TEACHING RADIATION PHYSICS AND RADIATION PROTECTION TO MEDICAL STUDENTS

Peter Holmberg
Department of Medical Physics, University of Helsinki, Helsinki, Finland

INTRODUCTION

Before even beginning, the good teacher needs to formulate answers to the following questions: Why is it necessary to teach a certain subject or to deliver a particular course? What should the content of the course be? How shall teaching take place? The goal of the course should be clear to both pupils and teachers right from the start. By commencing the course with a definition of goals, one at the same time indicates the content and provides the students with the necessary motivation. Further, if the content of the course is presented in a positive and appealing way, the students are likely to listen and actively participate in the work. In the following, there is discussed the teaching of a course in radiation physics for medical students in the context of the three questions stated above.

THE NEED FOR MEDICAL RADIATION KNOWLEDGE

Man is continuously exposed to ionizing radiation from natural sources, over which he has little control. This so-called background radiation is either "external" or "internal" depending on where the source is situated. Artificial sources also contribute to the total radiation dose. Figure 1 depicts the main sources (1). The natural radiation reaching man from outside consists of cosmic rays (13%) and radiation originating inside the Earth (16%). The internal radiation comes from the radioactive isotope ^{40}K (16%). The decay of radon also contribute to the annual radiation dose (33%). Artificially produced radiation, whose source is Man himself, includes the medical use of radiation (21%) and minor contributions from fallout, radioactive wastes from nuclear power plants and nuclear fuel (1%).

Although the annual radiation dose varies widely with geographical location, we have reason to believe that the values given are representative averages for industrialized countries. Man's own contribution to the annual radiation load is therefore slightly more than 20%. Among the artificial sources the medical contribution is overwhelming ; under normal conditions other artificial radiation sources are so small that they can be neglected.

On average, one fifth of the total annual dose received by the population in an industrialized country comes from medical radiation sources. The medical radiation dose per person is about 500 μSv/annum. It must be emphasized, however, that this is an average value and large individual fluctuations around this average may occur.

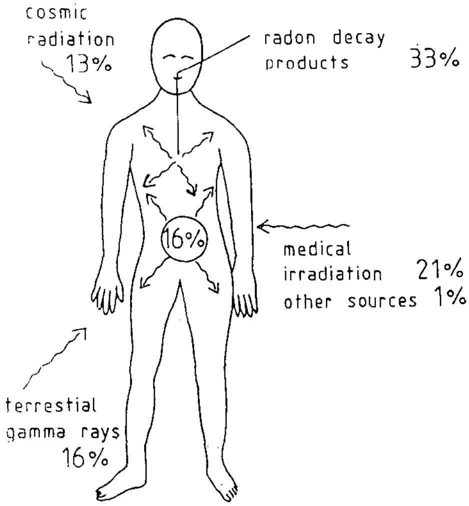

Figure 1 The main sources of background radiation including radiation from artificial sources.

The medical staff need to know how to minimize their own and their patients' radiation load. In many cases the radiologist will have to choose between different strategies of diagnosis or treatment. The positive medical benefit, i.e. a reliable diagnosis with visual material of good quality, will have to be weighed against the radiation dose the patient receives and to the possible complications.

There is one further aspect that is relevant in motivating students toward a course in radiation physics: That is the very fast development of radiological equipment and techniques. Present trends indicate that increasingly sophisticated methods will be used in diagnosis and therapy in the future: The rapid pace of development makes it essential that physicians have adequate scientific and technical knowledge of the equipment they are using so that it can be used in the most effective and safest way.

From the arguments given above it is self-evident that the medical staff of a radiological department should have a sound education in radiation physics and radiology. But it is also important that the ordinary physician have a thorough knowledge of the different methods he can apply, how they are carried out and what effects the complete procedure may have on patients and staff.

The aim of the course in radiation physics is to prepare the students for further studies in radiology, to show how physics can be applied to solve present medical problems and to create a sound basis for the understanding of phenomena and apparatus to be encountered in the future.

CONTENTS OF A COURSE IN RADIATION PHYSICS

The medical faculty of the University of Helsinki gives a compulsory course in medical physics and radiation physics. Figure 2 shows the volume of the course, how it fits into the gene-

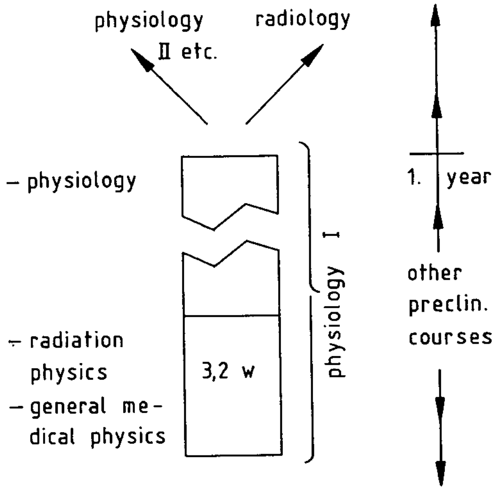

Figure 2 Graph showing the placement of medical physics and radiation physics in the program of medical studies. Also depicted are the connections with other disciplines.

ral course of studies, and its relations with other medical subjects. The course is given during the first year of studies (second semester) and the students are pre-clinical students still without a deep understanding of medicine. The course consists of lectures, exercises, demonstrations and laboratory work and is equivalent to a total of 3.2 working weeks (1 week = 40 hours). Table 1 shows the content of the course.

TEACHING FORMAT FOR RADIATION PHYSICS

The motivation of students towards the course varies during the term. The first part (general, medical physics) is not received as enthusiastically as the part dealing with radiation physics. From the outset the students have a fairly good idea as to how they can benefit from the course in radiation physics (everyone is aware of the usefulness of X-rays). But it is important that the students are motivated to study medical physics in all its forms. The complete course in medical and radiation physics consists of smaller parts (modules) that can easily be transported from one semester to another, if necessary.

Figure 3 shows different course formats. As the course proceeds from theory (lectures) to practice (clinical routines) the motivation of the students increases rapidly.

There are different ways of integrating the more theoretical aspects and clinical routines. One solution is to take the students to the clinics to become familiar with apparatus and see how it functions. However, it is often difficult to coordinate clinical visits with lectures and, as one alternative, slides can be shown describing the functioning of the apparatus. Also data from clinical routines can be analyzed. Video programs are included in the course from the start, to make the demonstrations more vivid. This audio-visual method is not excessively expensive: all that is required is a portable video camera and monitor. Since it makes possible a demonstration of the functioning principles of even large and expensive apparatus, the method is invaluable for pre-clinical courses.

Table 1   Content of the course in radiation physics

Atomic and nuclear physics :
- a basic knowledge

Radioactivity :
- radioactive decay
- half-life (phys. biol. eff.)
- series decay
- Tc-generator

Interaction between radiation and matter :
- different types of radiation
- modes of interaction
- detection of radiation
- scintigraph and gammacamera

X-rays :
- X-ray tubes
- X-ray spectra
- kVp, mA, s

Diagnostic radiology :
- radiological picture
- tomography
- CT

Nuclear medicine :
- isotopes
- statical investigations
- dynamical investigations
- radiation dose

Radiation biology :
- biological effects
- cell curvival curves
- radiation therapy
- radiation protection

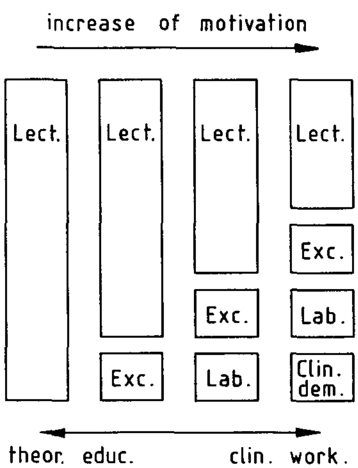

Figure 3   Different course formats. As the course proceeds from theoretical topics to clinical work the motivation increases.

REFERENCES

1. Hill, J., Atom N:o 295 (1981) 120.
2. Holmberg, P., Nordisk Medicin 3:1984, 90.
3. Holmberg, P., Nucl. Instr. & Meth. Phys. Research A255 (1987) 380.