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Book reviews

NCRP Report No 156, Development of a Biokinetic Model for Radionuclide-contaminated Wounds and Procedures for their Assessment, Dosimetry and Treatment
National Council on Radiation Protection and Measurements, Bethesda, MD (2006)
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In internal dosimetry, emphasis is generally placed on the radiological implications of ingestion and inhalation of radionuclides, with ingestion being of predominant importance in public exposure and inhalation predominating in an occupational context. The radiological implications of entry of radionuclides into the body through wounds have been much less adequately covered in the review literature, though there have been a wide variety of case reports and experimental studies relevant to this issue.

The lack of a comprehensive and authoritative review of the behaviour of radionuclides entering the body in wounds and the associated pathological effects has now been remedied by the publication of this report. The need for such a review is emphasised by the observation made by the authors that the scientific literature contains case reports of more than 2100 wounds contaminated with radionuclides. Although the majority of these were puncture wounds, contamination of lacerations, abrasions and thermally or acid burned skin have also to be considered.

Although the major strength of this report is a comprehensive review of the relevant literature, the needs of the radiation protection practitioner are well catered for through the development of a generic model for the biochemical transformation of radioactive material in wounds and the subsequent transport of radionuclides from the wound site to the systemic circulation. This model provides a basis for assessing the radiological implications of contaminated wounds analogous to the roles played by the ICRP respiratory and gastrointestinal tract models in assessing the radiological implications of intakes by inhalation and ingestion.

However, whereas in the respiratory and gastrointestinal tract models it is generally possible to neglect the effects of radionuclide intake on physiological function, this is clearly not the case with wounds. Intrinsic to the process are tissue responses that can affect radionuclide migration, e.g. due to capsule formation around a foreign body. Furthermore, radioactively contaminated wounds are seldom left untreated, so the effect of different treatment modalities needs to be taken into account in model simulations of radiological implications.

The proposed generic model is compartmental in nature and can, therefore, be readily integrated with most existing models of radionuclide retention following uptake to the systemic circulation. The wound site is represented using five compartments. These are characterised as follows: fragments; particles, aggregates and material in a bound state; trapped particles and aggregates; soluble; and colloidal and intermediate state material. Various transfers occur between these compartments and transfers also occur from the compartments to both lymph nodes and blood.

In practice, the compartments often do not have a simple one-to-one relationship with the observed partitioning and retention of radioactive materials, so, although the model is broadly descriptive of observations, it is not very closely related to specific physical or biological components or to particular physical, chemical or biological processes. Thus, the parameter values adopted for use in the model are primarily empirical in nature and do not represent the underlying processes in any fundamental sense.

As with the ICRP respiratory tract model, default parameter values are provided for different broad classes of soluble radioactive materials present in wounds. These classes are defined in terms of the degree of retention at the wound site: weak, moderate, strong and avid. Parametrisation for insoluble material, such as fragments, is necessarily more on a case-by-case basis. For such material, the reader will need to refer in detail to the comprehensive review material provided in appendices to the report.

For soluble materials, relevant data were identified for 51 different elements, based on 70 experimental studies. These studies are described in detail in Appendix A. Almost all the investigations were undertaken on rats and they are described as providing a systematic database for quantifying and classifying retention of soluble radionuclides deposited in deep wounds. Many of these studies date back to the 1940s and 1950s and key information has until now not been readily available. However, in preparing this report, the authors have gone back to the original project work

records and have extracted the detailed information of relevance. Thus, the data presented and the analyses provided represent a substantial original research study and not simply a reinterpretation of existing published material.

Where data have previously been published in the open literature, the report provides a very convenient compilation of detailed information, e.g. giving details of numbers of animals, site of injection, mass of injected material and observed histopathology. A particular strength is the discussion of biochemical considerations. Whereas Appendix A addresses the behaviour of soluble materials in wounds, subsequent appendices address insoluble materials deposited in experimental wounds and translocation from the wound site. A useful worked example of the recommended model is provided and a very helpful account is given of processes of wound healing and foreign body reactions at wound sites. Although many of the experimental data and case studies relate to plutonium, the report includes extended discussion of the behaviour of both depleted uranium and Thorotrast.

Overall, NCRP Publication Report 156 is a remarkable achievement. The detailed accounts of experimental studies in the appendices do not always make easy reading, but the radiation protection practitioner who has this book to hand is unlikely to need to go anywhere else for information relevant to the radiological assessment of contaminated wounds. For anyone involved in internal dosimetry this is a 'must have' addition to your personal reference library.

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