EUROPEAN COMMISSION

nuclear science and technology

Radionuclides Biokinetics Database (RBDATA-EULEP)

Contract N^{o} FIR1-CT2000-20056

Final report
(summary)

Work performed as part of the European Atomic Energy Community's research and training programme in the field of nuclear energy 1998-2002 (Fifth Framework Programme)
Generic research in radiological sciences

Directorate-General for Research
2007 Euratom

Project coordinator

M. R. Bailey, National Radiological Protection Board, United Kingdom

Project partners

V. Chazel, Institut de radioprotection et de sûreté nucléaire, (IRSN), France
P. Fritsch, Commissariat à l'énergie atomique (CEA), France
W. Kreyling, Forschungszentrum für Umwelt and Gesundheit (GSF), Germany
D. Newton, AEA Technology (AEAT), United Kingdom
D. M. Taylor, University of Wales (UWC), United Kingdom
M. Svartengren, Karolinska Institutet (KI), Sweden

Introduction

There is potential for people to be irradiated as a result of internal contamination by a wide range of radionuclides, which can be in a wide variety of chemical forms, both in the workplace and in the environment. For most people, by far the largest source of internal radiation exposure is radon gas, which is produced naturally in rocks and soils, and accumulates in enclosed spaces such as buildings. Nevertheless, there is generally far greater concern about artificially produced radionuclides amongst environmental pressure groups, the public, media, and politicians. For only a few kinds of internal contamination, such as inhalation of radon and certain medical exposures, do epidemiological studies enable a direct assessment to be made of the risks to people?

In all other situations, 'internal dosimetry' provides a systematic basis for assessing the risks from exposure to any radionuclide in any physico-chemical form, based on the radiation doses to organs and tissues. This process, however, requires information on the 'biokinetics' of radionuclides within the body after entry (intake): their distribution between organs, retention in each organ and subsequent excretion. This information is used to develop mathematical 'models' to calculate the distribution of radioactivity and hence the resulting radiation dose to each organ.

A large number of studies have been carried out of the biokinetics of radionuclides. Many were conducted during the period of rapid expansion of nuclear industries, because of concerns about exposures of workers and the difficulties of evaluating doses from such exposures. Additional relevant information is also available from studies following accidental intakes by people. There is a continuing need to use the results of these studies for the development of more realistic models to describe human radionuclide biokinetics and their application in new areas of concern, such as decommissioning of nuclear facilities and deliberate releases of radioactivity, so-called "dirty bombs". Many detailed results are in laboratory reports, which might not be found by online searches, and many of the scientists who conducted the studies have retired or will retire soon. Considerable effort is therefore required to assemble all the information relevant to a particular material. It is important to compile as much information as possible at this time. The availability of a comprehensive compilation can enable search for information and reduce duplication of effort.

Objectives

The overall aim of this Concerted Action was to provide information to improve the assessment of doses from intakes of radionuclides by workers and the public, by creating a compilation of information on radionuclide biokinetics for future reference. The main objectives were therefore to review the scientific literature on relevant experimental studies, to summarise important information in an electronic database, and to provide easy access to the database via the Internet. A further objective was to transfer expertise on methodology by organising small training workshops for young scientists.

Results

An existing electronic database developed by members of EULEP (European Late Effects Project Group) during the Fourth Framework Programme (1997-99) was enhanced and extended for use here. The electronic format facilitates extension, updating, and information retrieval. Data entry is facilitated by using drop-down lists wherever possible for frequently used terms (elements, chemical forms, etc.). The information is automatically organised because it is entered in specific fields. The database is built in Microsoft Access 97 and consists of a table of references linked to three tables of experiments, one for each route of intake: inhalation, ingestion and injection. A "reference" can be any type of publication obtainable by means of a library request: ideally a publication in a peer-reviewed journal, but for completeness it includes conference proceedings, laboratory reports etc.

Figure 1 shows the screen for entering or displaying information about each reference: citation details, abstract, and comments, e.g. whether it contains original data or is a review, covering many experiments but in less detail.

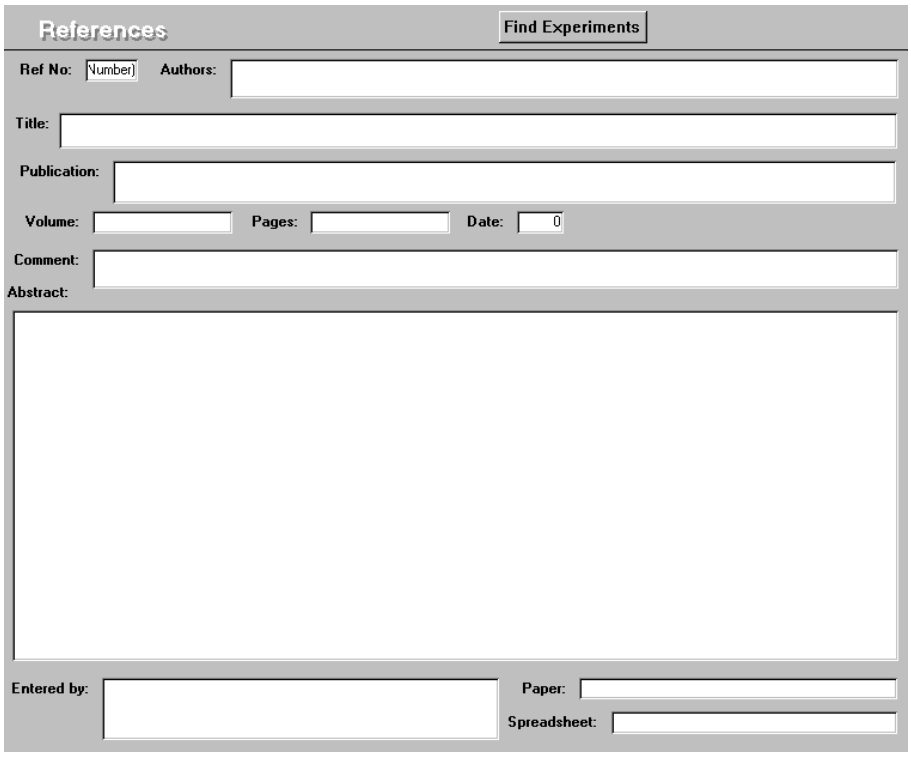

Figure 1: Radionuclides Biokinetics Database: data entry screen for publications

Each table of experiments summarises information on individual experiments, in three sections, which give information and comments on the material studied, experimental methods and results (more information about the results, including calculations, can be in a linked spreadsheet).

Figure 2 shows the screen for entering or displaying information about each injection experiment. (For this purpose, "injection" was taken to include absorption through the skin or via a wound.) The screens for inhalation and ingestion are similar, the main difference being that the inhalation table has more fields for information about the material, notably the particle size distribution.

Information can be retrieved in various ways. From the main menu (Figure 3), searches can be carried out to find all experiments (and associated references) relating to a route of intake, for a given element and chemical form. Alternatively, a search can be made for all references involving a chosen author. A button on the form that displays the information about a reference (Figure 1) gives lists of experiments linked to the reference. Similarly, a button on the form that displays the information about an experiment (Figure 2) lists all the publications that refer to it. A major benefit of the database is that it enables all the information about an experiment, which may be spread over several publications, to be assembled.

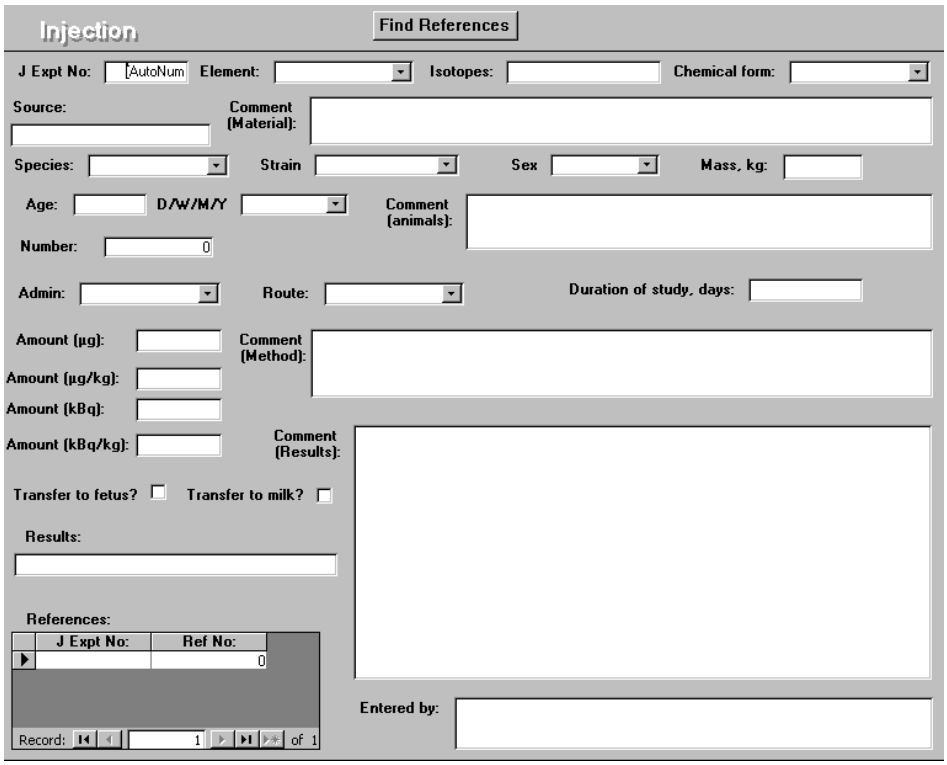

Figure 2: Radionuclides Biokinetics Batabase: data entry screen for injection experiments

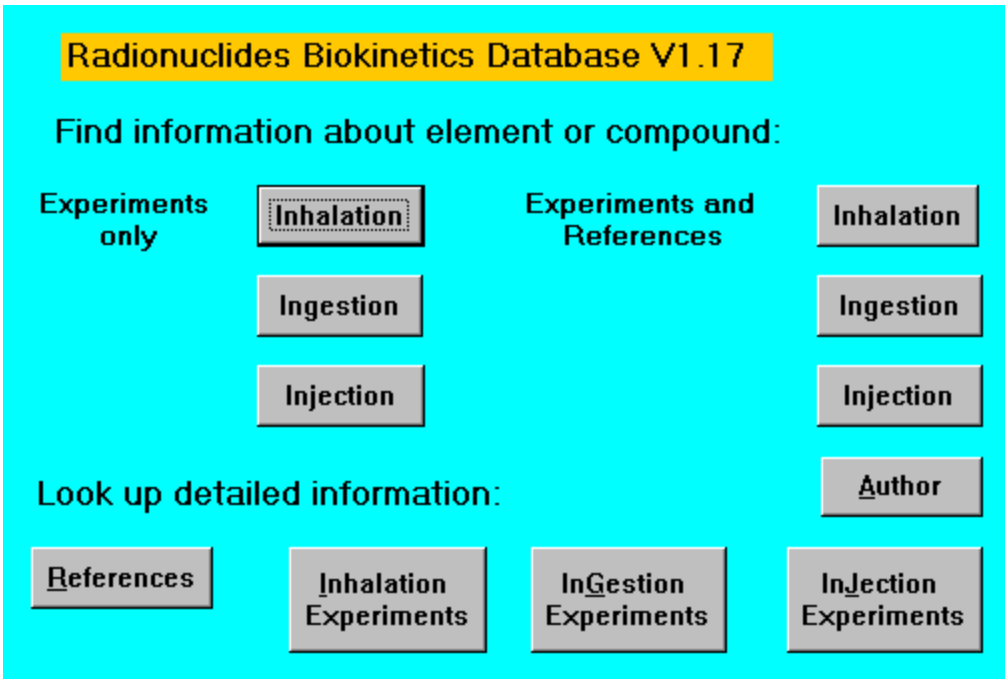

Figure 3: Main menu screen: buttons on the upper part activate queries to list experiments by route of intake and chemical form, buttons on the lower part open forms (Figures 1 and 2) with summaries of important information about each experiment and publication

At the start of the project, the database contained information on about 300 experiments from about 100 publications: enough only to demonstrate its potential usefulness. This was increased to nearly 2000 experiments from about 700 publications. There is information on 62 elements, although more than half relates to plutonium, uranium, cobalt, americium, strontium or neptunium (Figure 4).

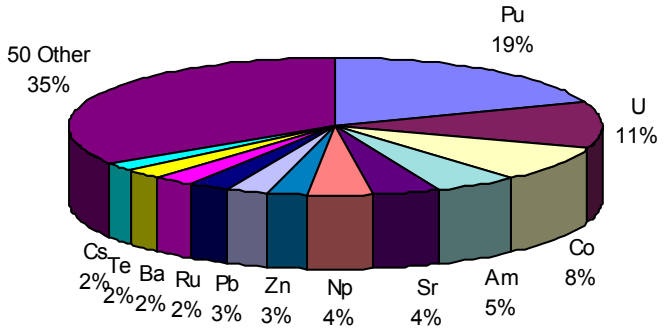

Figure 4: Distribution of records in the database between elements: the twelve with most entries are identified by symbol. A figure of 2 % represents 40-50 recorded experiments

A website has been set up in order to provide access to the database via the Internet, to enable scientists in the field and radiation-protection professionals to search for and extract information quickly and easily. Users can view information in the database directly using a web browser. The interface provides most of the important functions available from the main

menu screen of the Access database and the capability to identify all the references linked to a selected experiment.

The project included, as a second activity, the transfer to young scientists of expertise on experimental methods and computer modelling related to radionuclide biokinetics. Short workshops were organised for this purpose on inhalation techniques, (France, June 2002); *in vitro* dissolution techniques and aerosol characterisation (France, October, 2002); experimental techniques (Germany, October 2003) and interpretation of experimental data (Germany, October 2003).

Implications

The database structure has proved to be effective for this purpose, with few changes needed after those agreed at the start of the project; powerful for searching and collating information; and with the addition of linked spreadsheets and documents, flexible for storing information. Although it was designed and developed with radionuclide biokinetics in mind, a similar database could be used to store and retrieve information about any type of experiment. Despite the complexity of the database structure it was possible to set up a website which enables users to search and retrieve information from it using a web browser. This did however require substantial effort from staff with appropriate specialist knowledge of website design.

With information on nearly 2000 experiments from 700 publications, the database is now sufficiently comprehensive to be a useful resource. Nevertheless it is expected that members of the consortium and their colleagues will continue to update and extend it.

It is considered that there are three main potential types of direct users of the database, who will all benefit from simple and rapid access to the existing information:

- Groups of experts involved in developing guidance or standards relating to exposure to radioactive materials, in particular the Task Group on Internal Dosimetry (INDOS) of the International Commission on Radiological Protection (ICRP). INDOS is currently working on a new set of documents, "Occupational Intakes of Radionuclides: Dose Assessment and Monitoring", for publication following the new recommendations to be issued by ICRP in the near future. Development of these documents requires comprehensive reviews of the literature relating to radionuclide biokinetics for every element having isotopes of importance for worker exposure
- Scientists involved in research on radionuclide biokinetics. It will facilitate the design of further experiments and avoid unnecessary repetition
- Health physicists who need to assess the consequences of accidental intakes of radioactive materials. It can provide simple, rapid and comprehensive access to available information.

Selected references

Bailey, M. R., Ansoborlo, E., Camner, P., Chazel, V., Fritsch, P., Hodgson, A., Kreyling, W. G., Le Gall, B., Newton, D., Paquet, F., Stradling, N., and Taylor. D. M.: *RBDATA-EULEP: providing information to improve internal dosimetry*. Proceedings of the Workshop on Internal Dosimetry: Occupational, Public and Medical Exposure, Oxford, 9-12 September 2002, Radiat. Prot. Dosim. 105 (1-4) 633-636 (2003)

Bailey, M. R., Ansoborlo, E., Chazel, V., Fritsch, P., Hodgson, A., Kreyling, W. G., Le Gall, B., Newton, D., Paquet, F., Stradling, N., Svartengren, M., Taylor. D. M. and Wenman-Bateson, S. (2004): *Radionuclide Biokinetics Database (RBDATA-EULEP): an update*. Proceedings of the EULEP/EURADOS Symposium on Biological and Physical Dosimetry for Radiation Protection, Braunschweig, 10 March 2004, Radiat. Prot. Dosim. **112** (4) 535-536 – http://rpd.oupjournals.org/cgi/content/full/112/4/535?ijkey=80ze3fsK9WIvM&keytype=ref

Bailey, M. R., Ansoborlo, E., Chazel, V., Fritsch, P., Hodgson, A., Kreyling, W. G., Le Gall, B., Lomas, P., Newton, D., Paquet, F., Stradling, N., Svartengren, M., Taylor. D. M. and Wenman-Bateson, S. (2005): *Radionuclide Biokinetics Database (RBDATA-EULEP)*. To appear as an NRPB W-series Report, accessible at www.nrpb.org/publications/w_series_reports/index.htm.