



IAEA

International Atomic Energy Agency

CURRENT ISSUES WITH OPTIMISATION AROUND THE WORLD AND SUPPORT FROM THE IAEA

OPTIMISATION OF RADIOLOGICAL PROTECTION IN DIGITAL RADIOLOGY TECHNIQUES FOR MEDICAL IMAGING

TG 108 DIGITAL WORKSHOP: PART 1

26 OCT 2022 | 13:00-15:00 (BST)
STRUCTURE AND COMPONENTS FOR OPTIMISATION

27 OCT 2022 | 13:00-15:00 (BST)
PUTTING OPTIMISATION INTO PRACTICE

ICRP
Digital
Events

Jenia Vassileva

Radiation Protection of Patients Unit,
International Atomic Energy Agency
Member of the ICRP TG108

Olivera Ciraj-Bjelac

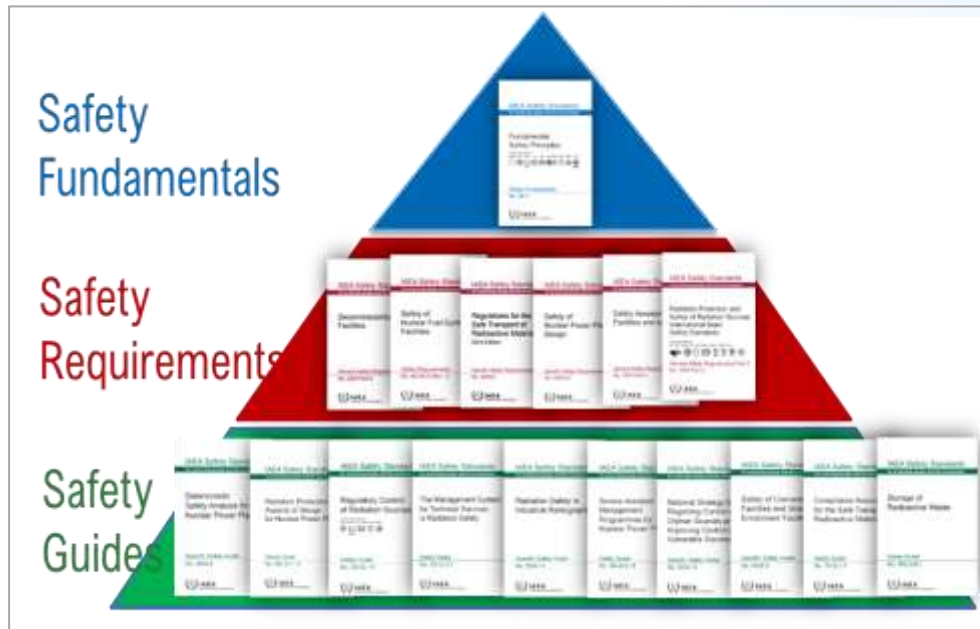
Dosimetry and Medical Radiation
Physics Section, IAEA

International system for radiation protection

UNSCEAR studies the sources and effects of radiation

ICRP provides recommendations for protection

IAEA establishes safety standards and provides for the application of these standards

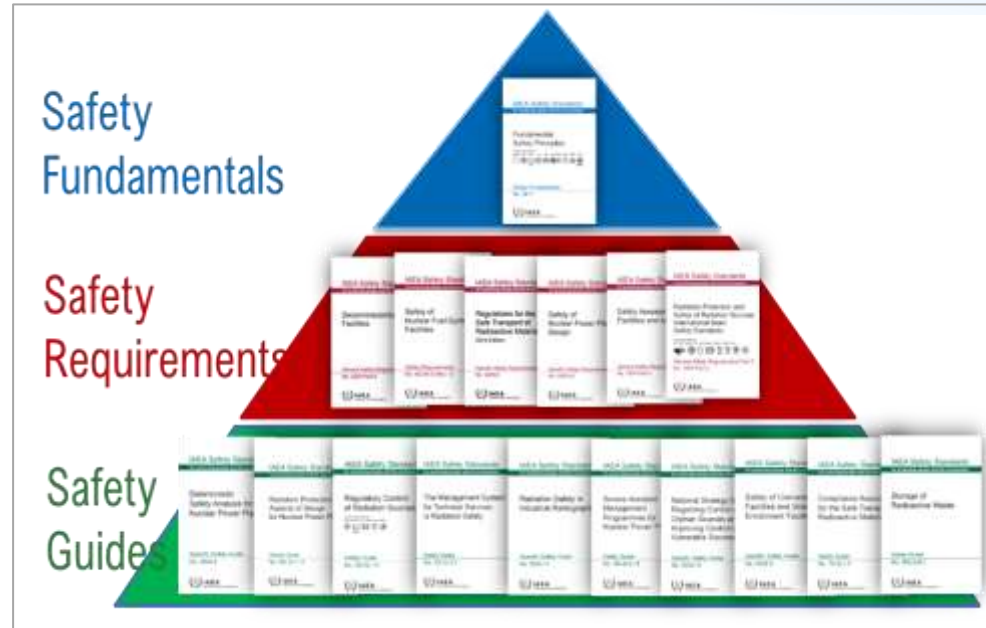


International system for radiation protection

- All Safety Standards go through a formal process of Member State comments
- Involve relevant professional bodies
- Reflect the international consensus



IAEA establishes safety standards and provides for the application of these standards



Radiation protection in medical uses

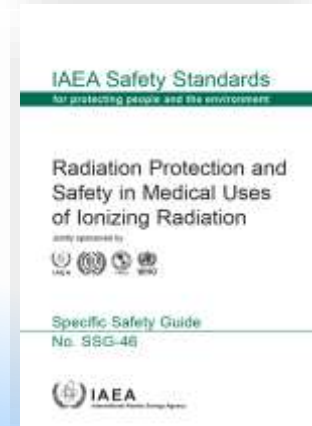
International Basic Safety Standards (GSR Part 3)

- Published 2014
- Set basic requirements for protection and safety
- Co-sponsored by 8 international organizations

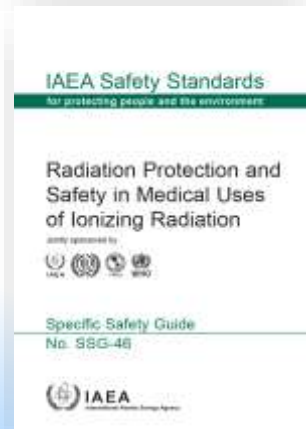
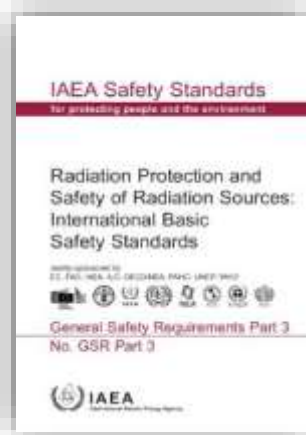


Safety Guide SSG-46: Medical uses of IR

- Published October 2018
- Jointly sponsored by IAEA, WHO, PAHO, ILO
- Cooperation in developing from international/regional professional organizations: IOMP, ISR, ISRRT, WFNMB, ESTRO



Optimization of protection (GSR Part 3, SSG-46)



- For medical exposure: The management of the radiation dose to the patient commensurate with the medical purpose.
- In diagnostic and interventional medical exposure: keeping the exposure of patients to the minimum necessary to achieve the required diagnostic or interventional objective.

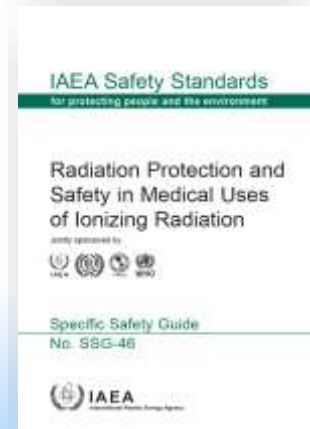
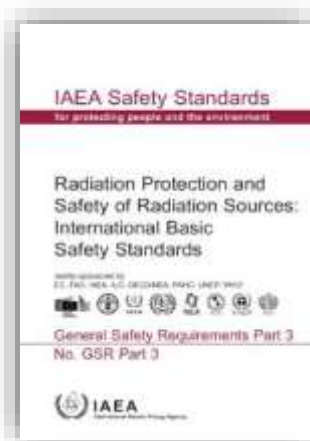
Components of optimization:

- Equipment design and software
- Calibration
- Quality assurance and quality control
- Dosimetry of patients and DRLs
- Operational aspects () protocols, technique and parameters
- Radiological review

Responsibilities:

- Radiological med. professionals
- Medical physicists
- Medical rad. technologists
- Vendors and service engineers
- Licensee
- Regulatory and health authorities
- Professional bodies

Application of safety standards into practice





Issues with optimization around the world

IAEA coordinated studies



- Large variations in patient doses for the same imaging exam

Radiation Protection Dosimetry (2009), Vol. 136, No. 2, pp. 118–126
Advance Access publication 17 August 2009

doi:10.1093/rpd/nep144

SCIENTIFIC NOTE

PATIENT DOSES IN CT EXAMINATIONS IN 18 COUNTRIES: INITIAL RESULTS FROM INTERNATIONAL ATOMIC ENERGY AGENCY PROJECTS

W. E. Muhogora¹, N. A. Ahmed², A. Beganovic³, A. Benider⁴, O. Ciraj-Bjelac⁵, V. Gershan⁶, E. Gershkevitch⁷, E. Grupetta⁸, M. H. Kharita⁹, N. Manatrakul¹⁰, M. Milakovic¹¹, K. Ohno¹², L. Ben Omrane¹³, J. Ptacek¹⁴, C. Schandorf¹⁵, M. S. Shabaan¹⁶, D. Stoyanov¹⁷, N. Toutaoui¹⁸, J. S. Wambani¹⁹ and M. M. Rehani^{20,*}

Radiation Protection Dosimetry (2011), pp. 1–6

doi:10.1

STATUS OF RADIATION PROTECTION IN INTERVENTION CARDIOLOGY IN FOUR EAST EUROPEAN COUNTRIES

O. Ciraj-Bjelac^{1,*}, A. Beganovic², D. Faj³, S. Ivanovic⁴, I. Videnovic⁵ and M. Rehani⁵

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Abdalkader Benider⁵
Latifa BenOmrane⁶
Rada Borisova⁷
Sotirios Economides⁸

Radiation Protection Dosimetry (2010), Vol. 140, No. 1, pp. 49–58
Advance Access publication 11 February 2010

doi:10.1093/rpd/ncq015

PAEDIATRIC CT EXAMINATIONS IN 19 DEVELOPING COUNTRIES: FREQUENCY AND RADIATION DOSE

W. E. Muhogora¹, N. A. Ahmed², J. S. AlSuwaidi³, A. Beganovic⁴, O. Ciraj-Bjelac⁵, V. Gershan⁶, E. Gershkevitch⁷, E. Grupetta⁸, M. H. Kharita⁹, N. Manatrakul¹⁰, B. Maroufi¹¹, M. Milakovic¹², K. Ohno¹³, L. Ben Omrane¹⁴, J. Ptacek¹⁵, C. Schandorf¹⁶, M. S. Shaaban¹⁷, N. Toutaoui¹⁸, D. Sakkas¹⁹, J. S. Wambani²⁰ and M. M. Rehani^{21,*}

Patient Doses in Radiographic Examinations in 12 Countries in Asia, Africa, and Eastern Europe: Initial Results from IAEA Projects

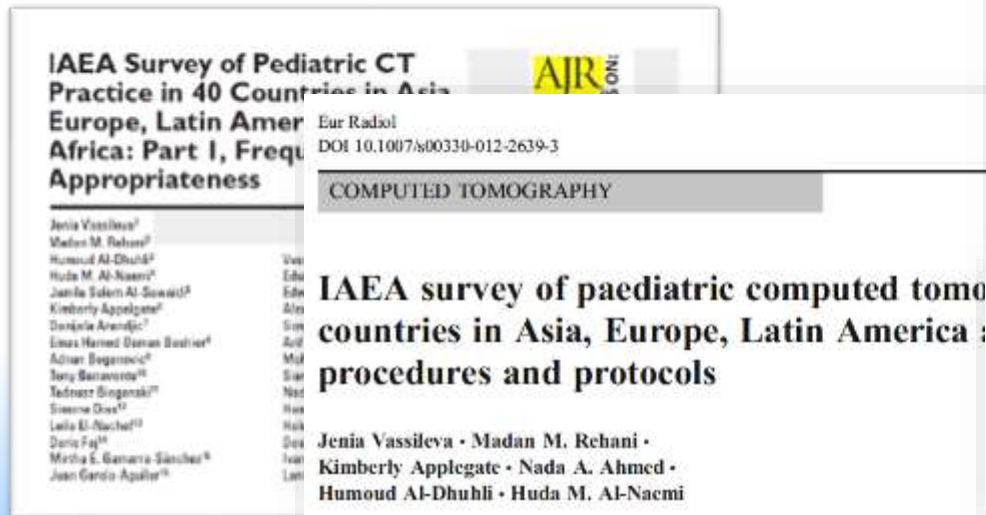
Radiation Exposure to Patients During Interventional Procedures in 20 Countries: Initial IAEA Project Results

IAEA coordinated studies

IAEA study of practice in paediatric radiology:

40 countries, 126 hospitals, 146 CT facilities

- 22-fold variation between average dose indexes for the same age group and the same type of CT exam
- Adult protocols often used for children



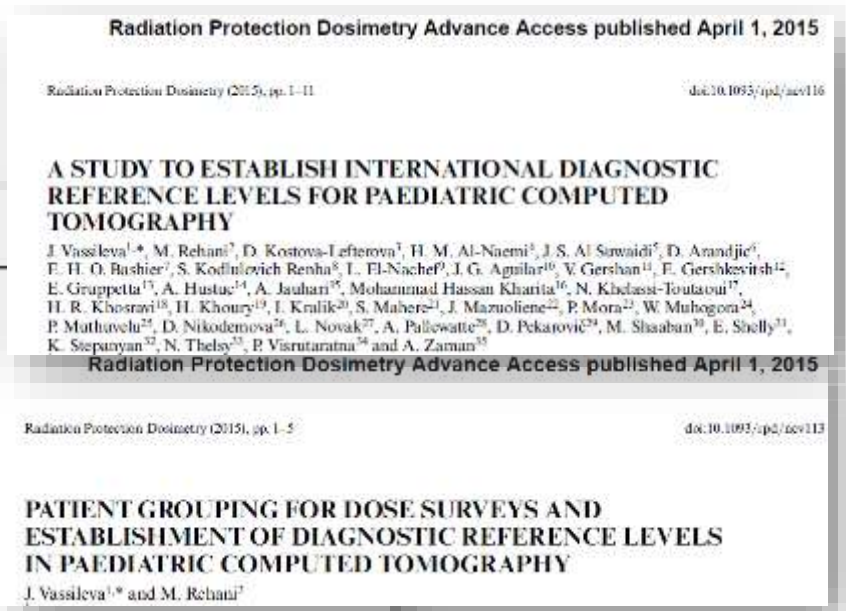
IAEA Survey of Paediatric CT Practice in 40 Countries in Asia, Europe, Latin America and Africa: Part I, Frequency and Appropriateness

COMPUTED TOMOGRAPHY

IAEA survey of paediatric computed tomography procedures and protocols in 40 countries in Asia, Europe, Latin America and Africa: Part I, Frequency and Appropriateness

Jenia Vassileva^{1*}, Madan M. Rehani², Humoud Al-Dhuhli³, Huda M. Al-Naemi⁴, Kimberly Applegate⁵, Donatella Arandjic⁶, Emad Hamed Osman Badier⁷, Adrian Begovic⁸, Tony Banerjee⁹, Yedrez Sioganski¹⁰, Saverio Dini¹¹, Laila El-Nachef¹², Doris Fay¹³, Mónica E. Gamero Sánchez¹⁴, Juan García Aguilera¹⁵

Eur Radiol
DOI 10.1007/s00330-012-2639-3



Radiation Protection Dosimetry Advance Access published April 1, 2015

A STUDY TO ESTABLISH INTERNATIONAL DIAGNOSTIC REFERENCE LEVELS FOR PAEDIATRIC COMPUTED TOMOGRAPHY

J. Vassileva^{1*}, M. Rehani², D. Kostova-Lefterova³, H. M. Al-Naemi⁴, J. S. Al-Suwaidi⁵, D. Arandjic⁶, E. H. O. Basher⁷, S. Kodinowich Renha⁸, L. El-Nachef⁹, J. G. Aguilar¹⁰, V. Gershan¹¹, E. Gershkevitch¹², E. Gruppeta¹³, A. Hustac¹⁴, A. Jauhari¹⁵, Mohammad Hassan Kharita¹⁶, N. Kbelassi-Toutaoui¹⁷, H. R. Khosravi¹⁸, H. Khoury¹⁹, J. Krulik²⁰, S. Mahere²¹, J. Mazuoliene²², P. Mora²³, W. Muhogom²⁴, P. Muthavelu²⁵, D. Nikodemova²⁶, L. Novak²⁷, A. Paliswatte²⁸, D. Pekarovic²⁹, M. Shaaban³⁰, E. Shelly³¹, K. Stepanyan³², N. Thelys³³, P. Visrutaratna³⁴ and A. Zaman³⁵

Radiation Protection Dosimetry Advance Access published April 1, 2015

PATIENT GROUPING FOR DOSE SURVEYS AND ESTABLISHMENT OF DIAGNOSTIC REFERENCE LEVELS IN PAEDIATRIC COMPUTED TOMOGRAPHY

J. Vassileva^{1*} and M. Rehani²

IAEA coordinated studies

IAEA study of CT protocols and doses for hematuria and urinary stones 20 countries

- Up to 12-fold variations in urinary stone CT examinations (median DLP values of 219–2664 mGy.cm) with use of reduced dose CT in only 4/20 participating countries.
- 80% use 3–6 phase CT urography protocols associated with 2.4–4.9-fold higher dose compared to 2-phase protocol

European Journal of Radiology 126 (2020) 108923

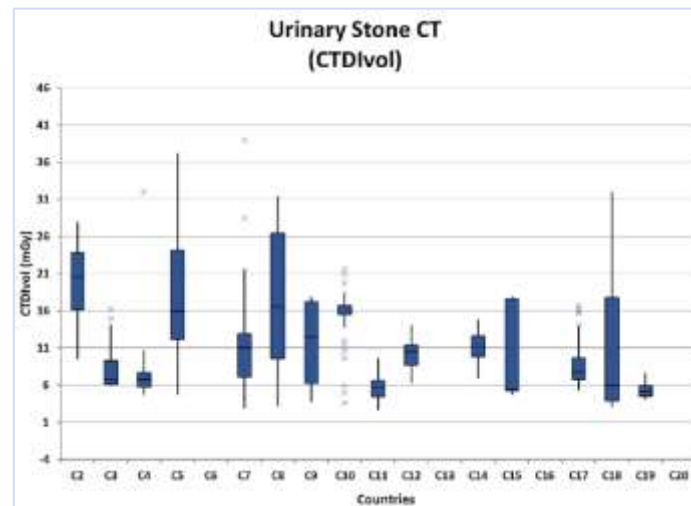
Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

CT protocols and radiation doses for hematuria and urinary stones: Comparing practices in 20 countries

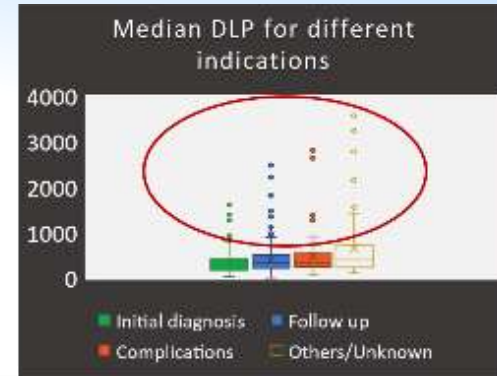
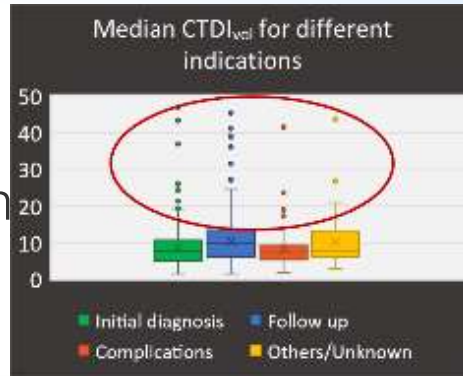
Vesna Gershan^a, Fatemeh Homayounieh^{b,c}, Ramandeep Singh^b, Simona Avramova-Cholakova^c, Dario Faj^d, Emil Georgiev^e, Olga Girjoaba^f, Birute Griociene^g, Edward Gruppetta^h, Darka Hadnadjev Šimonjiⁱ, Sjarhei Kharuzhyk^j, Andrej Klepanec^k, Desislava Kostova-Lefterova^l, Anna Kulikova^m, Ivan Lasicⁿ, Aleksandra Milatovic^o, Graciano Paulo^p, Jenia Vassileva^l, Mannudeep K. Kalra^b



IAEA coordinated studies

IAEA study on COVID-19

- 62 CT facilities from 34 countries
- 10-fold variations in median DLP
- CT use, scan protocols, and radiation doses showed wide variation across health care sites within the same and between different countries.



European Radiology
<https://doi.org/10.1007/s00330-020-07034-x>

COMPUTED TOMOGRAPHY

Chest CT practice and protocols for COVID-19 from radiation dose management perspective

Mannudeep K. Kalra^{1,2} • Fatemeh Homayounieh^{1,2} • Chiara Arru^{1,2} • Ola Holmberg³ • Jenia Vassileva²

Received: 17 April 2020 / Revised: 5 June 2020 / Accepted: 12 June 2020
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Radiology

ORIGINAL RESEARCH • THORAX

Variations in CT Utilization, Protocols, and Radiation Doses in COVID-19 Pneumonia: Results from 28 Countries in the IAEA Study

Fatemeh Homayounieh, MD • Ola Holmberg, PhD • Rashid Al Umairi, MD • Sallam Aly, MD • Algidas Basevičius, MD • Paulo Roberto Costa, PhD • Adham Darweesh, MD • Vesna Gershan, PhD • Pilsni Ilves, MD, PhD • Desislava Kostova-Lefterova, PhD • Simone Kodolovich Renba, PhD • Iman Mohseni, MD • Osvaldo Rampado, DMP • Natalia Rotaru, MD • Isabaku Shirazu, PhD • Valentin Sinityn, MD • Tajana Turk, MD • Claire Van Ngoc Ty, PhD • Mannudeep K. Kalra, MD* • Jenia Vassileva, PhD*

Challenges with optimization

- Access to dose reduction technology in different parts of the world
- Access to dose data in a digital format
- Knowledge and skills of health professionals, often linked to lack of good professional qualification or lack of training on practical RP aspects
- Access to qualified medical physicists in medical imaging
- Safety culture and team work
- Enforcement through national legislation
- Collaboration between regulatory bodies, health authorities and professional bodies
- National DRLs and patient dose monitoring programs
- Proper QM/QA/QC program, often limited to technical QC
- Operational procedures and optimized protocols

Enforcement through regulation

Main issues with the optimization, based on the analyses of the legislation of 24 countries from Europe and Central Asia (TC region Europe) made in 2021:

- [Access to medical physicists](#) in diagnostic and interventional radiology is required in only 10/24 (42%) countries.
- [Establishment of a QA program](#) for medical exposure is required in 10/24 (42%) countries and partly (limited to technical QC) in 10/24 countries
- [Establishment of DRLs](#) in diagnostic and interventional radiology and local assessment of typical doses for patients in DRL quantities considering image quality is required in 11/24 (46%) and partly in 10/24 countries
- [Formal education of medical radiation technologists](#) exists in only 40% of countries
- Requirements on [radiation protection training](#) and competence are in many cases general, not specific for medical exposures
- Much better enforcement in EU-member states due to the binding EU Directive

Status and challenges of the use of DRLs

IAEA Technical meeting in 2016
“Patient dose monitoring and the use
of DRLs for the optimization of
protection in medical imaging”

60 professionals
representing

35 countries and

8 international
organizations
and professional
bodies



Journal of
Medical Imaging

MedicalImaging_CIPD@pubs.iaea.org

**Patient dose monitoring and the use
of diagnostic reference levels for the
optimization of protection in medical
imaging: current status and
challenges worldwide**

Hanna Järvinen
Jenia Vassileva
Ehsan Samei
Anthony Wallace
Eliseo Vano
Madan Rehani

Journal of Radiological Protection

PAPER

**Medical imaging dose optimisation from ground up: expert
opinion of an international summit**

Ehsan Samei^{1,2}, Hannu Järvinen², Mika Kortenesniemi³, George Simantirakis⁴, Charles Goh⁵,

Anthony Wallace⁶, Eliseo Vano⁷, Adrian Bejan⁸, Madan Rehani⁹ and Jenia Vassileva¹⁰

Published 12 June 2018 • © 2018 IOP Publishing Ltd

[Journal of Radiological Protection, Volume 38, Number 3](#)

Main system components requiring development



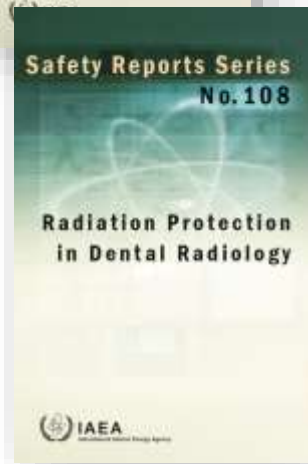
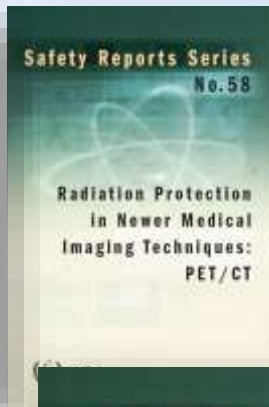
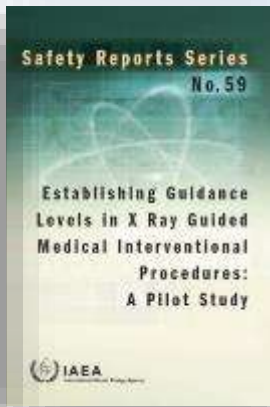
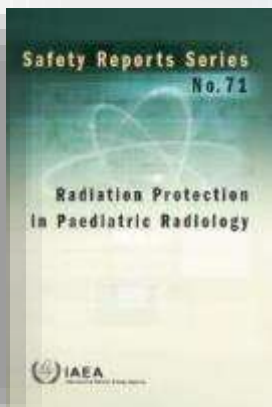
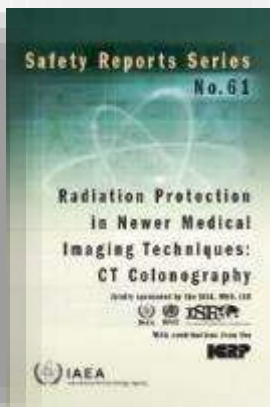
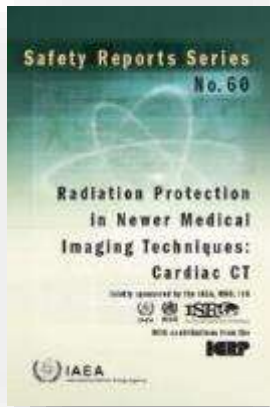
| Main point | Possible solutions |
|--|--|
| ① Human resources and responsibilities | Increase the number and recognition of medical physicists. Raise awareness and responsibilities of the principle professionals. |
| ② Training | Improve basic and continuous training in radiation protection. Ensure proper mentoring and oversight. |
| ③ Safety and quality culture | Enhance accountability, awareness, motivation, both at leadership level and among professionals. Emphasize team work. |
| ④ Regulations | DRLs, QA and medical physicists access should be required by legislation wherever lacking. Advocacy to authorities. |
| ⑤ Funding | Funding can facilitate quality of data collection. Motivate governments for funding. |



IAEA support for improving optimisation

- Radiation protection of patients (RPOP)
- Dosimetry and medical radiation physics (RDMP)

IAEA guidance



SAFETY REPORT SERIES No. XX

PATIENT RADIATION EXPOSURE MONITORING IN MEDICAL IMAGING

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https://preprint.iaea.org/search.aspx?orig_q=patient+radiation+exposure+monitoring&src=ics

Free training material for trainers

Training material

- Diagnostic and interventional radiology →
- Digital radiology →
- Paediatric radiology →
- Radiation dose management in computed tomography (CT) →
- Radiotherapy →
- Radiotherapy: Prevention of accidental exposure →
- Safety and quality in radiotherapy →
- Nuclear medicine →
- Cardiology →
- PET/CT →
- Doctors using fluoroscopy outside radiology (Urologists, Gastroenterologists, Orthopaedic surgeons etc.) →
- Dental radiology →
- Radiation Safety Culture Trait Talks Handbook →
- Radiation Protection in Interventional Procedures: Practical Tutorials →



<https://www.iaea.org/resources/rpop/resources/training-material>

Diagnostic and interventional radiology



Lectures →

Exercises →

Lectures (in Spanish) →

Exercises (in Spanish) →

Lectures (in Russian) →

Exercises (in Russian) →

Digital radiology



Lectures →

Paediatric radiology



Lectures →

Lectures (in Spanish) →

Radiation Safety Culture Trait Talks Handbook



Handbook →

Radiation dose management in computed tomography (CT)



Lectures →

Doctors using fluoroscopy outside radiology



Lectures →

Lectures (in Spanish) →

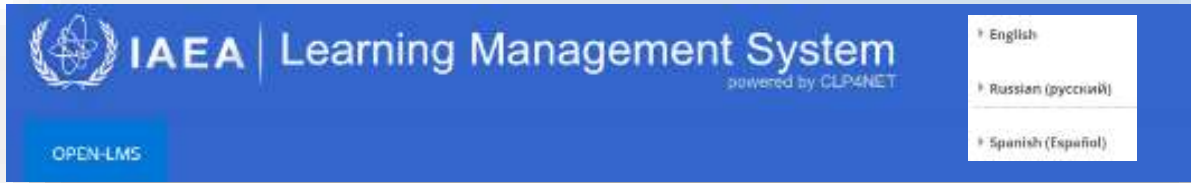
Cardiology



Lectures →

Lectures (Russian) →

E-learning material




IAEA | Learning Management System
powered by CLP4NET

OPEN-LMS


- English
- Russian (русский)
- Spanish (Español)




Diagnostic Reference Levels
in Medical Imaging




Radiation Dose Management in
Computed Tomography



Radiation Protection in Dental Radiology



Radiation Protection in
Fluoroscopy Guided
Interventional Procedures



Radiation Protection in Interventional Procedures
Practical Tutorials



<https://elearning.iaea.org/m2/course/index.php?categoryid=75>

Free webinars



Resources

RPDP Home

- International Safety Standards
- Publications
- Porters and leaders
- Born Call for Action platform
- Smart Card
- WEIRD Study
- Training material
- Webinars
- Online Training
- Databases and Learning Systems

Year: [dropdown] Search: [input] [button]

| | | |
|---|--|---|
| 16 October 2018 Dose and quality assessment of X-ray devices for interventional angiography and tomography | 5 September 2018 Radiation protection in interventional radiology: practical hints and tricks | 20 June 2018 Dose in Tomosynthesis |
| | | |

Since February 2016 → **75** webinars covering various topics → **over 25,000** participants attended from **100** Member States

- Online lectures on topics in radiation protection of patients and staff
- In English, Spanish, Portuguese, Russian
- Held in cooperation with Image Gently, ESR (EuroSafe Imaging), LatinSafe, EFRS, IOMP, CIRSE, IADMFR, etc.
- Free registration and attendance
- Recording available for viewing

<https://www.iaea.org/resources/rpop/resources/webinars>

Technical cooperation

- Regional and national meetings, workshops and trainings
- Participation in medical conferences and congresses
- Group scientific visits for teams of professionals
- Expert support
- Trainings of regulators on inspecting optimization



Public website <http://rpop.iaea.org>



The screenshot shows the homepage of the Radiation Protection of Patients (RPOP) website. At the top, there is a banner image of a medical professional in a white coat looking at a patient. Below the banner, the text reads "Radiation Protection of Patients (RPOP) - the leading resource for health professionals, patients and public on the safe and effective use of radiation in medicine. To access the Spanish version of the site click [here](#)." Below this, there are two main sections: "For health professionals" and "For patients and public". The "For health professionals" section includes a sub-section for "Health professionals can find answers to frequently asked questions about different medical procedures and the safe use of ionizing radiation in medicine." and a list of medical specialties: "Oncology", "Radiotherapy", "Nuclear medicine", "Interventional procedures", "Dentistry", and "Other specialties and imaging modalities". The "For patients and public" section includes a sub-section for "Patients, their caregivers, and the public can learn about what to expect during medical examinations that involve ionizing radiation." and a list of medical procedures: "X-rays", "Computer tomography (CT)", "Interventional procedures", "Nuclear medicine", "Radiotherapy", and "Brachytherapy". On the right side of the page, there is a "Resources" section with buttons for "Training", "Webinars", "Safety in Radiation Oncology (SARSO)", "Safety in Radiological Procedures (SARPR)", "Posters and talks", and "Publications". Below the "Resources" section is a "Contact" section with a button for "RPOP Newsletter".

Annually: 1 million pageviews

- Contains useful information and FAQs for health professionals, patients and public
- Links to resources: training material, posters, webinars, videos, etc.

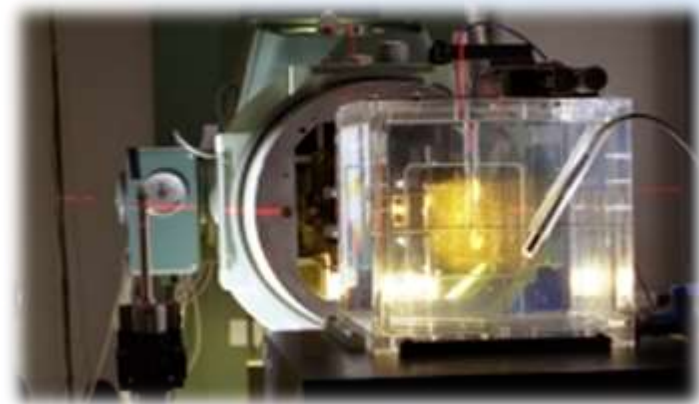


Dosimetry and Medical Radiation Physics Section (under the Human Health Division of the IAEA)



Medical physics

Development and harmonization of guidance on physical & technical aspects of QA to support safe & effective use of radiation in medicine



Dosimetry

*Calibration & audit services
Dosimetry Laboratory
and Dosimetry Audit Networks*

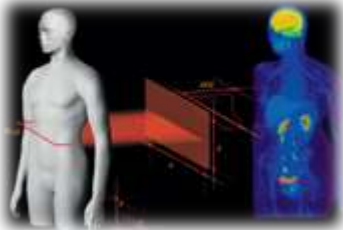
Education & Training

Dosimetry and Medical Radiation Physics



Harmonization of **radiation dosimetry** through the development of dosimetry codes of practice (e.g. TRS-457);

Publication of **guidelines on quality assurance and quality control** in therapy and imaging physics;



Publication of **guidelines for harmonization of education, training and professional development** of medical physicists in radiotherapy and imaging;

Provision of **dosimetry services** (comparisons and calibration of radiotherapy, X-ray diagnostic radiology and radiation protection standards) and **postal dosimetry audits** for radiotherapy centres.

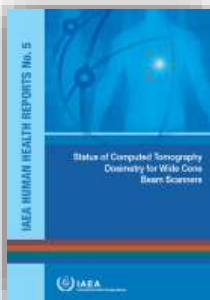
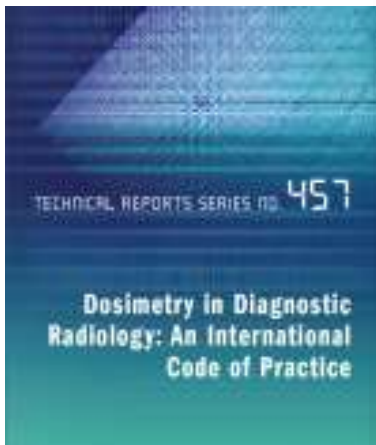


Supporting the **development of clinical medical physics services** in LMICs (in the framework of the IAEA 's Technical Cooperation Programme)

Supporting the establishment and **strengthening of national education programmes** in medical physics, including audit and certification aspects.

Radiation Dosimetry

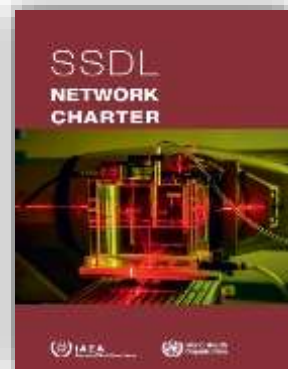
International harmonization and consistency in radiation dosimetry



Calibration service for national dosimetry standards

IAEA/WHO SSDL Network is an association of national SSDLs Members

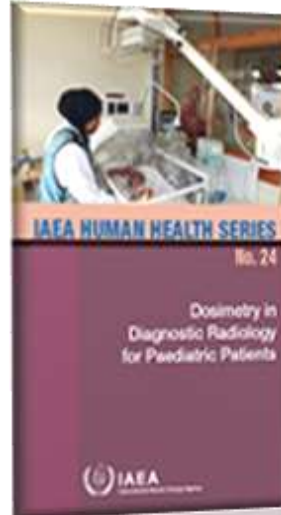
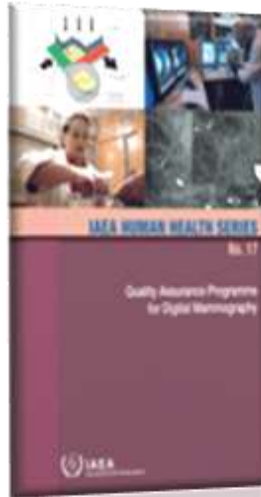
- 88 laboratories in 75 countries
- The IAEA laboratory acts as a central laboratory for the network



Clinical Medical Radiation Physics & Quality assurance



To achieve **international harmonization in quality assurance** in radiation medicine by enhancing quality in the practice of diagnosis and treatment in Member States.



Comprehensive clinical audits

Key elements for the development of effective systems for managing quality in health care.



5. TECHNICAL PROCEDURES

5.1. PRINCIPLES AND CRITERIA FOR GOOD PRACTICE

The principles and criteria for good practice of the technical aspects of radiology involve the available facility infrastructure, radiation protection and safety, imaging equipment QA processes, optimization in clinical practice, dosimetry, and instrumentation and calibration. All policies and procedures should be documented and regularly updated, and be available to staff at all times.

The imaging modalities include the following:

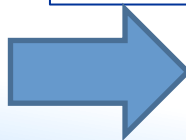
- Plain radiography
- Fluoroscopy;
- Image guided interventions
- Mammography;
- Computed tomography
- Dental radiography
- Ultrasonography;
- Magnetic resonance

5.1.4. Optimization in clinical practice

Optimization of image quality and patient dose is a dynamic process that aims to give sufficient diagnostic image quality with minimum doses to patients. Optimization involves inputs from the radiological medical practitioner, radiographer and medical physicist. The procedure used for examination optimization should be documented.

While all imaging examinations should be optimized, the following require special attention:

- Computed tomography examinations;
- Screening programmes (e.g. mammography);
- Interventional or procedural examinations;
- Examinations involving infants or children;
- Examinations involving pregnant patients;
- Volunteers for research (if applicable).



Relevant Coordinated Research Activities



Evaluation and Optimization of Paediatric Imaging

CRP E24020 (2015-2019)

To enhance the capabilities of Member States to improve the efficiency of existing modalities for paediatric medical imaging, as well as to implement and enhance optimization techniques and methodologies for advanced paediatric medical imaging

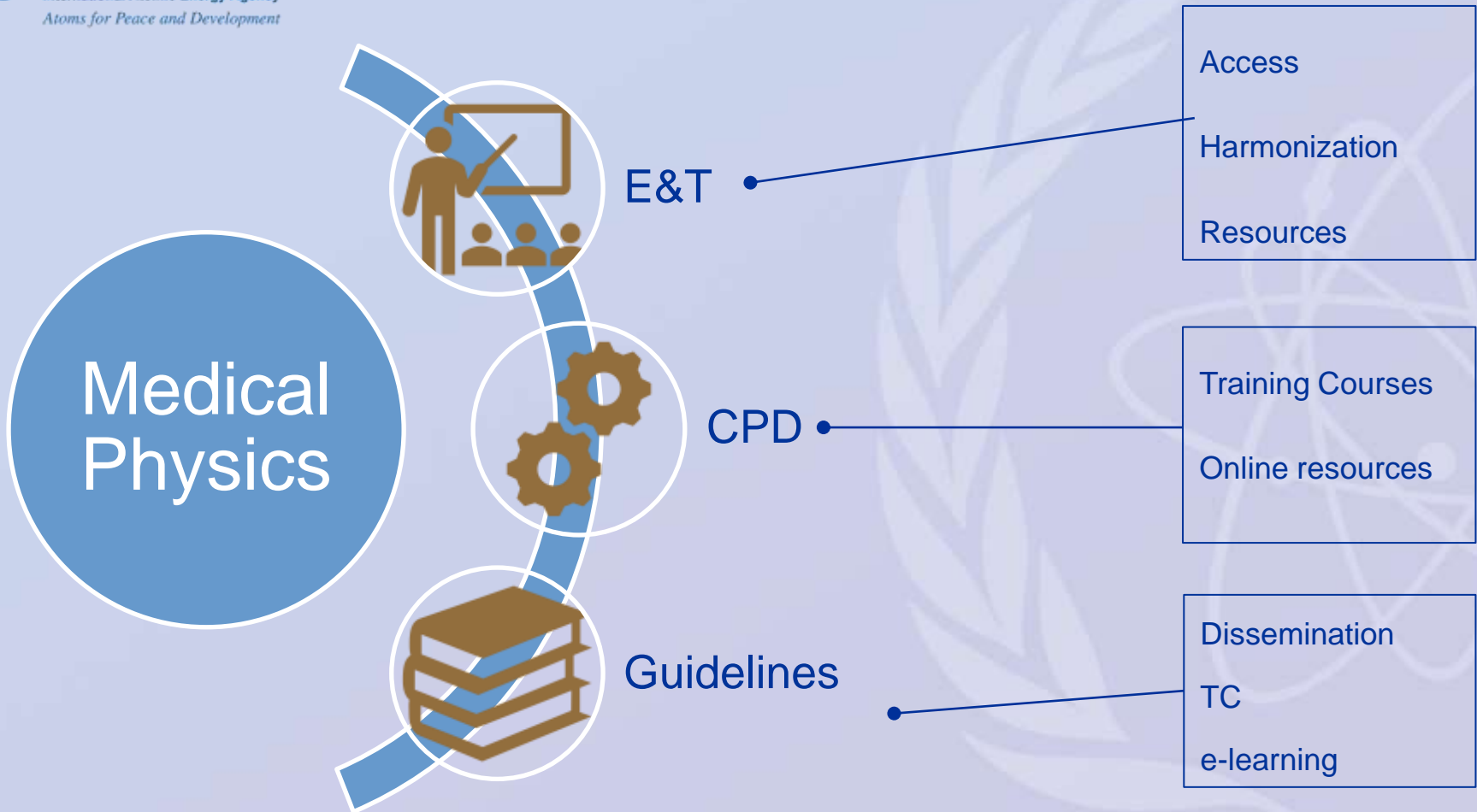
New CRP: Evaluation of the Dosimetry Needs and Practices for the Update of the Code of Practice for Dosimetry in Diagnostic Radiology (TRS-457) (E24024)

CRP E24024 (2021-2025)

Standardization of radiology medical physics dosimetry instrumentation, equipment and procedures in laboratories and hospitals to support the update of the IAEA Technical Reports Series (TRS) No. 457 “Dosimetry in diagnostic radiology: an international code of practice”.

The screenshot shows the JNM (The Journal of Nuclear Medicine) website. The article title is "Developing and Implementing an Imaging Optimization Medicine: Experience and Recommendations from an IAEA Project". The authors listed are Gian Luca Poli, Marco Cecia, Lionel Torres, Frederic Fahey, Michael Lissmann, Clara-Louise Chapple, Peter H. Frisby, M. Lissmann, G.L. Poli, H. Dellis, P. Homolka, C.L. Chapple, P.R. Costa, E. Arzulla, L.E. Lubis, T.A. Sackey, F. Fahey, M. Lissmann, G.L. Poli. The article is published in the Journal of Nuclear Medicine, April 2021, issue 62(4), pages 575-578. The DOI is 10.1186/s12885-021-2449-6. The article is categorized as an Original paper in the journal Physica Medica.





The Human Health Campus




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The IAEA online information resource for health professionals working in nuclear medicine, radiation oncology, medical physics, and nutrition, providing insight into the different aspects of modern clinical practice. [more >](#)



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What's New

- Seventh Newsletter of Nutritional & Health-Related Environmental Studies Section
- IAEA-NMQC Toolkit
- The Transition from 2-D Brachytherapy to 3-D High Dose Rate Brachytherapy: Training Material
- Sixth Newsletter of Nutritional & Health-Related Environmental Studies Section
- New (open source) paper published in the INM on, Standardization of administered Activities in Pediatric Nuclear Medicine
- Cardiovascular: ASNC Guidelines and Standards

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Thank you!