EMERALD - Vocational Training in Medical Radiation Physics

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INTRODUCTION

Training in the disciplines of medical radiation physics varies widely from country to country. This is quite clearly related to the number of practicing medical physics in the country or region. Whilst many countries provide specific educational programmes leading to a Masters degree, very few provide formal training to enable students to acquire practical skills and competencies .

A meeting of medical physicists from across Europe held in Hungary in 1995 (1) considered education and training standards. It was resolved that the considerable differences in training could and should be addressed by developing a scheme that was transportable across the states of Europe. A consortium of medical physicists from centres in the United Kingdom, Sweden, Italy and Portugal formed and applied to the Leonardo da Vinci programme of the European Community for funds to develop such a scheme. In 1995 funding was granted to the consortium for project EMERALD (European MEdical RAdiation Learning Development).

The objective of EMERALD was to develop a structured training programme which would enable students to develop the professional competency to use ionising radiations responsibly and safely in the medical environment.

BASIC DESIGN OF THE TRAINING PROGRAMME

The EMERALD programme was based on material contained in training prospectuses produced by the UK Institute of Physics and Engineering and Medicine (IPEM) and the European Federation of Organisations for Medical Physics (EFOMP). These documents list competencies required by medical physicists in a variety of specialist areas. The work undertaken by the EMERALD consortium was to expand the competency statements into a series of protocols (tasks) defining practical work which would enable the student to achieve the relevant competency.

Initially it was the intention of the consortium to produce training manuals in each of four specialist areas; radiation protection, diagnostic radiology, nuclear medicine and radiotherapy. However, after consideration, the consortium concluded that there was significant overlap between radiation protection and the other three subject area. It was therefore determined that rather than developing a specific training manual in radiation protection, this subject would be introduced, where appropriate, into the training manuals for the other areas.

Careful consideration was also given to the time required to complete the programme. Experience from the United Kingdom scheme indicates that the minimum time required to achieve a suitable level of competency in three related subject areas is 15 months, although the average length of training is closer to two years. The consortium considered that because the EMERALD programme was more structured than the UK scheme it would be possible to achieve completion in 1 year. Thus each task within each of the modules was given a notional completion time and the total for each module was 80 days (ie 4 months). To achieve completion of all three modules in a period of 1 year would require very intensive work. However the design of the EMERALD scheme would allow the individual modules to be taken separately with intervals between.

A problem faced by all trainees working in a practical environment is access to equipment and facilities. This is a particular problem in hospitals where the equipment used to diagnose and treat patients with ionising radiation is in constant use. To address this problem, EMERALD also included the preparation of an image database, the purpose of which was to assist in familiarisation and to provide images of equipment, features or problems that would not necessarily be encountered during a relatively brief training period. The image database has also been used to provide associated educational material.

The EMERALD programme has been prepared with the intention of using it widely at centres throughout Europe. To achieve consistency of use the programme includes a Teachers Guide which provides recommendations for using the programme. These include instructions for the supervisor on monitoring and assessing the progress of the trainee. The Teachers Guide also includes a section which discusses radiation risk, the framework for radiation protection and the application of radiation protection principles in the three subject areas.

DEVELOPMENT OF INDIVIDUAL MODULES

The competencies published by IPEM and EFOMP take the form of brief statements defining particular areas of work in which skills and experience are required. These were developed for the EMERALD programme into a series of tasks for the trainee to undertake. Some competencies could be achieved with a single task but most required several tasks. For example, there are 17 competencies listed for diagnostic radiology in the IPEM scheme. The EMERALD manual for diagnostic radiology contains 44 tasks.

Each task is described using a standard format. The sections within the task include; a statement of purpose, a list of equipment required for the task, references for further reading, a method, details of the results to be recorded and / or the analyses to be made and, where appropriate, a series of questions designed to ensure that the trainee has understood the task. At the end of each task the trainee and supervisor are both required to sign the trainee manual. The student sign to confirm that he understands the work described within the task and the supervisor signs to affirm, having discussed the task with the trainee.

Tasks within the training manuals are grouped into chapters. These are listed below.

Diagnostic Radiology

General principles of radiation protection
General principles of quality control
Dosimetry
Image parameters
X-ray tube and generator
Radiographic equipment
X-ray films and screens
Fluoroscopic equipment
Digital equipment and CT
Shielding calculations

Nuclear Medicine

General principles of radiation protection
General principles of quality control
Fundamental properties of radiopharmaceuticals and radioisotopes
Pharmacokinetics and internal dosimetry
Single detector systems and survey meters
General principles of scintillation camera systems
Single photon emission tomography - SPET
Positron emission tomography with dedicated PET or systems 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 nuclear medicine staff
Radiation protection of nuclear medicine patients
National and EU legislation in radiation protection and radiopharmacy

Radiotherapy

Basic methods in radiotherapy physics
Quality Assurance of a dosimetric system
Calibration of a kilovoltage x-ray beam
Calibration of a megavoltage x-ray 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 wedge beam data
Monitor unit and dose calculation for photon and electron beams
External beam treatment planning using a computerised system
Quality Assurance of orthovoltage unit
Quality Assurance of teletherapy unit
Quality Assurance of linear accelerator
Basic checks of a treatment planning system for external beam therapy
Calibration of brachytherapy sources
Manual treatment planning using 192-Ir sources for interstitial brachytherapy
Manual treatment planning for intracavitary brachytherapy
Surface moulds in brachytherapy
Computerised treatment planning systems for brachytherapy
Quality assurance for brachytherapy

The development of the task based training manuals was completed in a period of 18 months. The group from the United Kingdom was responsible for the Diagnostic Radiology module, the group from Sweden for the Nuclear Medicine module and the groups from Italy and Portugal for the Radiotherapy module. Once the manuals had been completed they were checked by a second group, primarily to ensure consistency of approach. The manuals were also sent for assessment to independent experts. A meeting was held in Trieste in 1998 at which senior representatives from medical radiation physics department throughout Europe were invited to review the manuals. Following this the manuals were subject to final editing prior to publication early in 1999.

IMAGE DATA BASE

Over 1400 images were collected during the preparation of the manuals. These are stored in jpeg format in directories which correspond to chapters of the manuals (figure 1). Image browser software (ThumbsPlus) enabled the images to be accessed easily.

Figure 1. Storage of Images on Database

The browser displays all the images from a particular directory as a series of 120 x 160 pixel slides. Once an individual image has been selected it can be displayed at resolutions up to 1024 x 1024 pixels. The image browser also stores a text description of each image which can also be displayed if required (figure 2). This enables a keyword search for particular images.

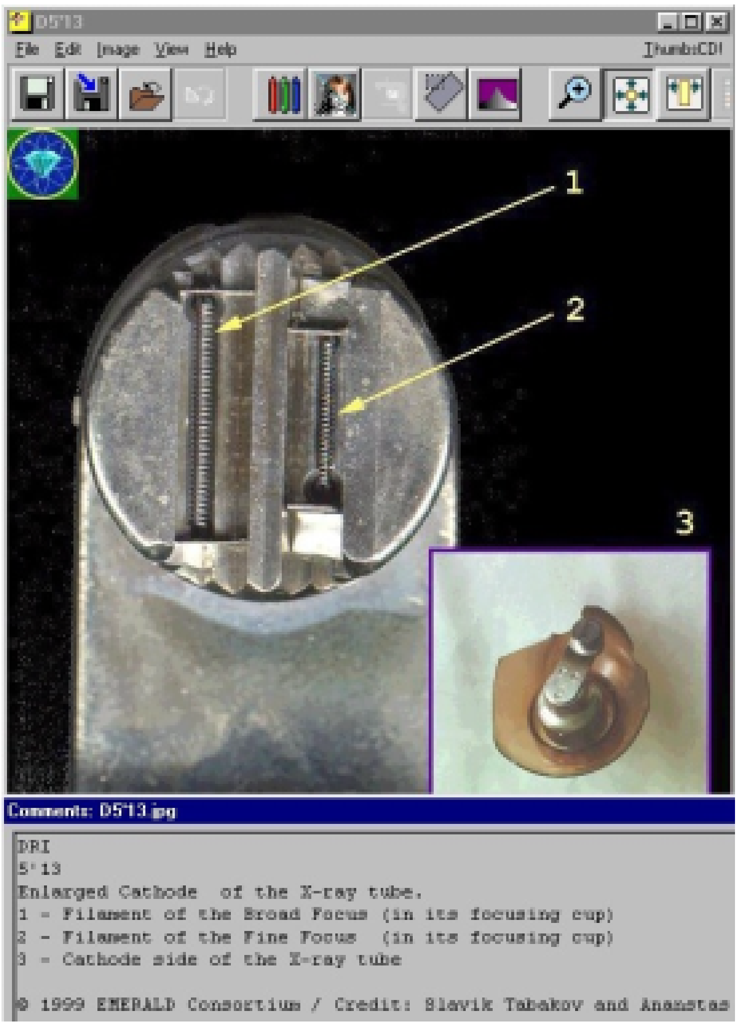

Figure 2. Enlarged Image with Text Description

The image browser has a limited amount of image manipulation software. This allows the trainee to investigate some of the basic techniques used in diagnostic imaging, *eg* filtering and edge enhancement (figure 3).

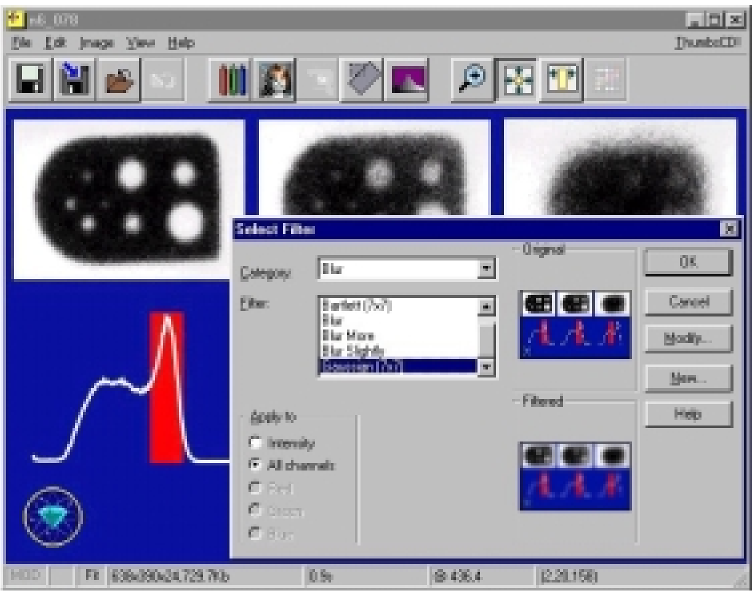

Figure 3. Image Manipulation

USING EMERALD

The EMERALD programme was developed to facilitate consistency of training across Europe. It was also intended to assist with the mobility of trainees between centres and also between countries.

Modules of the programme were tested in the centres where they were developed with trainees already studying at that centre. The original grant request also included funding to allow trainees from one centre to travel elsewhere to complete one of the modules. Two trainees from the University of Lund, Sweden were selected to travel to King's College Hospital, London to undertake the diagnostic radiology module of the programme. They were allowed the minimum time, 4 months, to complete the training.

During the 4 month period the trainees completed more than 80% of the tasks within the module. Their failure to complete 100% of the tasks was a consequence of limited access to equipment. At the end of the 4 month period the trainees sat a viva voce examination to test their understanding of the subject area. Their performance in the examination was judged to be entirely satisfactory and comparable to the level of competence reached by trainees on the national scheme.

FUTURE WORK

The EMERALD scheme has formally been launched across Europe. Funding has recently been granted by the European Community to assist in this process. A series of seminars have been planned in different countries to promote the scheme and provide instruction for those who will be supervising training under the scheme.

Another element of the future work is to translate the training manuals into a Computer Assisted Leaning package which can be accessed over the Internet. This will be accompanied by an internet forum to allow exchange of information and experience in the use of the scheme and more generally on issues related to training.

Developments in the EMERALD programme can be viewed by accessing the internet site on www.emerald2.net. This site also hosts the internet forum for information exchange.

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