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D7.3 Report on three exemplary training events and proposed model for the dissemination of the EURAMED rocc-n-roll RP E&T structure

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Abbreviations

E&T Education and training

KSC knowledge, skills, and competences

MOOC Massive open online course

RP Radiation Protection

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Disclaimer

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1. Introduction

In Task 7.1, a methodological framework guidance document on radiation protection education & training (E&T) was developed and presented in deliverable D7.1. In Task 7.2, three (online) training events to pilot the latter methodology were organised:

- EV1: training for health professionals (clinical staff), organised by IPC
- EV2: training for researchers, organised by UCD
- EV3: event to "train the trainers", organised by UGent

All events were developed through a multidisciplinary approach aiming to include attendees from different backgrounds and clinical areas. In order to anticipate the possible consequences of the COVID19-pandemic – still relevant in the first part of the EURAMED rocc-n-roll project – the original idea of having on-campus training events was shifted to the organisation of a series of webinars.

For EV1, a pre- and post-event survey was be made to measure the impact of the training on the knowledge, skills, and competences (KSC) of the attendees, especially on how it will potentially be translated into clinical practice. For EV2, a post-event evaluation was conducted to measure the quality of the training and the potential impact of the training on the job of researchers involved in the use of ionising radiation. For EV3 specifically, interactive discussions were held at the end of each webinar to evaluate if the proposed teaching methodologies are relevant/feasible in the field of medical radiation protection E&T.

Current deliverable, D7.3, presents an overview of the organised webinars as well as an analysis of the post-webinar evaluations.

2. Description of the training events

2.1 EV1: training for health professionals

EV1 was a training event specifically targeting health professionals such as radiologists, radiographers, and medical physicists. The training was organised through a series of 4 webinars from January 23rd - 26th 2023, each of them with a length of 2 hours. Pre-registration was required, and IPC's institutional Zoom web platform was used.

The participants received a link with pre-reading material and additional resources. The pre-reading material consisted of an article specific to the topic selected by speakers considering their expertise on the field. The additional resources were guidelines and reports (about 10 documents per webinar) from the European Commission (EC), International Atomic Energy Agency (IAEA), American Association of Physicists in Medicine (AAPM), International Commission on Radiological Protection (ICRP), EuroSafe Imaging and other recognised entities.

The participants of webinar 4, focussing on DRLs, were additionally invited to present their local/national DRL values for pelvic radiographs (in KAP or ESAK) and head CT examinations (in CTDI, DLP or SSDE).

Overall, the structure of the EV1 webinars was:

- Welcome & Introduction (5min)
- First survey to access the knowledge of the participants (10 min)
- Two presentations (20 minutes each)
- Zoom breakout sessions to define possible problems and solutions (12 min) and identify useful resources about the topic (5 min)
- Questions and Answers (20 min)

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- Repeat the first survey to access the change in knowledge of the participants (10min)
- Webinar evaluation (10 min)
- Conclusion (3 min)

Webinar 1 – 23/01/2023 | 18:00 – 20:00 CET

Dose management of patient and staff

Learning outcomes:

- To Understand procedure dose descriptors
- To increase awareness of radiation benefits and risks
- To understand staff monitoring

Speakers: Francisco Alves, Graciano Paulo

Webinar 2 – 24/01/2023 | 18:00 – 20:00 CET

Dose reduction strategies in fluoroscopy guided procedures

Learning outcomes:

- To understand the use of dose descriptors in fluoroscopy guided procedures
- To be able to apply patient dose reduction strategies
- To be able to apply staff dose reduction strategies

Speakers: Graciano Paulo, Barry Hallinan

Webinar 3 – 25/01/2023 | 18:00 – 20:00 CET

Dose reduction strategies in CT

Learning outcomes:

- To understand the use of dose descriptors in CT
- To be able to apply optimal dose reduction tools
- To become familiar with optimisation process (dose and image quality)

Speakers: Shane Foley, Joana Santos

Webinar 4 – 26/01/2023 | 18:00 – 20:00 CET

Establishment and use of DRLs

Learning outcomes:

- To understand the establishment of DRLs
- To be aware of the challenges of DRLs per image modality to apply patient dose reduction strategies
- To understand the utility of using DRLs

Speakers: Joana Santos, Shane Foley

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2.2 EV2: training for researchers

EV2 was a training event dedicated to researchers of all varieties (clinical, academic) who use ionising radiation equipment as part of their work or undertaking research linked to medical applications of ionising radiation. The latter includes research at all levels (Research Assistants, Research Masters or Doctoral Students, Post-Doctoral Fellows, Research Fellows, etc) using radioactive materials, pre-clinical imaging, clinical trial organisers, etc.

Two online webinars were organised, respectively on February 14th and 16th 2023. The duration of each webinar was 3 hours. Pre-registration was required, and UCD's institutional Zoom web platform was used.

Similarly as in EV1, pre-reading material was provided and interactive polls, breakout activities and group discussions were integrated in the EV2 webinars.

Webinar 1 – 14/02/2023 | 14:00 – 17:00 CET

Dosimetry in radiation protection for researchers

Learning outcomes:

- To understand the importance of radiation dosimetry for researchers
- To become familiar with common methods for dosimetry and their respective advantages and limitations
- To consider the most appropriate dosimetric quantities for varying research scenarios
- To apply available dosimetric tools to practical scenarios

Topics addressed:

- Dosimetry quantities
- Dosimetry for researchers
- Benefit-risk communication strategies

Speakers: Jonathan McNulty, Graciano Paulo, Rachel Toomey, Shane Foley

Webinar 2 – 16/02/2023 | 14:00 – 17:00 CET

Occupational radiation protection for researchers

Learning outcomes:

- To understand the key radiation protection principles for researchers who use ionising radiation equipment
- To become familiar with practical measures for personal radiation protection
- To discuss radiation protection measures specific to researchers
- To apply radiation protection principles using online / virtual simulation tools
- To discuss benefit-risk communication strategies linked to their research

Topics addressed:

- Principles of radiation protection
- Uncertainties in personal dosimetry
- Practical steps for radiation protection
- Virtual simulation tools for radiation protection

Speakers: Joana Santos, Marie Anne Chevallier, Shauna Murphy, Louise Rainford, Jaka Potocnik, Shauna Daly

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2.3 EV3: "Train the trainers"

Three webinars were designed, specifically dedicated to those involved in the E&T of health professionals using ionising radiation. Pre-registration was not required, and UGent's institutional Teams web platform was used.

The webinars took place on April 13, 18 and 20, 2023. Each webinar (duration 1.5 hours) tackled one or more weaknesses in the European radiation protection E&T, as identified in the SWOT analysis conducted in Task 7.1 [1]. Likewise EV1 and EV2, ample time for interaction and discussion was foreseen in the EV3 training courses.

Webinar 1 – 13/04/2023 | 13:00 – 14:30 CEST

Online education and training in radiation protection using a massive open online course (MOOC) and a simulation environment

This webinar discussed the development of a MOOC for radiation protection education and training in vascular surgery. The integration of interactive modules, a serious game simulating a clinical case and self-assessment tools in this MOOC was highlighted, as well as the impact of the MOOC on the observed radiation safety behaviour in endovascular surgery.

Learning outcomes:

- To understand the role of a MOOC in radiation protection E&T
- To understand how a simulation environment can be used as a tool for realistic hands-on training

Speaker: Gilles Soenens

Webinar 2 – 18/04/2023 | 13:00 – 14:30 CEST

Exploring different teaching methods in radiation protection education

The aim of this webinar is to give an overview of different education and training strategies, with an emphasis on interactive and active teaching methods.

Learning outcomes:

- To understand the differences in education efficiency of different teaching methods
- To become familiar with different interactive and active teaching methods
- To discuss evaluation strategies in medical radiation protection education & training

Speaker: Wies Allemeersch

Webinar 3 – 20/04/2023 | 13:00 – 15:00 CEST

On-the-job training strategies

In this webinar an innovative method for bite-size continuous learning was introduced. In addition, the impact of a real-time staff dose evaluation system on the training of practitioners was discussed.

Learning outcomes:

- To become familiar with strategies of bite-size and on-job training strategies during medical imaging routine practice
- To understand the impact of real-time staff dose evaluations in training of practitioners.

Speakers: Jurgen Jacobs, Klaus Bacher

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3. Results from the training events

It is not possible to give an exact number of participants in the training events, as due to the free nature of the events, not all registered colleagues attended the webinars and some of the attendees did not participate to full length of the webinars. A conservative estimate of the number of participants is:

- For all EV1 webinars ~750
- For all EV2 webinars ~40
- For all EV3 webinars ~15

The lower number of participants for both EV2 and EV3 events, reflects the significantly smaller group of target audience.

For EV1, the professional background of the participants per webinar is found to be:

- Webinar 1: 57% radiographer, 20% medical physicist and 18% other health profession
- Webinar 2: 59% radiographer, 26% medical physicist and 12% other health profession
- Webinar 3: 61% radiographer, 25% medical physicist and 14% other health profession
- Webinar 4: 54% radiographer, 29% medical physicist and 18% other health profession

For EV2, only a limited number of participants responded to the questions of the integrated surveys. Overall, the researchers seemed to be predominantly active in medical applications, radiation dosimetry and environmental applications. Most of the responders indicated to be a novice researcher or a junior researcher. Half of the responders indicated having had a formal education in radiation protection before.

Due to the low number of participants in EV3, data analysis of participants is meaningless. Basically all participants indicated to be actively involved in radiation protection E&T.

3.1 Knowledge assessment based on pre and post surveys for health professionals (EV1)

A limited number of participants had the opportunity to read the webinar pre-reading material: 16%, 36%, 26%, and 27% of the participants in webinars 1 to 4, respectively. However, participants considered the pre-reading material very useful:

- Webinar 1: 79% very useful and 7% extremely useful
- Webinar 2: 74% very useful and 13% extremely useful
- Webinar 3: 40% very useful and 11% extremely useful
- Webinar 4: 76% very useful and 10% extremely useful

Prior to the start of the EV1 webinars, the knowledge of the participants on the specific topic was evaluated using a set of online questions. At the end of each webinar, the same questions were presented again. Results pre/post-webinar were expressed in a percentage score.

All webinars resulted in an increase in short-term knowledge on the specific topic. On average, the participant score increased with 13% after the webinar (Table 1).

Table 1: Analysis of the percentage of correct responses pre and post webinar

webinar	Percentage of correct responses (%)		
	Before	After	Net result
1	32,8	60,3	27,5
2	62,8	69,8	7,0

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3	47,7	49,3	1,7
4	26,3	43,5	17,3

3.2 Problems and solutions for the different webinar topics of EV1

From the 215 health professionals that responded to the evaluation survey, 214 are considering attending to similar webinars in the future.

The identification of problems in group discussions was indicated to be relevant for their practice in 93,5% (47% agree and 46,5% strongly agree) of the participants and the identification of solutions in 91,2% (46,5% agree and 44,7% strongly agree).

An overview of different problems and solutions as identified by the participants, can be found in the tables in the Appendix (Table A1-A5).

The obtained DRLs for pelvic radiograph and head CT examinations, based on the survey responses (n= 70), revealed a large variation on dose values and a lack of harmonisation on dose descriptors and units. Identified problems and solutions are indicated in the Appendix (Table A6).

3.3 Identification of useful resources

Table 2 gives an overview of interesting E&T links as indicated by the participants during the EV1 webinars. Exchanging such information during interactive sessions is very valuable for the participants in RP E&T courses.

Table 2 - List of the useful links

Dose management of patient and staff
http://www.imagegently.org/
https://academic.oup.com/eurheartj/article/39/41/3715/5079037?login=false
https://insightsimaging.springeropen.com/articles/10.1186/s13244-021-01085-4
https://iopscience.iop.org/book/edit/978-0-7503-1317-9
https://journals.lww.com/health-physics/Abstract/2003/08000/EVALUATION_OF_PATIENT_AND_STAFF_DOSES_DURING.5.aspx
https://link.springer.com/article/10.1007/s00270-013-0685-0
https://link.springer.com/article/10.1007/s00330-020-07290-x
https://medizinphysik.wiki/
https://op.europa.eu/en/publication-detail/-/publication/a78331f7-7199-11eb-9ac9-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=37085&WT.ria_f=3608&WT.ria_ev=search
https://pubmed.ncbi.nlm.nih.gov/23860936/
https://www.aapm.org/
https://www.admnucleartechnologies.com.au/blog/comparison-active-and-passive-radiation-dosimetry-systems
https://www.aerb.gov.in/images/PDF/layout_guidelines.pdf
https://www.bir.org.uk/media/414334/final_patient_shielding_guidance.pdf

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https://www.cqc.org.uk/guidance-providers/ionising-radiation/ionising-radiation-medical-exposure-regulations-irmer
https://www.env.go.jp/en/chemi/rhm/basic-info/1st/index.html
https://www.gehealthcare.com/products/dose-management
https://www.gov.uk/government/publications/diagnostic-radiology-national-diagnostic-reference-levels-ndrls/ndrl
https://www.hmpgloballearningnetwork.com/site/cathlab/articles/importance-radiation-safety-healthcare-workers-well-patients#:~:text=Shielding%20includes%3A%201)%20Personal%3A,drapes%20to%20prevent%20scatter%20radiation.
https://www.iaea.org/publications/11102/radiation-protection-and-safety-in-medical-uses-of-ionizing-radiation
https://www.iaea.org/resources/rpop/health-professionals/nuclear-medicine/diagnostic-nuclear-medicine/diagnostic-reference-levels-in-medical-imaging
https://www.iaea.org/resources/rpop/resources/radiation-safety-culture-in-medicine
https://www.iaea.org/topics/health
https://www.icrp.org/publication.asp?id=ICRP%20Publication%20103
https://www.icru.org/report/patient-dosimetry-for-x-rays-used-in-medical-imaging-report-74/
https://www.itnonline.com/content/keys-dose-management-success-importance-ongoing-staff-education
https://www.ncbi.nlm.nih.gov/books/NBK557499/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8789964/
https://www.rcr.ac.uk/
https://www.rivm.nl/en/search?search=radiation
https://www.sciencedirect.com/science/article/pii/S1120179722019767
https://www.uofmhealth.org/conditions-treatments/radiology-and-imaging/patient-resources/limiting-radiation-exposure
https://www.who.int/initiatives/global-initiative-on-radiation-safety-in-health-care-settings
Dose reduction strategies in fluoroscopy guided procedures
https://op.europa.eu/en/publication-detail/-/publication/a78331f7-7199-11eb-9ac9-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=37085&WT.ria_f=3608&WT.ria_ev=search
https://ncrponline.org/publications/reports/ncrp-report-168/
https://pubmed.ncbi.nlm.nih.gov/27440524/
https://pubmed.ncbi.nlm.nih.gov/32861568/
https://pubmed.ncbi.nlm.nih.gov/36031041/
https://www.iaea.org/resources/rpop/health-professionals/interventional-procedures/radiation-protection-of-medical-staff-in-interventional-fluoroscopy
https://www.iaea.org/resources/rpop/resources/posters-and-leaflets
https://www.iaea.org/resources/rpop/resources/training-material

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https://www.iaea.org/resources/rpop/resources/training-material#14
https://www.icrp.org/publication.asp?id=ICRP%20Publication%20139
Dose reduction strategies in CT
http://www.imagegently.org/
https://healthmanagement.org/c/imaging/pressrelease/how-to-reduce-the-radiation-dose-in-a-ct-scan-the-example-of-the-patient-at-isocenter-feature
https://imagegently.org/Procedures/computed-Tomography
https://inis.iaea.org/search/search.aspx?orig_q=RN:43085711
https://op.europa.eu/en/publication-detail/-/publication/a78331f7-7199-11eb-9ac9-01aa75ed71a1
https://qaelum.com/news/news/ct-patient-positioning-more-important-than-you-think
https://www.iaea.org/resources/rpop
https://www.iaea.org/resources/rpop/health-professionals/radiology/computed-tomography
https://www.icrp.org/publication.asp?id=icrp%20publication%20135
https://www.imagewisely.org/
https://www.rcr.ac.uk/ct
Establishment and use of DRL's
http://www.eurosafeimaging.org/wp/wp-content/uploads/2015/05/Radiation-protection-180-part2.pdf
https://academic.oup.com/rpd/article-abstract/156/2/168/1605249
https://academic.oup.com/rpd/article-abstract/191/3/261/5935514
https://iopscience.iop.org/article/10.1088/1361-6498/ab826f/meta
https://op.europa.eu/en/publication-detail/-/publication/a78331f7-7199-11eb-9ac9-01aa75ed71a1
https://pubmed.ncbi.nlm.nih.gov/30190653/
https://pubmed.ncbi.nlm.nih.gov/32424428/
https://pubs.rsna.org/doi/10.1148/radiol.2017161911
https://www.ajronline.org/doi/10.2214/AJR.14.12794
https://www.euramed.eu/clinical-drls-for-x-ray-medical-imaging-published/
https://www.gov.uk/government/publications/diagnostic-radiology-national-diagnostic-reference-levels-ndrls/ndrl
https://www.hiqa.ie/sites/default/files/2021-07/Diagnostic-Reference-Levels_Undertaking-guidance.pdf
https://www.iaea.org/resources/rpop/health-professionals/radiology/diagnostic-reference-levels
https://www.icrp.org/docs/DRL_for_web.pdf
https://www.icrp.org/publication.asp?id=icrp%20publication%20135
https://www.imagegently.org/procedures/interventional-radiology/protocols
https://www.imagewisely.org/Imaging-Modalities/Computed-Tomography/Diagnostic-Reference-Levels
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4277375/

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https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4277375/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8385214/
https://www.sciencedirect.com/science/article/abs/pii/S0720048X20301686
https://www.sciencedirect.com/science/article/abs/pii/S1078817420301723
https://www.um.edu.mt/library/oar/handle/123456789/2540
https://www.vvd.gov.lv/lv/vadlinijas-mediciniskaja-apstarosana#vadlinijas-diagnostikas-standartlimeniem-radiologiskajam-proceduram

3.4 Webinar EV1 and EV2 evaluation

The Breakout rooms revealed to be a challenge for health professional participants. Considering the large number of attendees to the first webinar of EV1, a large number of breakout rooms was organised to facilitate small group discussions and allow time for everyone to speak. However more than a third of rooms had no activity or responses as many attendees did not actively participate. For the remaining webinar the number of breakout rooms was limited to 10 to drive interaction.

To increase the response rate in breakout rooms in the future, a moderator should be included to help and guarantee a good discussion. This suggestion was also made as a feedback received from the EV2 webinars.

From all the health professional participants, only 213 evaluated the webinar. Most of the responses were obtained from radiographers (61%), medical physicists (23%). An overall evaluation score of the webinars was calculated from the survey responses, using a 1-4 scale (1 “strongly disagree”, 2 “disagree”, 3 “agree”, 4 “strongly agree”).

The average obtained scores per webinar are presented in the tables below. No significant differences were obtained per profession.

Table 9 - Health professionals’ evaluation of the webinars

Webinar	n	Median	Mean	Std. Deviation
1	20	3,4	3, 5	0,4
2	67	3,6	3,5	0,4
3	67	3,7	3,6	0,4
4	61	3,8	3,7	0,4

From the researchers workshop only 18 participants completed the webinar evaluation. All researchers considered that the sessions provided specific ideas that they can use in their job. (Table 10):

Table 10 - Researchers evaluation of the webinars

Webinar	n	Median	Mean	Std. Deviation
1	13	3,6	3,6	0,2
2	5	3,6	3,6	0,2

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The obtained evaluation values revealed very good levels of satisfaction for the content relevance. Most participants indicated willing to participate in future editions of such webinars.

3.5 Specific discussion points address in the EV3 events

During the "train the trainers" events interactive discussions were organised. Due to the low number of participants, quantitative data cannot be presented. However, some important discussion items are worthwhile to mention:

- It was recognised that an interactive MOOC, including practical clinical examples is a very valuable tool for increasing KSC of healthcare staff involved in the use of ionising radiation. In fact, such a MOOC allows self-study of participants which might overcome agenda-conflicts often seen when registered to courses with a fixed time-schedule.
- Unfortunately, up to now, availability of training tools including a realistic simulation environment are scarce and difficult to design.
- Interactive teaching techniques should be preferred above the conventional 'one-way' theoretical lecturing technique. In addition, it is essential to provide similar material multiple times and in different formats in order to guarantee the best KSC improvement.
- Apart from on-campus education and online initiatives such as webinars and MOOCs, also on-the-job training methods are important. Currently systems are being developed to integrate this training possibility in daily clinical routine. Also the systematic use of real-time staff dose monitoring systems will evoke a better radiation protection awareness and will result in both patient and staff dose reductions.

4. Conclusions

This series of education and training events were focussed on three distinct cohorts. Each event attempted to move away from a pure theoretical lecturing approach by adopting principles of active learning to ensure a more efficient knowledge transfer. The latter approach is strongly recommended by educational experts.

Many radiographers and medical physicists participated in the webinars. The reading material provided in advance to all participants (to encourage better preparation and better participation) was actually read in only 26% of the participants. In future editions, the importance of this pre-webinar documentation should be highlighted more explicitly. On the other hand, those who had read the material in advance reported it as very useful (67%) or useful (10%). In an interactive MOOC, the self-study component is intrinsically larger than in a webinar format.

Involving the participants in discussions resulted in the generation of much useful information. It was possible to identify 141 problems and respective solutions for the 4 webinars topics. In addition, a list of 73 links with useful resources could be generated. A considerable number of the indicated problems were related to education and training. The identification of problems and solutions in group, during the breakout rooms, was relevant for the practice of more than 91% of the participants.

One can link the webinar E&T system with the European Credit Transfer System (ECTS). As the European recommendation is 27 study hours per ECTS, the EV1 webinar format could correspond to 1 ECTS: 8 contact hours and 19 hours of self-learning (pre-reading material, additional resources, discussion, and study). The increase in the knowledge score, after the webinars of EV1, demonstrated a positive short-term impact of the training on the KSC of the attendees.

The major fraction of health professionals and researchers responding to the evaluation survey indicated that they would attend more webinars in the future.

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To disseminate the E&T structure professional societies and academic institutions must be involved in further development and refinement, to integrate this format in RP CPD of health professionals.

References

1. Rainford et al. Education and training in radiation protection in Europe: an analysis from the EURAMED rocc-n-roll project. Insights into Imaging (2022) 13:142

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Appendix

An overview of different problems and solutions as identified by the participants during the breakout sessions is presented in Table A1-A5.

Table A1 – Problems and solutions from webinar 1, linked to E&T

Problems	Solutions
Education health workers	Instruct radiation safety health workers every year
Apathy by radiographers regarding radiation safety	Regular CPD on radiation safety to periodically remind radiographers of the risks
Avoiding side effects of ionising radiation	Training and knowledge in radiological protection and safety
Challenging to keep my colleagues up to date and understand what parameters do. (e.g. extra tube filtration with different KV: it is really a grey area, even the vendor doesn't always give a direct answer	Regular, short, in-house training sessions (2 times per year). However, many colleagues go there because they need to not because they want to…
Equipment not set up properly by radiographer	More coordinated staff training through constant training like in CT for instance
Excess repetitions of research, especially noticeable among some doctors traumatologists and orthopaedists.	Endeavour to optimise the number of tests required,
People from other departments not understanding radiation	Education - posters, hospital seminars, reminders
Lack of education and training programmes in RP including continuous training for health professionals.	Integration of RP education at the medical and dental schools, but also for other health professionals (e.g. technicians). This education and training (initial and continuous) should also be implemented in a more advanced level during the clinical residency. Progress indicator: Number of annual educational activities on RP for the different scientific societies.
Lack of knowledge regarding ionising radiation by referring doctors	Educational seminars to raise awareness among requesting doctors regarding the harmful effects of ionising radiation
Lack of RP culture in the health sector (including the lack of benefit-risk dialogue) and the need to work as a team of different professionals.	Promote the RP culture trough the teamwork (radiologists, radiographers, and medical physicists) involving the hospital management. Use of adverse event reporting systems to learn lessons from unintended and accidental exposures. Improve communication with patients and media (e.g. RP campaigns).
Medical/technical illiteracy on the topic	Training, training, and training
Staff	More educated staff
Staff does not wear dosimeter, changing repeatedly	Repeatedly briefing and supervision of radiation protection officer
The use of the dosimeters by the professionals	The daily log of dosimeter usage on entry and exit
Theatre staff who do not wear appropriate PPE when necessary	More education

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Table A2 – Problems and solutions from webinar 1, linked to Dose analysis and QC/QA

Problems	Solutions
Insufficient optimization actions and lack of diagnostic reference levels (DRLs)	Develop or adapt quality control (QC) manuals, protocols for specific procedures (e.g. paediatrics, pregnancy, screening, dental, etc), establishment of DRLs, use of dose management tools and a planning to implement new technology. Progress indicator: Number of countries with QC manuals in use. Number of protocols adopted. Number of countries with DRLs implemented.
Dose Management of PATIENTS:	Harmonization of dose quantities between different x-ray modalities and different brands/providers for easier automisation of statistical management.
Dose Management of STAFF: Lack of Usage	Develop and implement attractive, interactive, and periodic presentations and communications with the staff to better engage them. Change core curricula to include Masters in RP
Dose measurement differences between equipment vendors and challenges comparing these.	Vendors to work towards some consistency in reporting dose reduction and dose measurement functions and the realistic dose reduction they provide
Dose reference levels in image guided radiation therapy	Establishment of DRLs for IGRT
Dosimetry in low doses	In low dose examinations, maybe DRLs can be set after 2 years
Establishing a dose management system due to costs or licence	Including colleagues of radiology and nuclear medicine
Exposure in Pregnancy	Better training, information, and education specifically for pregnancy situations including practical simulation scenarios. Use or not of PPE such as lead aprons.
high dose in all exams	establish protocols and follow local NRD
High risk of professionals develops radiation disease	Using dosimeters, QA of equipment
absence of dosimeters	severe monitoring
No clear tasks for radiation protection, no one responsible for supervision of DRL	Is needed for licence, assignment of tasks, assigning several tasks due to short-staffing
safety culture awareness	build protocols and check

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Table A3 – Problems and solutions from webinar 1, linked to Justification

Problems	Solutions
A patient has more than one physician, they have the same complaint to different physicians and may be sent for multiple variety of exams increasing their medical dose of radiation.	National identifier necessary to collate all the exams and doses, so practitioners are aware of total dose.
Increase of the number of unjustified requests	The person who justifies the request has to take full responsibility
Justification	With training about the risk
medical protection	corporate, education involve medical design and implementation of radiation protection
Growing number of CT scans	More critical justification and better clinical information so the right scan is made
repetition of an exam because the clinician doesn´t know what he truly wants at that time, what they need to see precisely	double check
Repetitive x rays	To follow the protocol and repeat the x ray in 6months

Table A4 – Problems and solutions from webinar 1, linked to practical aspects

Problems	Solutions
Carers who attend with patients without information regarding doses.	visual information in the department as the carers may not know that they are in a department dispensing radiation. Especially with nuclear medicine where the radiation may be emitted from their companion.
During fluoroscopy and radioscopy, the dosimeter is forgotten.	It's hard to notice among your employees or colleagues that someone is not using a dosimeter.
Failure to incorporate all the professionals involved in medical imaging during designs and implementation of radiation protection.	Ensuring that all professionals involved in medical imaging are incorporated into the design of radiation protection such as doctors, radiographers, and medical physicists
High risk to public people develops radiation diseases	Using protection devices
Negligence in personnel's wearing their dosimeters.	Ensuring that we have our dosimeters on throughout our work.
Prolonged exposure time in operation rooms	Few quick exposures during the operation
unnecessary exposures, over exposures etc.	awareness of ALARA, and proper justification of exams

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Table A5 – Problems and solutions from webinar 1, linked to technology

Problems	Solutions
Cost of some procedures	Compare about different modalities to ensure the best result with less cost
Diverse staff in interventional radiology rooms and these personnel may have different levels of knowledge regarding radiation risk which may be challenging for the radiographer in the room to manage. Also vendors can oversimplify dose reduction options e.g., have a + button for better image quality and an - button for less quality. With this the staff really lose their knowledge about the real effect of exposure parameter changes.	Vendors need to work with radiographers to understand what we know about radiation dose & radiation safety and our legal responsibility in these roles so that they provide an adequate & substantial explanation of the functionality of their equipment.
Dosimeters, correct dosimeters for the tasks	Interventional radiology needs finger dosimeters. Eye dosimeters also due to high radiation levels on the eye. Dosimeters must be worn in the correct position. Individual use, the dosimeters must be changed monthly or every three months.
Equipment	New modern equipment
Increasing the dose for better image	Update the equipment
Obsolescence of equipment	investment and awareness of decision makers
Old equipment or not enough equipment	Buying more equipment. Investing more money in this
The passive dosemeters	Instadose to have more immediate notification for exposure notification
Privacy of the patient data different hospital have different systems	Have one national PACS
Information systems integration issues	up-to-date software and dedicated IT teams
Interventional radiology personnel do not always wear lead shields.	Taught to constantly wear lead shields and goggles. To instil this habit from the time of study.
Not enough staff: medical physicist, RPR, dosimetrist	Employing new staff
Registering patient dose. Modality to get it out.	Better PACS system where it is integrated

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Table A6- Problems and solutions linked to DRLs

Type	Problem	Solution
Patient size	Too large patient weight, outside the median weight	Local DRL,
	Finding the ideal patients	Set up criteria for a specific range of patients to help in creating homogenous DRLs.
	DRLs are relevant for individual age groups	their distribution according to age group
	over weighted	local DRL
	Size of the patient size, the data (BMI etc.) often not available	
Paediatric patients	Collection of dose data for children is challenging because of the different age and weight categories	Departments have to provide time and staffing and experienced personnel (medical physicists & radiographers) to support DRL calculation. Small hospitals find it difficult to meet an annual review of DRLs for all exams. Automation of dose collection would be of benefit but need weight & height measurements which is time-consuming.
	DRLs for children's examinations are applied depending on the age of the children, not on the weight, because children of the same age have different weights. In that case, DRL doesn't match the requirements	a better methodology and training for achieving the right DRL for the right (age+ weight + height).
	paediatric DRLs	age weight height
	Paediatric DRL are difficult to gather	Combine age, size, and weight
Guidance	Different methodologies applied by different societies difficult comparison	standardise methodology worldwide
	DRLs are very different, within the same technique, but with different equipment we have different values	better control of radiological equipment performance so that our DRLS information is not affected
	few information about protocols/technology considered	improve description
	the technique used is not the same in all departments	The use of similar working protocols for the same anatomical areas, manufacturers shall implement DRL calculation into patient protocols
Data collection	CT DRLs - DLP and not CTDIvol	Choose one metric to investigate
	Different units used in general radiography (comparing different radiography rooms)	Convert units to one standard unit for comparison (e.g. mGycm2)
	difficult of extract the data, different dose descriptors	multidisciplinary approach required to optimised
	Continuously updating DRLs	To keep in line, rigorous number of examinations need to be carried. A body needs to be appointed in order to make sure the updates keep on being put to good use
	It is challenging to collect enough data for some examinations (e.g., lumbar spine radiography) because patients referred for these may be above the ideal weight	Departments have to provide time and staffing and experienced personnel (medical physicists & radiographers) to support DRL calculation. Small hospitals find it difficult to meet an annual review of DRLs for all exams. Automation of dose collection would be of benefit but need weight & height measurements which is time-consuming.

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	lack of data for analysing properly DRL´s (problem for both national and local DRL´s)	improve the data collection, and the engagement of more institution (clinal, hospital, etc..)
Technology	better software integration	cheaper apps
	Equipment variability between institutions may influence reference level	standardization of the PACS system over the hospitals or national. It will be great to optimise kV for contrast studies but in some hospitals, they do use same kV as in regular studies
	not having DMS	hard work and excel tables
	Older equipment presents higher doses	New SI detectors can improve image quality with low doses. Older equipment could be made better with modifiers techniques, new equipment's. equipment's. Increase contrast to 350 lower operating kVp for some exams to 100?
	older technology still in use with no dose values available	renew equipment's or adapt with external dosimeters
	Manual work takes time and labour	Programs automate, but are not perfect
E&T	medical stuff not understanding importance of DRLs	more education and training
	not enough information about the importance of using the DRL´s, and adjust the optimisation on the dose	more training and seminars about this, and engage the staff for this awareness
	RP awareness, understanding meaning and benefit of DRLs	education and training
	Have the time to do DRL´s, keep everyone involved and motivated	education and training everyone, show the importance of DRL´s increase the staff
	When to revise DRLs	In certain high dose examinations, a yearly follow-up is the biggest stretch one can allow as the risk is already very high
Other	Time factor (small team of physicists, not a lot of interested physicians)	establish dose management teams (physicists, physicians, radiographers), regular meetings, regional cooperation's
	Sometimes national DRLS do not exist for particular exams	Ensure we have a local DRL e.g. for interventional fluoroscopy
	Small hospitals/ clinics may not have access to a medical physicist for advice and calculation of DRLs	A medical physicist from a nearby larger hospital could be asked to provide support to smaller hospitals/ clinics.
	unjustified high or low doses can be the consequence of doctors asking for a little bit bigger picture or something	keep same parameters as in regular studies to improve diagnostic quality, t will be great to optimise kV for contrast studies but in some hospitals they do use same kV as in regular studies t will be great to optimise kV for contrast studies but in some hospitals they do use same kV as in regular studies, t will be great to optimise kV for contrast studies but in some hospitals they do use same kV as in regular studies Too many unjustified requests in ER room. Some Hospitals (Portugal) Nurses prescribe trauma x-ray and there are too many mistakes and errors. All X-ray should be justified. If not clinically indicated no matter who orders why not reject

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