Manual on radiation protection in hospitals and general practice

Volume 2
Unsealed Sources

D. FROST & H. JAMMET

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WORLD HEALTH ORGANIZATION GENEVA

MANUAL ON RADIATION PROTECTION IN HOSPITALS AND GENERAL PRACTICE

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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 second in the series, reviews the radiation protection requirements in hospitals using unsealed radioactive sources and discusses the problems associated with the administration, handling, and transportation of these sources. The authors also describe the design, construction, and management of nuclear medicine departments and give guidance on methods of reducing the exposure of the patient, the attendant personnel, and the general public to a level consistent with sound medical practice, without impeding the acquisition of necessary medical information.

The preparation of the volume was undertaken by Dr D. Frost and Dr H. Jammet. The final text was completed by Dr H. T. Daw (IAEA) in cooperation with Dr W. Seelentag and Dr B. Waldeskog (WHO).

The draft was reviewed by the experts listed on page 8, 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.

Introduction

The application of radionuclides in medicine is becoming more and more widespread. They are used both as tracers for diagnosis (particularly gamma emitters) and as therapeutic agents (particularly beta emitters).

The distribution of radionuclides in the body is governed by their physicochemical and pharmacokinetic properties. Various physiological systems may be involved in the process. The pharmacokinetic properties are utilized in diagnosis to study a particular physiological function or to carry out morphological examinations. They are utilized in therapy to obtain selective concentrations in particular organs or tissues.

Almost all physiological systems are involved in such investigations.

(1) The circulation of the blood is nearly always involved and is sometimes itself the object of study (as in cardiography); at other times it may constitute the main element of a study (as in placentography).

(2) The respiratory system may be the object of an examination, or it may serve to distribute a tracer in the lungs for morphological examination.

(3) The blood clearance system is very widely employed, as in the clearance of rose bengal by liver cells, sodium iodohippurate by the kidneys, defective red cells by the spleen, colloidal gold particles by the reticuloendothelial system in the liver, spleen, lymphatic system, and skeleton, and macro-aggregate of albumin by the lungs.

(4) The excretory functions are frequently utilized, particularly those of the liver and kidney.

The use of the pharmacokinetic properties of a radionuclide or labelled molecule constitutes the most significant aspect of the application of radioactive materials. Examples of pharmacokinetic behaviour that may be exploited are: the role of iodine in the production of thyroxine, the preferential concentration of strontium and fluorine in the skeleton, the preferential concentration of sulfur in cartilaginous tissue, and the preferential concentration of phosphorus and iron in blood-forming tissues.

Because of the diversity of physiological systems, the distribution of radioactive sources in the body is both complex and unstable. Hence, a knowledge of this distribution frequently requires multiple measurements, in time and in space. The measurements are carried out either on the patient himself or on biological specimens.

In the former case the topographical distribution is measured externally in different ways, notably by localized measurements, whole-body counting with the aid of a gamma spectrometer (the profile method), or the scanning