

Manual on radiation protection in hospitals and general practice

Volume 4

Radiation Protection in Dentistry

K. KOREN & A.H. WUEHRMANN



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WORLD HEALTH ORGANIZATION GENEVA

MANUAL ON RADIATION PROTECTION IN HOSPITALS AND GENERAL PRACTICE

Volume 4

Radiation Protection in Dentistry

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Preface

Much technical material has been published at the national and international levels on radiation protection in the nuclear power industry, nuclear research, and conventional industries. On the other hand, the subject of radiation protection in hospitals and general practice, where a large proportion of public and occupational radiation exposure occurs, has not yet received much attention in the international literature.

The International Labour Organisation, the International Atomic Energy Agency, and the World Health Organization all have a long-standing interest in these problems from various points of view. They therefore decided to collaborate in the preparation of a Manual on Radiation Protection in Hospitals and General Practice in several volumes, with each agency taking special responsibility for the volumes that concern it most. However, to simplify distribution and to make it easier for readers to purchase the various volumes, the entire work is being published by WHO.

The manual as a whole deals with the radiation protection of patients, occupationally exposed persons, and the public and is written for the reader having a basic general knowledge of radiation and biology. It is hoped that it will be found helpful not only to those who are directly engaged in radiation protection in hospitals and general practice but also to national authorities, hospital administrators, supervisors, hospital workers, teachers in training centres, and all those who have some responsibility in the subject.

The present volume, the fourth in the series, deals with radiation protection in dentistry. Dental radiology has developed as a subspecialty of radiology in several countries and is applied most frequently by dentists rather than radiologists. The aim of the work, taken together with Volume 1, is to provide the dentist with all the technical information he needs to perform appropriate dental radiology safely and efficiently without bothering him with problems of general radiology with which he is not directly concerned.

The preparation of the volume was undertaken by Dr Kristian Koren and Professor Arthur H. Wuehrmann. Originally planned as a separate book, the text was modified by Dr Koren in collaboration with Dr W. Seelentag to harmonize with the other volumes of the manual.

The draft was reviewed by the experts listed on page 7, some of whom are the authors of other volumes in the series. The observations received were taken into account in the preparation of the final text, and the contributions are gratefully acknowledged.

1. The Need for Radiation Protection

The use of ionizing radiation in dentistry, like that in general medicine, was initiated soon after the discovery of X-rays by Roentgen in 1895. A rapid growth in the application of this new tool by dentists can be dated from 1913, the year of Coolidge's invention of the hot-cathode X-ray tube. By the decade following 1930, X-rays had come into general use in dentistry. Today, particularly in the more highly developed countries of the world, a complete radiographic survey of the mouth is considered an essential adjunct to diagnosis, and indeed, failure to examine a dental structure radiographically prior to diagnosis and treatment has in certain places been considered an act of malpractice. This vast increase in the use of X-rays by the dental profession calls for the development of guidelines, the purpose of which is to protect the dentist and the public by offering suggestions for minimizing exposure of the individual and the population as a whole.

The ionizing radiation used by the dental profession is mainly limited to X-rays, and this book deals only with that subject. The reader's attention is also directed to the radiation protection recommendations published by the International Commission on Radiological Protection¹ and by the International Dental Federation.²

Three kinds of biological consequences of radiation exposure of man are usually considered for radiation protection: (1) evident somatic effects, e.g., erythema of the skin up to destruction and necrosis of tissues, and retardation of growth when epiphyseal regions in children are irradiated; (2) somatic stochastic effects, sometimes called "late" effects, e.g., leukaemia, cancer, and life shortening; and (3) genetic effects occurring in the descendants of the irradiated persons. These effects are described in detail in Volume 1 of this manual, pages 19-26.

The unit of exposure to X-rays used in this book is the roentgen (R) or the milliroentgen (mR). The new SI unit for this quantity recommended by the Conférence générale des Poids et Mesures is the coulomb per kilogram (C/kg), which it is intended should replace the roentgen by 1985. To enable readers to become familiar with the new unit, values expressed in roentgens are also given in coulombs per kilogram (in parenthesis). The conversion factor is $1 \text{ R} = 2.58 \times 10^{-4} \text{ C/kg}$. For definitions of the quantities

¹ INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION. *Recommendations of the International Commission on Radiological Protection (adopted September 17, 1965)*. Oxford, Pergamon, 1966 (ICRP publication 9).

² INTERNATIONAL DENTAL FEDERATION. Rules for dental radiation hygiene. *International dental journal*, 16: 541-546 (1966).

and units used in dosimetry the reader is referred to Volume 1 of this manual, page 16.

In dental radiology, the genetic effects are particularly important owing to the great number of persons undergoing dental examinations and the high radiation dose that can be delivered to the gonads if radiation protection measures are not properly applied. It has been demonstrated that the dose to the male gonads, due to a full mouth series of films, can vary from 0.01 mR (2.5×10^{-9} C/kg) when appropriate techniques are used (including the application of a lead rubber apron to the patient) to over 200 mR (5×10^{-5} C/kg) when little care is taken. The resulting factor of more than 20 000 between the two extreme techniques means that one full mouth exposure with a careless technique has the same genetic impact on the population as 20 000 such examinations performed on patients of the same age and sex with a careful technique!

Somatic stochastic effects are of less importance in dental radiology because of the limited extent of the irradiated volume. However, a careless technique and unnecessary repetition of examinations can provide considerable radiation doses to the mucosa of the mouth, the eye, and the thyroid. Irradiation of the thyroid can increase the frequency of thyroid tumours, particularly in children.

Evident somatic effects must not occur after dental radiology, and are to be considered as a technical failure. When using obsolete equipment¹ or applying careless techniques, however, such effects are still possible. One of the most common effects is chronic radiation dermatitis of the fingers of the dentist or his technician caused by holding the films in the mouth of the patient and so exposing the fingers to primary radiation. Following the rules in this manual will prevent all such occurrences.

It has been demonstrated that the X-radiation exposure at the cone end from a complete mouth radiographic survey varies with practitioners from less than 5 R (13×10^{-4} C/kg) to more than 200 R (5×10^{-2} C/kg). This fact puts into perspective at least one aspect of the total problem and demonstrates how radiographic exposure can be reduced when maximum radiological care is exercised by the practitioner and the radiographic equipment is fully satisfactory.

It is also important to remember that the number and variety of radiation sources contributing to the total exposure of the public is continuously increasing. No user or group of users of ionizing radiation has the right to defend its position on the basis that, in comparison with other users, it is producing only a small population exposure and is therefore immune to

¹ Equipment not conforming to the recommendations given in the following publications:

INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION. *Data for protection against ionizing radiation from external sources*. Oxford, Pergamon, 1970 (ICRP publication 15); *Protection of the patient in X-ray diagnosis*. Oxford, Pergamon, 1970 (ICRP publication 16);

INTERNATIONAL ELECTROTECHNICAL COMMISSION. *Radiation protection in medical X-ray equipment, 10 kV to 400 kV*. Geneva, 1973 (Publication 407) and *First supplement to Publication 407 (1973) : Sub-clause 7.5.5 : Equipment for dental radiology*. Geneva, 1975 (Publication 407 A).