Radiation Protection Dosimetry (2011), Vol. 144, No. 1–4, pp. 551–554 doi:10.1093/rpd/ncq421
Advance Access publication 25 November 2010

THE DESIGN OF RADIATION ACCIDENT REGISTRY

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In order to provide effective monitoring and follow-up on the health effects of individuals accidentally exposed to ionising radiation, a Radiation Accident Registry (RAR) has been designed and constructed as an extension to the existing National Dose Registry (NDR). The RAR has basic functions of recording, monitoring and reporting. This type of registry is able to assist responders in preparing for and managing situations during radiological events and in providing effective follow-up on the long-term health effects of persons exposed to ionising radiation. It is especially important to register radiation-exposed people in vulnerable population groups, such as children and pregnant women, to ensure proper long-term health care and protection. Even though radiation accidents are rare, a registry prepared for such accidents could involve a large population and, in some cases, require lifetime monitoring for individuals. One of the most challenging tasks associated with RAR is the assessment of radiation dose resulting from accidents. In some cases, the assessment of radiation doses to individuals could be a process requiring the involvement of various methods. The development of fast and accurate dose assessment tools will remain a long-term challenge associated with the RAR. To meet this challenge, further research activities in radiation dosimetry for individual monitoring are needed.

INTRODUCTION

A radiation accident is an unintentional exposure to ionising radiation or radioactive contamination. In order to effectively respond to any radiological accident or emergency and to provide effective monitoring and follow-up on the health effects of exposed individuals, a Radiation Accident Registry (RAR) is a valuable asset. The need for such an RAR was well outlined in a presentation given at the Workshop on Emergency Preparedness for Vulnerable Population Groups in 2009[1].

The main purpose of an RAR is radiation dose record-keeping for individuals accidentally exposed to, or who believe they may have been exposed to radiation. It is not for regulatory control as applies to the National Dose Registry (NDR)[2, 3] in Canada for radiation workers, but for information and health care of the general public. For this purpose, the registry should have the basic functions of recording, monitoring and reporting.

The design criteria for an RAR are outlined here. Special characteristics and requirements of the RAR are discussed.

DESIGN CONSIDERATIONS

As outlined in the previous publication[1], the proposed RAR should have basic functions and various desirable research functions. In the design phase, all those functions were taken into considerations. However, the first blueprint of the registry had to focus on the basic key functions, they are exposure recording, monitoring and reporting. For recording radiation exposures during a radiological accident or event, reliable and fast data entry on the scene should be considered. Because a radiological accident or event can occur in various unpredictable ways, involve different radiation types and have quite different scales of effects, it is important for the registry to be able to effectively monitor exposed individuals including prenatally exposed individuals. In some cases, radiation doses need to be re-assessed after initial screening measurement or initial assessment. Availability and timeliness of records are valuable features to the registry as well.

A key challenge to be considered is how to determine radiation doses to individuals involved in a radiological accident. Dose data recorded in the existing NDR are readings from dosemeters assigned to individual workers or workplaces. For a radiation accident, various types of doses due to internal or external exposure may need to be reconstructed based on the accident descriptions, including initial and follow-up physical and biological dosimetry during and after the accident. Doses to individuals can be estimated initially, however, the estimation needs to be updated when more information, especially monitoring data become available.

Like various registries maintained at Health Canada, such as the NDR, the RAR should have stated policies on access and should have measures in place to allow authorised access and maintain confidentiality and data security.

DATA MODEL AND DATABASE STRUCTURE

There are three kinds of basic information that are stored in an RAR. These are individual information (individual's identity), exposure or dose information,

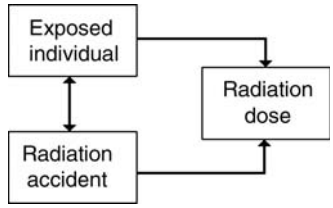

Figure 1. Data model of the RAR.

and accident information. The relationship between these three different types of data is illustrated in Figure 1.

This data model is similar to the data model of the existing NDR for radiation workers. The NDR also has three data types: employer, employee and radiation dose. The differences between the RAR and the NDR are: 'exposed individual' in the RAR could be any individual of the public including radiation workers; 'radiation accident' in the RAR replaces 'employer' in the NDR.

Like the information for Employer in the NDR, the *Radiation Accident* component in the RAR has various categories or classifications. However, much more detailed information is required to describe each accident individually, even within a specified category, such as a radiological attack from a nuclear explosive.

Similar to doses recorded in the NDR, the radiation dose data in the RAR have various types. In addition to different types of radiation doses, there are also different methods of how the doses are determined, which is one of the major different characteristics to the existing NDR.

A radiation accident could occur anywhere and result in radiation doses to individuals involved. Similar to employees registered in the NDR, accidentally exposed individuals will be registered in the RAR when they are involved in a radiological accident the first time. Individuals accidentally exposed to radiation before birth would be registered in the database when they are born. Their initial radiation doses are the corresponding fetal doses previously recorded in the dose types and histories of their mothers. Once an individual is registered in the system, he or she may be monitored for a long period or even lifetime depending on the accident type and the extent of his or her involvement in the accident. For those who require lifetime monitoring, such long-term monitoring will be terminated with the recording of the date of death.

For the three different types of data as illustrated in Figure 1, there is a one-to-many relationship between individual information and dose information, and between accident information and dose information. The relationship between individual information and accident information is many-to-many. These relationships must be taken into account in establishing necessary databases.

The three types of information are stored as keyed databases and are linked together by common keys. The individual information and dose information due to an accidental exposure can be linked by the individual's identifying number (a national identity number, unique to an individual). The dose information can be linked to the accident information by accident's identifying number.

The RAR consists of 13 tables, as illustrated in Figure 2:

- The ACCIDENT table represents the primary entity in the database. In addition to accident's identifying number, the nature of an accident could determine characteristics of radiation exposure, exposure pathways and radiation dose types. The supporting tables provide a complete description of an accident.
- The INDIVIDUAL table contains all information necessary to characterise a single person, i.e. individual's identity including individual's

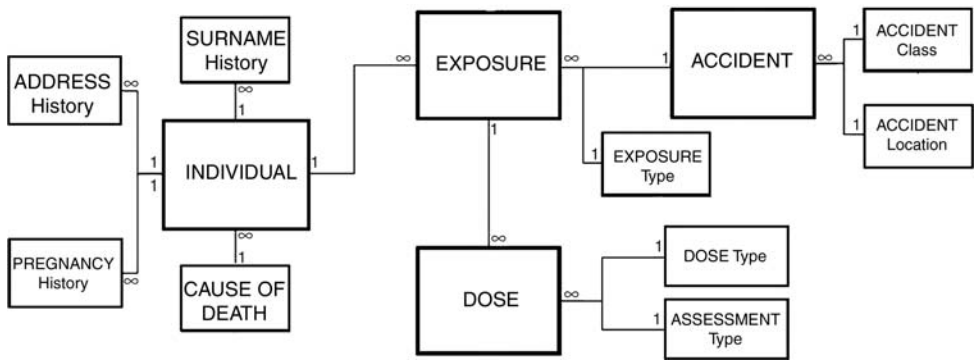

Figure 2. Database structure of the RAR.

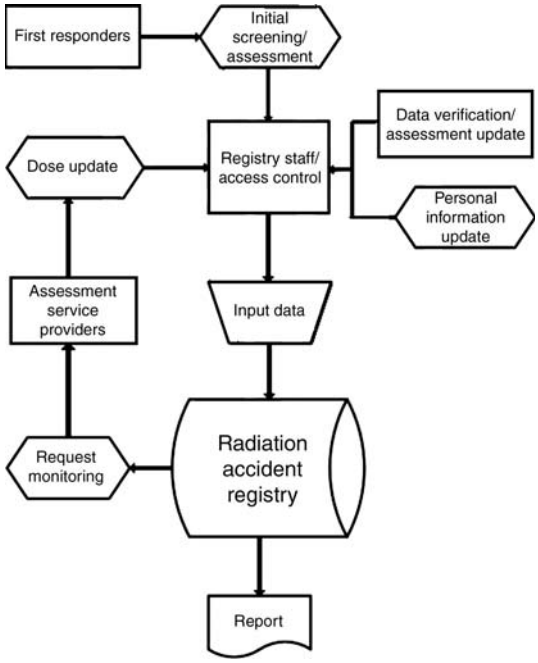

Figure 3. Data flow process for the RAR.

unique identifying number as well as temporal identifying number given at the scene of an accident. There are supporting tables around the INDIVIDUAL table, and those supporting tables provide updates on time-dependant information: address, surname and pregnancy.

- The EXPOSURE table contains descriptive information relating to individual's exposure situation in an accident. It is understood that a given accident may involve many individuals and an individual may be involved in multiple accidents.
- Radiation dose information is recorded in the table DOSE. Radiation doses could represent initially measured or assessed doses, follow-up doses and the history of dose monitoring. The supporting tables provide information on dose types and methods used in dose assessment.

In an emergency or accident, it is unlikely that panic people carry their personal IDs to radiation screening. Due to the unique nature of the accident registry and that an accident can occur at anytime and anywhere unexpected, a temporal identifying number or a barcode given by first responders at the scene of the accident should be recorded before detailed personal identity information can be entered. Those detailed information are most likely available at a later time.

The table EXPOSURE describes how an individual was involved in an accident. For example, in a radiation explosive event, it will record individual's distance to the event location. Parameters in the EXPOSURE table are important for subsequent dose assessment.

An exposure could result in different doses. A characteristic of a dose instance is the assessment type. There are various methods to assess radiation doses based on the nature of an exposure and descriptions of individual's exposure situation. Therefore, it is important to record the methods used in the dose assessment process.

DATA FLOW PROCESS

With the database structure in place, data flow needs to be designed for field use. The first draft design of the data flow process is outlined in Figure 3.

Unlike the existing NDR where data flow is a routine process, the data flow to and within an RAR is triggered by a radiological accident, which can occur anywhere and at anytime. In emergency cases, especially if an accident involves a large number of exposed individuals, the initial screening measurement or dose assessment has to be performed in a timely fashion. Therefore, there is a need to verify initial data and track detailed information at a later time. Depending on exposure situations, some individuals may need follow-up studies or long-term monitoring. Their dose information will be logged in and updated regularly in the registry as the individual's dose history.

Input data into the RAR could be done by the professional staff of the RAR. With the advance of information technology, authorised first responders and radiation protection professionals could also have limited access to the RAR.

In addition to the data flow, templates for recording and reporting were also developed.

DISCUSSION

The basic functions of the RAR are recording, monitoring and reporting. Even though radiation accidents are rare, a registry prepared for such accidents could involve a large population and, in some cases, require long-term or even lifetime monitoring for individuals. It is especially important to register radiation-exposed people in vulnerable population groups, such as children and pregnant women, to ensure proper long-term health care and protection.

One of the most challenging tasks associated with RAR is the assessment of radiation doses resulting from accidents. In some cases, the assessment of radiation doses to individuals could be a process requiring the involvement of various methods. The process of dose estimation and the history of the

assessed doses for exposed individuals should be recorded in the registry. Recording of the monitoring and updating process for dose estimation is a unique feature of the newly constructed RAR. It is very challenging to do it correctly and quickly in radiological and nuclear emergencies. The development of fast and accurate dose assessment tools will remain a long-term challenge associated with the RAR. To meet this challenge, further research activities in radiation dosimetry for individual monitoring are needed.

While the existing NDR contains dose records for radiation workers, the 'exposed individual' in the RAR could be any individual of the public including radiation workers. The RAR is designed to use the same unique identifying numbers as used in the NDR, so that individual's accumulated exposure history can be requested without duplication when the two registries interoperate.

The database structure presented here is the first version of the RAR, as well as the design of data flow process. In consultations with first responders and through field trials, the registry should be fine tuned, not only with better database structure but also with user-friendly data flow.

With the basic functions, the designed RAR is able to assist responders in preparing for and managing situations during radiological event and in providing effective follow-up on the long-term health effects of persons exposed to ionising radiation. Following the establishment of the registry, it should be routinely tested in training exercises to ensure its readiness for implementation whenever the need might arise.

FUNDING

This work was funded by the Chemical, Biological, Radiological-Nuclear, and Explosives (CBRNE) Research and Technology Initiative (CRTI)[4], under the project #9000899253.

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