

1. Executive Summary

This Report is the second of two reports by the National Council on Radiation Protection and Measurements (NCRP) that focus on measurement of radionuclides deposited internally in a population exposed in a radiological or nuclear incident. The first report, NCRP Report No. 161, entitled *Management of Persons Contaminated with Radionuclides* (NCRP, 2008a), is an update and expansion of NCRP Report No. 65, *Management of Persons Accidentally Contaminated with Radionuclides* (NCRP, 1980) that provides detailed guidance for many radionuclides in a much broader range of exposure scenarios. The present Report focuses on screening a population exposed to one or more radionuclides that may be involved in a radiological or nuclear incident.

Screening as used in this Report means rapid assessment and measurement for external or internal contamination. Screening is a singular activity intended to enable intervention and management of persons who may have been or who were exposed to radioactive contamination from a radiological dispersal device (RDD) or a nuclear incident. Thus, a group of people who may be contaminated are first screened for external contamination (a single survey). If contaminated externally, they are decontaminated prior to screening for internal contamination (a single measurement). The emphasis is on rapid screening that quickly identifies those patients who may need medical treatment to decorporate internally-deposited radionuclides. This Report uses the term *monitoring* in a broad sense, which is either the monitoring of a population for internal contamination by taking a number of measurements or collecting a number of bioassay samples over a period of time or the medical monitoring of a population for subsequent medical effects depending on the context. External monitoring for radioactive contamination is not addressed in detail in this Report but is discussed in much greater detail in other referenced literature.

The radionuclides in this Report were selected based on information published by various regulatory and advisory organizations including the Centers for Disease Control and Prevention (CDC, 2009) and the U.S. Department of Health and Human Services (DHHS, 2009). This Report addresses screening a population for internal contamination and the possible use of decorporation

therapy for patients who exceed a level of internally-deposited radionuclide called the *Clinical Decision Guide* (CDG), a concept developed in NCRP Report No. 161 (NCRP, 2008a).

This Report provides information intended for use by emergency responders and planners and public-health officials for development of emergency response plans that include screening a population for internally-deposited radionuclides. However, this Report is not intended to be a procedure manual that can be incorporated directly into an existing radiological response plan. This Report should be used to evaluate and upgrade, to the extent feasible, the capability to screen small, medium and large populations for the presence of internally-deposited radionuclides and to assist in decisions about the possible medical treatment of patients who contain levels of radionuclides in excess of the CDG. This Report also discusses broadly the monitoring of a population for external contamination and decontamination as necessary prior to screening for internal contamination and refers to other literature that treats these subjects more completely.

Background information is provided, including various settings in which members of the public might incur internal depositions of various radionuclides. These sections may be of particular interest to those who are involved in development of emergency response plans. Initial screening of individuals at the scene and hospital and mass screening are described, and previous experience with internal radionuclide contamination of members of the public is summarized. Incident command is described briefly to provide the reader with an appreciation for the importance of incident response coordination between the community and the hospital(s) that will be receiving potentially-contaminated patients. It also emphasizes the importance of timely communications during an incident to optimize medical care and treatment of patients to decorporate internally-deposited radionuclides. Efficient and frequent communications facilitate the ability of hospitals to tailor their response to the number of patients who need treatment of acute injuries and screening of patients for internal contamination.

The process of sorting victims from a radiological incident based on their risk of having significant radiation exposure or contamination is referred to as *radiological triage*. The outcome of radiological triage depends partly on whether people receive direct irradiation or contamination from the plume or the contaminated environment. For purposes of this Report, it is assumed that most people who are impacted by the incident or who perceive that they may be contaminated will wish to be screened for contamination.

The CDG can be used by physicians to consider whether the level of radionuclide intake by a patient warrants use of decorporation therapy. This concept was first published in NCRP Report No. 161 (NCRP, 2008a) to provide guidance on when physicians may want to consider the use of decorporation agents to reduce the radiation dose that a patient might receive from an internally-deposited radionuclide. Hospital equipment discussed in this Report that may be used to determine whether the CDG has been exceeded includes nuclear medicine cameras and uptake probes, portal monitors, multichannel analyzers, and portable survey meters for direct screening. Procedures discussed for indirect screening include use of nasal swabs and the collection and analysis of urine and fecal samples.

Physicians will be particularly interested in Section 9, which provides guidance on the medical management of patients who have been identified as containing one or more internally-deposited radionuclides. Section 9 provides information on the use of the CDG in making treatment decisions and general guidance for treating patients. It also provides information on how patient care providers can request equipment, supplies and pharmaceuticals from the Strategic National Stockpile (SNS) (CDC, 2008). Medical management guidance is restricted to the radionuclides of interest in this Report and includes consideration of treatment with decorporation agents and over-the-counter products.

In addition to the many technical and logistical issues associated with screening patients for internal contamination; social, psychological and communications issues are important. This Report provides guidance on organizing and conducting a screening program in a manner that is sensitive to these issues. It also offers guidance on practical needs such as information hotlines, setting up population screening centers, and considering the needs of special populations including children and pregnant women.

Exposure of a population to radioactive materials from an RDD or an improvised nuclear device (IND) may increase the risk of deterministic or stochastic effects from external exposure and internally-deposited radionuclides. This Report describes a long-term follow-up program to monitor (*i.e.*, to follow the health of) this population. Guidance includes the immediate identification of patients who should be included in long-term follow-up and a survey form that includes appropriate identification information for long-term follow-up.

Screening activities can be readily undertaken for a few patients but can become complicated or impractical when large numbers of patients present themselves. This Report discusses scalability of emergency response plans and recommends that communities and

hospitals consider dividing their responses into three classes based on the numbers of people involved: small (*e.g.*, 1 to 10 people); medium (*e.g.*, tens of people), and large (*e.g.*, over 100 people).

Also included in this Report is an assessment of the current capacity within the nation to perform rapid screening of a population exposed to radioactive materials from a radiological or nuclear incident. Surveys of manufacturers and state radiation-control program directors suggest that most communities that responded to the survey have the necessary resources to provide rapid screening of a limited number of patients to determine whether they are internally contaminated.

NCRP (2008a) identified major areas of research and development needed to address the management of contaminated persons. These areas are decontamination facilities to remove external contamination, instrumentation and modeling for assessment of internal contamination, bioassay facilities and automation, biomarkers and devices for biodosimetry, software for rapid estimates of organ equivalent dose and effective dose, decorporation agents for use post-exposure, medical follow-up of exposed populations, and educational programs in health physics. In addition, this report identified the need for research to develop a more complete understanding of the capabilities of states, communities and hospitals to respond to a radiological incident and to screen populations of different sizes and in different locations for internal contamination. While most communities probably could provide appropriate screening and treatment of a limited number of internally-contaminated patients, more complete information is needed to fully understand capabilities to respond to incidents that create a need to screen large numbers of patients.

Several appendices to this Report provide both practical and more detailed information. While the purpose of this Report is to address internal contamination, accurate screening for internal contamination cannot be performed with survey instruments if the patient has external contamination. The appendices contain practical advice on how to perform radiation surveys, how to distinguish between alpha, beta and gamma radiation using a Geiger-Mueller (GM) survey meter equipped with a pancake probe, and how to perform decontamination at home. Survey and registry forms are provided to enter patients into a registry for recordkeeping and for long-term follow-up. GM count rates from CDC (2009) are provided to determine whether a patient has internal contamination in excess of the appropriate CDG values. Procedures are provided for preparation of urine samples and shipping biological samples for analysis. The appendices contain a summary of the ^{210}Po poisoning of a single individual in United Kingdom and contrasts that with the

large-scale ^{137}Cs contamination incident in Goiânia, Brazil. The purpose for these case studies is to compare the procedures used to identify the radionuclide and the individuals who were exposed and to describe monitoring for external contamination and screening for internal contamination. Emergency phone numbers are provided for requesting government assistance following a radiological or nuclear incident. Finally, various U.S. Food and Drug Administration (FDA) drug categories for pregnant women are defined.

This Report makes several recommendations and emphasizes a number of points that are highlighted within the various sections. For preplanning purposes, emergency planners should be aware that radiological and nuclear incidents have the potential to cause widespread contamination of people and the consequences will place enormous stress upon emergency response and healthcare organizations. In the development of an emergency response plan, emergency planners should recruit volunteers such as health physicists, radiation-safety officers, and medical personnel who could serve as subject matter experts or perform specific tasks to support planning and response to a radiological incident. Due to their regular duties, nuclear medicine staff may assist but will not be able to support fully the needs of the emergency department for quick screening of patients during a mass casualty incident. Therefore, other hospital staff should be trained and made available to assist with these activities.

The planning process should address capabilities for rapid detection and identification of radionuclides. This is particularly challenging for pure alpha- and beta-emitting radionuclides. Screening a population for internal contamination requires planning and practice. In particular, the use of nuclear medicine cameras and thyroid probes to screen patients following exposure to radionuclide contamination from a radiological or nuclear incident requires advance planning, training and rehearsal. It cannot be implemented *ad hoc* during an emergency. Local municipalities and public-health agencies should develop procedures for requesting, receiving and distributing SNS assets. This planning should include providing the diagnostic and medical management guidelines to healthcare providers for the use of decorporation agents for internally-deposited radionuclides. Planning for population screening should incorporate provisions for establishing stakeholder advisory boards or other mechanisms for making the public a partner and should take into account psychosocial, behavioral and communication issues likely to arise during the screening of a population.

Regarding the management of contaminated patients in all but the most extreme cases, standard precautions provide adequate

protection to healthcare workers to prevent secondary radioactive contamination. Patients who have suffered life-threatening injuries should be given medical care immediately, without regard to contamination. The presence of external contamination should almost never delay urgent medical care. Emergency personnel should be aware that patients with the most serious injuries are also likely to be the most contaminated both externally and internally. The presence of internal contamination is rarely life-threatening to a patient. Therefore, treatment of conventional injuries that may be immediately life threatening should take precedence over decorporation of internal contamination.

Rapid identification of the radionuclide(s) involved in a radiological or nuclear incident is essential to the selection of appropriate methods for assessment of internal contamination and subsequent treatment decisions. The CDG may be used by physicians as a basis for medical treatment of individuals who have internal radionuclide deposition. The CDG is not intended to instruct physicians on a specific course of action such as administration of decorporation agents. Rather, CDGs are intended as a tool to be used to help a physician determine when radiation exposure may have clinical significance. NCRP recommends a bioassay action-level or benchmark equal to one-half of the CDG value for identifying those individuals for whom continued bioassays should be considered for the purpose of correlating internal contamination with long-term biological effects. Community or hospital emergency response plans should include resource needs to scale the response to the size of the incident.

The following recommendations are made in this Report to improve capability of the nation to screen populations for internal contamination following exposure to a radiological incident. Additional surveys of local communities and states should be conducted to assess more accurately their capability to screen populations for internal contamination. Consideration should be given to utilizing strategically located clinical laboratories to analyze bioassay samples for radionuclide identification and concentrations. A limiting factor here is the small number of radiochemists in the United States. Additional research should be conducted to define radiological instrument or bioassay trigger levels that correspond to the CDG for a wider variety of radionuclides such as those identified in NCRP Report No. 161 (NCRP, 2008a), which may be produced by the explosion of an IND.