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Escola Superior de Tecnologia da Saúde
Politécnico de Coimbra

Regional Meeting on Radiation Protection Education and Training of Medical Radiation Technologists/Radiographers

Online via WebEx, 3 December 2020

Escola Superior de Tecnologia da Saúde
Politécnico de Coimbra

Graciano Paulo

IPC – ESTESC, Coimbra Health School

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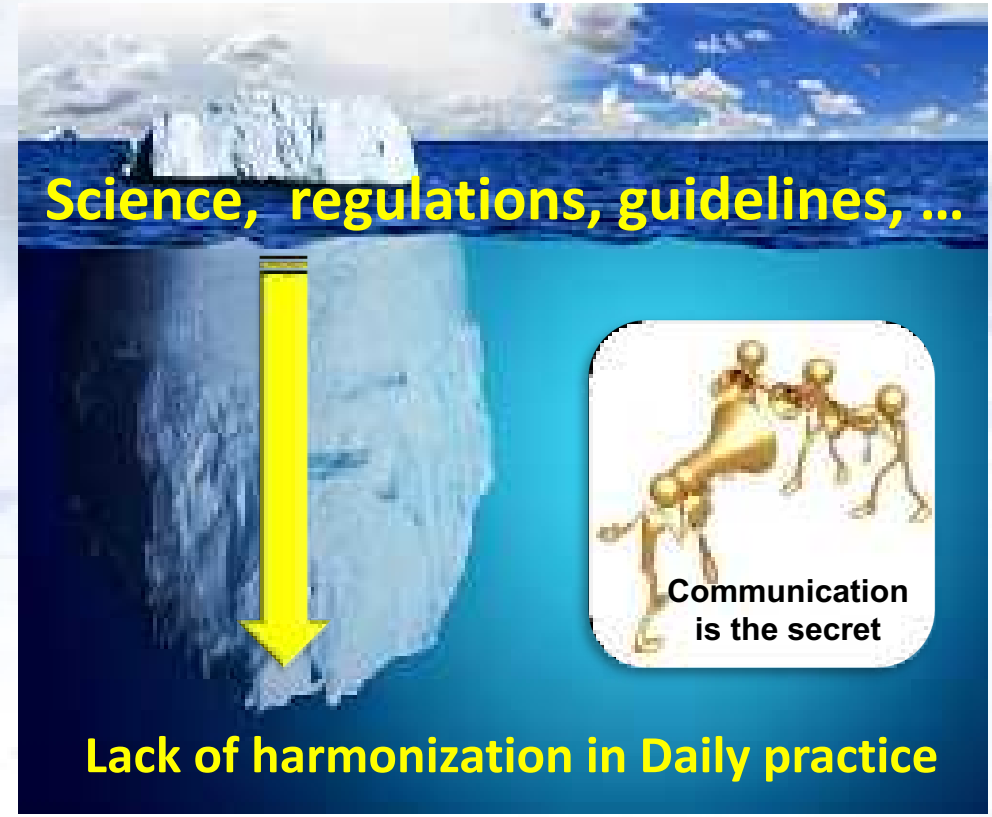
Each one of the +/- 700 million medical imaging procedures made every year in Europe

Radiographer challenges



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Council Directive 2013/59/EURATOM

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Article 18

Education, information and training in the field of medical exposure

1 Member States shall ensure that practitioners and the individuals involved in the practical aspects of medical radiological procedures have adequate education, information and theoretical and practical training for the purpose of medical radiological practices, as well as relevant competence in radiation protection.

For this purpose Member States shall ensure that appropriate curricula are established and shall recognise the corresponding diplomas, certificates or formal qualifications.

3 Member States shall ensure that continuing education and training after qualification is provided and, in the special case of the clinical use of new techniques, training is provided on these techniques and the relevant radiation protection requirements.

4 Member States shall encourage the introduction of a course on radiation protection in the basic curriculum of medical and dental schools.

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The Motto

- The European Commission published in 2000 "Guidance on Education and Training in Radiation Protection for Medical Exposures" (Radiation Protection nº 116) WITH THE AIM TO PROVIDE SOME CLARIFICATION AND ORIENTATION FOR THE APPLICATION OF THE MED.

- Rapid technological development during the past decade and constantly growing use of ionizing radiation in medicine, WERE THE DRIVERS FOR EU TO CALL FOR AN UPDATE of this document.

- Training in radiation protection is widely recognised as one of the basic components of optimization programmes for medical exposures, it is necessary TO ESTABLISH HIGH STANDARDS TRAINING PROGRAMMES HARMONIZED AT EU LEVEL.

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THE TARGET

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Radiation Protection Authorities

EDRAPET

WP1

Medical Radiation Protection
EDUCATION AND TRAINING

Professional Societies

Educational Institutions

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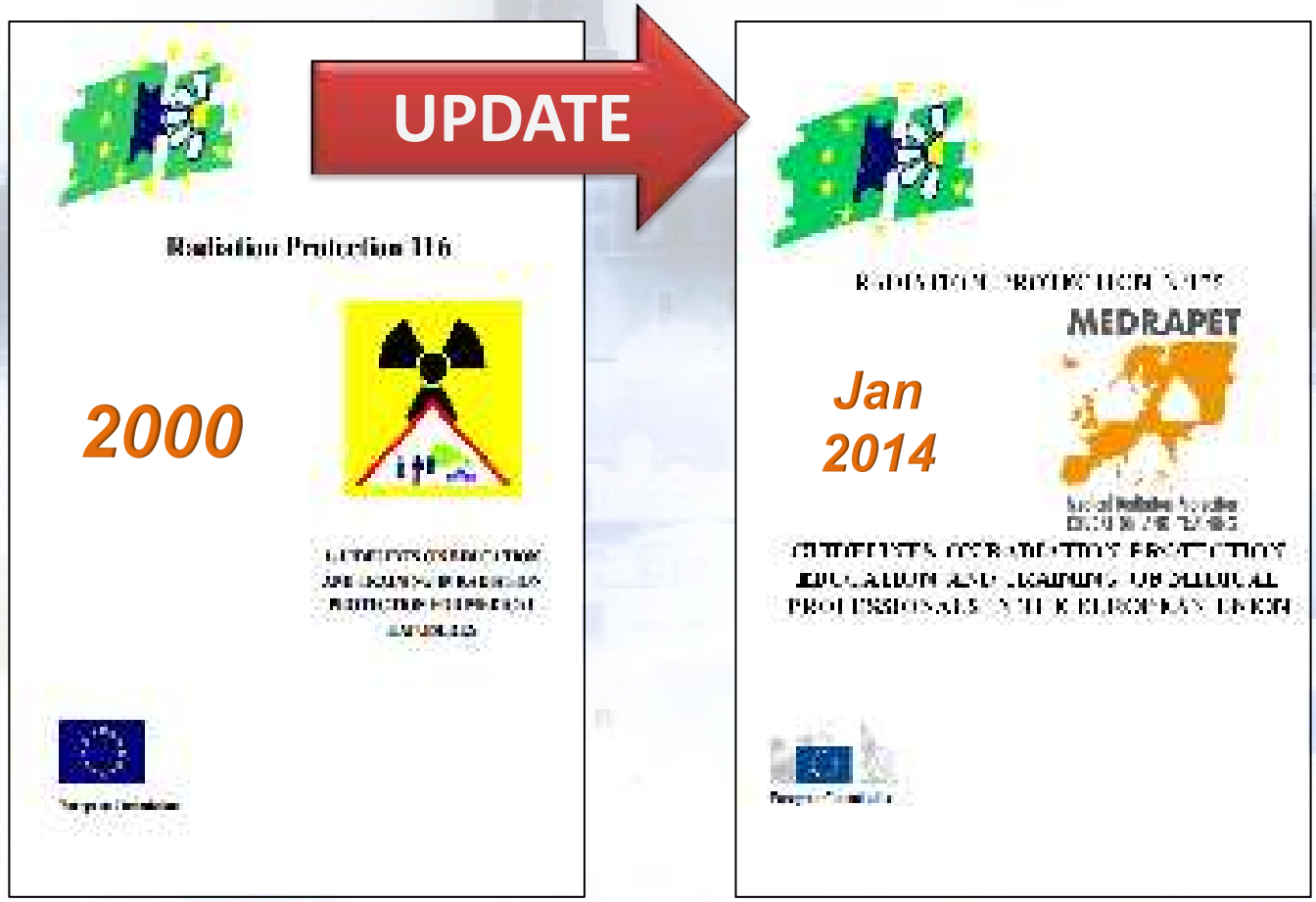
Action



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ICRP + MEDRAPET topics

T1 - Atomic Structure, X-ray production and interaction of radiation
T2 - Nuclear structure and radioactivity
T3 - Radiological quantities and units
T4 - Physical characteristics of the X-ray machines
T5 - Fundamentals of radiation detection
T6 - Fundamentals of radiobiology, biological effects of radiation
T7 - Risks of cancer and hereditary disease and effective dose
T8 - Risks of deterministic effects
T9 - General principles of RP
T10 - Operational RP
T11 - Particular patient RP aspects
T12 - Particular staff RP aspects
T13 - Typical doses from diagnostic procedures
T14 - Risks from foetal exposure
T15 - Quality control and quality assurance
T16 - National regulations and international standards
T17 - Dose management of pregnant patients
T18 - Dose management of pregnant staff
T19 - Justification of imaging examinations
T20 - Dose optimization in digital radiographic and fluoroscopic techniques.
T21 - Dose optimization in computed tomography (CT)
T22 - Dose optimization in diagnostic and therapeutic procedures with unsealed radionuclides.
T23 - Biokinetics of incorporated radionuclides
T24 - Treatment plan optimization and strategies for maximizing the therapeutic ratio
T25 - Target volume-confined (conformal) irradiation in an radiation protection perspective

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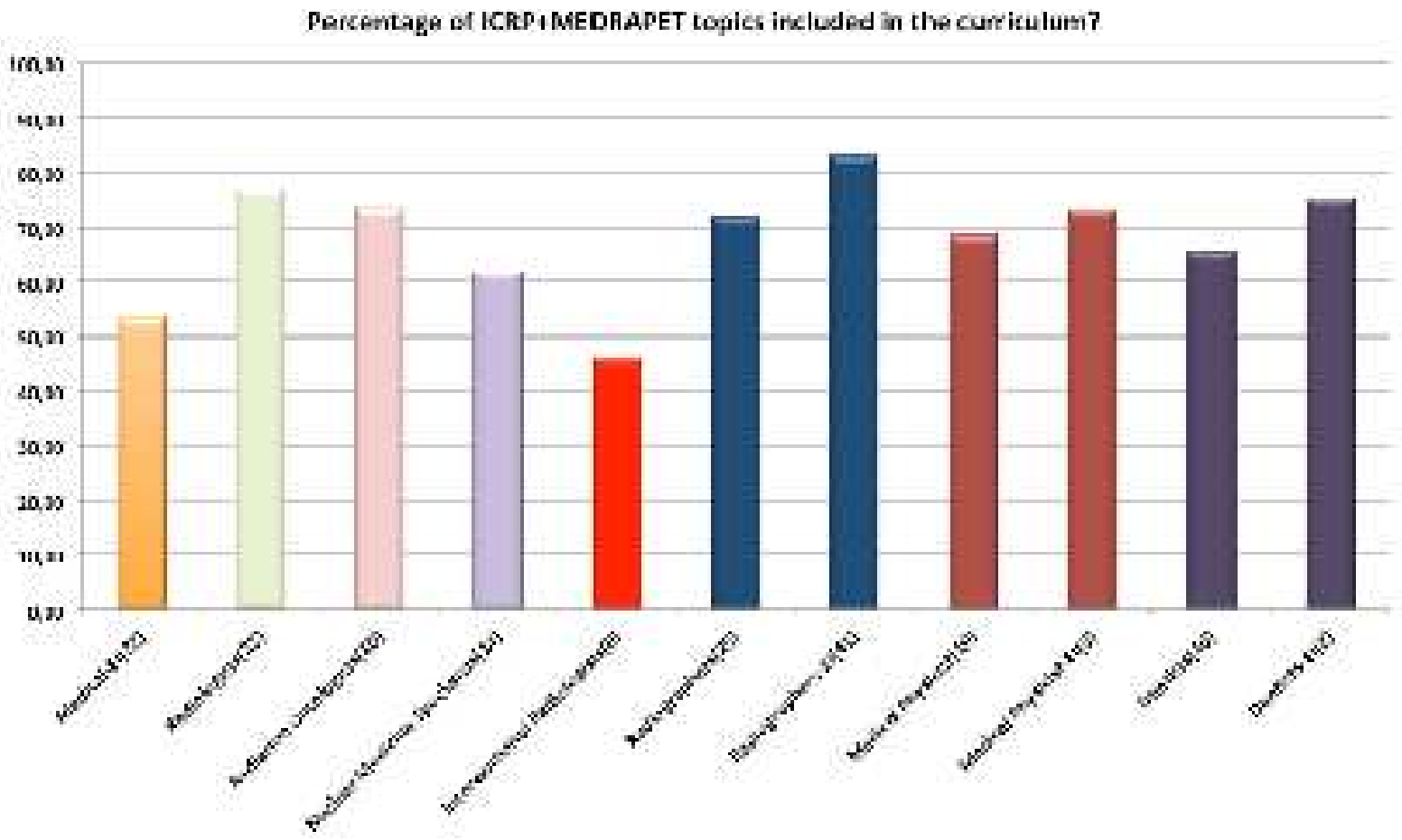
Professional Societies



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[Table 1] Typical higher education qualifications of the FHEQ-Portugal and the corresponding level of EQF and cycle of the FQ-EHEA

Higher education qualifications of the FHEQ-Portugal	Corresponding FQ-EHEA cycle	Corresponding EQF levels
Doctoral degrees	Third cycle qualifications	8
Doctoral course diplomas	–	–
Master's degrees	Second cycle qualifications	7
Master's course diplomas	–	–
Licenciatura degrees	First cycle qualifications	6

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ABOUT European Qualification Framework (EQF) – level 6

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Knowledge

Advance knowledge of a field of work or study, involving a critical understanding of theories and principals

Skills

Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems ins a specialised field of work or study

Competences

Manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts.

Take responsibility for managing professional development of individuals and groups

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Knowledge

Skills

Competences

Rethink the professions Field of knowledge & practice

Professional Role Development

Advance Practice

Increase professional Satisfaction

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Table 6.1 Specific learning outcomes for Radiation Protection at entry level

Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
Core Learning outcomes in radiation protection		
K1. Explain physical principles of radiation generation, interaction, modification and processing;	S1. Use the appropriate medical devices in an effective, safe and efficient manner;	C1. Practise effectively, accurately and safely and within the guidance of legal, ethical and professional frameworks;
K2. Explain radiation physics, radiation hazards, radiation biology and dosimetry;	S2. Use effective, safe and efficient radiation protection methods in relation to staff, patients and the general public applying current safety standards, legislation, guidelines and regulations;	C2. Use appropriate and correct identification, address and treatment of the patient (and any accompanying carer if appropriate);
K3. Understand risk: benefit philosophy and principles involved in all aspects of radiography;	S3. Critically review the justification of a given procedure and apply it in the light of appropriate/relevant guidelines and protocol (and consult the responsible specialist);	C3. Avoid unnecessary exposure and minimise necessary exposure as part of optimisation;
K4. Identify current national and international radiation protection legislation and regulations relating to staff, patients, carers and the wider general public;	S4. Use and undertake clinical audits;	C4. Seek consent for any examination/treatment to proceed;
K5. Explain physics underpinning non-ionising imaging techniques including magnetic resonance imaging and ultrasound along with associated safety considerations;	S5. Identify the principles of evidence based practice and the research process;	C5. Carry out work in a safe manner when using/receiving radiation, taking into account current safety standards, guidelines and regulations;
K6. Describe protocols and roles and responsibilities in terms of aspects of justification and optimisation;	S6. Critically reflect on and evaluate his/her own experience and practice;	C6. Participate in the process of creating and guaranteeing maximum safety for the patient, one self and others during examinations/treatments involving ionising radiation and maintain the ALARA principle;
K7. Explain QA and QC practices to include legislation, regulations and guidelines, test equipment and methodologies, programme design and implementation and reporting to thus ensure the provision of an effective, safe and efficient service;	S7. Participate in CPD;	C7. Refuse to accept or carry out a request or referral which, in his/her professional opinion, is dangerous or inadvisable;
K8. Understand occupational risks, health and safety that may be encountered such as safe moving and handling of patients and equipment;	S8. Recognize the complicated situation pertaining to radiation protection regarding scientific knowledge on the one side and societal aspects and personal emotions on the other side;	C8. Recognise the limitations in his/her scope of competence and seek advice and guidance accordingly;
K9. Describe the importance of valid, research and evidence-based practice to include the stages in the research process, research governance, ethics, statistics and statistical analysis to facilitate a deeper understanding of research findings and clinical audit;	S9. Identify different image quality standards for different techniques;	C9. When taking decisions about care for (individual) patients be able to make use of relevant national and international (scientific) insights, theories, concepts and research results and integrate these approaches in one's own professional actions (evidence-based practice).
K10. Identify the different determinants of radiation risk perception; know the pit falls of communication on radiation risk.	S10. Apply the concepts and tools for radiation protection optimisation.	

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Table 6.1.1 Additional learning outcomes in radiation protection for radiology radiographers

Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
Additional for radiology		
K1. Explain the relationship of exposure factors to patient exposure; K2. Understand how patient position affects image quality and dose to radiosensitive organs; K3. Understand the effect of filter type in diagnostic x-ray systems; K4. Understand the purpose and importance of patient shielding; K5. Understand post-processing possibilities for CR and DR systems (filters, noise, magnification, raw data manipulation); K6. Know recommendations and legal requirements applying to medical, occupational, and public exposure	S1. Performs the medical procedure with the appropriate X-ray equipment suited and optimised for the specific medical procedure (adult, paediatric, projection possibilities, adjustments for longer procedure time, etc.); S2. Operates according to Good Medical Practice in order to minimize overall fluoroscopy time; S3. Puts into practice the basic principles of preventing (unnecessary) exposure (time, distance, shielding); S4. Program the use of beam filters in mammography and conventional radiography (proper use of additional filtration); S5. Use and record the integrated dose meter (DAP) and checks the measured values against DRLs and/or threshold dose for deterministic effect in order to prevent deleterious effects on patients whenever possible; S6. Identify various types of patient shielding and state the advantages and disadvantages of each type; S7. Use the appropriate method of shielding for a given radiographic procedure; S8. Identify difference between continuous and pulsed fluoroscopy and use each mode when appropriate; S9. Explain and communicate effectively the nature and magnitude of radiation risk and benefits, in order to obtain informed consent.	C1. Take responsibility for use of proper exposition parameters according to type of modality and to radiological procedure; C2. Identify the appropriate image receptor that will result in an optimum diagnostic image with the minimum radiation exposure to the patient; C3. Identify proper C-arm position regarding non-patient doses; C4. Discuss added and inherent filtration in terms of the effect on patient exposure; C5. Compares dose measurements (DAP, DLP, KAP, ESD, CTDI, glandular dose) readings to equivalent to National or European DRLs; C6. Participate in the optimization of all parameters to create protocols regarding to National or European DRL; C7. Optimize radiological procedure to fit for pregnant women and use appropriate paediatric protocols; C8. Take responsibility of choosing post processing tools and change exposure parameters to obtain lower dose for clinical diagnostic images; C9. Advise proper use of personal protection; C10. Optimize the use of radiology equipment according to ALARA principles.

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Table 6.1.2 – Additional learning outcomes in radiation protection for nuclear medicine technologists

Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
Additional for nuclear medicine		
K1. Explain the physical principles of how radionuclides can be generated; K2. Explain how radionuclides can be physically shielded (gamma, beta, positron); K3. For the range of therapy and diagnostic procedures, explain the biological basis on which radiopharmaceutical localisation occurs; K4. Understand the risk-benefit philosophy as applied to NM procedures; K5. State which QC tests should be applied to which pieces of NM equipment, why, how and their frequency; K6. Explain the legal and clinical basis on which NM procedures, both diagnostic and therapeutic, are requested and justified; K7. Identify which non-ionising radiation diagnostic examinations can be used as possible alternatives to NM procedures; K8. Explain how doses for children can be varied from those of adults; K9. Indicate which diagnostic examinations carry radiation risk to breast feeding babies, indicate the contingencies which might apply; K10. For diagnostic procedures, explain what practical steps can be taken to minimise radiation risk to radiosensitive organs (e.g. thyroid); K11. Understand interactions, pharmacology and adverse reactions of drugs commonly encountered within NM with a particular emphasis on radiopharmaceuticals and X-ray contrast agents; K12. Understand biological and physical half-lives of the radiopharmaceuticals used for diagnostic and therapeutic procedures.	S1. Acquire and process images and data that have clinical relevance within NM, observing the principles of exposure optimisation and dose management (e.g. PET/CT); S2. Use devices which can be used to monitor and also minimise radiation dose; S3. Use all relevant laboratory equipment; S4. Translate guidance and local rules into practical working routines so as to minimise dose to staff, patients and the public; S5. Be able to assist only (or where handling radionuclides but not at the expense of incurring an adverse incident); S6. Be able to communicate effectively with patients and carers so that diagnostic examination requirements are met but not at the expense of compromising the patient experience; S7. Be able to discuss with the medical referrer on whether the requested NM procedure is appropriate in part or in whole; S8. Be aware of the fact that a patient after a radioactive injection is to be separated from other patients; S9. Be able to prepare, manipulate and administer radioisotopes, to patients, assuring prior, per and post administration radioprotection measures; S10. Perform laboratory tests (e.g. GFR).	C1. Take responsibility for conforming to national regulations for all handling of unsealed radioactive substances; C2. Take responsibility for conforming to local standards and standard SOPs while handling unsealed radioactive substances; C3. Take responsibility for handling unsealed radioactive substances in a manner that accidental / undue limited exposure of oneself as well as co-workers is avoided; C4. Comply with good manufacturing practice when working within the radiopharmacy; C5. Take responsibility for interpreting QC tests to determine whether NM equipment is within manufacturer specification; C6. Take responsibility for drawing up the correct quantity of radiopharmaceutical for administration, taking into account DRLs; C7. Working within a described framework, justify the diagnostic NM procedure; C8. Take responsibility for obtaining patients' consent for diagnostic procedures, for explaining procedures to the patient and responding appropriately to their questions.

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Table 6.1.3 – Additional learning outcomes in radiation protection for for radiotherapy technologists

Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
Additional for Radiotherapy		
K1. Understand biomedical physics underpinning the scientific, effective, safe and efficient use of medical devices used in radiation therapy, including medical imaging devices used for tumour localization and treatment planning.	S1. Use medical devices in radiation therapy, including medical imaging devices, used for tumour localization and treatment planning in a safe and effective manner	C1. Able to take into account, from the perspective of the patient, the technical, clinical and treatment while it is being conducted
K2. Knowledge and understanding of the radiation physics underpinning radiation therapy treatments and medical imaging examinations for tumour localization and treatment planning to include: nuclear structure, radioactive decay, interaction with matter, electromagnetic radiation, particle radiation, sources of radiation, tissue in homogeneity, wedges, weigh factors, beam shape and properties	S2. Analyse the properties of particle and electromagnetic radiation	C2. Able to select and argue a suitable treatment on the basis of (one's own) analysis of a question and/or indication, give an account of this and advise accordingly
K3. Knowledge and understanding of radiation protection underpinning radiation therapy treatments and medical imaging examinations for tumour localization and treatment planning to include: radiation hazards, radiation shielding, detection methods, current national and international radiation protection legislation and regulations relating to staff, patients and the general public	S3. Apply treatment planning including 3D planning, virtual and CT simulation and applies these procedures to plan patients' treatments	C3. Work in an independent, methodical and evidence based manner in term of quality, complete the treatment and report accordingly
K4. Knowledge and understanding of the radiobiology underpinning radiation and cytotoxic therapy treatments, and medical imaging examinations for tumour localization and treatment planning to include: cell biology, effects of ionising and non-ionising radiation, radiation risks, radio sensitivity, side effects of radiation therapy treatments	S4. Prepare treatment plans using IMRT and other techniques such as stereotactic, particle and IGRT	C4. Able to work in a safe manner when carrying out treatments with ionising radiation, taking into account current safety standards, guidelines and regulations
K5. Explain DNA damage	S5. Define the target and OAR using ICRU terminology	C5. Critically evaluate the dose distribution and DVHs
K6. Describe the cellular effects, mechanisms of cell death	S6. Describe how DVHs are created and used to evaluate plans	C6. Optimise and evaluate the plan options
K7. Explain the cell survival curves	S7. Relate the influence of changing planning parameters on DVHs	C7. Assess the daily physical and psychological status of the patient prior to treatment
K8. Describe the normal tissue, solid tumour and lymphatic system	S8. Use radiation protection methods relating to staff, patients and the general public, taking into account current safety standards, guidelines and regulations	C8. Record all side effects and advise the patient on their management in accordance with departmental protocol
K9. Explain the effects of oxygen, sensitizers and protectors	S9. Justify and optimise all procedures effectively	C9. Calculate/check monitor units and treatment times
K10. Explain the effect of time-dose-fractionation, LET and different radiation modalities and interaction between cytotoxic therapy and radiation	S10. Recognize OAR on medical images for tumour localization and treatment planning	C10. Check treatment prescription calculations for accuracy and take/check consent as per departmental

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Table A1: Recommended syllabus and ECTS for radiation protection education and training for radiographers

Syllabus	ECTS	From Table 2.1	
		Topic number	TOPIC
Radiation protection and safety	5	9	General principles of radiation protection
		10	Operational radiation protection
		11	Particular patient radiation protection aspects
		12	Particular staff radiation protection aspects
Quality control and optimisation in medical imaging and radiotherapy	5	16	National regulations and international standards
		19	Justification of imaging examinations
		4	Physical characteristics of X-ray systems
		5	Fundamentals of radiation detection
		15	Quality control and quality assurance in radiation protection
Radiobiology	3	6	Fundamentals of radiobiology, biological effects of radiation
		7	Risks of cancer and hereditary disease and effective dose
		8	Risks of deterministic effects
Radiation physics and dosimetry	4	14	Risks from foetal exposure to ionising radiation
		3	Radiological quantities and units
		13	Typical doses from diagnostic procedures
		17	Dose management of pregnant patients
		18	Dose management of pregnant staff
Nuclear and atomic physics	3	1	Atomic structure, X ray production and interaction of radiation
		2	Nuclear structure and radioactivity

The following recommendation represents average values after eliminating 15% of the lowest and highest values

- 20 ECTS for radiation protection education and training for Radiography
- Total workload in hours: 540;
- Contact hours: 240 (140 theoretical + 100 practical);
- Independent study hours: 300 (1.25 hours of personal study for each contact hour).

Independent of the model used by the HEI, the students should always be assessed in order to assure that the KSC in radiation protection education and training is obtained.

Only as a suggestion (because the HEI are autonomous in defining their curricula), the recommended syllabuses are given in Table A1 matched with the topics in Table 2.1

ECTS for continuous professional development

CPD programmes should ideally be developed and organised using ECTS methodology for credit award, not only because it would facilitate the recognition process (at national and international level), but also because it would allow the creation of a quantitative indicator of what health professionals dealing with ionising radiation should obtain during their LLL activities [3].

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http://www.eurosafeimaging.org/ask-eurosafe-imaging

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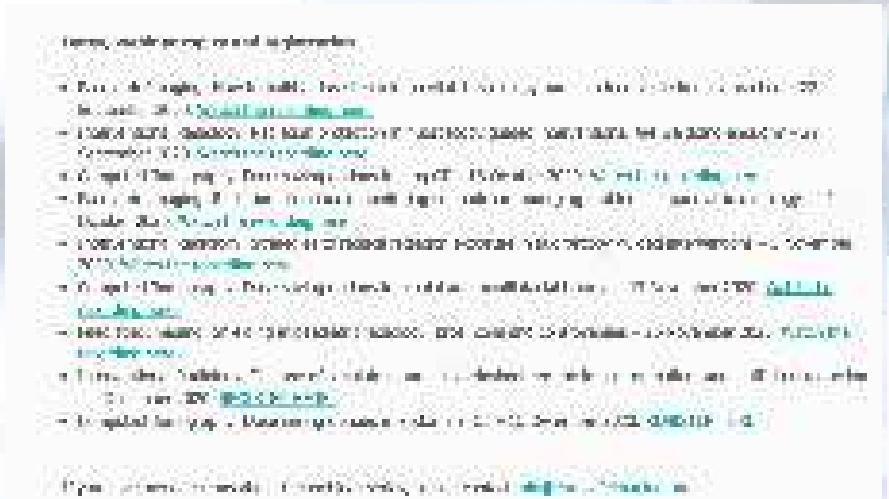

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Increase the Visibility & Recognition of the Importance of RADIOGRAPHERS in Health Systems

European Radiographers development pillars

- Continuous Professional Development
- Increase Knowledge Skills and Competences
- Deliver Patient centred healthcare
- Develop Field of Knowledge: RESEARCH

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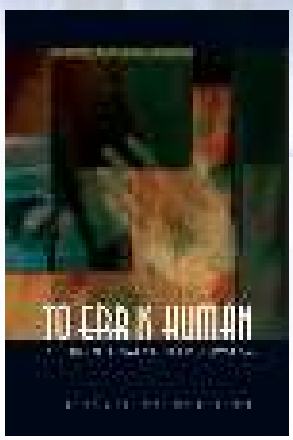
The way forward

In health care, knowledge and skills to deliver a specific task is not enough

T E A M W O R K

Teamwork depends on each team member to be capable to undertake their role with professionalism and be able to identify when errors occur and how to recover and correct for these errors:



The best are those who err less

- **Anticipate the needs of others;**
- **Adjust to each other's actions and to the changing environment;**
- **Have a common understanding on how a procedure should be performed.**

Adapted from: The Role of Teamwork in the Professional Education of Physicians, Baker et al., Joint Commission Journal on quality and patient safety

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Pathway for the future Radiographer

promoting best practice

Obtain essential KSC in all areas of Medical Imaging and Radiotherapy

Post graduate courses to increase KSC in a specific field

Increase Best Practice through evidenced based research

Head of Departments must acknowledge that developing Radiographers KSC will allow them to achieve high technical and professional differentiation, to minimize practice error and maximize patient and staff protection.

Life Long Learning is essential to maintain KSC up-to-date

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Final Message

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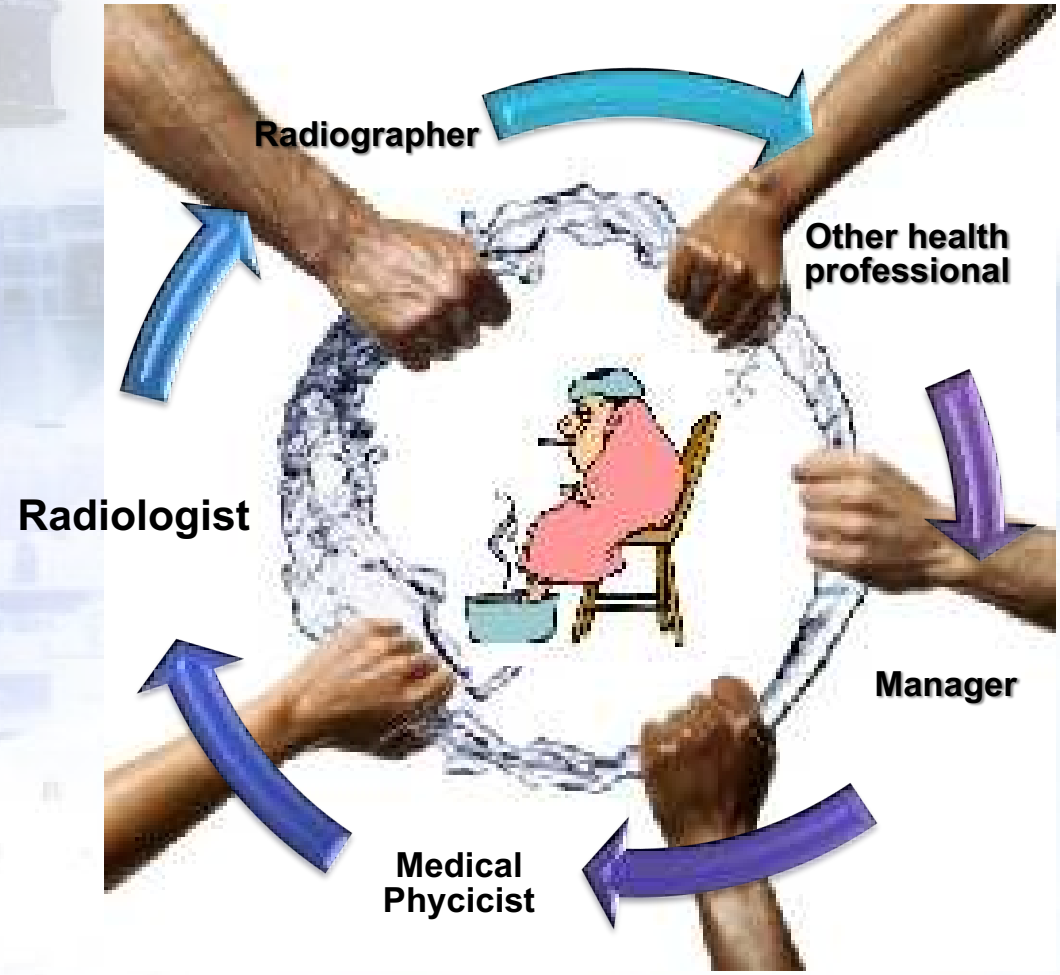
The future of Medical Imaging & Radiotherapy depends on our capability of building a Team-Work Model based on Roles and Responsibilities, bearing in mind that the patient should be always in the center of the process, with a holistic approach



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