UNDER CONSIDERATION

During the 2013 Committee 3 meeting in Abu Dhabi, several topics were considered as potential areas of interest for future publications and will be kept under consideration. The topics identified were as follows.

- Individual human sensitivity to ionising radiation (Michel Bourguignon)

The areas covered by this report could include: variation in radiosensitivity – evidence from epidemiological studies; clinical radiosensitivity; radiosensitivity in animals; mechanisms contributing to radiosensitivity; radiosensitivity disorders and familial cancers; cellular radiosensitivity in human subpopulations; human radiosensitivity and ethics; implications of variation in radiosensitivity for radiological protection of workers and the public; implications of variation in radiosensitivity for radiological protection in emergency situations; clinical implications in radiotherapy; clinical implications in diagnosis; clinical implications regarding syndromes; and implications in radiological protection with regard to ethical issues. Both Committee 3 and Committee 1 are interested in this topic. Terms of reference for future work will be drafted and presented at the 2014 meeting.

- Framework for optimisation for individual patients (Madan Rehani)

While the principle of 'as low as reasonably achievable applies' to each medical exposure, there is an assumption that this will lead to overall optimisation. There are many situations where individual events are not optimised. How can overall optimisation be achieved for individual patients who have received multiple medical exposures, some of which are optimised and some of which are not? This requires consideration of optimisation extended throughout an individual patient's lifetime, through monitoring and recording of radiation dose from each exposure, and consideration of the impact of previous and predicted future medical exposures on the effect of the next medical exposure. This may lead to a consideration of risk estimates for individual patients.

- Dose quantities and units in imaging equipment (Pedro Ortiz-López)

The International Electrotechnical Commission has a working group on CT and an agreement has been reached on this topic. The manufacturers of medical equipment are not the only stakeholders interested in the topic. Other companies offer software to collect and process radiation doses from patient exposures based on metadata included in the image header, but some relevant information is missing or is included in proprietary (private) fields. It is appropriate that the Commission

takes the initiative and prepares criteria on the information that is needed from the perspective of radiological protection.

- Patient eye dose in CT

The topic was considered of potential interest in light of the Commission's new threshold for the lens of the eye. It was pointed out that the Radiation Protection of Patients website of the International Atomic Energy Agency has good material on this issue. There is some guidance available in German from the German Federal Radiation Protection Committee, and some papers on this topic are now appearing in the scientific literature. Committee 3 will follow this topic.

5. UPDATE OF AN EXISTING DOCUMENT

- Radiation and your patient – a guide for medical practitioners (Sandor Demeter)

The Commission published this document as *Supporting Guidance 2* in 2001. It is not a formal publication of the Commission. This document needs to be updated and extended to include risk communication. The target audience is referring medical practitioners. The intention is to help them in the day-to-day practice of justification of medical imaging, and in communicating effectively with their patients regarding the benefits and risks of imaging examinations and the risks of not performing these examinations when they are indicated.

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