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MEDICAL RADIATION PHYSICS TRAINING EMERALD

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Abstract

Training of young medical physicists is an essential part of the framework of measures for Radiological Protection of Patients. The paper describes the Medical Radiation Physics Training Scheme EMERALD, developed by an European Project Consortium. EMERALD Training covers the Physics of X-ray Diagnostic Radiology, Nuclear Medicine and Radiotherapy. Each of these 3 modules covers 4 months training period. The EMERALD training materials are 3 Workbooks with tasks and a Teachers' Guide (total volume approx 700 pages) and 3 CD-ROMs with image database.

1. Introduction

The increased awareness that medicine delivers about 95% of people's exposure to radiation from man-made sources led to number of measures being taken within the European Community. Subsequent Policy Statements of the European Federation of Organizations for Medical Physics (EFOMP) - the regional chapter of the International Organisation for Medical Physics (IOMP) - specified further measures for radiation protection and requirements for the knowledge and skills of the professionals responsible for the safe and proper use of radiation in medicine. On this basis an EC Leonardo da Vinci pilot project [1] was prepared for developing a Framework of common training modules in Medical Radiation Physics (Physics of X-ray Diagnostic Radiology, Nuclear Medicine, Radiotherapy). These modules are for the training of young graduates and post-graduate students in medical physics or related disciplines, their tutors, as well as other Hospital employees applying radiation to medicine. The partners in the project are a Consortium of Universities and Hospitals from UK, Sweden, Italy and Portugal: King's College London - School of Medicine and Dentistry, University of Lund, University of Florence, King's Healthcare Trust, Lund University Hospital, Florence University Hospital, The Portuguese Oncological Institute, the International Centre for Theoretical Physics in Trieste. The acronym of the project is EMERALD (European Medical Radiation Learning Development). It is Managed and Coordinated by King's College London and is supported by the EFOMP. Special training materials were developed in the framework of EMERALD [2].

2. General structure of EMERALD training modules

The Consortium developed the three Training modules with a common length of 4 months (80 days) each. During this time the trainee will have to acquire most necessary professional skills. This part of the training was called "condensed" and can be performed in most countries, where training conditions are set up. Further the trainee can spend up to 2 months in his own country/state where he/she can additionally study the local Regulations and professional requirements. The paper here describes the "condensed" training EMERALD.
Each of the three Training Modules incorporates:

- List of Competencies (in accord with the UK IPEM Training scheme);
- Student Workbook with tasks (performance of each task leads to certain competency);
- Structured Timetable (describing the approximate time necessary for each task);

Each task in the Workbooks contains explanations and protocols to be followed and requires answers to specific questions and problems. The proper performance of each task should be verified by the Trainer and on this basis the Trainee can continue with other tasks. To help in this process a Teacher's Guide was prepared.

The main types of tasks are:
- Observing real activities and taking notes
- Using existing Regulations, Protocols, Software
- Using various types of measuring equipment
- Understanding the basic characteristics & parameters of equipment
- Performing Measurements (including Dosimetry), Collecting Results, Calculating Parameters and other activities most often related to Quality Control (QC).
- Full Equipment Assessment (as part of the overall Quality Assurance Program)

3. X-ray diagnostic radiology physics module

This module was developed mainly by the UK partners. The training tasks in the X-ray Diagnostic Radiology (DR) Physics Workbook are grouped in the following chapters:
- General principles of DR radiation protection;
- General principles of DR quality control;
- X-ray dosimetry and patient dosimetry;
- Radiological image parameters;
- X-ray tube and generator;
- Radiographic equipment;
- X-ray films/screens and laboratory;
- Fluoroscopic equipment;
- Digital imaging and CT equipment;
- Basis of shielding in DR

4. Nuclear medicine physics module

This module was developed mainly by the Swedish partners. The training tasks in the Nuclear Medicine (NM) Physics Workbook are grouped in the following chapters:
- General principles of Radiation Protection in NM;
- General principles of NM Quality Control organisation and equipment;
- Fundamentals and basic properties of radiopharmaceuticals and radioisotopes;
- Pharmacokinetics and internal dosimetry;
- Single detector systems and survey meters;
- General principles of Scintillation Camera systems;
- Single photon Emmission Tomography – SPECT;
- Positron Emission Tomography with dedicated PET or Dual-Head Coincidence Scintillation Camera;
- Image evaluation and Data analysis;
- Preparation and QC of radiopharmaceuticals;
- QA of equipment and software;
- Radionuclide therapy;
- Radiation Protection of NM staff;
- Radiation Protection of NM patients;
- National and EU legislation in Radiation Protection and Radiopharmacy.

5. Radiotherapy physics module

This module was developed mainly by the Italian and Portuguese partners (with input from Swedish partners). The training tasks in the Radiotherapy Physics (RT) Workbook are grouped in the following chapters:

- Basic methods in Radiotherapy Physics;
- Quality Assurance of a Dosimetric System;
- Calibration of a Kilovoltage x-ray Beam;
- Calibration of a MVXR Beam;
- Calibration of an Electron Beam;
- Calibration of an In-vivo Detector;
- Acquisition of Open Beam Data;
- Acquisition of Dose Distributions and Dose Profiles;
- Acquisition of Wedged Beam Data;
- Manual Monitor Unit and Dose Calculation for Photon and Electron Beams;
- External Beam Treatment Planning using a Computerized System;
- Quality Assurance of an Orthovoltage Unit;
- Quality Assurance of a Teletherapy Unit;
- Quality Assurance of a Linear Accelerator;
- Basic Checks of a Treatment Planning System for external beam therapy;
- Calibration of Brachytherapy Sources;
- Manual Treatment Planning using 192Ir Sources for Interstitial Brachytherapy;
- Manual Treatment Planning for Intracavitary Brachytherapy;
- Surface Moulds in Brachytherapy;
- Computerised Treatment Planning Systems for Brachytherapy;
- Quality Assurance in Brachytherapy.

6. CD-ROM image database EMERALD

Being very expensive contemporary radiological equipment can not be purchased for training purposes. Additionally this equipment is intensively used for diagnostic and treatment purposes. As a result the young medical physicists have extremely limited time for training in the hospitals. The only solution to this problem is to encourage the use of modern educational technology.

In order to provide possibilities for off-site (distance) studying of contemporary radiological equipment the EMERALD Consortium has developed a digital image database (IDB). The volume of the IDB is about 1400 images of Radiological equipment and its components; Block diagrams and performance parameters, graphs, waveforms; QA procedures and measuring equipment; Test objects and image quality examples; Typical images and artefacts, etc. A PC type image browser (ThumbPlus) is used for quick and easy search through the IDB. The browser presents each image as a ~ 128x128 slide, which can be further viewed in its original size (JPEG up to 1024x1024 pixels). Each image is visualised with corresponding caption, on which basis Keyword search of IDB can be performed as well. The IDB is engraved on three CD-ROMs – one for each Training module. The image organisation within each IDB follows the chapters in the Training Workbooks - Fig.1.

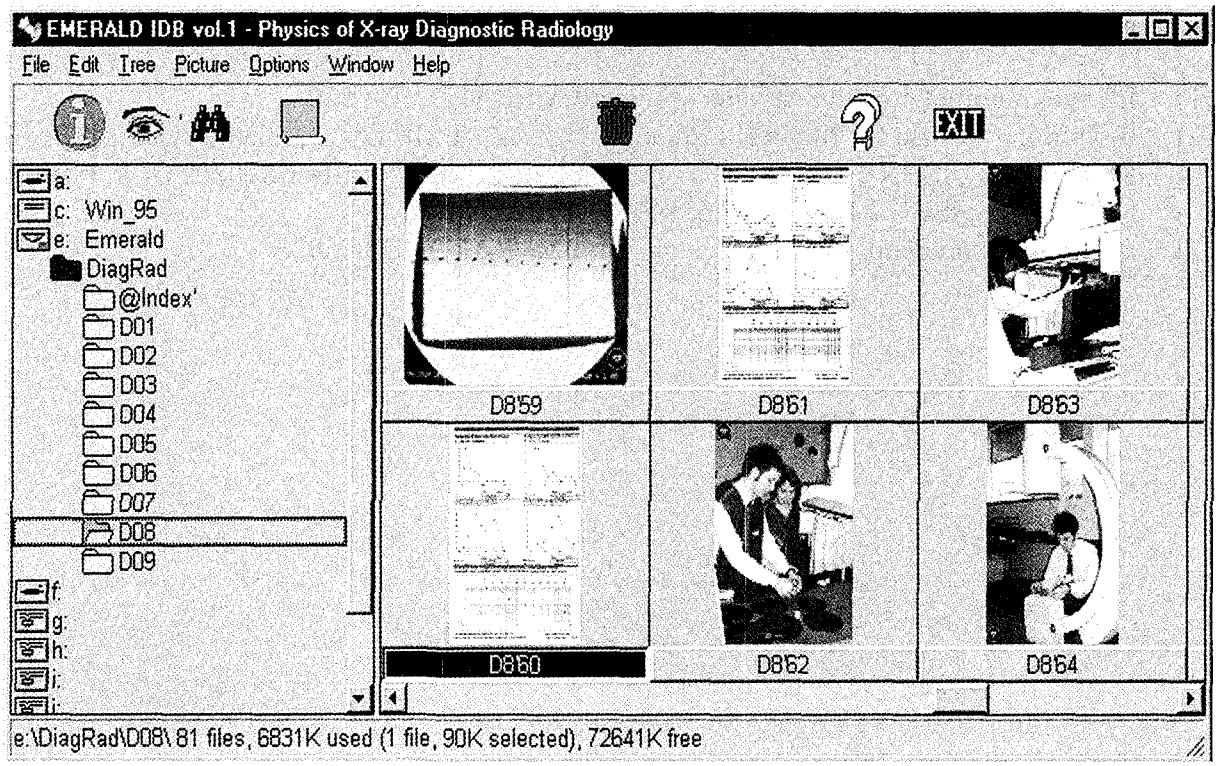

Figure 1. Graphical interface of the EMERALD Image Database with Thumb+Plus browser. An example from Image Directory 8, corresponding to Chapter 8 (Fluoroscopic Equipment - the task on image quality assessment) of the training module on Physics of X-ray Diagnostic Radiology

7. Practical implementation

All teaching materials were tested in practice and refereed. A special European Conference on Medical Physics was organised at ICTP Treiste, on 25-26 September 1998. Senior specialists from 24 countries gathered tt this Conference to discuss the common European approach to Medical Physics Training using EMERALD. The feedback of this Conference was later used during the editing of all EMERALD Training materials. These materials have now been exported in approximately 35 countries.

For the purposes of dissemination a further projects EMERALD II (EMERALD – Internet Issue) was prepared with enlarged Consortium including the old partners and new partners from France, Ireland, Northern Ireland, Czech Republic and Bulgaria [3]. During this second phase of the EMERALD a sequence of international Seminars "Train-the-Trainer" have been organised in Dublin, Lille, Prague, Lisbon, Lund and London . A special session was held also during the Word Congress in Chicago, WC2000. An interactive Training Multimedia is in development at the moment. This new material will be Internet distributable to assist the distance learning on the subject in the world.

Regular information about the development of EMERALD and the Network of specialists who are using this training can be found at the dedicated Web site: http://www.emerald2.net.

References

[1] EC programme Leonardo da Vinci, project EMERALD, ID 2620.
[2] A Training Course for Medical Radiation Physics – EMERALD, related issues: ISBN 1 870722 04 3 ; ISBN 1 870722 05 1; ISBN 1 870722 06 X; ISBN 1 870722 07 8; ISBN 1 870722 03 5; ISBN 1 870722 08 6; ISBN 1 870722 09 4
[3] EC programme Leonardo da Vinci, project EMERALD, ID 80502.